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IJACSA Editorial

From the Desk of Managing Editor…

It is a pleasure to present to our readers the fourth issue of International Journal of Advanced Computer Science and Applications (IJACSA).

IJACSA focuses on research and conceptual development based in a very wide range of inquiry methods, ways of thinking and modes of expression.

We believe that open access will be an essential component of scientific publishing in the future and that works reporting the results of current scientific research should be as openly accessible and freely useable as possible.

IJACSA collaborates with The Science and Information Organization (SAI) that brings together relevant people, projects, and events in the domain, drawing on a wide research community studying various aspects of computer sciences in various settings like industrial and commercial organizations, professionals, governments and administrations, or educational Institutions.

In order to publish high quality papers**,** all received articles are thoroughly peer reviewed by a board of internationally recognized experts. As a consequence only 28% of the received articles have been finally accepted for publication.

We look forward to receiving quality contributions from researchers and practitioners in Computer Science and Applications for the next issue of the journal.

IJACSA expresses its appreciation to all Reviewers, whose role is a paramount importance not only to enhance the standard of the journal, but also help authors to improve the readability of their articles.

On behalf of the Editorial Board, I would like to thank all authors and reviewers for their high-quality contributions and efforts expended in preparing this issue of IJACSA.

We hope that the relationships we have cultivated will continue and expand.

Thank You for Sharing Wisdom!

Managing Editor
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CONTENTS

Improving the Technical Aspects of Software Testing in Enterprises

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***Abstract*—Many software developments projects fail due to quality problems. Software testing enables the creation of high quality software products. Since it is a cumbersome and expensive task, and often hard to manage, both its technical background and its organizational implementation have to be well founded. We worked with regional companies that develop software in order to learn about their distinct weaknesses and strengths with regard to testing. Analyzing and comparing the strengths, we derived best practices. In this paper we explain the project's background and sketch the design science research methodology used. We then introduce a graphical categorization framework that helps companies in judging the applicability of recommendations. Eventually, we present details on five recommendations for technical aspects of testing. For each recommendation we give implementation advice based on the categorization framework.**

Keywords: Software testing, testing, software quality, design science, IT alignment, process optimization, technical aspects

I. INTRODUCTION

Striving for improved software quality is no new emergence. The idea to optimize technical aspects respectively to use technology to achieve this aim is known for decades. Unsurprisingly, the term *software engineering* [28] has been coined in the 1960s and the *software crisis* is known—and unfortunately still lasting—since the 1970s [8].

Especially large-scale projects that end in disasters nurture the public's picture of unreliable software. An example is the NASA Mars Climate Orbiter, which crashed because metric and imperial units were mixed in a software subsystem [27]. The miscalculation leading to the crash would most likely have been detected by detailed software testing. Unfortunately, there are many other examples of failed major projects that have similar root causes: inscrutable, ill-designed or not exhaustively tested software [17].

Despite the widely perceived disasters, the *main* problem is failure of everyday projects [6][10]. Even after decades of research, no *silver bullet* has been found and many problems remain unresolved [4]. Complexity of software obviously increases faster than methods to control it are developed [16]. As a consequence, problems of varying severity can be found in projects in any industrial sector and for any kind of software developed. But not all software development projects fail; in fact, many companies produce software systems of notable quality. We propose to study effectual development to discover best practices for reaching quality especially with regard to testing. In combination with the processes and techniques for the development of software, software testing is the foundation of software quality [17].

To better support businesses with results from academic research, a combination of research in information systems and software engineering is a feasible approach [21]. We undertook a project with regional enterprises and tried to learn what makes software development projects *successful*. After identifying the companies' status quo [21], we analyzed the myriad of observations we made and the experiences the project's participants shared with us. Eventually, we derived a set of novel best practices.

It appears to be easy to say how software development should be done. But although techniques are described in the literature and there is knowledge about successful development, this knowledge has not necessarily been transferred into business reality. Some of the best practices we found have been denoted earlier e.g. in different contexts or with different prerequisites. However, adopting them seems to be very challenging. We thus give details on how to implement the recommendations and which conditions have to be met. We also name related work for each recommendation *rather* than discussing them in a section of their own. Best practices presented in this work have a technical focus; suggestions for the organizational embedding of testing can be found in [20].

This paper is organized as follows. Section II introduces the project's background. We sketch our research methodology in Section III. A framework for categorization is explained in Section IV. Five effective technical recommendations are discussed in Section V. A conclusion is drawn in Section VI and future work is highlighted in Section VII.

II. BACKGROUND

Münster is located in North Rhine-Westphalia, Germany. In the city and its surrounding region a lot of IT-based companies have been sited. Most of them are medium-sized and specialize

This article is an extended and revised version of the paper presented by Majchrzak [22] at the i-Society 2010 conference in London on 28 June, 2010.

on software development. Some larger companies with far over 1.000 employees do not develop software for customers; as financial service providers their individually developed software enables their business processes. The number of their developers exceeds the number of employees most of the smaller companies have in total.

All companies are members of the local chamber of commerce which supports the *Institut für Angewandte Informatik* (IAI – Institute of Applied Informatics). The IAI is hosted by the University of Münster and based on the work of both computer scientists and economists. Projects undertaken by the IAI are run by academics that seek both research progress and mean to support the local industry.

By frequent exchange with companies the IAI learned about their dissatisfaction with software testing. While most companies were ambitious to improve the quality of the software they developed and to cut down costs for testing, they did not know how to achieve this. Additionally, many enterprises lack the time to try out new technologies or to evaluate changes to their processes. However, the companies were not economically endangered and apparently developed software of quality. Thus, two conclusions could be drawn. Not a single company has a *perfect* testing process. All of them face a number of testing related problems. Nevertheless, each company has developed distinct strengths that help it in creating *good* software products.

Based on these observations the IAI project to improve software testing was initiated. Two main purposes were set: Firstly, the status quo of software testing in the regional enterprises was to be brought to light. Secondly, successful strategies used by the companies were to be identified and aggregated to best practices. In this work we present five major best practices that change or influence the technical way of software testing or the technology used.

From the exchange with the enterprises and due to the diversity of software developed as well as the differences in culture in each company, we expected strengths to be complementary. Hence, it could be estimated not only to find a few known methods for successful development but a plethora of promising attempts to increase software quality and to optimize processes.

Diversity is both a blessing and a curse. It helps to identify best practices that form recommendations unknown to most companies and therefore highly beneficial to them. At the same time, prerequisites have to be met so that a recommendation can be adopted at all. Consequently, a framework is needed to support companies in choosing which recommendation to implement. The framework is described in Section IV and used for each recommendation in Section V.

III. Research Methodology

The project was meant to combine scientific rigor with relevance and efficiency as demanded by businesses. We decided for a methodology based on *design science* which "addresses important unsolved problems in unique or innovative ways or solves problems in more effective or efficient ways" [15]. It of course is impossible to describe the *perfect* testing process or to offer a general description on *how to* test software. However, we searched for a larger number of satisfactory solutions that address typical problems. Finding such *satisficing* [31] solutions helps enterprises even though not all possible problems can be addressed.

Since we wanted to learn about problems from the point of view of the participating companies, we decided for a qualitative approach [26]. Best practices can hardly be found with a simple questionnaire. Thus, we conducted semi-structured expert interviews. Using only a rough guideline for the interviews [19], we were able to learn about how testing is done in the companies. As the interviews developed, distinct weaknesses and strengths could be identified as well as common problems and successful strategies discussed with the participants. The data gained in each interview is far too verbose to be published as such. But each of it forms a kind of case study [36] which greatly aids further analysis.

Recommendations derived from the discussion with the interview partners are meant to complement the literature. Even comprehensive work on software testing processes [2] or quality improvements [19] does not cover all problems typically faced by practitioners. Some ideas published also do not seem to be directly accessible to practitioners. Along with literature, that promotes result-driven testing [13], we want to help closing this gap. Technical aspects as depicted in this work should be given special attention. If conducting IT research, it should be kept in mind that *information technology* is studied [25]—even if organizational aspects are likewise important.

A quantitative analysis would augment the qualitative approach. Without quantitative data it is hard to *prove* that a recommendation is effective and efficient. However, deducing best practices is a first step and was very laborious; verifying results was identified as a further step (see Section VII).

The course of action we took can be sketched as follows. We began by contacting IAI supporting companies and by identifying staff for the interviews. Both managers and technically skilled employees were chosen. In a second step we interviewed the participants. While there usually was only one longer interview done with smaller companies, medium-sized and larger companies were visited more than once. We were able to address both organizational and technical issues with the respective experts. In the interviews we tried to identify *who* is responsible for testing, *when* it is done, *what* is included in tests (graphical user interface, interfaces to other systems, etc.), *which* methods are used and *how* testing is generally done. We also tried to learn about the usage of *testing tools* [23].

After discovering the status quo, we discussed general problems met and successful strategies found. This included evaluating which improvements the participating companies desired. Eventually, potential best practices were discussed with them. This part of the interview was the most open one. A lot of ideas were exchanged and many interesting approaches considered.

The third step was to analyze the results and to aggregate data. As it is of high interest to the regional companies, an overview of the status quo has been drawn. For reasons of space and scope it is not included in this paper but can be found in [21]. By finding interdependencies as well as aligning and judging best practices identified by the participants, we extracted recommendations. Of course, particularities of the companies' situations were taken into account. This lead to the construction of a framework (see Section IV) that describes the conditions under that a recommendation applies.

IV. FRAMEWORK

Recommendations for a topic as complex and intertwined on various levels as software development require a sophisticated categorization. Their full value can only be accessed if it is known *how* to use them and which prerequisites have to be met. Besides, support on deciding which best practices are most applicable for the own business is advisable. We thus use the framework first described in [20] to classify recommendations.

The *level of demand* shows how great the organizational change required to adopt a recommendation is. *Basic* recommendations should be adopted by any company. If recommendations are not only basic hints but require considerable effort to be implemented, they are considered to be *advanced*. Eventually, *target states* are ideals that cannot be reached unlabored. In fact, they are guidelines on what level of perfection can be reached and require a process of continuous optimization. However, the benefits of an actual implementation will be immense in the long run.

It is important to consider the *project size*. *Small-sized* projects commonly have a single team that does development and testing. For *medium-sized* projects these tasks are undertaken by at least two teams. *Large* projects can comprise hundreds of employees and include general departments that contribute to it. If thinking about a recommendation, not just the sole number of employees that participate in it should be taken into account. In fact, the typical size of projects as well as their character should be kept in mind.

Another important determinant is the *kind of software* developed. Based on contracts, *individual software* is developed for a single customer. Usually, there is close contact to the principal. Standard or *mass market software* often is developed over a long period of time. This makes regression testing important. Many recommendations can be applied to both kinds of software.

Similarly, the *number of releases* of a software product has to be taken into consideration. It is differentiated between *one*, *several* and *regular* releases whereas regular means that there will be releases for some month or years.

The fifth determinant distinguishes between the *phases* (or *stages*) of testing. It is divided into the phases of *component test*, *integration test*, *system test* and *acceptance test* that also can be found in the literature [35].

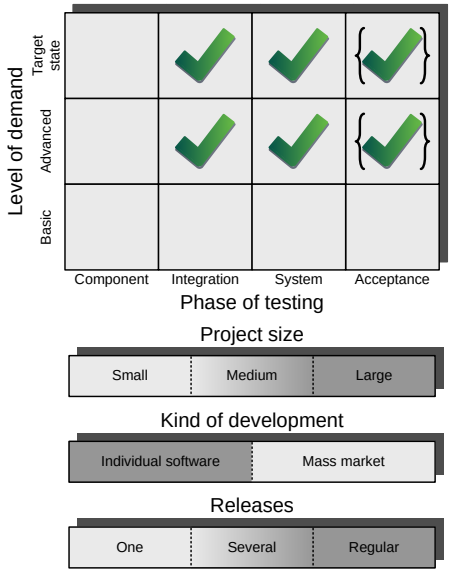

Figure 1. Exemplary use of the framework

As represented in Figure 1, the level of demand and the phase of development are used to set up a matrix. A tick indicates that a recommendation is meant to be beneficial for the depicted phase and level. Ticks might be shown in brackets which indicate that benefits will be observable but might be less pronounced than for other phases and levels. The three other determinants are shown as bars. A shade of (dark) gray means that a recommendation applies under the specified conditions. Fading indicates that adoption of the recommendation should be considered if the depicted determinant is met. Recommendations still require more detail so that companies can judge them. However, the framework can be used to get a quick overview of the main prerequisites for it.

Please consider Figure 1 for clarification:

- The recommendation requires advanced effort. It is possible to be extended in order to mark a target state in which beneficial effects will be much stronger.
- Implementing it especially aids integration and system testing. Positive effects are also likely to be observed for acceptance testing.
- The recommendation is meant to be adopted for at least medium-sized projects and it aims at individually developed software.
- It aims at individually developed software. Theoretically, there could be a fading of the gray shade into the box for mass market software. This would mean that it would also benefit while the main focus was individual software.
- For full effect, there should be a greater number or regular releases of the software developed.

V. TECHNICAL RECOMMENDATIONS

The following sections present five recommendations for the optimization of technical aspects of software testing. Their order reflects the implementation complexity.

A. *State-of-the-art Development Environment*

The first recommendation is pretty straightforward. We encourage using the latest development environments available, particularly integrated development environments (IDE) that are customizable and support plug-ins. They offer magnificent opportunities to increase the quality of the developed software. Using the latest IDEs is especially appealing since development software is used anyway and many of these products or at least plug-ins for them are *free*.

Admittedly, using an IDE is not only about testing. But the support it offers significantly helps to increase development quality. If the developer is aided in his routine work, testers do not have to struggle with defects in programs that originated in unthoughtfulness. Testers can then concentrate on finding actual bugs e.g. in algorithms. Consequently, this recommendation is a testing best practice even though parts of it do not *directly* deal with testing; they have a noticeable indirect impact.

Unlike expectation, companies do not necessarily use state-of-the-art IDEs. It is common to do so for individual developers in small enterprises. However, once the choice of development tools is not solely based on developers' discretion but there are general guidelines or even mandatory directives, tools that do not offer as much functionality as would be possible are used. This is especially true for situations in which developer PCs are centrally set-up by IT organization staff rather than by the developers themselves. Changing development tools could not be possible since tools for cooperative work or versioning, or software to access corporate-wide storage systems or resource pools might not be exchangeable.

Some of the participants drew a picture of the way their development is supported by the tools used that reminded us of the 1980s. There was no kind of *syntax highlighting* and no built-in supportive functionality to aid the developer with coding. There was no direct access to the programming languages or library documentation; developers would look it up on the Internet or use books even for the simplest questions. And, probably worst, there was no testing and debugging support. Debugging was done by putting `print()`-statements into the code that almost arbitrarily supplied the developers with fragments (or rather shreds) of information.

Seeing how much more productive developers using modern IDEs are and how much these tools aid them in achieving high quality software, we strongly recommend using up-to-date development environments and the functionality that comes with them. This general recommendation is suitable for any company. It is extremely helpful for component testing (see Figure 2).

If IDEs are used that do not offer some of the more sophisticated functions and cannot be extended—e.g. with plug-ins—upgrading to a more recent version or another IDE is recommended. Eclipse arguably is the most widely known and one of

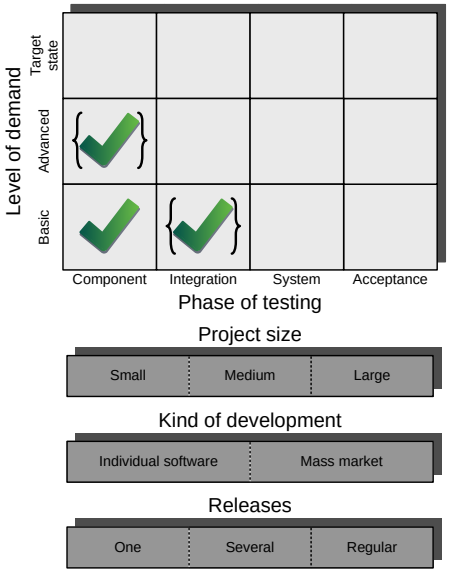

Figure 2. Classification of Development Environment

the most powerful IDEs. It supports Java, C/C++ and (by using extensions) many other languages such as PHP. Even though a lot of functionality is built-in, there is a four-digit number of plug-ins to enhance it further (an exemplary site that lists them is [9]). To benchmark the development environment used, it is a good idea to compare it to leading IDEs. Speaking with the participants showed that some of them used IDEs that were far from offering what Eclipse or Microsoft Visual Studio (the leading tool for .NET) do. Partly the functionality does not even reach what the leaders provided years ago.

Coloring the source code to point up the syntax (syntax highlighting) [7] and automated suggestions while typing (code completion) are common. Documentation fragments can be shown directly to e.g. prevent the usage of methods marked as deprecated. Many IDEs also offer direct checking of the code so mistakes are immediately highlighted. Partial compilation can provide error information without the need to explicitly invoke the compiler. Thus, software with syntax errors will not even be tried to compile and will be fixed by the developer before they consider it to be finished.

Semantic correctness cannot be guaranteed automatically but many typical mistakes can be prevented. For example, levels of warning can be defined. We strongly encourage enabling this feature. Eclipse can for example show Java warnings by underlining code in yellow color. A variable that may take the value of `null` but is used without checking for this will be marked. Consequently, code that provokes so called `NullPointerException`s can be fixed. Many other mistakes can be prevented from being made. Despite an unfamiliar feeling programmers might have in the beginning, they are getting used to the warnings quickly. Superfluous warnings usually can be disabled; in Java this e.g. can be done by using so called annotations [3].

The next step is checking *code rules*. IDEs do not offer this functionality but there are tools and plug-ins available. While

the above described warnings are generated by the compiler and shown by the IDE, tools for checking code rules have a logic on their own which makes them more powerful. Moreover, they are customizable and allow having corporate-wide coding standards enforced. While developers should not feel patronized, having common standards is highly recommended. Many problems arise when several developers work on the same code and probably misunderstand what their colleagues did. This is particularly problematical if developers introduced the style of their choice and then leave the company while the code they wrote has to be maintained. This can be prevented by having corporate-wide schemes and conventions. We suggest using tools or plug-ins to check compliance with general coding standards suggested by the programming language vendors (e.g. [33]), literature (e.g. [34]) and company-specific additions.

We also advocate using the debugging functionality of modern IDEs. Instead of printing out variable contents, modern *trace debuggers* visualize the complete state of a program at a point of the developer's choice. Pointers can be followed and variables modified; execution can be continued step-by-step. Visualizing graphs for control flow and data flow further aids debugging. Combined with knowledge on modern debugging techniques [11] the debugger of a state-of-the-art IDE is a tool of immense power and versatility.

To sum up, we strongly recommend using a modern IDE, even if giving up old libraries, methods, paradigms or even programming languages is a precondition. Along with this process, binding standards for formatting source code and for naming variables, methods etc. should be set up. For a better understanding how the optimal usage of a programming language can be supported by an IDE, practitioner literature such as [3][24] is recommended. There is a plethora of work on programming best practices that can be utilized to augment this recommendation.

B. *Test Case Management and Database*

In small projects testing often is seen as a stateless task. Tests are done once a module is finished and found defects are corrected directly. This is repeated at the levels of integration and system testing. Unfortunately, it is inefficient and cannot be combined with a holistic view [20] of testing. Hence, we recommend using a test case management tool. It already helps medium-sized projects that have at least a couple of releases. While the later phases of testing are supported with little effort, the solution can be expanded and will be beneficial for all phases of testing (see Figure 3).

Typical functions include the compilation and categorization of test cases, ideally using a highly customizable interface that supports users with suggestions to disburden them of repetitive tasks, and setting statuses of test cases. Optionally, assignment of tasks and responsibilities can be done. A tool should further support cooperative work and offer reminders (via e-mail) for employees about assigned tasks, nearing deadlines and other important dates. Connections to the environments that run test cases are another amenity. They allow testing to be triggered automatically.

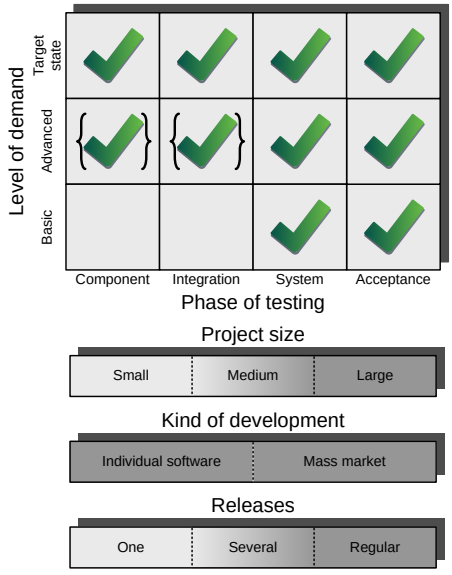

Figure 3. Classification of Test Case Management

Thus, the main purpose is formalization and structuring. Ideally, each employee knows exactly what he has to do at any time and can look up that information in a test case management tool. To a certain degree he can choose from tasks yet unassigned. When pursuing these tasks, he likely will spend his efforts with high efficiency. The tool should also be able to report a project's status which is especially helpful for large projects. The added effort for entering test cases can be minimized with intelligent help from the tool. Besides, regression testing is improved.

Despite not many facts on test case management being published, we know of one detailed work. Parveen et al. present a case study [30] on the implementation of a centralized test management using *TestDirector*, a tools by then sold by Mercury Interactive. While the study is different in context and scope, experiences are similar to our observations of the beneficial effects of test case management.

The test case management's functionality can be extended successively. Not only can it be used more precisely but additional functionality can be added. It is a good idea to include support for *requirements engineering*. Tasks can be derived from requirements and test cases can be linked to them. Should test cases fail, the employee responsible for the requirement might be able to help. Reporting can also help to find modules that have a high rate of defects which probably result from mistakes in their requirements.

Especially for products that are continuously refined, integration of a *bug tracker* is recommended. This software is used to report and manage defects (*bugs*) and therefore ideal for integration with test case management. Bug trackers can become an interface to the technical staff of the customer. A wealth of further functionality can be easily added.

Test case management is thought to be an interface between steps of processes. Erstwhile informal and hardly checkable process components are represented by it. Information is pro-

vided in a structured form. The management software is used for any operative testing procedures. In fact, each testing process begins and ends with utilizing it.

Beginning with using table calculation sheets can foster the creation of an integrated system that offers interfaces to other tools. Expanding the test case management should be done step-by-step. Both a bottom-up (beginning with component tests) and a top-down approach (beginning with system tests or even acceptance tests) are possible. Media disruption should be avoided as it lowers efficiency. An example for media disruption is to write results from a test run to a piece of paper and later type the results from the paper into a tool. If a strategy for implementation is worked out in advance, a delay of projects is unlikely and a return-on-investment (ROI) should be achieved timely. While implementation details are out of scope of this paper, we strongly advise setting up a test case management.

On the first look a *test case database* appears to be equal to test case management software. While both purposes can be combined in one tool, there is a functional distinction between them. Test case management serves towards the aim of structuring and documentation. A test case database is driven technically. It is used to collect test cases in executable form and stores components such as *test stubs* and *mock objects*. The main aim is to increase the rate of test case reuse and hence to facilitate regression testing.

Test case databases are usually integrated into tools but can be implemented separately. Test cases have to be saved in a structured way and it should be easy to find and retrieve them. Ideally, the database system can directly invoke the environment test cases are coded for and run them. It is very helpful for data-driven applications if (e.g. relational) databases can be stored along with test cases. Arbitrary testing results are prevented since the database can be reset to a defined and consistent state for any test cases that requires this.

A test case database has amenities beyond the mere reuse of test cases. A good strategy for testing larger software systems is to have a defined suite of test cases and run it both for an old, correctly working version *and* the new version of the software. If results differ, defects are likely. The same applies to test databases. First the database is set to a defined state. Then the test suite is run for the old version of the software. The same is repeated for the newer version of it after the database has been reverted to the defined state. Resulting states are compared since differences hint to problems. If results are identical but the old version is known to be *buggy*, problems have apparently not been fixed. While such testing is possible manually, tool support avoids mistakes and saves much manual labor.

Test case databases are also useful if libraries are developed that are incorporated into several other systems. They can be tested even if changes were made. Changes to interfaces or defined functionality are noticed immediately without deploying the library to productive systems.

The strengths of test case databases are most apparent if regression testing is used. Consider an example: If two algorithms for the same purpose but with different runtime characteristics have to be tested, test cases have to be implemented only once. The test cases can simply be reused. It will only be needed to add more test cases if the new algorithm has an extended functionality. With a good test case management, this is even true if the second algorithm has been implemented month or years after the first one. Without such a system, the old test cases most likely have been deleted in the meantime, were lost along abandoned data, or there will be no knowledge how to use them.

We advocate both using test case management and a test case database. They are especially successful if they are integrated (see Section V.D).

C. Aligning Systems for Testing and Production

Utilizing modern programming languages and paradigms for developing complex distributed applications does not only bear advantages. Developing applications on workstations but deploying them to servers or mainframes is prone to compatibility and scaling problems.

In the very beginning of programming, software only ran on the system it was developed for. For any other platform the code at least had to be adjusted. It might even have been easier to rewrite it from scratch if architectures were entirely different. Nowadays the environment used for development and testing usually differs from the one software is developed for. Moreover, at least an operating system is mediating with the hardware. In most cases virtualization hypervisors, application servers and other components form additional layers. This has a plethora of amenities. Using high level programming languages allows for the compilation of the same code for different platforms; virtual machines and other components can even offer hardware abstraction. However, the productive system often is far more powerful and not only its hardware is different but often the software is different, too.

In simple cases, differences only apply to the workstations and servers' operating systems. However, additional components such as libraries, database management systems (DBMS) or application servers are likely to be different as well. Server versions of these systems will probably not even run on workstations. Consequently, problems arise. To give an example: Java EE applications are commonly run in a sophisticated application server such as IBM *WebSphere*. Workstations often run a lightweight Apache *Tomcat*. Even though an application that runs on Tomcat should seamlessly do so on WebSphere, practice shows that unexpected behavior or crashes can be expected. This can be explained with a different interpretation of specifications, differing versions, conflicting libraries and similar issues.

We recommend aligning development and testing systems with the intended productive environment. By *alignment* we mean to reasonably adjust development and productive hardware and software while keeping the effort economically feasible. It will in most cases e.g. not be justified to buy a second mainframe system just to have a testing platform that is equal to the productive system. Nevertheless, options are often available that guarantee a high technical compatibility but are cost-effective. Exactly to find these options alignment is about.

Business/IT alignment in general is subject to lively scientific discussion [5].

Aligning systems is suggested for at least medium-sized projects with a couple of releases. It is especially useful for individually developed software and early development phases (see Figure 4). Due to our observations we even deem additional effort to align systems justified. Surprisingly, no work seems to be published on system alignment for the reasons of testing.

The more advanced a testing phase is the more alike should systems be. Compatibility problems should however be resolved as early as possible. Achieving this can be easier than thought. For example, lightweight versions are available for common server applications. This applies to the earlier WebSphere example; Tomcat should be used on the client only if the target system is Tomcat either.

Instead of installing a DBMS on the developing system, the one installed on the server can be used remotely. A separated database should be created to protect productive data from corruption. Modern servers and to an even higher degree mainframes offer virtualization that allows to completely separate instances not only of databases but of any application. Thus, testing is possible on the same machine and with the same system software that the application will eventually run on. Resource usage should be protected so that a tested application running into a deadlock or massively using resources does not endanger productive applications running in parallel.

Applications accessed by a number of parallel users require realistic testing. Problems that arise with memory usage or parallel execution can hardly be found with systematic testing. Such problems will not reveal themselves if just "trying out" the application on the testing system. An acceptable performance on the testing system cannot be assumed for the productive system even if it is more powerful. Not yet considered dependencies, growing data and similar issues can cause problems in the (far) future. Thus, testing *has* to be done under realistic conditions. Defects in parallel algorithms might only reveal themselves under certain conditions. *Race conditions* in which several threads of an application obstruct each other will probably occur on fast systems only. Reasonable conclusions about an application's performance can solely be drawn when thoroughly testing them in a productive environment.

Besides all advocating to testing under realistic conditions, we strongly advise *not* to test on productive systems without making sure that productive data cannot be modified and that the performance remains unaffected. Negative (side-) effects on productive systems would render any benefit of realistic testing useless.

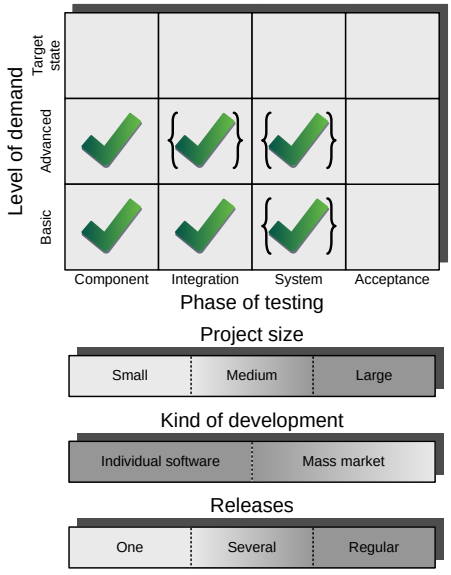

Figure 4. Classification of Aligning Systems

D. *Integration of Tools*

We learned from the participants that using tools for testing is common. A general observation was that tools are hardly integrated. However, exactly this is recommended.

Testing tools are applications on their own in most cases. Common formats or defined interfaces seldom exist. Only larger tools such as *IBM Rational* products provide an interchange of data. Most participants desired the integration whereas only few of them actually had experiences with it. We recommend it for medium-sized and larger projects with at least a couple of releases. Due to the high complexity some effort is required before benefits can be observed for the phases of integration and system testing. Ultimately, amenities can be realized for all phases (see Figure 5).

Several kinds of integration are desirable. First of all, documentation systems should be linked with systems for testing. Undocumented tests are only worth a fraction of documented ones. Automatically synchronizing the results of execution with the test case management system (cf. Section V.B) disburdens testers of repetitively entering test cases. A well structured documentation as described in [16] can be achieved more easily. An improved database of testing results can also be used for statistical examination. Test managers can easily learn about running times, success rates of test cases and similar data. For regularly released software integrating the bug tracker with the management system is another option. Reported bugs can be adjusted with known defects and test cases. This decreases redundancy.

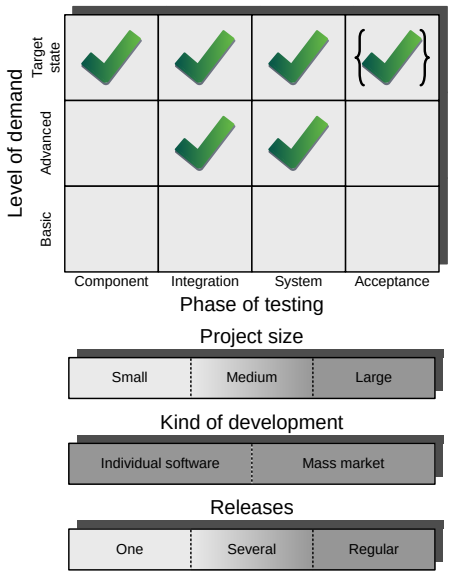

Figure 5. Classification of Integration of Tools

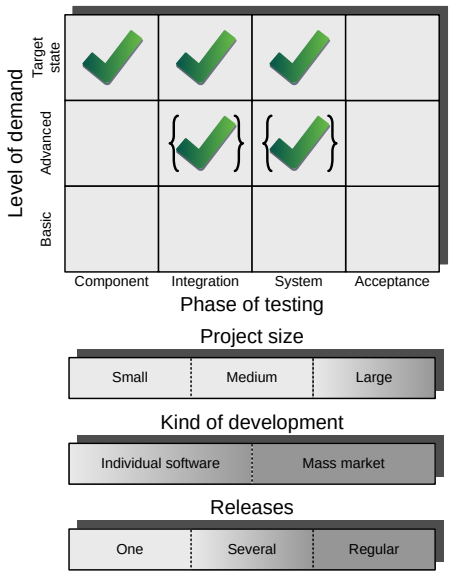

Figure 6. Classification of Customizing of Tools to Fit wih Processes

Linking systems for test case execution supports regression testing. Test cases run in earlier phases can easily be repeated. Automated synchronization again relieves testers of repetitive tasks and ineffective work. Connections to test case management systems and a test case database can make tasks economically feasible that would be too laborious if done manually.

The above ideas will seem utopian in a development landscape without integration. They should motivate alignment and encourage challenging the status quo. To our knowledge there is no exhaustive solution offered and there are no well-defined standards. Individually developing tools for integration will be unavoidable. Nevertheless, for tools newly bought integration capabilities can be checked. Even small tools for data transformation can yield dramatic reductions of manual workload. A tool for aggregating data and computing statistical reports from the test documentation can e.g. be implemented with little effort and refined continuously.

By undertaking a strategy of small refinements, integration is possible without much trouble or high costs. Growing knowledge will bolster further development. We found open source software to be convenient for integration. It can be modified to work with existing software with ease.

Full integration of tools enables new possibilities. This includes installing a *test controlling* which is used to keep an overview of the testing process and to calculate key figures [20]. The vision is an integration of systems that comprise test case management, development (project) planning, test scheduling, staff assignment, time control, task management, controlling and even a *management cockpit*.

E. Customizing of Tools to Fit wih Processes

In most cases, testing tools are driven by the underlying technology. Even if they can be customized, they induce a certain way in which they have to be used. As a consequence, business processes are changed in order to fit with a tool's requirements. Without changing the processes, many tools can hardly be used. Alternatively, customizing tools is possible but very laborious. However, tools should be tailored to fit with business processes and not the other way around.

Especially companies that have *defined* testing processes pointed out, that changing processes to enable the usage of tools is a particularly bad idea. In fact, tools should be customizable in order to seamlessly integrate into the processes. Therefore, we recommend selecting tools based on their customizability. While introducing a new tool could be used to benchmark the affected business processes, well performing processes should not be changed. Customizing tools should be done in larger projects with at least several releases of a software product. The benefits will become most obvious if a company strives for a continuous optimization of its testing processes. Optimizations will be most apparent in tool-driven phases—hence, there will be hardly an effect on acceptance testing (see Figure 6).

In general, introducing new tools or installing upgrades of existing tools entails changes. They for example are caused by the implementation of additional phases of testing or the addition of new functionality. This kind of changes is both normal and desirable. Companies should try to optimize their processes, though. Adapting the course of action and procedures given by the tool should be a starting point for own considerations. Only in a small number of cases these presets will align with a company's standards. Consequently, a well-founded strategy of integrating a tool has to be found. Moreover, evaluations of the tool's performance should be scheduled. Experiences gained after using it for a while should be used for further improvements.

Implied processes are often based on technical details of tools. We learned in the underlying project of this article that only a small number of testing tools can be intuitively used.

Thus, tools should be checked for their customizability upon evaluation and selection. Steps for creating a test case should be designed to align with employees' flow of work. If the documentation, demonstration materials, or tool presentations hint to fixed and unchangeable presets, tools have to be carefully checked. It is particularly impedimental if enforced processes cannot be divided into substeps or if tools lack interfaces. A common problem would be tools for test execution that cannot be integrated with documentation software.

Adaptability and customizability can be given in several dimensions. Technically speaking, it should be possible to interrupt tests during execution in order to save intermediate results. Moreover, interfaces to import and export data are very helpful—in particular, if they can be used in real time (cf. Section V.D). With regard to the usability, a configurable interface positively affects the acceptance of a tool. The possibilities to tailor a tool should be based on its complexity. Customizing in the technical dimension (e.g. by writing scripts) is acceptable for small tools only. Ideally, tools should offer the possibility to load plug-ins. Furthermore, tools that are plug-ins by themselves and can be loaded into an integrated development environment (IDE) are well suited. They help to design continuous processes.

The experiences we gained in the project suggest that it is a successful strategy to carefully calculate the effort required for changes to tools. This effort commonly is preferable to the disadvantages of adapting the processes. Besides, customizing tools offer the chance to reflect on the testing processes and optimize them. In the long run, even small changes have great effect. Irregularities caused by hardly changeable tools are likely to cut productivity. Moreover, when tools are not customized or no tools are introduced at all due to the strategy of saving the effort of selecting and adapting them, the company might loose competitiveness. Improving processes and using cutting-edge tools will improve testing and raise the quality of the developed software.

VI. Conclusion

In this paper we presented results from a project that aimed at finding best practices for software development and especially testing. We described its background, the research approach and the framework used to categorize recommendations. Out of about 30 recommendations found and classified with the framework, we presented five recommendations that make novel contributions to the technical dimension of how testing can be done in enterprises.

Using a modern IDE greatly supports development. It enables testing to focus on finding bugs rather than on eliminating mistakes that entered the code by neglectfulness. Using test case management and a test case database leads to a structured testing process. Moreover, it supports regression testing. Alignment of testing and productive systems prevents many problems that arise due to incompatibilities and scaling issues. Integrating testing and development tools requires continuous governance but increases testing performance and efficiency. Consequently, regression tests can be run much more efficiently. Finally, customizing tools to fit with processes should be preferred over changing processes in order to be able to work with tools.

We found a discrepancy of testing knowledge described in the literature and the reality of testing in enterprises. To give an example: Even practitioners literature such as [1] distinguishes between *black box* and *white box* testing. However, hardly any of the project participants made an explicit distinction like this. Not a single participant had ever heard of *gray box* tests. The above described recommendations might thus be partly found in the literature— but many companies have not implemented them, yet. Apparently, literature is inaccessible for some practitioners, not practically usable in the everyday work, or unknown [30]. This has also been found for organizational aspects of testing [20]. Research progress and testing improvements that were hoped for [14] seem to have reached the industry only partly.

Developing software of high quality is not a mere economic obligation. Neither is it just needed to improve the idea the general public has about software quality. Preventing that software harms humans in any way is an ethical obligation [11]. We thus encourage further research in both organizational areas (i.e. information systems research) and in the technical field (e.g. computer science and formal methods). Moreover, we encourage enterprises to reach a culture of testing instead of perceiving testing as a costly delay in the development process. We therefore propose a structured approach and to keep research bound to cooperation with enterprises.

VII. Future Work

The project this work is based on is continued in order to evaluate the recommendations found. Future work will contain a discussion of the results with practitioners and probably a quantitative study. Ideally, a study could be done on a national or even global scale. It could not only try to capture the success of the recommendations but check how the literature on software testing is used.

It is without question that a quantitative analysis would perfectly augment the qualitative approach. For example, measuring a return-on-investment (ROI) of the improvements made would be ideal [28]. Without quantitative data it is hard to prove that a recommendation is effective and efficient. Deriving best practices is a first step and was very laborious due to the problematic nature of software testing. Verifying results implemented by companies was identified as a further step. Design science—the research approach of our choice—is incrementally iterative [15]; adding additional rigor and verifying results actually implemented by companies was identified as a further step.

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REFERENCES

[1] R. Black. Pragmatic Software Testing. Wiley, Indianapolis, 2007.

[2] R. Black. Managing the Testing Process. Wiley, Indianapolis, 3rd edition, 2009.

[3] J. Bloch. Effective Java. Prentice Hall, Upper Saddle River, 2nd edition, 2008.

[4] F. P. Brooks, Jr. The mythical man-month (anniversary ed.). Addison-Wesley, Boston, 1995.

[5] Y. E. Chan and B. H. Reich. IT alignment: what have we learned? Journal of Information Technology, 22, 2007.

[6] R. N. Charette. Why software fails. IEEE Spectrum, 42(9):42–49, 2005.

[7] M. F. Cowlishaw. Lexx—a programmable structured editor. IBM J. of Research and Development, 31(1):73–80, 1987.

[8] E. Dijkstra. The humble programmer. Communications of the ACM, 15:859–866, 1972.

[9] Eclipse marketplace. Online: http://marketplace.eclipse.org/ (Access date: 14 September 2010).

[10] R. L. Glass: Computing Calamities: Lessons Learned from Products, Projects, and Companies that Failed, Prentice Hall, Upper Saddle River, 1999.

[11] D. Gotterbarn and K. W. Miller. The Public is the Priority: Making Decisions Using the Software Engineering Code of Ethics. Computer, 42(6), 66–73, 2009.

[12] T. Groetker, U. Holtmann, H. Keding, and M. Wloka. The Developer's Guide to Debugging. Springer, 2008.

[13] D.-J. de Grood. TestGoal: Result-Driven Testing. Springer, Heidelberg, 2008

[14] M. J. Harrold. Testing: a roadmap. In ICSE – Future of SE Track, pages 61–72, New York, 2000. ACM.

[15] A. R. Hevner, S. T. March, J. Park, and S. Ram. Design science in information systems research. MIS Quarterly, 28(1), 2004.

[16] IEEE. IEEE Std 829-2008: IEEE standard for software ans system test documentation. New York, 2008.

[17] C. Jones. Software Quality: Analysis and Guidelines for Success. Thomson Learning, 1997.

[18] D. Kopec and S. Tamang. Failures in complex systems: case studies, causes, and possible remedies. SIGCSE Bulletin 39(2):180–184, 2007.

[19] W. E. Lewis. Software Testing and Continuous Quality Improvement. Auerbach, Boston, 3rd edition, 2008.

[20] T. A. Majchrzak. Best practices for the organizational implementation of software testing. In Proc. of the 43th Annual Hawaii Int. Conf. on System Sciences (HICSS-43). IEEE Computer Society, 2010.

[21] T. A Majchrzak. Status Quo of Software Testing - Regional Findings and Global Inductions. Journal of Information Science and Technology, 7(2), The Information Institute, 2010.

[22] T. A. Majchrzak. Best Practices for Technical Aspects of Software Testing in Enterprises. In Proc. of the Int. Conf. on Information Society (i-Society 2010), IEEE Computer Society, 2010.

[23] T. A. Majchrzak and H. Kuchen. Handlungsempfehlungen für erfolgreiches Testen von Software in Unternehmen. In J. Becker, H. Grob, B. Hellingrath, S. Klein, H. Kuchen, U. Müller-Funk, and G. Vossen, editors, Arbeitsbericht Nr. 127. Institut für Wirtschaftsinformatik, WWU Münster, 2010.

[24] S. Meyers. Effective C++: 55 SpecificWays to Improve Your Programs and Designs. Addison-Wesley, 3rd edition, 2005.

[25] J. Morrison and J. George. Exploring the software engineering component in MIS research. Commun. ACM, 38(7):80–91, 1995.

[26] M. D. Myers. Qualitative research in information systems. MIS Quarterly, 21(2):241–242, 1997.

[27] NASA. Mars climate orbiter mishap investigation board phase I report, 1999.

[28] P. Naur and B. Randell. Software Engineering: Report of a conf. spon. by the NATO Science Committee, Garmisch, Germany. Scientific Affairs Division, NATO, 1969.

[29] W. J. Orlikowski and C. S. Iacono. Research commentary: Desperately seeking the "IT" in IT research—a call to theorizing the IT artifact. Info. Sys. Research, 12(2):121–134, 2001.

[30] T. Parveen, S. Tilley, and G. Gonzalez. A case study in test management. In ACM-SE 45: Proceedings of the 45th annual southeast regional conference, pages 82–87, New York, 2007. ACM.

[31] H. A. Simon. The sciences of the artificial. MIT Press, Cambridge, 3 edition, 1996.

[32] S. Slaughter, D. Harter, and M. Krishnan. Evaluating the cost of software quality. Commun. ACM, 41(8):67–73, 1998.

[33] Sun Microsystems, Inc. Code Conventions for the Java Programming Language. Online: http://java.sun.com/docs/codeconv/ (Access date: 14 September 2010).

[34] H. Sutter and A. Alexandrescu. C++ Coding Standards. Addison-Wesley, 2004.

[35] J. Watkins. Testing IT: an off-the-shelf software testing process. Cambridge University Press, New York, 2001.

[36] R. K. Yin. Case Study Research: Design and Methods. Sage Publications, London, 3rd edition, 2002.

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Organizational and collaborative knowledge management: a Virtual HRD model based on Web2.0

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Abstract- Knowledge development and utilization can be facilitated by human resource practices. At the organizational level, the competitive advantage depends upon the firm utilization of existing knowledge and its ability to generate new knowledge more efficiently. At the individual level, increased delegation of responsibility and freedom of creativity may better allow the discovery and utilization of local and dispersed knowledge in the organization.

This paper aims at introducing an innovative organizational model to support enterprises, international companies, and governments, in developing their human resource, through the virtual human resource, as a tool for knowledge capturing and sharing inside the organization.

The VHRD organizational model allows different actors (top Management, employees, and external experts) to interact and participate in the learning process, by providing non-threatening self-evaluation and individualized feedback. In this way, the model, which is based on possible patterns and rules from existing learning systems, Web 2.0 and a homogeneous set of integrated systems and technologies, can be of support to the enterprise human resource department.

In addition to this, the paper presents an evaluation method to assess the knowledge management results inside the organisation, by connecting the financial impacts with the strategy map.

Keywords – Virtual Human Resource Development, Knowledge Management, Human Resource Management, Web2.0, Organizational model.

I. INTRODUCTION

Knowledge development and utilization can be facilitated by human resource practices ([1], [2], [3]). While the competitive advantage depends upon the firm utilization of the codified knowledge and its ability to generate and create new knowledge more efficiently ([1], [4], [5]), According to reference [6], the process of managing knowledge creation, integration and utilization inside the enterprise is linked to Human Resource Management (HRM) as a main coordination mechanism of these actions. Furthermore, the human resource is considered as crucially important in creating sustainable competitive advantage of organizations and enterprises ([7], [8]). Human resource practices and initiatives contribute to the firm's ability in utilizing their codified and existing knowledge to generate new knowledge ([9], [6]), adding to the firm a new competitive advantage ([10], [11]).

According to the Resource Based View (RBV), the enterprises are able to create competitive advantage by means of developing and deploying their human resource in a way that adds unique value difficult to be imitated by the competitors. At the individual level, increased delegation of responsibility and freedom of creativity may better allow the discovery and utilization of local and dispersed knowledge in the organization, as well as expanding the depth and breadth of employee knowledge by promoting the process of knowledge creation and utilization through the individual learning practices such as" know how" or learning by doing [6].

Furthermore, the interpersonal cooperation and communication among the employees have been considered as one of the factors that likely utilizes knowledge diffusion and allows the employees to bond knowledge that is flying separately or dispersed across function, and creating new knowledge combination enhancing solving creative problems ([12], [13]). Continuously, the knowledge base of the firm reorganized by the interpersonal cooperation and communication between the employees, practices and communication managed and carried out by the HRM.

During the past years, many researchers introduced the Virtual Human Resource Management (VHRM) / and e- e-HRM in different ways. These patterns can be considered as an application of information technology for both networking and supporting at least two individuals or collective actors in their shared performing of HR activities [14]. Accordingly to reference [15], the VHRM is characterized as a kind of network structure based on partnership, using information technology as carriers, to help organizations to access, develop and utilize the human capital.

During the past decades, the physical assets used to be considered as critical factor in determining the enterprise value and market's position, while on the current time this value is measured by their intellectual assets such as patents, technologies, ideas, and designs. Moreover, the main goal of the intangible asset management is utilizing tools and indicators to increase earnings within the business enterprise through managing knowledge [16].

But what challenges the enterprise is facing today are in codifying, sharing and applying knowledge inside their business environment in way they can benefit from the discoveries of others. Since firm's intangible asset development is strictly related to its competitive strategy and the adopted strategy reflects management's decision on how to respond to external reality ([17], [18]), managerial perception

should shape knowledge resources and value of intangible assets to the organization [19].

This paper aims at introducing an innovative organizational model to support enterprises, international companies, and governments in developing their human resource through the VHRD, as a tool for knowledge capturing and sharing inside the enterprise for the purpose of the HRD (Experience, competences and production of new knowledge). In addition to this, the paper presents an evaluation method to assess the knowledge management results inside the organisation, by connecting the financial impacts with the strategy map.

The purpose of the proposed organizational model is to allow the different actors (top Management, employees, external experts) to progressively interact and participate in the learning process, by providing non-threatening self-evaluation and by defining individualized feedback to the learners and efficient tracking and supervision tools to the Human resource management.

II. FROM KMS TOWARDS COLLABORATIVE KM

In the last years, knowledge management has become one of the most considerable topics both in literature and in practice. Knowledge has assumed the role of strategic resource in companies searching for the competitive advantage ([1], [30], [31], [32], [17], [17]). Also according to Reference [26], knowledge is information possessed in the mind of individuals: it is personalized information (which may or may not be new, unique, useful, or accurate) related to facts, procedures, concepts, interpretations, ideas, observations, and/or judgments.

Today, companies need to manage this knowledge efficiently in order to succeed. In particular, they need to develop precise plans and to provide managerial guidelines, in order to make the available knowledge proper of the organization. As matters of fact, their success is strictly connected with the integration of tangible and intangible resources, organizational functions, core processes and technologies. Furthermore, the IT literature contributed greatly to the field of knowledge management, there is much more for knowledge management than just technology alone; knowledge management is a business process [26], the spread of information and communication technology has increased the ability of the firms to store, share and generate knowledge, accelerating the emergence of a new economic, organizational and technological context, named as "knowledge-based economy" [33], and in order to achieve a competitive position, it is very relevant to understand how the value creation processes and the business goals can be realized and combined ([30], [34], [35], [36]), but to identify that the pure availability of innovative technology not always involves an effective knowledge management.

According to [20], the information technology applications enable the firm to have a simple selection and internalization process only after having defined and codified the roles and the interpretative procedures. It appears that there is no direct correlation between information technology investments and knowledge management performance: business policies and practices are rather enabled by the strategic integration of information technology tools, business processes and intellectual, human and social capital ([21], [22], [23]).

Every organization has resources that are altered into capabilities such as the know-how that can be considered as tacit knowledge. Knowledge management has a purpose to create, collect and convert individual knowledge into an organizational one [24]. Nonaka presented also a dynamic theory of knowledge management that suggests that both explicit and tacit knowledge interact to generate process of organizational knowledge creation [25].

Organizational knowledge can be traced back to the beginnings of organizations where methods of scientific management and other succeeding management schools have implicit reference to current knowledge management practices. This is because organizations always have the need to deal with their internal or external experiences related to knowledge such as the patents or inventions [26]. However, it was in the mid or late 1980s that knowledge management emerged as an independent concept. This was a direct result of knowledge being an important source of competitive advantage for organizations [27]. Hereafter, two of the most relevant definitions of knowledge management found in literature are proposed. Firstly, it is the process of continually managing all kinds of knowledge to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities [28]. Secondly, it is the effort to make the knowledge of an organization available to those within the organization who need it, where they need it, when they need it, and in the form in which they need it in order to increase human and organizational performance [29].

A. Virtual Human Resource Development

Considering the evolution from Human Resource Management (HRM) towards Human Resource Development (HRD), several and widely published definitions consider HRM as the major management activity. HRD usually includes a wider range of activities to develop personnel inside organizations, such as career development, training and development as well as the organization development [37]. Besides, at one hand the changes in definitions of HRM have not been significant, at the other; some definitions of HRD have made an important conceptual shift away from the process of training or organization development towards a focus on outcomes in terms of HRD's impact on people, Organizations, community, nation.

HRD is a major constituent of any civilization, and the more advanced it is the more thriving and prosperous a nation is. As with any other phenomena or ideology with crucial importance, it has been evolved from very intuitive to very complicated and advanced nowadays.

Today the world is experiencing and focusing on the web learning and the knowledge sharing phenomenon which has had major attention globally from governments and even worldwide institutions. Web Learning relies and is based upon technology and electronic means. This gave the rise to what is known as virtual education or Virtual Human Resource Development, which is the education and development training conducted online as opposed to the time and space bound traditional human resource development, in the age of

obscurity, chaos, and change; the world is obscure as reality is not known, chaotic because the outcomes are never certain, and is changing as what can be true and right today would be completely the opposite tomorrow.

During the past years, many researchers introduced the Virtual Human Resource Management (VHRM) in different patterns where it is considered as an application of information technology for both networking and supporting at least two individuals or collective actors in their shared performing of HR activities [14]. According to reference [38], the Virtual HRM is characterized as a kind of network structure based on partnership, using information technology as carriers, to help organizations to access, develop and utilize the human capital.

According to reference [39], the Virtual HRM was introduced as "A process for developing and/or unleashing human expertise through training and development (T&D) and organization development by utilizing a technology-enabled environment for the purpose of improving performance".

A. *The Role of KMS in HRD*

The KMS as an IT-based system was developed to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer and application [40]. With the growing attention of the KM importance in organizations, many of this start developing KMS that offer various benefits to facilitate KM activities [41], but [42], recommend that during the development of KMS, the organization should pay attention to various issues and challenges related to using IT to support KM.

Most of the traditional KMSs merely focus on capturing the enterprise's knowledge, storing and organizing it in the enterprise database. However, the purpose of the KMSs was not only to make information available, but also to make sure it will be shared and leveraged in enterprise context and between the users. Therefore, focusing only on the half of this equation does not add any advantage for human capital development. And the result will be that the KMS act like a cyberspace; full with immense amount of information and data, but still not yet leveraged, the VHRD model could be considered as the new generation of the KMSs or at least more mature.

In connection to this, the results of an online survey released by Accenture consulting firm in 2007 contain a survey of more than 1,000 middle managers of large companies in the U.S & U.K [43]. These results uncover the way they gather, use and analyze information inside their organizations, and found that managers spend up to 2 hours a day looking for information, and more than 50% of what they found has no value to them. Furthermore, nearly three out of five respondents (59%) said that, because of their company's poor information distribution, they lack access to critical information.

Moreover, various studies show that less than 20% of the knowledge inside enterprises is captured and in the same time less than 20% of that is retrieved in solving future problems and situations the enterprise faced [45].

Most of the traditional KMSs usually focus on capturing knowledge inside the enterprise and brushing off the importance of sharing this knowledge, and its affect on enterprise productivity and competitive advantage for both employees and enterprise.

III. THE VHRD MODEL

The VHRD model presents a new approach of utilizing the captured knowledge and information inside the enterprise environment (top management, external expertise, knowledge worker, workforce), and leveraging this knowledge to a dynamic T&D e-content for developing and enhancing the human capital competitive advantage.

Figure 1. The interaction between the model users within the organisation environment

This model focuses on rendering the human capital with the skills needed and driving their performance to face any future situation and solve it, by capturing the knowledge object during the interaction activities between the users and reuse it in producing a dynamic e-content for the training and development purpose and in the same adding value for the enterprise competitive advantage; fig. 1 and fig. 2 illustrate the interaction between the users.

Figure 2. The interaction process actors and activities

As stated in the fig.2 the VHRD counts on a number of actors and activities users the interaction process as it is described below in (Table I)

TABLE I USER'S INTERACTION PROCESS IN VHRD MODEL

Actor	Activity Description
Human Resource Development	Authoring the T&D e-content for the training courses, updating it with the new captured knowledge to enhance the user's competences, monitoring the user progress , KPI assessment, and selecting the right T&D material according to the users and enterprise needs.
Top Management	Online assessment / KPI reports, Sharing knowledge and experiences.
External Experts	Capturing the knowledge during the In-class training, and write it down codifying it to reuse it in creating the T&D e-content.
System Administrator	Tracking the user interactivity during the virtual T&D period, maintenance and upgrade and updating the used systems and any further technical requirements.
Users / Employees	Virtual T&D courses, Social network tools (Chat, multimedia communication), Web2.0 tools (Wiki, Blogs), to share ideas, information, experience, knowledge, Case failure/success.

B. The conceptual model

VHRD model utilizes the knowledge captured from the interaction between the enterprise members and the codified knowledge inside the enterprise environment context. Furthermore, leverage this knowledge in a dynamic training and development e-content to enhance the human capital skills, competence, knowledge, experiences and improve their performance.

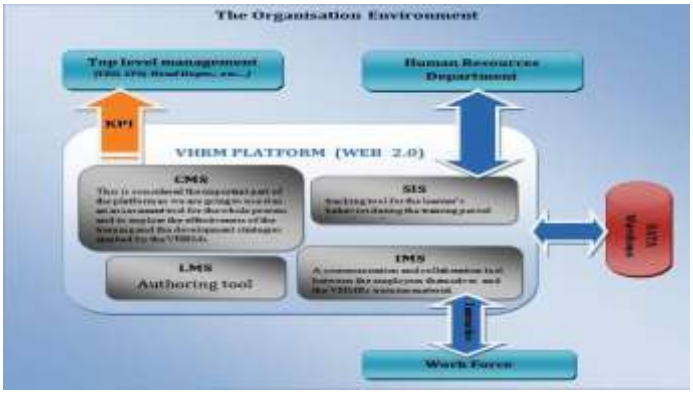

Figure 3. The VHRD conceptual model components

The proposed model (Fig. 3) facilitates these activities through the web 2.0 tools, information management system (IMS) and learning management system (LMS), where together are considered the backbone of the interaction activities, allowing the enterprise members to interact extensively in a high secure and trusted environment, and facilitate the freely information flows and intensive hands-on experience to induce knowledge accumulation in the data warehouse, where knowledge will be codified, documented and indexed or in another word "took stock" that mean it's ready to be accessed and shared inside the enterprise environment or as its proposed in this model to share it the VHRD model in order to develop and train the internal workforce of the enterprise.

The development of the dynamic T&D e-content counts on the accumulated knowledge in the data warehouse, after it has been created, shared, and captured during the interaction activities between the employees inside the enterprise, thanks to the web 2.0 technology.

The authoring process for different T&D dynamic objects will count on the integrated LMS in the model and human resource department of the enterprise, which will have another role of following and tracking the user's activities during the interaction activities, through the student Information system (SIS) which will work as a tracking and user feedback tool.

The competency management system (CMS) play the role of the intelligent self-evaluation and grade reporting system for the competencies that have been earned during the T&D course, and steering of competence development & direction, besides, the management of unstructured competence (tacit knowledge), moreover the CMS will provide the VHRD administrators with the competencies earned by the employees and how this influence their work, competences and competitive advantage among the growing need for high and qualified work force, which directly affect the enterprise competitive advantage among their competitors.

The VHRD model consists of different learning technologies with a different relationship (Table II) to serve and support the international enterprises with the process of sharing and capturing dynamic knowledge objects that could be created through a continuous dialogue between tacit and explicit knowledge, to be utilized for the HRD purpose and creating a competitive advantage for both the organization and employees. Besides, the contributing to the development of empirical research in the domain of virtual human resource development aimed at clarifying the relationship between virtual human resource development and knowledge management orientation. The paper contributes towards a better understanding of the degree of adoption of such a model in the enterprises, international companies, and governments, paving the way for future comparative studies which might take other sectors (health, education) into consideration.

TABLE II THE VHRD MODEL STAKEHOLDER RELATIONSHIPS

Actor Name	Abb.	Role	Relationship with
Learning Management System	LMS	T&D e-content authoring role	HRM, DW, U
Information management system	IMS	Communication and collaboration Role	U,LMS, SIS, Web2.0, CMS
Student Information system	SIS	Dynamic user feedback tool	HRM, U, TM
Web 2.0	Web.2.0	Dynamic environment for interaction between the user through web2.0 tools	IMS, LMS, U, DW
Competency Management System	CMS	Intelligent self-evaluation for the competency earned from the proposed T&D e-content.	HRM, TM
Enterprise Environment	EE	Where K create, share, capture and retrieved as a T&D e-content	HRM, DW
Data Ware house	DW	Codifying and accumulating the captured knowledge for T&D purpose.	HRM, U
Human Resource Management	HRM	The VHRD model administrative for the e-content development for the users	LMS, U, DW, TM
Top management/Stock holders	TM	TM affect or be affected by the attainment of organizational model.(earning retunes , profits , competitive advantage)	KPI, CMS, WEB2.0
Users / Employees	U	End User of the VHRD Model	VHRD Model
Key Performance Indictors	KPI	Measurement tool for the	TM, HRM
Virtual Human Resource Development	VHRD	Human resource development and training	All

C. *Practical implementations*

The model should serve and support the enterprise in processing the tacit knowledge inside their environment and utilizing the captured data, in creating a dynamic T&D e-content to enhance the employees experiences, competency, innovation, and at the same time supporting the enterprises by providing them with the proper technology model for knowledge utilization and processing to get the ultimate benefit of the codified and accumulated knowledge in their database.

However, enterprises have different process and structure drawing by their own unique identity, therefore, developing and implementing the VHRD model inside these enterprises was drawn as follows:

Change management process as a first step, through the attempt of changing and creating new values, organizational culture, beliefs and behaviors inside the enterprise for both management and employees.

The business processes reengineering inside the enterprise environment and differs from business to another focusing on the information flow, data management and the needed qualified people in all the enterprise levels.

Technology readiness aspect which is considers the existence of the relevant technology solutions and tools, as well as the availability of specific competencies and skills of the people using this technology. Usually, this is determined by assessing existing IT infrastructure and strategies.

Knowledge and Communication aspects are necessary to the transition process. These refer to the communication models and the way that knowledge is shared and exchanged in the enterprise's platforms and technology.

Furthermore, the dimensions of this model could help an enterprise VHRD project team to check whether all relevant factors are covered within the implementation and changing processes, and regardless of the long-term perspective of most change management and business reprocess engineering programmers, the short-term improvements have to be achieved in order to preserve enough activity to continue going for further growth and commitment on all organizational levels.

D. *Comparison with the traditional KMS*

Before introducing the VHRD model business impact, the paper goes in a comparison with the traditional KMS. Table III summarizes this comparison.

TABLE III VHRD MODEL COMPARISON AMONG TRADITIONAL KMS

Compression	Traditional KMS	VHRD model
Connectivity	Online/intranet	Online/ intranet
Content	Out-dated, irrelevant, ill-structured	Utilized according to the business requirement/ employees need/ updated with the new knowledge captured
Community	Management not involved/ organization internal environment	Management involved / external expertise /organization environment
Culture	Contract Sharing Knowledge (forced without motivation)	Sharing for development and earning new experiences/ Management commitment through their participation
Capacity	Online interaction	In-class interaction/online interaction /external expertise
Business strategy	Traditional KMS taken as a short project and non long term project/ Unalignment between the Knowledge managed & the strategy goals.	VHRD aligning between the Knowledge managed and the strategy goals of the organization.

Business Impact	Deficulyies in defining the business impact.	Knowledge evaluated according to performance. Measurement of ROI and the achievements of the employee's performance.

The comparison which is held based on Connectivity, Content, Community, Culture, Capacity, Business strategy, Business Impact. These six criteria show us the difference among the traditional KMS and the VRHD model, and why the VHRD model could be considered as the next KMS generation.

Therefore, the paper considers the VHRD model as a candidate to replace the traditional KMS, as a innovative technological solution for the human resource development and grapping the benefits to the business with high financial impact.

IV. EVALUATION OF THE BENEFITS OF THE MODEL

Measuring direct business impact is the most powerful way to demonstrate the added value of VHRD model on enterprise performance and the human capital competencies.

The necessity of evaluating the benefits, for tangible and intangible value added, has led to the proposition of an approach based on the Balanced Scorecard (BSC) method.

The BSC offers an architecture to evaluate how intangible assets help create value in terms of financial income. The BSC emphasizes the importance of non-financial indicators, by proposing a hierarchy among the four axes: customer satisfaction, internal processes, organizational learning, and value for shareholders. In particular, the first three axes are merely the means to achieve financial targets, which is the fourth axis.

Thus human skills (in line of organizational learning) improve productivity and quality of services (internal processes), which in turn contribute to customer satisfaction and ultimately serve for financial objectives of the company.

For this reason, the Balanced Scorecard can be considered as a very result-oriented economic, even if financial aspect cannot be considered as a tool for evaluating the overall performance.

The BSC could be considered as an important contribution to KM evaluation and measurements, while the traditional financial indictors focused on measuring the tangible assets. As a consequence, the BSC offers architecture model to evaluate how intangible assets help to create value in terms of financial income.

A new requirement of knowledge management today is the ability to monitor and evaluate, in addition to financial results, all the factors involved in the process of value creation. The best answer appears to be the establishment of an effective reporting system dedicated to performance management that is easily accessible, legible and safe. The BSC creates a strategic management system of this kind means "to improve performance to optimize the business", by identifying the improvement areas in line with the broad holding link between strategic planning and operational implementation of the business strategy.

Fig. 4 illustrates how the BSC system supports the enterprises to focus on the performance metrics, by means of balancing financial objectives with customer, internal business process and learning (innovation) after the implementation of the VHRD organizational model. This process will optimize the human capital skills and competences in the mean of organizational learning, which should develop the employees (ideas, skills, experience, innovation, competences) and improve their productivity and quality of services with the mean of internal processes. Besides, the quality and the improvement of the customer relationship management in mean of stakeholder satisfaction and ROI.

Moreover, this process is considered as a continuous knowledge life cycle, where the improvement, learning and human capital development are keep running. The internal processes will keep improving as well as financial objectives will keep growing.

Figure 4. The VHRD performance balanced scorecard cycle.

The five linked perspectives of performance define the VHRD model performance measurement metrics, by identifying the questions which tackle the following subjects:

- **Strategy**: what strategies do the firms have to put in place in order to satisfy the requirements and the needs of the key stakeholders e.g. change management strategy?
- **Shareholder satisfaction:** who are the firm's key shareholders and what are their requirements and needs from the VHRD model?
- **Knowledge:** what critical knowledge do the firms need to operate and enhance their processes, their employees, experiences and knowledge process?
- **Learning and T&D:** what kind of T&D do firms need to operate and enhance their processes and productivity?
- **Personal contribution:** what contributions do firms require from their employees to maintain and develop their knowledge?

Today there are several KM evaluation tools that could be utilized to evaluate and assess the organization knowledge flow

value. To realize benefits counts essentially on the implementation of VHRD systems, where practitioners can learn extensively from each other and develop their competences and skills.

Besides, the influence image that comes through VHRD is not simply a technological solution to share knowledge among the organization members, but also a system which connects employees, managers, and involved processes.

Moreover, to state this point, many of the KM groundbreakers, who have seen their organizations attain significant benefits, did not have to disclose ROI in financial terms. There are several leaders who have a clear vision and understanding about the non-rational contribution of KM to their business processes and human capital development, without having a proper justification in terms of ROI. In addition to this, many managers face problems in calculating the added value to their financial statement, deriving from managing their organization knowledge and utilizing and implementing different tools and technology. Thus the following steps draw a road map to support the managers in calculating the financial impacts of such VHRD model or in general any KMSs.

1) *Identify the model goals*

To implement the VHRD model enterprise should identify gaps between outcomes that expect (performance) and what is actually happening related to employee job performance. Thus identified specific gaps and looking to fill them by the virtual T&D.

Moreover, this may include improved productivity/quality, reduced scrap/waste, reduction in accidents or injuries, improved customer satisfaction, reduced customer complaints or some other aspect of job performance, which increased skills and abilities gained through training should positively impact.

Soft skill training such as supervisory or communication training can be more difficult to measure.

2) *Develop model evaluation criteria*

Identifying specific criteria to measure the success of the training held through the VHRD model, these criteria may include quality control reports, scrap reports, production statistics or any other measurable elements.

Establishing a baseline level by determining the current level of performance against each measuring criteria before the model implementation and training commences, so the top management will have a clear understanding of the effect of the VHRD model has on performance. Without specific and measurable criteria, it is virtually impossible to measure the impact of VHRD model effects.

3) *Collect feedback during & after the model implementation*

It's important to seek feedback from the users regarding their training and interaction experience. The feedback should include satisfaction with the model and its features as well as the training and specific action plans being developed based on the learning (i.e. how are they going to apply the training to their job), these action plans should assist in measuring the impact of the T&D.

4) *Collect Data re: Impact of model on evaluation criteria*

Based on the criteria identified in the second step, monitor and track performance against the baseline data. The positive change in these elements represents the real impact of the T&D programs.

While there may be some other elements the management would like to consider, such as the users being happier employees, if those elements not translated into a measurable improvement against the baseline of the evaluation criteria, there is no real way to factor it into the ROI calculation.

5) *Translate Impact Data into Financial Benefits of VHRD T&D Program*

Based on the data collected and the performance improvement against the baseline data, the real financial impact of the model T&D can be calculated.

Using criteria such as improved productivity or reduced scrap/waste, the management will be able to calculate the actual financial value and benefits that the VHRD model is providing.

6) *Calculate the Model Costs*

The costs of running the VHRD should be fully loaded into this calculation.

Costs should include applicable items including the administrative and operational costs. And overhead costs for the organization can also be allocated to it.

The period for which the returns from the VHRD model calculated may vary, but as a general rule, it should not exceed one year from the completion of the model implementation.

V. CONCLUSIONS

Learning plays a critical role in our everyday lives. Education has evolved from very primitive to highly advanced and technologically based methods, this evolution is necessary and normal so as to adapt with the knowledge economy and its requirements and challenges nowadays. New words and concepts have evolved since the integration of technology in the learning field and the benefits can be sensed at all levels and at various degrees.

There is no doubt that knowledge management is entering a new phase of theoretical and practical development.

The presented VHRD model, as organizational approach based on Web 2.0 for collaborative KM, offers a coherent solution to this challenge. The VHRD model is built on a theoretical framework and on an integrated modeling method with organizations.

Also this basic framework has been enhanced with empirically validated and practically proven knowledge management element like the four core activities as well as criteria for analysis and design of a coherent knowledge management solution.

Besides, knowledge management provides a kind of toolbox with several generic methods, instruments and tools to improve the handling of knowledge in daily routine.

Moreover, the technological opportunities to improve interaction and increase collaboration in enterprises are growing rapidly and the need for an organizational model that can utilize the human resource capabilities and knowledge worker inside the enterprises become highly demandable, there are many benefits of a well-designed knowledge collaboration system taking in our consideration the importance role that human resource play in knowledge creation, sharing and applying it, through utilizing this captured knowledge in a e-content object for T&D purpose of the employees inside the enterprise environment, this also includes saving time, effort and cost to get the right knowledge usually expected of the traditional training and development courses.

REFERENCES

[1] Nonaka, I., Takeuchi H. (1995) The Knowledge Creating Company, Oxford University Press, New York.

[2] Leiponen, A., (2000), "Collaboration, Innovation, and Firm Performance - Increasing Returns from Knowledge Complementarities ?", Paper prepared for the Conference "Supermodularity and Innovation", UQAM, Montréal, June.

[3] Laursen, K. (2002), "The Importance of Sectoral Differences in the Application of Complementary HRMPractices for Innovation Performance", International Journal of Economics and Business, Vol. 9, pp. 139-156.

[4] OECD, (2000), Knowledge Management in the Learning Economy, Paris.

[5] Tidd, J., (2000), From Knowledge Management to Strategic Competencies, Series on Technology Management, Vol. 3, Imperial College Press, London.

[6] Laursen K., & Mahnke, V. (2001). Knowledge strategies, firm types, and complementarity in human-resource practices. Journal of Management and Governance, 5, 1-27.

[7] Colbert, B. A. (2004). The complex resource based view: Implications for theory and practice in strategic human resource management. Academy of Management Review, 29, 341–358.

[8] Subramony, M., Krause, N., Norton, J., & Burns, G. (2008). The Relationship Between Human Resource Investments and Organizational Performance: A Firm-Level Examination of Equilibrium Theory. Journal of Applied Psychology, 93, 778-788

[9] Lado, A. A., & Wilson, M. C. (1994). Human Resource Systems and Sustained Competitive Advantage: A Competency Based Perspective. Academy of Management Review, 19, 699–727.

[10] Amit, R., & Schoemaker, P. J. H. (1993). Strategic assets and organizational rent Strategic Management Journal, 14, 33–46.

[11] Barney, J. (1995). Looking inside for competitive advantage. Academy of Management Executive, 9, 49–61.

[12] Pini, P., and G. D. Santangelo (2005): "Innovation types and labour organizational practices: a comparison of foreign and domestic firms in the Reggio Emilia industrial districts," Economics of Innovation and New Technology,14(4), 251–276.

[13] Souitaris, V. (2002). Firm-specific competencies determining technological innovation: A survey in Greece. R&D Management, 32, 61-77.

[14] Strohmeier, S. (2007). Research in e-HRM: Review and Implications, Human Resource Management Review, 17 (1), 19-37.

[15] Lepak, D.P., & Snell, S.A. 1998. Virtual HR: Strategic human resource management in the 21st century. Human Resource Management Review, 8: 215-234.

[16] Sullivan, P. H. (1998). Value-Driven Intellectual Capital: How to Convert Intellectual Corporate Assets into Market Value. Brisbane: Wiley.

[17] Zack, M.H. (1999) Managing Codified Knowledge, Sloan Management Review, Summer 1999, 40:4, pp. 45-58.

[18] Zack, M.H. (1999) 'Developing a Knowledge Strategy', California Management Review, Vol. 41, No. 3, pp. 125–145.

[19] St Leon, M.V. (2002), Intellectual Capital: Managerial Perceptions of organizational knowledge resources, Journal of Intellectual Capital, Vol. 3, No. 2, pp. 149-166.

[20] Bloodgood, J.M., Salisbury, W.D. (2001) 'Understanding the influence of organizational change strategies on information technology and knowledge management strategies', Decision Support Systems, Vol. 31, pp. 55-69.

[21] Carayannis E.G., Alexander J. (1999) 'Winning by Co-Opeting in Strategic Government-University-Industry R&D Partnerships: The Power of Complex, Dynamic Knowledge Networks', Journal of Technology Transfer, Vol. 24, pp.197-210.

[22] Carayannis, E. G. (1999) 'Fostering synergies between information technology and managerial and organizational cognition: the role of knowledge management', Technovation, Vol. 19, pp. 219-231.

[23] Malhotra, Y. (1998) 'Deciphering the knowledge management hype', Journal for Quality and Participation, Vol. 21, No. 4, pp. 58-60.

[24] Nonaka, I. (1998). The Knowledge-Creating Company. Harvard Business Review on Knowledge Management, Boston: Harvard Business School Press.

[25] Nonaka I., & Konno, N. (1998) The Concept of Ba: Building a Foundation for Knowledge Creation. California Management Review, 40 (3), 40-54.

[26] Sarvary, M. (1999). Knowledge management and competition in the consulting industry. California Management Review, 41 (2), 95-107.

[27] Wiig, Karl M. (1997), Integrating Intellectual Capital and Knowledge Management, Long Range Planning, Vol. 30, No. 3, June, pp. 399-405.

[28] Quintas,P., Lefrere, P., Jones, G. (1997), "Knowledge management: a strategic agenda", Journal of Long Range Planning, Vol. 30, No. 3; pp.385-91.

[29] Ives W, Torrey B. Gordon C (1998). "Knowledge management: anemerging discipline with a long history", J. Knowl. Manage. 1(4): 269-273.

[30] Davenport, T., Prusak, L. (1998) Working Knowledge: How organization manage what they know, Harvard Business School Press, Boston, MA.

[31] Skyrme D.J. (2000) 'Developing a Knowledge Strategy: From Management to Leadership', in Morey, D., Maubury, M. and Thuraisingham, B. (Eds.), Knowledge Management: Classic and Contemporary Works, MIT Press, MA.

[32] Tiwana A. (2000), The Knowledge Management Toolkit: Practical Techniques for Building a Knowledge Management System, Prentice-Hall PTR, NJ.

[33] Schwartz, P., Kelly, E., Boyer, N. (1999) 'The Emerging Global Knowledge Economy', OECD (Hg.): The Future of the Global Economy. Towards a Long Boom?, Paris.

[34] Anand, V., Manz, C. C., Glick, W. H. (1998) 'An organisational memory approach to information management', Academy of Management Review, Vol. 23, No. 4, pp. 796-809.

[35] Hansen, M. (1999) 'The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge Across Organizational Subunits', Administrative Science Quarterly, Vol. 44, No.1, pp. 82-111.

[36] Hansen, M.T., Nohria, N., Tierney, T. (1999) 'What's your strategy for managing knowledge?', Harvard Business Review, pp.106-116.

[37] McLean, G. N., & McLean, L. (2001). If we can't define HRD in one country, how can we define it in an international context? Human Resource Development International, 4(3), 313-326.
[38] Lepak, D.P., Snell, S.A. (1998), "Virtual HR: strategic human resource management in the 21st century", Human Resource Management Review, Vol. 8 No.3, pp.215-34.
[39] McWhorter, Mancuso, & Hurt. "Adult Learning in a Virtual Environment" 2008.
[40] Alavi, M. and D. E. Leidner (2001). "Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues." MIS Quarterly 25(1):107-136.
[41] Alavi, M. and D. E. Leidner (1999). "Knowledge Management Systems: Issues, Challenges and Benefits." Communications of AIS 1: 1-37.
[42] Hahn, J. and Subramani, M.R. 2000.A Framework of Knowledge Management Systems: Issues and Challenges for Theory and Practice Proceedings of the 21st International Conference on Information systems, pp302-312.
[43] "Middle Managers Around the World Unsatisfied with Their Organizations", Accenture Survey Finds, Press Release, Accenture, January 09, 2007.
[44] Alavi, M. and A. Tiwana. (2002), 'Knowledge integration in virtual teams: The potential role of KMS', Journal of the American Society for Information Science and Technology, 53(12):1029-1037.
[45] Fruchter, R., Demian, P., 2002. CoMem: Designing an interaction experience for reuse of rich contextual knowledge from corporate knowledge. Artifical Intelligence for Engineering Design, Analysis and Manufacture 16, 127–147.

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Development of a Low-Cost GSM SMS-Based Humidity Remote Monitoring and Control system for Industrial Applications

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***Abstract*— The paper proposes a wireless solution, based on GSM (Global System for Mobile Communication) networks [1] for the monitoring and control of humidity in industries. This system provides ideal solution for monitoring critical plant on unmanned sites. The system is Wireless [2] therefore more adaptable and cost-effective. Utilizing Humidity sensor HSM-20G, ARM Controller LPC2148 and GSM technology this system offers a cost effective solution to wide range of remote monitoring and control applications. Historical and real time data can be accessed world wide using the GSM network. The system can also be configured to transmit data on alarm or at preset intervals to a mobile phone using SMS text messaging. The proposed system monitors and controls the humidity from the remote location and whenever it crosses the set limit the LPC2148 processor will sends an SMS to a concerned plant authority(s) mobile phone via GSM network. The concerned authority can control the system through his mobile phone by sending AT Commands to GSM MODEM and in turn to processor. Also the system provides password security against operator misuse/abuse. The system uses GSM technology [3] thus providing ubiquitous access to the system for security and automated monitoring and control of Humidity.**

Keywords-Automation, GSM, SMS, Humidity Sensor (HSM-20G), ARM Controller LPC2148, Remote Monitoring & Control, AT Commands, Password Security, Mobile phone.

I. INTRODUCTION

Remote Monitoring, Control and intelligent maintenance is one of the most important criteria for maximizing production and process plant availability. Wireless media has been undergoing a rapid innovation process in search for a reliable, simple and business-viable technology for fast, easy and inexpensive diagnosis of faults in industries.

Today, growth is coming from global expansion and services. A new surge of growth will come through new technology (Wireless) [4], production at the lowest cost for global distribution, and fast time-to-market. A Wireless Industrial Automation communications segment, at the present time, presents a mixture of standardized and proprietary technologies.

Recently, there has been much interest in remote monitoring and control in the field of the Industrial automation. There has also been much interest in wireless communication [5] in industrial sector for uses in automation as well as to increase the safety and security standards. There is a great deal of benefits for industries to adopt the wireless communication to control systems. Currently the common conditions of use of SCADA systems [6] only allow for control and supervision to take place when the operator and the plant being observed are in the same general vicinity. It led to the emergence of the wireless remote monitoring and control systems. This contribution develops the systematic design methods for the development of a low cost GSM SMS-based Humidity Remote Monitoring and Control system for industrial applications over the wireless communication. Measurement and control of relative humidity [7] has significant appliance in industry, science, healthcare, agriculture and controlling technological processes. This is the main objective and focus of the present work.

The use of mobile phones or handsets has grown exponentially over the years [8]. As the number of mobile phone users increased, the technology and infrastructure supporting the handsets have also evolved to cope with the traffic created by the number of users. On top of that, the demands of mobile phone users have also changed, and the average mobile phone of today can do many things that would have never been dreamt of 10 years ago.

The dominant mobile phone network in the world today is GSM. It is a digital mobile communication network, which developed, rapidly in recent years. This network has coverage in most urban areas and offer support for the SMS [9] that allows users to communicate with each other by sending short text messages to each other at minimal cost. The maximum length of the

messages cannot exceed 150 alphanumeric Latin characters. This is enough to send short alert messages or commands to remote system. In the world of automation and control, several methods have thus far been employed to attain remote monitoring and control of various processes. These attempts have met with varying levels of success.

The primary aim of this paper is to propose the concept of Development of a Low-Cost GSM SMS-Based Humidity Remote Monitoring and Control system for Industrial Applications using the combination of a Embedded ARM Controller (ARM7 TDMI-S LPC2148) [10] and a GSM communications module linked by a serial communications port. Using this relative humidity could be efficiently recorded from the remote location and whenever it crosses the set limit, the ARM processor will send an SMS alert to a concerned authority(s) mobile phone. The concerned authority(s) can control the system through the mobile phone by sensing AT commands to the GSM MODEM. Also the system provides password security against operator misuse/abuse

The benefits of this paper are:

- Flexibility / modularity in control by the use of an ARM processor.
- Global coverage through the use of the GSM network.
- Extremely low cost device adapted for different applications.
- Scalable, Robust and Reliable.
- Provides password security.
- Efficient and cheap means of communication by use of SMS.
- True mobility using mobile phone sets.
- Ideal for monitoring and control critical plant on unmanned sites.

II. FUNCTIONAL BLOCK DIAGRAM AND DESCRIPTION

The Functional Block diagram of the entire system is as shown in the Figure 1. All the major subsystem blocks are shown with their interconnections to each module .The block diagram consists of Humidity Sensor (HSM-20G) , ARM TDMI-S LPC2148 Processor, GSM MODEM (SIM300), MAX232 Level converter and inverter, Controlling device, Mobile phone, Line driver ULN2003 and Relay set and Personal computer. In this application, the system was set up to monitor and control the relative humidity and ensures that it was within safe operating limits. The detailed descriptions of the blocks used in the system are explained below.

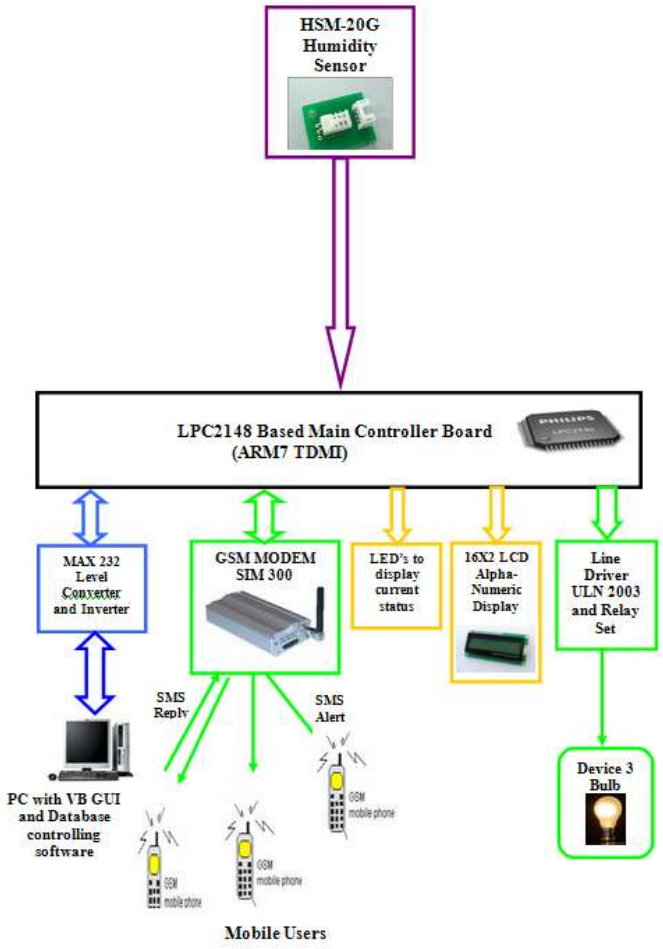

Figure 1: The Functional Block diagram

A. *ARM7 TDMI LPC2148 Processor*

The NXP (founded by Philips) LPC2148 is an ARM7TDMI-S based high-performance 32-bit RISC Microcontroller with Thumb extensions 512KB on-chip Flash ROM with In-System Programming (ISP) and In-Application Programming (IAP), 32KB RAM, Vectored Interrupt Controller, Two 10bit ADCs with 14 channels, USB 2.0 Full Speed Device Controller, Two UARTs, one with full modem interface. Two I2C serial interfaces, Two SPI serial interfaces Two 32-bit timers, Watchdog Timer, PWM unit, Real Time Clock with optional battery backup, Brown out detect circuit General purpose I/O pins. CPU clock up to 60 MHz, On-chip crystal oscillator and On-chip PLL. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit

DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

B. Sensors

Sensors are used for process monitoring and for process control. These are essential elements of safe and profitable plant operation that can be achieved only if the proper sensors are selected and installed in the correct locations. In this paper the sensor is for the measurement of relative humidity.

1) Humidity Sensor (HSM-20G)

Humidity sensor [11] is a device consisting of a special plastic material whose electrical characteristics change according to the amount of humidity in the air. Basically it is a sensor that senses the amount of water vapor in air. The module of HSM-20G is essential for those applications where the relative humidity can be converted to standard voltage output. The humidity sensor module HSM-20G is shown in Figure 2.

Figure 2: Humidity Sensor Module HSM-20G

The features of HSM-20G include:

- Voltage analog output for both humidity and temperature.
- Small size makes it easy to conceal
- Compatible with all types of microcontrollers
- High sensitivity to humidity in the air

C. GSM MODEM

A GSM modem is a specialized type of modem, which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone. A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it may be a mobile phone that provides GSM modem capabilities. A GSM modem could also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on computer. Any phone that supports the "extended AT command set" for sending/receiving SMS messages, as defined in the ETSI GSM 07.05 Specification can be supported by the Now SMS/MMS Gateway. In the proposed system we have used SIMCOM SIM300 GSM module.

SIM300 [12] is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz. SIM300 provides GPRS multi-slot class 10 capability and support the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.With a tiny configuration of 40mm x 33mm x 2.85 mm , SIM300 can fit almost all the space requirement in your application, such as Smart phone, PDA phone and other mobile device. The physical interface to the mobile application is made through a 60 pins board-to-board connector, which provides all hardware interfaces between the module and customers' boards. The SIM300 is designed with power saving technique, the current consumption to as low as 2.5mA in SLEEP mode. The SIM300 is integrated with the TCP/IP protocol, Extended TCP/IP AT commands are developed for customers to use the TCP/IP protocol easily, which is very useful for those data transfer applications.

D. Mobile Phone

A mobile phone also known as a wireless phone, cell phone, or cellular telephone is a little portable radio telephone. Mobile Phone can serve as powerful tool for world-wide communication. The Mobile Phone is a natural choice, since it is a communication resource generally available by people, which makes them practically always contactable and capable to send commands to operate the parameters in the industries.

The use of mobile phones or handsets has grown exponentially over the years. As the number of mobile phone users increased, the technology and infrastructure supporting the handsets have also evolved to cope with the traffic created by the number of users. On top of that, the demands of mobile phone users have also changed, and the average mobile phone today can do many things that would have never been dreamt of 10 years ago.

The mobile phone can be used to communicate over long distances without wires. It works by communicating with a nearby base station (sometimes called a "cell") which connects it to the main phone network. As the mobile phone moves around, if the mobile phone gets too far away from the cell it is connected to, that cell sends a message to another cell to tell the new cell to take over the call. This is called a "hand off," and the call continues with the new cell the phone is connected to. The hand-off is done so well and carefully that the user will usually never even know that the call was transferred to another cell. Since a cell phone allows you to be anywhere, and to move around while calling, they became very popular.

E. MAX 232 Level Converters

Since the RS232 is not compatible with today's Microprocessors and Microcontrollers, we need a line driver or voltage converter to convert RS232's signals to TTL voltage levels. One example of such a converter is MAX 232 from Maxim corp. The MAX232 converter converts from RS232 voltage levels to TTL voltage levels and vice versa. One advantage of the MAX232 chip is that it uses a +5v power source, which is the same as the source voltage for the microcontroller. In other words,

with a single +5v power supply we can power both the microcontroller and MAX232, with no need for the dual power supplies that are common in many older systems. The MAX 232 has two sets of line drivers for transferring and receiving data.

F. Line Driver (ULN 2003)

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers. The ULN2003 has a 2.7kilo ohms series base resistor for each Darlington pair for operation directly with TTL or 5V CMOS devices. The features are 500mA rated collector current (Single output), High-voltage outputs: 50V, Inputs compatible with various types of logic, Relay driver application.

G. Controlling Device

The device used to control the humidity in the industry is Alarm.

H. Personal Computer

A Personal computer is a programmable machine that receives input, stores and manipulates data, and provides output in a useful format. A personal computer may be a desktop computer, a laptop, a tablet PC, or a handheld PC. The most common microprocessors in personal computers are x86-compatible CPUs. Software applications for personal computers include word processing, spread sheets, data bases, Web browsers and e-mail clients, games, and myriad personal productivity and special-purpose software applications. Modern personal computers often have high-speed or dial-up connections to the Internet allowing access to the World Wide Web and a wide range of other resources. Personal computers may be connected to a local area network (LAN), either by a cable or a wireless connection.

The data logging is achieved continuously by the ARM7 TDMI LPC2148 processor to the personal Computer via the MAX232. This data is received by the software running on the PC and continuously updates a database by using Visual Basic and also we can generate reports and graphs automatically. Focusing on the client requirements, the following capabilities have been provided in the software.

- **Monitoring** – This is the main feature of the system where extracted information is presented for the operator in near real-time. Monitoring has been divided in two sections.
- **Full graphical data representation** – In this section, the user is able to monitor the plant in a very user friendly manner where details are represented in dynamic graphical interfaces in personal computer.
- **Text base data representation** – In this section, the near real time details are represented in tables without graphical objects.

III. HARDWARE IMPLEMENTATION AND DESCRIPTION

The circuit diagram of the entire system is as shown in the Figure 3.

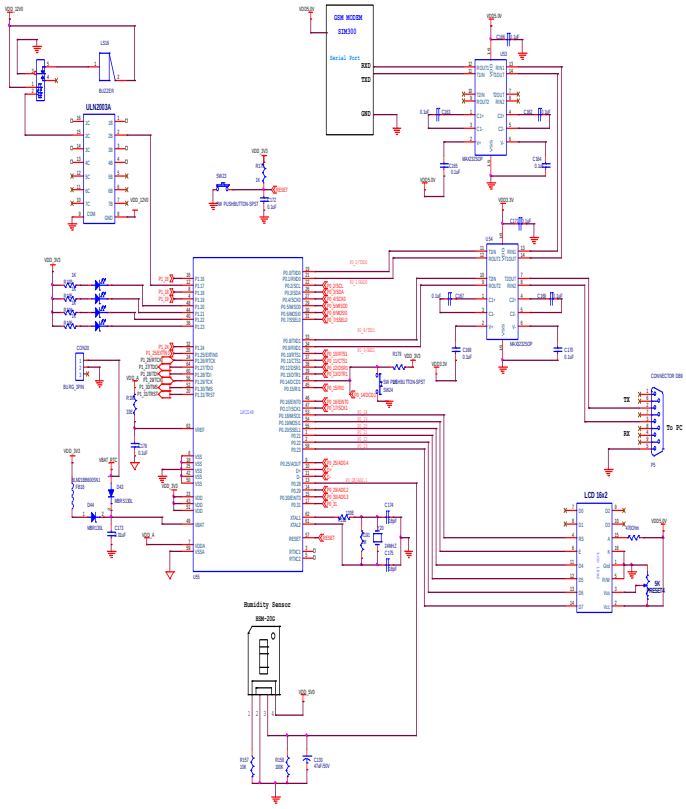

Figure 3: Circuit diagram of the entire system

The circuit diagram of the entire system is shown in Figure 3. Humidity is taken as a parameter and the humidity sensor HSM-20G will sense the humidity and will give a voltage output corresponding to the humidity value. This signal is taken into LPC2148 processor through the analog input channel for comparison. This signal is digitized using the inbuilt 10-bit ADC of the LPC2148 processor and compare the data with its threshold value for any status changes or value crossing the limit. If the value is more than the threshold limiting alert the concerned authority(s) by sending an SMS through GSM MODEM to his/her Mobile phone and switch the Bulb ON. If the values are within limits switch

the Bulb OFF. The authority(s) concerned to the plant can control the threshold value by changing the humidity value or by switching ON the Bulb by sending AT commands to GSM MODEM, which will be directed to the processor. The authority(s) can also monitor the status of the humidity value remotely through his/her mobile phone by issuing a string of commands to GSM MODEM and in turn to the processor. The measured values are displayed in personal computer for further analysis to download reports and graphs.

IV. SOFTWARE DEVELOPMENT

The software for the system is developed in Embedded C and Visual Basic. The flowcharts depicting the monitoring and the control of humidity are shown in Figure.4 and Figure.5.

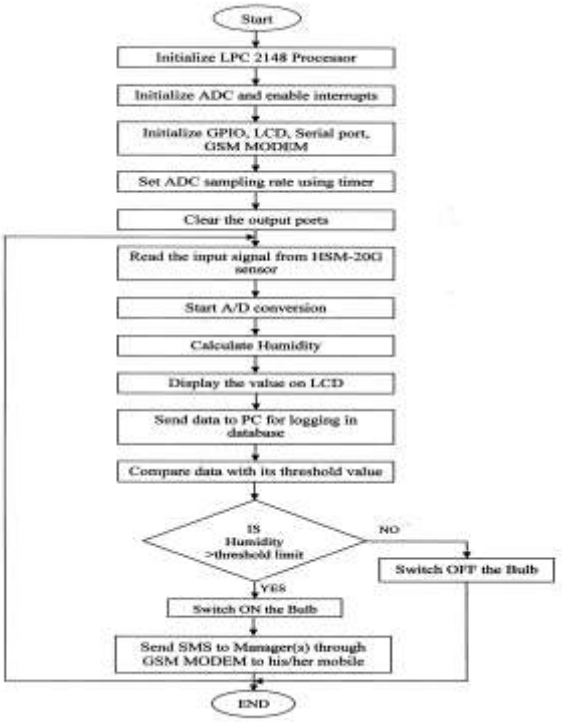

Figure 4: The flowchart for monitor process

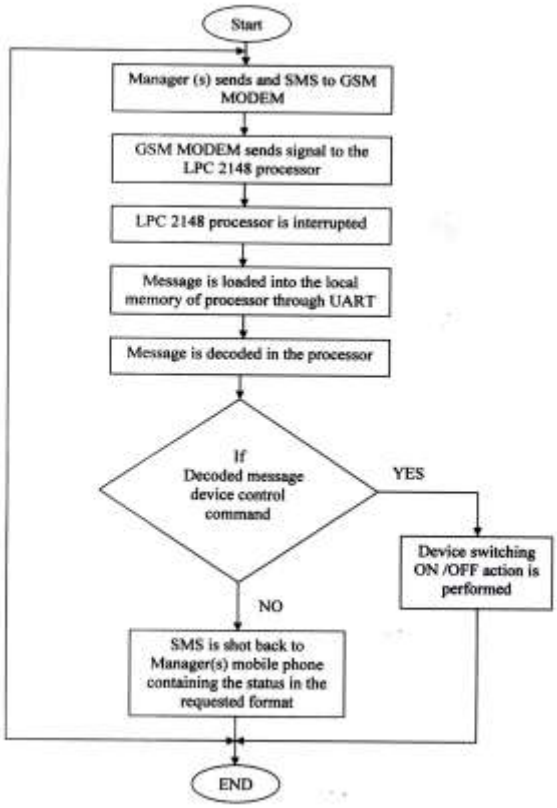

Figure 5: The flowchart for Control process

V. RESULTS AND DISCUSSION

The results obtained by using the proposed system are discussed in this section. Figure 6 shows the measurement and control of Humidity in the graphical representation, Figure 7 shows the status of the humidity in the mobile phone, Figure 8 shows the device status, current data and high limit values of sensors.

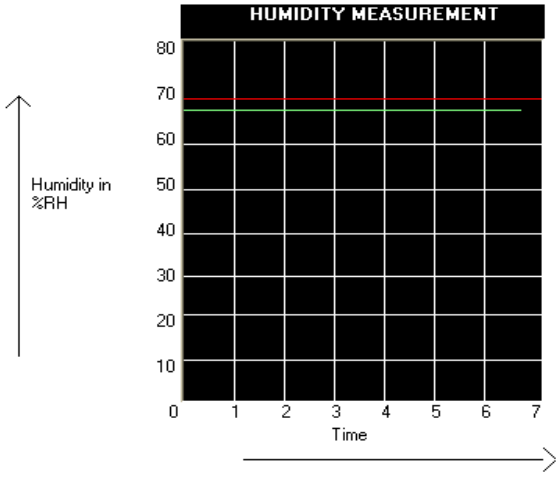

Figure 6: Graphical Representation of Humidity Measurement

Figure 7: Status of Humidity in the Remote Mobile Phone User

Figure 8: Device status, Current data and High limit values of sensors

In RMACS if there is any deviation observed in the measured value the remote user can change the set point value with his mobile phone by sending command " SET HUMI XXXX %RH " where XXXX indicates the value. The designed RMACS tested with remote user mobile phone for different set points along with measured values of humidity with real time is shown in Figure 9. System is tested with the standard set point and also with different set point values in the present study. The results are tabulated in Table 1.

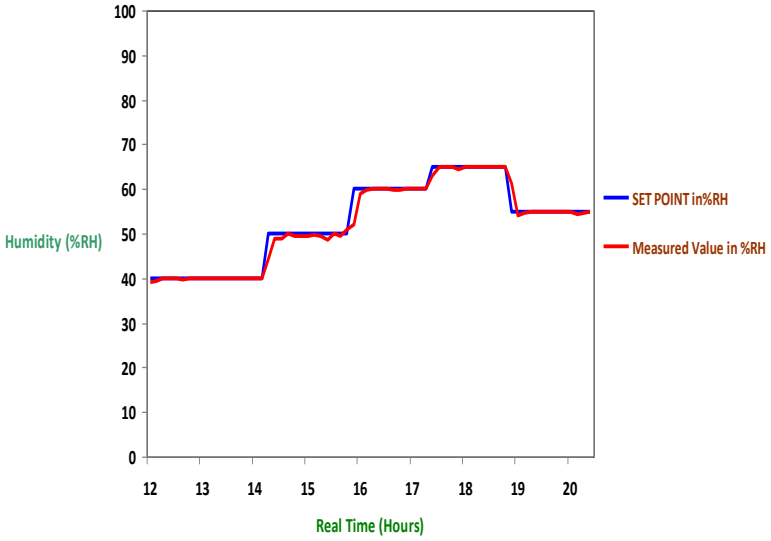

Figure 9:Graphical Representation of Humidity with different set point values

Humidity %RH	Bulb Status	SMS status	SMS Message
10	OFF	NO	___
20	OFF	NO	___
35	OFF	NO	___
40	OFF	NO	___
65	ON	YES	Humidity crossing limit
70	ON	YES	Humidity crossed limit

Table 1: Results of the system

The above results confines that the monitoring and control device is always with the concerned authority(s) and also it is possible to read the data from any remote place. If the input value is near or more than the threshold limit then the processor will sends an SMS as "Humidity crossing limit" or "Humidity crossed limit" to a authority(s) mobile phone through GSM MODEM. The authority(s) concerned to the plant can control the set point by changing the input value or can switch ON the Bulb by sending AT commands to GSM MODEM, which will be directed to the processor. The authority(s) can also monitor the status of the Humidity remotely by issuing a string of commands to GSM modem and in turn to the processor. The measured values are stored in personal computer for further analysis to download the reports and graphs. The system was tested by measuring humidity up to %90 RH and the results are in good agreement with experimental values.

VI. CONCLUSION

The system has provided a low cost, secure, ubiquitously accessible, remotely monitored and controlled solution for automation of industries has been introduced. The use of a ARM Processor, GSM module, Sensors and actuators provide exciting possibilities. However as far as the industrial applications are concerned this can be viewed as a low cost, customized wireless RMACS system. Thus this solution can be customized to suit any other industrial requirement related to monitoring and controlling provided industrial sensors are in use.

The approach discussed in the paper is novel and has achieved the target to control humidity remotely using the GSM SMS-based system satisfying user needs and requirements. GSM technology capable solution has proved to be controlled remotely, provide security and is cost-effective as compared to the previously existing systems. Hence we can conclude that the required goals and objectives of the system have been achieved.

REFERENCES

[1] Drumea A, Popescu Camelia, Svasta P, GSM Solutions for Low Cost Embedded Systems for Industrial Control, 28th Int. Spring Seminar on Electronics technology, IEEE, 2005, pp. 226-230.

[2] Malik Sikandar Hayat Khiyal, Aihab Khan, Erum Shehzadi "SMS Based Wireless Home Appliance Control System (HACS) for Automating Appliances and Security", Issues in Informing Science and Information Technology, Volume 6, 2009.

[3] Chen Peijiang Xuehua, "Design and Implementation of Remote Monitoring System Based on GSM", 2008 IEEE Pacific-Asia Workshop on Computational Intelligence and Industrial Application

[4] Ciubotaru-Petrescu B, Chiciudean D, Cioarga R,Stanescu D,"Wireless Solutions for Telemetry in Civil Equipment and Infrastructure Monitoring", 3rd Romanian-Hungarian Joint Symposium on Applied Computational Intelligence (SACI) May 25-26, 2006.

[5] Catalin Pancu, Adrian Baraboi, Maricel Adam, Adrian Plesca, GSM Based Solution for Monitoring and Diagnostic of Electrical Equipment, Proceedings of the 13th WSEAS International Conference on CIRCUITS.

[6] Daniel J.S.Lim, Vishy Karri,"Remote monitoring and control of hydrogen Safety Via SMS", 1st International Conference on Sensing Technology November 21-23, 2005 Palmerston North, new Zealand.

[7] Grisha Spasov, Nilolay Kakanakov, Measurement of Temperature and Humidity using SHT 11/71 intelligent Sensor, ELECTRONICS'2004, 22-24 September, Sozopol, BULGARIA.

[8] Ken Wieland, "Spreading the Word" Telecommunications Magazine International Edition October 2004, Issue Highlights.

[9] Puneet Gupta, SMS: How, what and where, Wireless Developer Network

[10] Trever Martin, The Insider's Guide to the Philips ARM7 Based Microcontroller, CEng MIEE, Feb 2005

[11]HSM-20G Humidity Sensor Module, datasheet from seeedstudio.com.

[12] http://www.shoky.com.tw/en/PDF/SIM300.pdf

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Design, Development and Simulations of MHD Equations with its proto type implementations

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***Abstract*— The equations of motion of conducting fluid in a magnetic field are formulated. These consist of three sets. First is the mass conservation equation, second Navier Stokes equation which is Newton's second law taking into account the force of magnetic field on moving charges. The electrical field effects are neglected as is usually done in MHD. The third set is Maxwell's equation especially to monopole condition along with Ampere's law with the current given by ohm's law in a moving frame (the frame in which the moving particles of fluid is at rest).The mass conservation equation assuming the fluid to be incompressible leads us to express the velocity field as the curl of a velocity vector potential. The curl of the Navier Stokes equation leads to the elimination of pressure, there by leaving with an equation involving only magnetic field and the fluid velocity field. The curl of the Ampere law equation leads us to another equation relating to the magnetic field to the velocity field. A special case is considered in which the only non vanishing components of the fluid are the x and y components and the only non vanishing component of the magnetic field is z component. In this special case the velocity vector potential only has one non zero component and this is known as stream function. The MHD equation in this reduces to three partial differential equations for the three functions in 2D model. Ψ stream function embeds v_x and v_y components. Application of MHD system prototype has been worked and presented.**

Keywords- Lorentz force, Navier Stokes Equation, Maxwell's Equation, Iterative Solution, Prototype.

I. INTRODUCTION

Magneto hydrodynamic equation solutions in the field of fluid dynamic have been very recent in many of the applications.. In current era, there has been a growing interest of research in the interaction between ionic currents in electrolyte solutions and magnetic fields. Magneto hydrodynamics (MHD) (magneto fluid dynamics or hydro magnetic) is the academic discipline, which studies the dynamics of electrically conducting fluids. Examples of such fluids include plasmas, liquid metals, and salt water. The word magneto hydrodynamics (MHD) is derived from magneto- meaning magnetic field, and hydro- meaning liquid, and dynamics meaning movement. MHD is the study of flow of electrically conducting liquids in electric and magnetic fields. Magneto hydrodynamics involves then a combination of both electrical and magnetic fields in order to induce mechanical flow in a fluid that is made conductive by dissolving an electrolyte in it. Since the ionic flow in the magnetic field is the cause of the movement of the conductive fluid, then it is necessary to understand the properties of the electromagnetic forces at work.

The idea of MHD [1-5] is that magnetic fields can induce currents in a moving conductive fluid, which create forces on the fluid, and also change the magnetic field itself. The set of equations which describe MHD are a combination of the Navier-Stokes equations of fluid dynamics and Maxwell's equations of electromagnetism

These differential equations have to be solved simultaneously, either analytically or numerically. MHD is a continuum theory and as such it cannot treat kinetic phenomena, i.e. those in which the existence of discrete particles or of a non-thermal velocities distribution are important. The electric currents transmitted in an electrolyte solution interact with the magnetic field to form Lorentz body forces that in turn, drive fluid motion. Lorentz force is the flow in the direction perpendicular to both magnetic and electric fields in conductive, aqueous solutions in the MHD system.

The phenomenon is commonly referred to as magneto-hydrodynamics (**MHD**). The modelling of MHD flow of electrolytes can be often more complex than that of liquid metals since the local electric conductivity is a function of the electrolytes concentration. The MHD flow is governed by classical fluid dynamics and electromagnetic, including a set of coupled partial differential equations that express the conservation of mass continuity and Navier Stokes equation joined to the Maxwell's, current continuity and constitutive equations.

Navier Stokes equation is nonlinear PDE based on Newton's second law. Navier stokes equation dictates velocity not position. When mean free path becomes comparable to the flow characteristics length scale i .e. Molecule length scale that is smaller than mean free path flow deviates from Navier stokes equation. It is quantified by $\mathrm{K}_n = \lambda/L$. Solution to Navier Stokes [1-3] equation is called velocity field or flow field description of fluid flow at given point in space and time. Once velocity is solved then flow rate and drag can be evaluated. In the absence of steep gradients in fluid properties NS ceases to be valid and similar when Knudson no increases.

Magnetohydrodynamic (MHD)[3-5] is the theory of the interaction of electrically conducting fluids and electromagnetic fields. In this paper, electrically conducting

fluid flow constrained in a rectangular MHD duct, where a uniform magnetic field is applied perpendicular to the stream-wise direction and to the homogeneous electric field. Our model treats the electrolyte as a conductor, and uses current and momentum conservations. Application to MHD can be to drive and control flows in micro fluidic sensors, networks, astronomy [5-7] and geo-physics and liquid metal cooling of nuclear reactors, electromagnetic casting of metals, MHD power generation and propulsion systems[8-10] .

This document is organized in six main sections. The first section is devoted to the fundamentals of magneto hydrodynamic. In the second section, the magneto hydrodynamic 2D modelling with all relevant formulations are presented. Section three discusses special case for z axis. Evaluated results are presented in section four. Section five deals with its proto type implementation. Conclusion has been briefed in section six.

II. MHD FORMULATIONS

Despite its apparent simplicity, MHD describes a remarkably rich and varied mix of phenomena. MHD theory is a marriage between fluid mechanics and electromagnetism. Subject is one whose development continues to flourish. The MHD flow is governed by classical fluid dynamics and electromagnetic, including a set of coupled partial differential equations.

let there be a conducting fluid $having\ \sigma$ conductivity, ρ mass density , p Pressure, $\nu = \eta / \rho$ kinetic viscosity, R Reynolds Number, v velocity of fluid and J= ρ V mass flux density , J = $\boldsymbol{\sigma}$ (E + V x B), where J= Current Density , B is Magnetic Field ,E= Electric Field, F = J X B, where F Lorentz force i.e. force on this current on the fluid per unit volume, Navier Stoke's [1] equation is given by the relation

$$\rho (v . \nabla v + v, t) = -\nabla p + \eta \nabla^2 v + J \times B$$

Above can be expressed as

$$\rho (\Omega \times v + \frac{\nabla^2 v}{2} + v, t) =$$

$$- \nabla p + \eta \nabla^2 v + J \times B \quad (2)$$

Where $\Omega = \nabla \times v$ is vorticity.

$$\rho (\Omega \times v + \nabla^2 v /2 + v, t) =$$

$$- \nabla p + \eta \nabla^2 v + J \times B \quad (3)$$

Taking curl of equation (3) to eliminate pressure term

$$(\nabla \times (\Omega \times v) + \Omega, t) = v \nabla^2 \Omega + \nabla \times (J \times B) \quad (4)$$

Evolution of 2D solution of the above equation

As $\vec{v} = \vec{\nabla} \times \vec{\psi}$

$\Omega = \nabla \times v = \nabla \times \nabla \times \psi$

V = $v_x \hat{x} + v_y \hat{y}$ (for 2D flow)

B = $B_z \hat{z}$

$\nabla^2 \Omega = \nabla (\nabla . \Omega) - \nabla \times \nabla \times \Omega$

$\nabla \times (\Omega \times v) =$

$$\hat{k} \quad [\frac{\partial}{\partial x}(v_x \frac{\partial v_y}{\partial x} - v_x \frac{\partial v_x}{\partial y}) +$$

$$\frac{\partial}{\partial y}(v_y \frac{\partial v_y}{\partial x} - v_y \frac{\partial v_x}{\partial y})]$$

$$\frac{\partial \Omega}{\partial t} = \hat{k} \frac{\partial}{\partial t} [\frac{\partial v_y}{\partial x} - \frac{\partial v_x}{\partial y}]$$

$\nabla \times \nabla \times \Omega =$

$$\hat{k} [[-\frac{\partial^3 v_y}{\partial x^3} + \frac{\partial^3 v_x}{\partial^2 x \partial y}] - [\frac{\partial^3 v_y}{\partial^2 y \partial x} - \frac{\partial^3 v_x}{\partial y^3}]]$$

$$\nabla \times J \times B = \hat{k} (\frac{\partial v_x B_z^2}{\partial x} - \frac{\partial v_y B_z^2}{\partial y})$$

$\nabla \times B = (\mu J + \mu \in E, t)$;

On neglecting displacement current

$J = \frac{\nabla \times B}{\mu}$;

We have force per unit volume due to electromagnetic field as

$F = \mu^{-1} (\nabla \times B) \times B$

$= \mu^{-1} B . \nabla B - \frac{1}{2\mu} (B^2)$

We thus get Navier stroke's equation as

$$(\nabla \times (\Omega \times v) + \Omega, t) = v \nabla^2 \Omega + \frac{1}{\mu p} \nabla \times (\Omega B \times B)$$

Where $\Omega B = (\nabla \times B) = \mu J$

If $v_x = \frac{\partial \psi}{\partial y}$, $v_y = -\frac{\partial \psi}{\partial x}$

The equation (4) can be reduced in terms of two variable i.e. B Magnetic field and ψ Stream function.

Hence above equation can be reduced

$$\hat{k}\,[-\frac{\partial^2\psi}{\partial x\,\partial y}\,\frac{\partial^2\psi}{\partial x^2}-\frac{\partial\psi}{\partial y}\,\frac{\partial^3\psi}{\partial x^3}-\frac{\partial^2\psi}{\partial y\,\partial x}\,\frac{\partial^2\psi}{\partial y^2}-\frac{\partial\psi}{\partial y}\,\frac{\partial^3\psi}{\partial^2 y\partial x}+\frac{\partial^2\psi}{\partial y\,\partial x}\,\frac{\partial^2\psi}{dx^2}+\frac{\partial\psi}{\partial y}(\frac{\partial^3\psi}{\partial y\partial^2 x})+\frac{\partial^2\psi}{\partial y\,\partial x}\,\frac{\partial^2\psi}{\partial y^2}+$$

$$\frac{\partial\psi}{\partial x}\,\frac{\partial^3\psi}{\partial y^3}\,]+\hat{k}\,\frac{\partial}{\partial t}\,[-\frac{\partial^2\psi}{\partial x^2}-\frac{\partial^2\psi}{\partial y^2}\,]\quad=$$

$$\upsilon\,\hat{k}\,[-[\frac{\partial^4\psi}{\partial x^4}+\frac{\partial^4\psi}{\partial x^2\partial y^2}]-[-\frac{\partial^4\psi}{\partial y^2\partial x^2}-\frac{\partial^4\psi}{\partial y^4}\,]\,]$$

$$+\sigma\,\hat{k}\,[\,\frac{\partial}{\partial x}\,[\,\frac{\partial\psi}{\partial y}B_z 2\,]+\frac{\partial}{\partial y}\,[\,\frac{\partial\psi}{\partial x}B_z 2\,]\qquad(5)$$

As per Maxwell's Ampere's law

∇ x E = — B, t ;

Taking curl on both sides and solving

$(\nabla^2 \mathrm{B} - \mu\sigma\,\mathrm{B},\mathrm{t}\,) + \mu\sigma\nabla\,\mathrm{x}\,(v\,\mathrm{x}\,\mathrm{B}) = 0$

When fluid velocity and magnetic field are

Functions of x, y, t .

$$\nabla^2 B_0 - \mu\sigma\,B,\mathrm{t} + \mu\sigma\nabla\,\mathrm{x}\,(\mathrm{V}\,\mathrm{x}\,B) = 0$$

Here v_x, v_y , B_z are functions of x, y, t

$$(\nabla\,\mathrm{x}\,V\,\mathrm{x}\,B)_x = (V\,\mathrm{x}\,B)_{y,z} - (V\,\mathrm{x}\,B)_{z,y}$$

$$(\nabla\,\mathrm{x}\,V\,\mathrm{x}\,B)_y = (V\,\mathrm{x}\,B)_{z,x} - (V\,\mathrm{x}\,B)_{x,z}$$

$$(\nabla\,\mathrm{x}\,V\,\mathrm{x}\,B)_z = (V\,\mathrm{x}\,B)_{y,x} - (V\,\mathrm{x}\,B)_{x,y}$$

Evolution of 2D MHD system can be found under assumed initial and final conditions. Taking initial input as Gaussian pulse = $e^{-(t-t0)/\sigma^2}$

$$(\nabla^2.\mathrm{B} - \mu\sigma\mathrm{B},\mathrm{t}) + \mu\sigma\nabla\,\mathrm{x}\,(v\,\mathrm{x}\,\mathrm{B}) = 0$$

$$(\nabla^2.\mathrm{B} - \mu\sigma\frac{\partial B}{\partial t}) + \mu\sigma\nabla\,\mathrm{x}\,(v\,\mathrm{x}\,\mathrm{B}) = 0$$

Solving the above equation

∇ . B = 0,

∇ x E = — B, t

∇ x B = $\mu\sigma$ (E + v x B)

$$\nabla\,\mathrm{x}\,B = \hat{\imath}\,(\frac{\partial B_z}{\partial y}) - \hat{\jmath}\,(\frac{\partial B_z}{\partial x})$$

$$\nabla\,\mathrm{x}\,\nabla\,\mathrm{x}\,B = \hat{k}\,(-\frac{\partial^2 B_z}{\partial x^2} - \frac{\partial^2 B_z}{\partial y^2})$$

$$\mathrm{V}\,\mathrm{x}\,\mathrm{B} = \hat{\imath}\,(v_y B_z) - \hat{\jmath}\,(v_x B_z)$$

$$\nabla\,\mathrm{x}\,(\mathrm{V}\,\mathrm{x}\,B) = \hat{k}\,(-\frac{\partial v_x B_z}{\partial x} - \frac{\partial v_y B_z}{\partial y})\qquad(6)$$

Hence final reduced equation is given below in B and ψ variables.

$$\hat{k}\,(\frac{\partial^2 B_z}{\partial x^2} - \frac{\partial^2 B_z}{\partial y^2}) - \mu\sigma\,\hat{k}\,\frac{\partial B_z}{\partial t} -$$

$$\mu\sigma\,\hat{k}\,[\,\frac{\partial}{\partial x}(\frac{\partial\psi}{\partial y}B_z) - \frac{\partial}{\partial y}(\frac{\partial\psi}{\partial x}B_z)\,] = 0\qquad(7)$$

Taking initial magnetic field B_{z0} as Gaussian and initial electric field negligible. We shall solve this problem for Magnetic field, B and Stream function ψ taking them as function of x, y and . From above equation, we observe that velocity of conducting fluid is varying whenever magnetic field is changed and vice versa. Solution of above equation (7) has been worked out by iteration method. As equation (7) has been reduced to only two variables in stream function ψ and magnetic field B. We can solve this equation by Finite Difference Method numerically for computing stream function ψ and their corresponding magnetic field B by iterative solution. Now substituting the value of magnetic field obtained in the problem equation and solving it for new set of stream function ψ , we shall continue the same approach till convergence. Here we can assume initial stream function ψ as 2n $\pi\,radian$ and then proceed to evaluate their corresponding value magnetic field B. We have also worked this problem with experimental and analytical methods. It has been found[11] from results that computed results are in close proximity. We can get much better results if simulated for 3 D solution but process may be complex.

III. SPECIAL CASE FOR Z AXIS

One Special Case for Solution of MHD equation taking only z-axis into account.

As we know from Nervier Stokes equation

$$(\nabla\,\mathrm{x}\,(\vec{\Omega}\,\mathrm{x}\,\vec{v}) + \frac{\partial\dot{\Omega}}{\partial t}) = \nu\,\nabla^2\Omega + \frac{1}{\rho}\,\nabla\,\mathrm{x}\,(\vec{j}\,\mathrm{x}\,\vec{B})$$

$$\mathrm{J} = \sigma\,(\vec{v}\,\mathrm{x}\,\vec{B})$$

$v_x(\mathrm{t},\mathrm{x},\mathrm{y})\,\hat{x} + v_y(\mathrm{t},\mathrm{x},\mathrm{y})\,\hat{y}$

$\Omega_z = v_{y,x} - v_{x,y}$; angular velocity

$$\vec{\Omega}\,\mathrm{x}\,\vec{v} = \Omega_z\hat{z}\;\mathrm{x}\;v_x\,\hat{x} + v_y\,\hat{y}$$

$$= \Omega_z\,(v_x\,\hat{y} - v_y\,\hat{x})$$

$$\nabla\,\mathrm{x}\,(\vec{\Omega}\,\mathrm{x}\,\vec{v}) = [\,(\Omega_z\,v_x)_{,\,x} + (\Omega_z\,v_y)_{,y}]\,\hat{z}\qquad(8)$$

∇. v = 0

$v_{x,x} + v_{y,y} = 0$

$v_x = \psi_{,\,y}$

$v_y = -\psi_{,\,x}$

$\nabla \times (\vec{\Omega} \times \vec{v}) = \Omega_{z,x} v_x + \Omega_{z,y} v_y$

$\Omega_z = \psi_{,\,xx} - \psi_{,\,yy} = -\nabla^2 \psi$

where $\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}$

$\nabla \times (\vec{\Omega} \times \vec{v}) = -\nabla^2 \psi_{,x} (\psi_{,y}) - \nabla^2 \psi_{,\,y} (-\psi_{,\,x})$

$= (\psi_{,\,x} \nabla^2 \psi_{,\,y} - \psi_{,\,y} \nabla^2 \psi_{,\,x})$

$= \psi_{,\,x} \nabla^2 \psi_{,\,y} - \psi_{,\,y} \nabla^2 \psi_{,\,x} - \nabla^2 \psi_{,\,t}$

$-\nu \nabla^2 \nabla^2 \psi \hat{z} + \frac{\sigma}{\rho} \nabla \times ((\vec{v} \times \vec{B}) \times B$ (9)

$J = \sigma(\vec{v} \times \vec{B})$

$\nabla . B = 0$,

$(\vec{v} \times \vec{B}) \times \vec{B} = ((v_x \hat{x} + v_y \hat{y}) \times B_0 \hat{z}) \times B_0 \hat{z}$

$= (\vec{v} \times \vec{B}) - B^2 \vec{v}$

$= -B_0^2 (v_x \hat{x} + v_y \hat{y})$

$= B_0^2 (\psi_{,Y} \hat{x} - B_0^2 \psi_{,X} \hat{y})$ or $B_0^2 \psi_{,X} \hat{y} - B_0^2 \psi_{,Y} \hat{y}$

$\frac{\sigma}{\rho} ((B_0^2 \psi_{,x})_{,\,x} + (B_0^2 \psi_{,y})_{,y}) = \frac{2\sigma^2}{\rho} (B_{0,x} \psi_{,x} + B_{0,y} \psi_{,y})$

$\nabla \times B = \mu \sigma (\vec{v} \times \vec{B})$

$\nabla(\nabla . B) - \nabla^2 B = \mu \sigma \nabla \times (\vec{v} \times \vec{B})$

$\nabla^2 B_0 + \mu \sigma (\vec{v} \times \vec{B}) ((v_y B_0 , -v_x B_0 , 0)$

$(\nabla \times (\vec{v} \times \vec{B})) - (v_x B_0)_{,x} - (v_y B_0)_{,y}$

$= -v_x B_{0,x} - v_y B_{0,y}$

$= -\psi_{,y} B_{0,x} + \psi_{,x} B_{0,y}$

Hence $\nabla^2 B_0 - \mu \sigma (\psi_{,y} B_{0,x} + \psi_{,x} B_{0,y})$

$= 0$ (10)

Here we find solution for z- axis. We shall assume initial velocity and initial magnetic field by keeping electric field as negligible. We shall compute the changes in velocity and magnetic field iteratively by keeping initial conditions at an assumed value and then evaluate the results which shall follow the MHD principle and plot the simulation results. Basically magnetic and electric field are perpendicular to each other and velocity in the direction of plane is to be seen for z coordinate.

IV. EVALUATED RESULTS

Convergence plot for iterative solution of Magnetic field and Stream function have been shown in figure1- 5. Plot for B, vx and t has been presented. Velocity profile plots have been shown in fig 1-4. We have obtained two sets of equations after optimization and iterative solution have been worked with numerical technique for convergence using MATLAB. Figure1- 5 clearly depicts solution to this problem.

We have reduced system to two variables as seen from equation (5)and (7). For 2D analysis of MHD system figure (1- 4) presents magnetic field and velocity profile as function of x, y, t. We have observed that velocity variation is dependent on magnetic field and electric field during experimental results We have taken plot for stream function and magnetic field under certain boundary conditions and initial conditions in figure (1-5). Dimensions and material of electrodes, conductivity of fluid , dimensions of channel and working chamber with inlet and outlet, gap between electrodes and position of magnets producing cross field make the difference in velocity of fluid. Fluid velocity found to be increasing when any of the field is increasing during experiments. These results in line with numerical results obtained . Bubble formation due to electrolysis has observed in the conducting fluid when operated with DC source which produces retardation effect. During investigations bubble formation got reduced when MHD system operated with AC source and fluid velocity enhances significantly. MHD system has been observed bidirectional capability on electric field reversal. Heating of fluid takes place because of electric current in conducting fluid which need to be investigated for control of temperature rise. Life of the MHD system can be significantly large as compared to system having moving parts, as there are no moving part in the proposed system

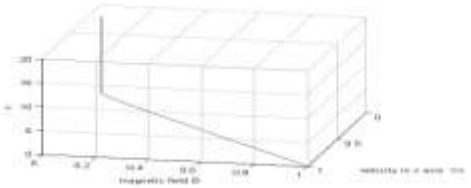

Figure 1 Velocity vx profile

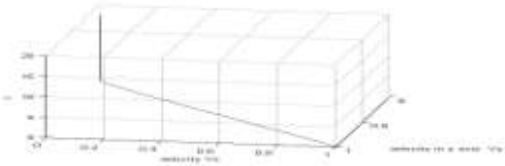

Figure 2 Velocity vy profile

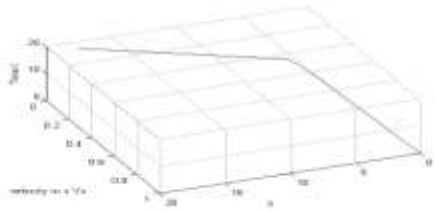

Figure3 Velocity vx profile

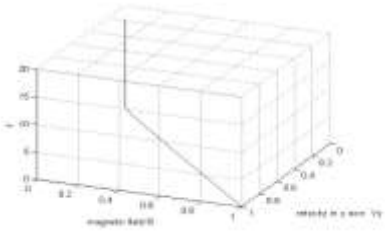

Figure 4 Velocity vy profile

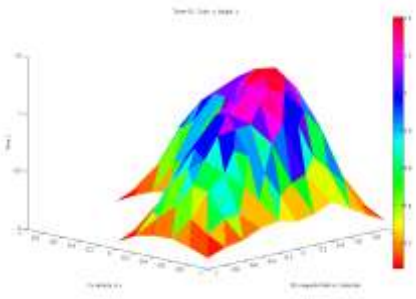

Figure 5 plot of Vx ,Bz and time t

V. PROTO-TYPE MHD SYSTEM

Magneto hydrodynamic system resulting pumping action when an electromagnetic field interacts directly with the conducting fluid. The current flow in a direction perpendicular to the direction of magnetic field causes the fluid to experience a force. The force is in a direction perpendicular to both the magnetic field and the current flow. This high conductivity fluid can be used to produce a useful pumping effect. The measurement of bead velocity under the influence of MHD has been difficult due to strong electro kinetic flow in the side-channel. We made visual estimations of bead velocity. Note that no movement in the main channel is observed when only the magnetic field is applied. We have fabricated MHD system using transparent cuboids having two electrodes of zinc plates of 7 cms with inlet and out let ports and with an excitation connector for AC / DC operating voltage. We have designed and developed its proto type model and operated on DC and AC supply both. Experiment for flow of conducting fluid based on MHD principle have been realized , video for the same has been prepared. First we have operated our proto type MHD system with 12 V DC car batteries and then same system we tried to operate with 230 V AC supply with rheostat arrangement. We varied electric and magnetic fields one by one and noticed flow of fluid. It was found to be varying proportional to fields as effective result i.e. flow of conducting liquid found to be dependent on Intensity of the magnetic and electric field.

Figure 6 Prototype of MHD system developed

Direction of flow fluid also noticed to be varying depending on polarity of the supply. Direction of flow of fluid getting opposite on reversing its polarity. The MHD system used NaCl (salty water) as conducting fluid. Two electrodes of zinc strips were connected with 12 V , 20Amp hr battery later with 20V-60V ac supply with a on/off switch. Model was provided with provision of inlet and outlet pipe with two small tanks for storage of conducting fluid. We have operated 12 V DC switch and observed that flow of conducting fluid have taken place. Then with changed input dc supply with AC source varying from 20V to 60 V and observed that there was significant enhancement in the velocity of the fluid as compared to DC source. These results were compared with analytical and numerical methods and found to be very close. More accurate results with data need better instrumentation for necessary set up and process to develop the same is under way.

An electrically conducting fluid (NaCl) using Lorentz force. (Force produced when an electric current is applied across a channel filled with conducting solution in the presence of a perpendicular magnetic field). Flow measurements by mixing salt solution by recording a five seconds movie by mobile video capture camera. The measurements carried out by varying the NaCl concentrations and the experiments were carried out varying both, the magnetic field and electric field . Figure 1 -5presents numerical results and fig 6 has been for experimental test set up of proto type with inlet ,outlet and MHD chamber with two permanent magnets.

VI. CONCLUSION

To summarize, inspection of the flow velocity characteristics shows that the Lorenz force effect has successfully accelerated the electrolytic solution. From Lorenz force analysis, we noticed that the oscillation amplitudes of the velocity increase with the increasing of the current density and the magnetic flux density. So, the flow rate becomes more significant with the increase of magnetic and current density value. The obtained results confirm a directly influence of the

external electromagnetic excitation and the chosen geometrical dimensions of the MHD. Bubble formation under DC source was observed inside the chamber. Bubbles produced in higher induced current not only retard flow motion, but also lower the hydraulic head.

This paper has presented for design and development with necessary simulation of MHD system. MHD system has been described by analytical, numerical and experimental methods. The concept has been new and has been worked for two dimensional solutions applying finite difference scheme. From results, we can conclude that the cited method achieves good convergence for velocity field and magnitude of flow rate can be more significant with AC source as compared with DC source, also formation of bubbles are less in AC source. Our research can be implemented for social usage in desert coolers as water sprinklers where we can implement pump without having any moving parts, with long life span as can be seen in our prototype model. We look forward for its realistic implementation. We have developed special case for z axis solution. Our future work shall be towards evolution of three dimensional MHD system taking Electric field into consideration. We have developed an efficient method for full system of PDE to reduced system of PDE. We intend to commercialize such MHD system in near future for social use and precision work in this direction is on the way.

VII. APPLICATIONS

Microwave propulsion, Satellite propulsion, Space weather, MEMS Development, Micro fluidic devices, Sensors and Actuators, Precision Switch, Stirring of fluids and Desert Cooler water Sprinkler etc.

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REFERENCES

[1] Bahadir, A.R. and T. Abbasov (2005). A numerical investigation of the liquid flow velocity over aninfinity plate which is taking place in a magnetic field. International journal of applied electromagnetic and mechanics 21, 1-10.

[2] EM Lifshitz and LD Landau "Electrodynamics of continuous media "Butterworth-Heinemann.

[3] Fermigier, M. (1999). Hydrodynamique physique. Problèmes résolus avec rappels de cours, collectionsciences sup. physique, edition Dunod.

[4] Wait, R. (1979). The numerical solution of algebraic equations. A Wiley-interscience publication.

[5] Chorin, A.J., 1986, "Numerical solution of the Navier-Stokes equations" Math. Comp
Vol. 22, pp. 745-762.

[6] Cramer, K.R. & Pai, S., 1973, "Magneto fluid Dynamics For engineers and Applied Physicists", McGraw-Hill Books.

[7] Feynman, R.P., Leighton, R.B. and Sands, M., 1964, "The Feynman Lectures on Physics" Addison-Wesley, Reading, USA, Chapter 13-1.

[8] Gerbeau, J.F. & Le Bris, C., 1997, "Existence of solution for a density dependant magnetohydrodynamic equation", Advances in

[9] Guermond, J.L. & Shen, J., 2003, "Velocity-correction projection methods for incompressible flows", SIAM J. Numerical Anal. Vol. 41, No. 1, pp. 112-134.

[10] Holman, J.P., 1990, "Heat Transfer" (7^{th} edition), Chapter 12, Special Topics in Heat Transfer, MacGraw-Hill Publishing Company, New York.

[11] PY Picard,"Some spherical solutions of ideal magnetohydrodynamic equations",Journal of non linear physics vol 14 no4 (2007),578-588.

Multipath Fading Channel Optimization for Wireless Medical Applications

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***Abstract*-- In this paper, a new method has been proposed to eliminate the intersymbol interference (ISI) and interchannel interference (ICI) for discrete multitone/orthogonal frequency division multiplexing (DMT/OFDM) systems by considering Time to Live (TTL) of multipath channel fading, especially for wireless medical application. In this method, the existence time of the packet is considered as the maximum propagation time and when the packet is sent to the receiver, the down count of the TTL starts. The existence of the packet in a network depends on TTL in an Internet Protocol (IP) packet that tells a network router whether or not the packet has been in the network too long and should be discarded. The proposed structure prevents ICI with a preprocessing method that utilizes a particular time that is equal to the continuation time of the packet and removes ISI by canceling the replica at the receiver. The simulation results show that the proposed method reduces the BER/ISI better under mutipath fading environment than other existing system.**

Keywords: ISI, ICI, OFDM, TTL, Channel Fading

I. INTRODUCTION

Recently, multipath fading channel is an imperative aspect for wireless communication, especially for biological data transmission. Fading is a serious impairing effect introduced by the radio wave's propagation through the channel and causes a big problem to the signal detection process at the receiver. When the signal experiences fading in the channel, both its envelope and phase will fluctuate over time. Where a coherent modulation scheme is concerned, the fading effects on the signal phase can seriously impair performance, unless some necessary measures are taken to compensate for them at the receiving end even at the cost of complexity of the receiver. In many cases, analysis of systems using such coherent modulation schemes assumes that the phase effects due to fading are perfectly corrected by the receiver randomness to the received signal [1]. So, it is needed to remedy the problem regarding this. There are many works on multipath channel fading [2-11]. Van Duc Nguyen et al considered the case of time-invariant channel for intersymbol and intercarrier interference [2]. Cheol-Jin Park et al described a new method to eliminate intersymbol interference (ISI) and interchannel interference (ICI) for discrete multitone/orthogonal frequency division multiplexing (DMT/OFDM) systems with insufficient cyclic prefix (CP) [3]. Yun Hee Kim et al analyzed the combined influence of the interchannel and intersymbol interferences, which result from the time variation and delay spread of mobile channels, on the performance of an orthogonal frequency-division multiplexing (OFDM) system [4]. Wei Zhong et al proposed two novel iterative cyclicity restoration (CR) schemes to efficiently cancel the interferences for OFDM-based wireless local area network (WLAN) systems [5]. Noriyoshi Suzuki et al proposed a new OFDM demodulation method in order to reduce the influence of the ISI and improved the bit error performance in the presence of multipath whose excess delays are longer than the Guard Interval [6]. Most of the works focused on to reduce the ISI and ICI and improved the bit error rate. Still the ISI and ICI tendency is being appeared in the existing work. In this method, the existence time of the packet is equal to the maximum propagation time and when the packet is sent to the receiver, the down count of the TTL starts. Time-to-Live (TTL) is a value in an Internet Protocol (IP) packet that tells a network router whether or not the packet has been in the network too long and should be discarded. When the TTL is equal to zero of a particular packet, the corresponding packet is discarded. In the proposed OFDM symbol the TTL value tells the network that how much time it travels in the network. Let, 20ms is the time require for an OFDM symbol to travel from transmitter to receiver. When one symbol is reached to the receiver, the receiver is ready to receive the next symbol. When the next symbol is reached to the receiver the replica of the pervious symbol is also reached to the receiver. This is how the ISI happened. If the TTL is set in the OFDM symbol less than 25ms, after 25ms the replicas of all symbols will be discarded and no ISI will be happen. In this paper, the ISI tendency has been eliminated mostly and an acceptable improvement of bit error rate has been introduced which is better than existing techniques. Simulation and results have been tested and verified using NS2.

II. BACKGROUND THEORY

A. Capacity of fading channels

The required theoretical background regarding the fading channel have been considered and discussed for the

proposed method.

Consider the complex baseband representation of a flat fading channel:

$$y[m] = h[m]x[m]+w[m]$$

Where {h[m]} is the fading process and {w[m]} is noise. As before, the symbol rate is W Hz, there is a power constraint of P joules/symbol, and $E[|h[m]|^2] = 1$ is assumed for normalization. Hence $SNR = P/N_0$ is the average received SNR [1].

B. Uplink fading channel

Let us now include fading. Consider the complex baseband representation of the uplink flat fading channel with K users:

$$y[m] = \sum h_k[m]\, x_k[m]+w[m],$$

where $\{h_k[m]\}_m$ is the fading process of user k. We assume that the fading processes of different users are independent of each other and $E[|h_k[m]|^2] = 1$. Here, we focus on the symmetric case when each user is subject to the same average power constraint, P, and the fading processes are identically distributed [1].

C. Effect of fading channel

Generally in telecommunication the fading channel/multipath propagation is the main reason for Intersymbol Interference (ISI). In telecommunication, intersymbol interference (ISI) is a form of distortion of a signal in which one symbol interferes with subsequent symbols. This is an unwanted phenomenon as the previous symbols have similar effect as noise, thus making the communication less reliable. ISI is usually caused by multipath propagation or the inherent non-linear frequency response of a channel causing successive symbols to "blur" together. The presence of ISI in the system introduces errors in the decision device at the receiver output. Therefore, in the design of the transmitting and receiving filters, the objective is to minimize the effects of ISI, and thereby deliver the digital data to its destination with the smallest error rate possible. Ways to fight intersymbol interference include adaptive equalization and error correcting codes [1].

D. Remedy of the effect of fading channel

In the fading channel generally the ISI is caused by creating the interference between the consecutive symbols. To eliminate this problem the Viterbi equalizer is used in GSM system and Rake receiver is used in CDMA system [1]. To avoid the ISI we proposed a new OFDM symbol structure that is given below. The extra parameter TTL (Time to leave) is added in the OFDM Symbol.

III. Proposed Method, Simulations and Results

Proposed OFDM packet format, Ns-2 simulation model, and algorithm have been introduced to overcome the problem. Time-to-Live (TTL) is a value in an Internet Protocol (IP) packet that tells a network router whether or not the packet has been in the network too long and should be discarded. In other words, it specifies the number of router hops the packet is yet allowed to travel before it must be discarded or returned. Time-to-Live is a field in the IP header of a packet and is defined to be a timer limiting the lifetime of a datagram. It is an 8-bit field and the units are seconds. The Time-to-Live (TTL) field of the IP header is defined to be a timer limiting the lifetime of a datagram. It is an 8-bit field and the units are seconds. Each router (or other module) that handles a packet MUST decrement the TTL by at least one, even if the elapsed time was much less than a second. Since this is very often the case, the TTL is effectively a hop count limit on how far a datagram can propagate through the Internet which is shown in fig. 1.

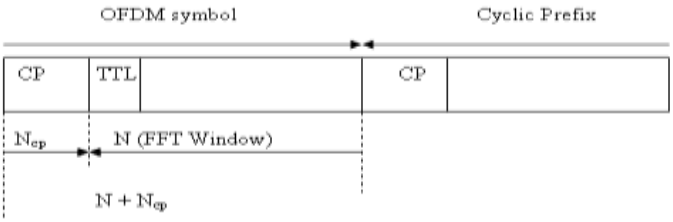


Fig.1 OFDM packet format using TTL

It is shown in Fig.2 that from node 0, data is being sent to destination node 10. Path 0-3-6-9-10 has been confirmed for packet propagation rather than other path while they are going to be eliminated. In this experiment, every node carries the TTL value and do perform correctly. To conduct the simulation perfectly, algorithm of TTL script has also been considered in the following.

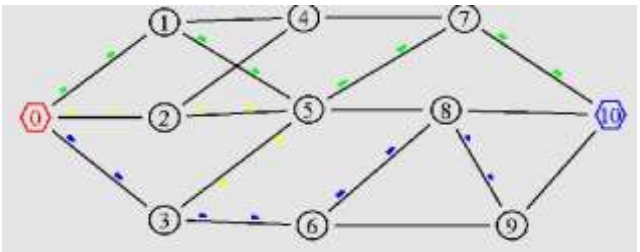


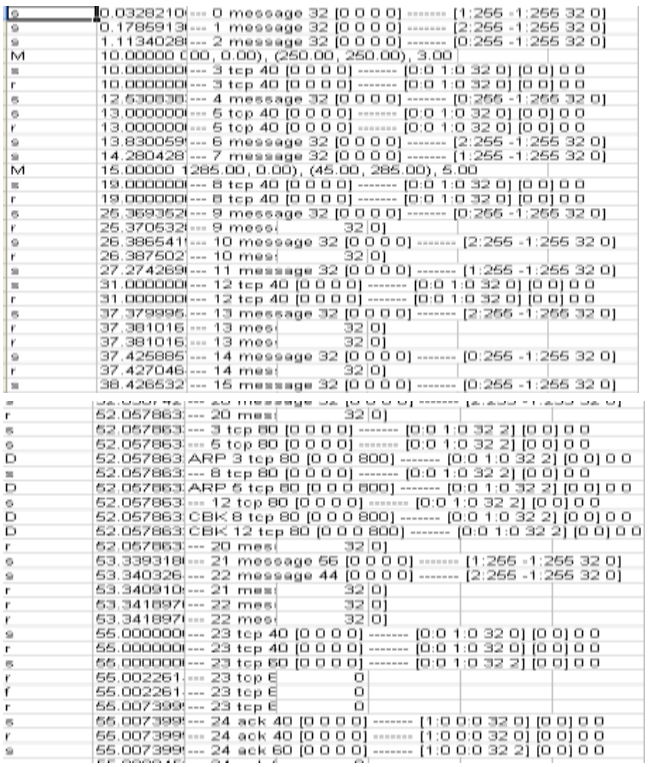
Fig.2 Simulation topology

TCL Script Algorithm:

Channel/WirelessChannel	set value	# channel type
Propagation/TwoRayGround	set value	# radio-propagation model
Phy/WirelessPhy	set value	# network interface type
MAC/802_11	set value	# MAC type
Queue/DropTail/PriQueue	set value	# interface queue type
LL	set value	# Link Layer type
Antenna/OmniAntenna	set value	# antenna model
[Numerical Value]	set value	# Max Packet in interface queue
[Numerical Value]	set value	# Number of mobile nodes
DSDV	set value	# Routing Protocol.
[Numerical Value]	set value	# X dimension of topography
[Numerical Value]	set value	# Y dimension of topography
[Numerical Value]	set value	# time of simulation End.

Fig. 3: Contents of the packet

System trade-offs are fundamental to all digital communication designs. It is important that the system performance may include to minimize probability of bit error and also to minimize required system bandwidth. Trade-off can be viewed as changes in the operating point on one of the curves or as changes in the operating point from one curve to another curve of the family. Movement of the operating point can be viewed as trading off between P_B and E_b/N_0 performances (with bandwith (W) fixed). Similarly movement can be viewed as trading off between P_B and W performances (with E_b/N_0 fixed). Also movement can be viewed as trading off between W versus E_b/N_0 performances (with P_B fixed). Simulation results based on the proposed method have been evaluated in the following figure.



During the experiment, 20898 packets have been sent on multipath fading channel and 21758 packets have been received, and 31 packets have been dropped which is mentioned in fig.3. Here the redundant bits are appeared in the receiver and movement can be viewed as trading off between W versus E_b/N_0 performances (with P_B fixed). From the fig.4 , movement along points B to D can be viewed as trading off between P_B and E_b/N_0 performance (with bandwidth (W) fixed). But the proposed model, movements along points B to C can be viewed as trading off between W versus E_b/N_0 performances (with P_B fixed). Error-correction coding needs redundancy. If we assume that the system is a real-time communication system (such that the message may not be delayed), the addition of redundant bits dictates a faster rate of transmission, which of course means more bandwidth [1].

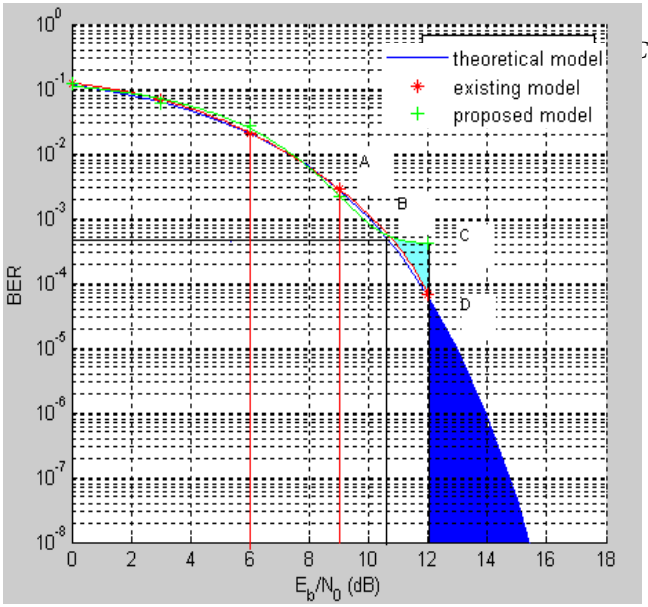


Fig.4: BER performance of the proposed model

This result ensures that due to the elimination effect of ISI and ICI, the bits of redundancy have been received and no bits are absolutely quite discarded.

IV. Conclusions

In this paper, BER performance by considering TTL rather than effects of the ICI and ISI on the performance of OFDM systems in a time-varying multipath fading channel has been analyzed. ISI and ICI have almost totally been eliminated by considering the TTL and it is showed that the BER performance has greatly improved. To verify the result, the performance of the proposed system was examined by analysis and simulation in NS2. And it is found that the proposed improved BER performance of OFDM is better than the existing technique.

References

[1] Bernard Sklar (2003) "Digital Communication", ISBN 81-7808-373-6.

[2] Van Duc Nguyen, Kuchenbecker, H.-P. (2002) "Intercarrier and Intersymbol Interference Analysis of OFDM Systems On Time-Invariant Channels" Indoor and Mobile Radio Communications.

The 13th IEEE International Symposium on Volume 4, 15-18 Sept. 2002 Page(s):1482 - 1487 vol.4.

[3] Cheol-Jin Park; Gi-Hong Im (Sept. 2004) "Efficient DMT/OFDM Transmission with Insufficient Cyclic Prefix" Communications Letters, IEEE Volume 8, Issue 9, Page(s):576 – 578.

[4] Yun Hee Kim; Iickho Song; Hong Gil Kim; Taejoo Chang; Hyung Myung Kim (Sept. 1999) "Performance Analysis of a Coded OFDM System in Time-Varying Multipath Rayleigh Fading Channels", Vehicular Technology, IEEE Transactions on Volume 48, Issue 5, Page(s):1610 – 1615.

[5] Wei Zhong; Zhigang Mao (May 2006) "Efficient Time-Domain Residual ISI Cancellation for OFDM-Based WLAN Systems", Consumer Electronics, IEEE Transactions on Volume 52, Issue 2, Page(s):321 – 326.

[6] Suzuki, N.; Uehara, H. Yokoyama, M. (2002) "A NEW OFDM DEMODULATION METHOD TO REDUCE INFLUENCE OF ISI DUE TO LONGER DELAY THAN GUARD INTERVAL" Communication Systems. ICCS 2002. The 8th International Conference on Volume 1, 25-28 Nov. 2002 Page(s):239 - 244 vol.1.

[7] Minn, H.; Zeng, M.; Bhargava, V.K. (July 2000) "On Timing Offset Estimation for OFDM Systems", Communications Letters, IEEE, Volume 4, Issue 7, Page(s):242 – 244.

[8] Shaoping Chen; Cuitao Zhu (Feb. 2004) "ICI and ISI Analysis and Mitigation for OFDM Systems with Insufficient Cyclic Prefix in Time-Varying Channels" Consumer Electronics, IEEE Transactions on, Volume 50, Issue 1, Page(s):78 – 83.

[9] Klenner, P.; Kammeyer, K.-D. (22-25 April 2007) "Spatially Interpolated OFDM with Channel Estimation for Fast Fading Channels" Vehicular Technology Conference, 2007. VTC2007-Spring. IEEE 65th Page(s):2455 – 2459.

[10] Wei Zhong; Zhigang Mao (May 2006) "Efficient Time-Domain Residual ISI Cancellation for OFDM-Based WLAN Systems" Consumer Electronics, IEEE Transactions on Volume 52, Issue 2, Page(s):321 – 326.

[11] Dah-Chung Chang (Dec. 2008) "Effect and Compensation of Symbol Timing Offset in OFDM Systems With Channel Interpolation" Broadcasting, IEEE Transactions on Volume 54, Issue 4, Page(s):761 – 770.

Performance Analysis of Indoor Positioning System

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***Abstract*- In the new era of wireless communication, Wireless Local Area Network has emerged as one of the key players in the wireless communication family. It is now a trend to develop the WLAN in various colleges and office campuses for increasing productivity and quality of goods. There are many obstacles when deploying WLAN, which demands seamless indoor handover. The objective of the work reported here is to develop modeling tools using QUALNET 5.0 simulation design tool for performance optimization of WLAN access points. To predict the signal strength and interference in a WLAN system, propagation model has been used.**

Keywords-WLAN, Access point, Path loss model, Qualnet 5.0.

I. INTRODUCTION

The popularity of IEEE 802.11 based wireless LAN has increased substantially in recent years. WLAN networks have become very popular means for providing a wireless networking facility for home users, educational institutions, companies etc. due to their ease of installation and their high data rate provision, apart from providing, although limited, mobility to users. Most of today's WLAN systems operate in the unlicensed 2.4 GHz band and follow the IEEE 802.11b standard, which is a wireless extension of the Ethernet standard and allows data rates up to 11 Mbps [2].

If the APs are placed too far apart, they will generate a coverage gap, but if they are too close to each other, this will lead to excessive co-channel interferences and increases the cost unnecessary. In this paper, we present methods to determine location in such a WLAN. For the indoor environment, there are two types of elements; namely static and dynamic elements. The static elements are such as natural and manmade materials. The dynamic element comprises of moving objects [3]. In an indoor environment, additional parameters must be considered, such as reflection, wall penetration, how fast the channel changes and etc.

The capability of QUALNET to simulate this indoor environment scenario close to the real situation condition motivates us to employ this software to further the study on RF indoor characteristics.

This paper is organized as follows: Section II presents the indoor path loss. Notations are given in section III. Section IV presents the mathematical model description and path loss model. Section V shows the algorithm of the access point's calculation. Section VI shows the comparison of various models. Section VII describes the method of testing. Section VIII shows the results. Finally, section IX gives the conclusion.

II. INDOOR PATH LOSS

Path Loss or attenuation of RF signals occurs naturally with distance. Obstacles between the transmitter and receiver also attenuate signals. The amount of attenuation varies with the frequency of the RF signal and the obstructing materials type and density [6]. Generally speaking, the lower the frequency of transmission the better the signal will travel through the air and through objects as shown in figure-1.

Indoor propagation mechanism needs to overcome three specific main electromagnetic wave phenomena, namely the reflection, diffraction and scattering. These phenomena may occur and degrade the signal strength quality of the WLAN network. The distance between transmitter and receiver is shorter due to high attenuation caused by the internal walls & furniture and often also because of the lower transmitter power. The short distance implies shorter delay of echoes and consequently a lower delay spread.

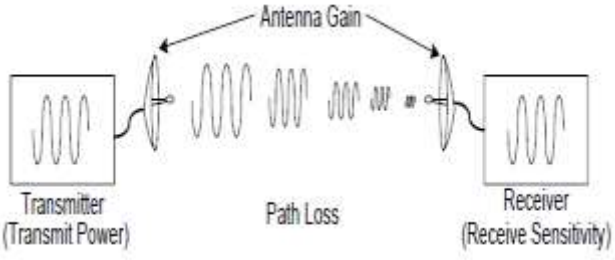

Figure 1 .Indoor path loss

III. GENERAL NOTATIONS

Throughout this paper the following notations are used:

a_j	$j = 1 \ldots N$	Access point (AP)
r_i	$i = 1 \ldots M$	Receiver/user
$d(a_j, r_i)$		Distance between AP and receiver
$g(a_j, r_i)$		Path loss from i_{th} user to access point j
$g\max$		Maximum tolerable path loss
P_t		Transmit power
P_r		Received power
R_{th}		Receive threshold
Ap		Position of AP

It should be noted that a_j represents the unknown coordinates of APs. Their number N is not known either. The coordinates of users r_i are assumed to be known and these users can be distributed in design area according to the design specifications.

In the present analysis the distance function assumed to be Euclidean, hence on the plane, the distance (d) between an AP a_j and a receiver r_i is given by [4]:

$$d(a_j, r_i) = \sqrt{(r_i^1 - a_j^1)^2 + (r_i^2 - a_j^2)^2}$$

where $a_j = a_j(a_j^1, a_j^2)$, and $r_i = r_i(r_i^1, r_i^2)$

IV. MODEL DESCRIPTION

The aforementioned problem can be modeled as an optimization problem for which the objective function is to minimize the path loss. Mathematically it may be given as:

$$\min g(a_j, r_i) \le g\max \; \forall i = 1, \ldots, M \quad (1)$$

Constraint (1) states that path loss is evaluated against the maximum tolerable path loss $g\max$. This ensures that the quality of coverage at each receiver location is above the given threshold.

This given value, $g\max$ can be calculated by subtracting receiver threshold (R_{th}) from transmitter power (P_t).

$$g\max = P_t - R_{th} \quad (2)$$

The above inequality (1) can be expressed in the equality form as:

$$(\min_j g(a_j, r_i) - g\max)^+ = 0, \quad (3)$$

Where $(\alpha)^+ = \max(\alpha, 0)$

A. Path Loss Model

In general the power received by an antenna that is separated from the transmitting antenna by the distance d in free space is given by [4-5]:

$$P_r(a_j, r_i) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d(a_j, r_i)^2} \quad (4)$$

where P_t is the transmitted power, G_t and G_r are the transmitter and receiver antenna gain, d is the distance between transmitter and receiver, and $\lambda = c/f$ is the wavelength of the carrier frequency, c is the speed of light (3×10^8 meter per second) and f is the frequency of radio carrier in hertz. The path loss, which represents signal attenuation between the transmitted and the received power and is measured in dB (decibels), in free space environments, is given by [4-5]:

$$g(a_j, r_i)[dB] = -10\log\left[\frac{G_t G r \lambda^2}{(4\pi)^2 d(a_j, r_i)^2}\right]$$

The above equation does not hold when points a_j and r_i are very close to each other. Therefore, large scale propagation models use a close–in distance, d_0 which is known as the received power reference distance point. Therefore, path losses at reference distance assuming transmit and receive antenna with unity gain as described in [4-5] can be calculated from:

$$g(a_j, r_i) = g(d_o)[dB] = 20\log\frac{4\pi d_o f}{c} \quad (5)$$

Therefore, path loss function in free space at a distance greater than d_0 is given by

$$g(a_j, r_i)[dB] = g(d_o)[dB] + 10\log\left(\frac{d(a_j, r_i)}{d_o}\right)^2 \quad (6)$$

V. COMPUTATIONAL STEPS FOR ACCESS POINT'S CALCULATION

Initially set the number of APs to 1: N = 1; then the necessary number of APs is found through the following steps.

1) Solve the constraint condition of path loss for each receiver using equation (3);

2) Solve the power received by an antenna in free space using equation (4);

3) If the solution exists, then *N* is the desired number;
4) Otherwise, *N* is increased by 1: *N*= *N* +1;
5) Go to step 1.

VI. COMPARISON OF VARIOUS MODELS

Mari Kobayashi, et.al [1] has applied a nonlinear optimization scheme called very fast simulated annealing to search for an approximate optimal solution using orthogonal frequency division multiplexing (OFDM) for high data rate indoor wireless LAN.

Max Kamenetsky, et.al [2] has described the methods for obtaining a close-to-optimal positioning of WLAN APs and evaluates their performance in a typical downtown or campus environment using pruning for obtaining an initial set of transmitter positions and refining these by using either neighborhood search or simulated annealing.

Mohd. Dani Baba, et. al [3] has developed a mathematical path loss model using OPNET 10 simulation design tool, to evaluate the performance of indoor WLAN mobility.

S. Kouhbor, et. al [4] has described a mathematical model developed to find the optimal number and location of APs. To solve the problem, he used the Discrete Gradient optimization.

S. Kouhbor, et. al [5] has described the mathematical model that finds the minimum number of APs for indoor buildings and places them in the area in a manner that the physical security of the network is maintained.

Table I. shows the comparison of various models.

VII. METHOD OF TESTING

A. Setup

A simple case without obstacles was considered for conducting the test in order to examine the model. The design area has 40 users. The specification of the model

TABLE.I COMPARISON OF VARIOUS MODELS

S.No.	Paper	Model	Technique	Available Information	Authors	Year
1	Optimal Access Point placement in Simultaneous Broadcast System using OFDM for Indoor WLAN	Ray Tracing Model	Very Fast simulated Annealing Algorithm (VFSA)	Discontinuous Cost Function has many local minima	Mari Kobayashi, et.al [1]	IEEE PIMRC 2000
2	Coverage Planning for Outdoor Wireless LAN systems	Path Loss Model	Pruning, Neighborhood Search and Simulated Annealing	Discrete Search Space	Max Kamenetsky, et.al [2]	IEEE-2002
3	Performance Analysis of Indoor WLAN Mobility	Indoor Path Loss Model	OPNET 10 Simulator Software	Reflection, Diffraction, Scattering	Mohd. Dani Baba, et.al[3]	WSEAS 2005
4	Optimal Placement of Access Point in WLAN Based on a New Algorithm	Path Loss Model	Discrete Gradient Optimization Algorithm	Nonsmooth, Nonconvex, has many local minima	S.Kouhbor, et.al[3]	IEEE-July 2005
5	Physical Security Enhancement in WLAN Systems	Path Loss Model	A New Global optimization Algorithm (AGOP)	Nondifferentiable, nonconvex	Shahnaz Kouhbor et.al[5]	ISSNIP-IEEE 2007

TABLE.II SIMULATION PARAMETER

Area	1500*1500 m
No. of Nodes	8
Frequency	2.4 GHz
Simulation Time	60sec
Node Placement	Random
Mobility Model	Random waypoint
Speed	0-20 m/s
Propagation Model	Free space
Channel Bandwidth	5.5 Mbps
Traffic Type	CBR
Routing Protocol	Bellman Ford
MAC Protocol	IEEE 802.11b

of Access point is LINK (DWL-3200AP) and IEEE 802.11b standard are used to test the model.

We conducted our experiments at the ground floor of the Boys Hostel Building in IIT Roorkee, Saharanpur Campus. Eight Access Points were installed in the ground floor of the building and these were configured to use channels since these eight channels are non overlapping. Our data collection system comprised of a laptop, running Windows 2007. Table II. Shows the simulation parameters.

B. Methodology

Once the priority areas have been identified, look for places nearby where it will be easy to install an access point. Access point will require a connection to the wired LAN and also a source of power. The signal strength, noise level and signal/noise ratio should then be measured, using 3.3GHz Spectrum analyzer with Omni directional dipole antennas has been chosen, at a number of points around the access point. The coverage should be checked in those priority areas that are within range. While in other places the aim should be to identify the points where the available bandwidth is likely to drop below the theoretical maximum: typically where the signal strength falls below -70dBm or where the signal/noise ratio is less than about 15dB [7].

VIII. RESULTS

A. Case I

Fig. 2 shows that the mobile node moves from one to another access point using Qualnet 5.0 simulation software. It should be noted that in the developed model, the aim is to provide only the coverage for the users. Figure.2 shows a part of the Boy's Hostel Map. In this figure the access points covering the whole region.

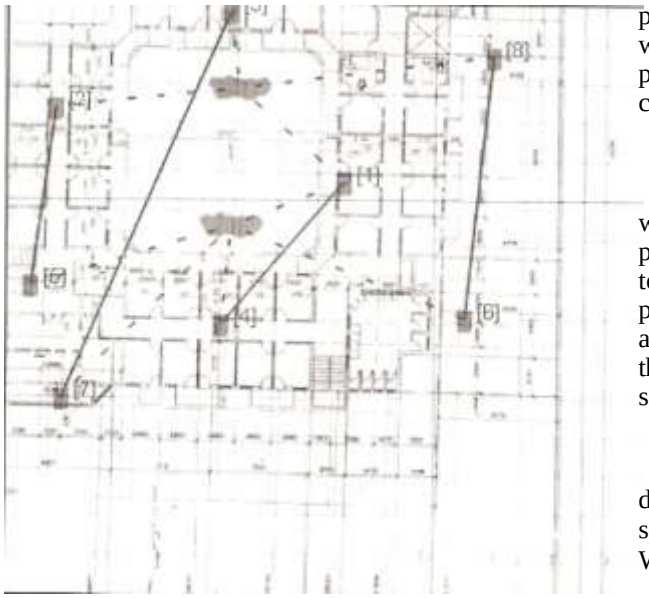

Figure.2 shows Mobility in the part of the Boy's Hostel Map

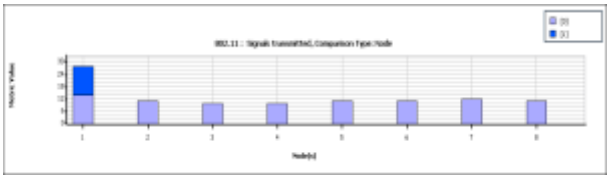

Figure.3 shows the signals transmitted

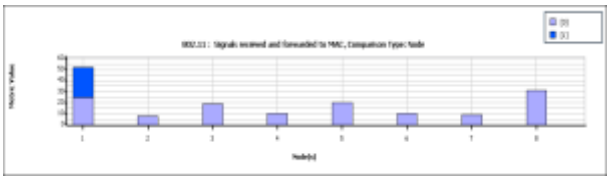

Figure.4 shows the signals received

Figure.4 shows the signals received so that we can assure the coverage of all users.

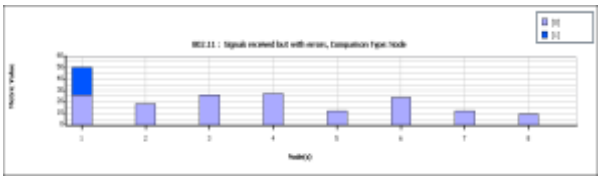

Figure.5 shows the signals received but with errors

Figure.5 shows the signals received but with errors so that we can calculate the path loss in free space.

Figure.3, Figure.4 and Figure.5 show that results have been achieved for indoor path loss model for WLAN coverage.

Drawing a line through these points will create a rough contour map of the wireless coverage. The access point should then be moved to the next priority area that was not properly covered from the first position and the process repeated until all the required areas have been covered.

IX. CONCLUSION

By using this simulation program, WLAN planner will be able to setup the access point for the optimum propagation coverage. Further work will be extended to include obstacles in the mathematical model presented in this paper and test will be conducted and also it will involve the comparison of results taken by the optimization technique and by the simulation software.

ACKNOWLEDGMENT

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REEFERENCES

[1] M.Kobayashi, S.Haruyama, R.Kohno, M.Nakagawa, "Optimal Access Point Placement in simultaneous broadcast system using

OFDM for indoor wireless LAN", *IEEE symposium on PIMRC*, Vol.1, PP.200-204, 2000.

[2] M. Kamenetsky and M. Unbehaun, "Coverage Planning for outdoor Wireless LAN Systems," in Proc. IEEE International Zurich Seminar on Broadband Communications, Sweden, pp.49-1 – 49-6, 2002.

[3] Mohd. Dani Baba, Mohammad Ibrahim, Bdulmukti Ahmad, "Performance Analysis of Indoor WLAN Mobility", Proceedings of the 4th WSEAS International Conference on Electronics,Hardware, Wireless and Optical, 2005.

[4] S. Kouhbor, J.Ugon, A. Kruger, A.Rubinov, "Optimal Placement of Access Point in WLAN Based on a New Algorithm", In: proc. Of the International Conference onMobile Business-IEEE/ICMB, pp. 592-598, July 2005.

[5] Shahnaz Kouhbor, "Physical Security Enhancement in WLAN Systems", ISSNIP-IEEE, pp.733-738, 2007.

[6] AvaLAN Wireless Systems Inc**.,** 1020 Corporation Way,Palo Alto, CA 94303, August 2006. www.avalanwireless.com/assets_ *v3/.../*

[7] "Surveying Wireless Networks", GD/JANET/TECH, 2008. www.ukema.ac.uk/documents/.../technical../

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Performance Comparison between Ant Algorithm and Modified Ant Algorithm

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***Abstract*—This paper gives a brief about two of the meta-heuristic techniques that are used to find best among the optimal solutions for complex problems like travelling salesman problem, Quadratic problem. Both of these techniques are based on the natural phenomenon of ant. Ant algorithm find good path but due to some short comings of it, this algorithm is not able to give best out of the good or optimal solutions, but modified ant algorithm which is based on probability finds out the best among the optimal paths We will also see that the modified ant algorithm can obtain less number of hops which helps us to get the best solution to typical problems.**

Keywords*— *Ant Algorithm, Modified Ant algorithm, Travelling Salesman Problem, Quadratic problem, Ant System

I. INTRODUCTION

Both meta-heuristic techniques i.e. ant algorithm and modified ant algorithm are based on of the natural phenomenon that ants take the shortest path as and when they move out from their nest in search of their food and vice-versa. The ant algorithm can be used to traverse the shortest path for the complex problem like travelling salesman. When probability comes into picture it makes work of selecting the shortest or the best path from the good ones a bit easy. We have simulated the nodes for Travelling Salesman problem using ant algorithm and modified Ant algorithm. Study below shows us that the modified ant algorithm gives lesser number of hopes than Ant algorithm at the same connection time. Modified ant algorithm technique chooses the best among all good paths that are available. As a part of study we will see that the average number of hops at connection time after changing the probability by the formula of ant algorithm gives lesser number of hops and hence gives the better option for selecting the shortest path. Experimentation will show that modified ant algorithm is a promising optimization technique for solving complex combinatorial optimization problems like TSP. Modified ant algorithm makes use of the probability theory to get the maximum pheromone where ant can go and take their food gives us the best path among the goods.

In ant colony optimization algorithms, all ants begin to generate the same result. This situation is named as stagnation behaviour, because after a point algorithm stops to generate alternative solutions. The reason of this situation is after a certain number of iterations, ants start generating the same solutions because pheromone amount intensifies in some points and the difference between pheromone concentrations on paths become very huge.

At this point modified ant algorithm comes into picture and after calculating the best probability of the pheromone the optimal path is taken out from the simulations results related to ant algorithm and modified ant algorithm.

II. BACKGROUND

Social insects like ants, bees or termites are generally conceived as simple, non-intelligent animals however, collectively they exhibit impressive problem solving skills. Inspired by these insects research in the past decade has led to some fascinating progress in the field of natural algorithms. In the real world, ants (initially) wander randomly, and upon finding food return to their colony while laying down pheromone trails. If other ants find such a path, they are likely not to keep travelling at random, but to instead follow the trail, returning and reinforcing it if they eventually find food. Over time, however, the pheromone trail starts to evaporate, thus reducing its attractive strength. The more time it takes for an ant to travel down the path and back again, the more time the pheromones have to evaporate. A short path, by comparison, gets marched over faster, and thus the pheromone density remains high as it is laid on the path as fast as it can evaporate. Pheromone evaporation has also the advantage of avoiding the convergence to a locally optimal solution.

If there were no evaporation at all, the paths chosen by the first ants would tend to be excessively attractive to the following ones. In that case, the exploration of the solution space would be constrained. Thus, when one ant finds a good (i.e. shortest) path from the colony to a food source, other ants are more likely to follow that path, and positive feedback eventually leads all the ants following a single path. The idea of the ant colony algorithm is to mimic this behaviour with "simulated ants" walking around the graph representing the problem to solve.

In the existing ant algorithm ant will travel to the node whose probability is higher, out of these ant used to select one path and use to travel to all the nodes with high probabilities only. In this process ant generally doesn't look at the other possible solution or paths available for her to traverse and in this way sometime ant used to miss the best among the good paths. Modified ant algorithm overcomes this problem via looking at the all possible solutions and calculating the shortest path to cover all the paths.

III. FORMULA USED

Ant system algorithm can be described as in following steps:

(a) Parameters:

Parameters that are used to evaluate and analyse the performance of ant algorithm mentioned below:

- Processed node probability
- Update probability

- Ratio of proceed node probability

The formula of finding the probability and modification of probability:-

$r=\sum pi/100 \quad i=1\text{-}n$

$pu = ((pi+100)+(\sum p-pi))*r$

r -> ratio

pi -> processed node prob.

p -> prob. Of nodes before processing

pu -> Updated Probability.

(i) Calculation of probability:-

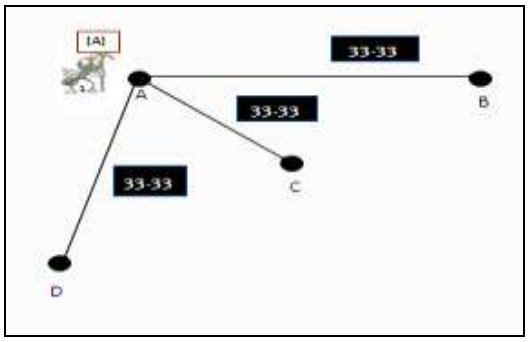

Fig 1 Equal probability at all nodes

(i) How probability is calculated?

The above formula is used to calculate the probability

1) Initialize

Node 2 was the destination (probability 1 = 100%), divide 100% into three paths as shown in the fig 1 above. Probability of all the three paths i.e. A to B is 33.33%, A to C is 33.33% and A to D is 33.33%

In which m ants are positioned on n towns. The starting town and the nodes allowed to visit are initialized for each ant.

2) Iteration

//traverse all nodes, and come back to the starting nodes.

{The ant moves to next town according to the highest probability in second iteration}

3) It takes 1 hop to get its destination

Divide 1 hop by 100:100%

Add 100 to the probability value of node 2(currently 33.333) = 133.333.

100 + 33.333 = 133.333%

4) Add the values of the other nodes to 133.3333 (133.3333+ 33.3333 + 33.3333) = 200 (approximately)

Calculate the ratio: ratio = 100/200 = 0.5

Set the probability of the node to its current value multiplied by the ratio

Node 2: 133.3333 * ratio (0.5) = 66.6666%

Node 3: 33.3333 * ratio (0.5) = 16.6666%

Node 4: 33.3333 * ratio (0.5) = 16.6666% Node 2 (66.6666%) + Node 3 (16.6666%) +
Node 4 (16.6666%) = 99.9999%

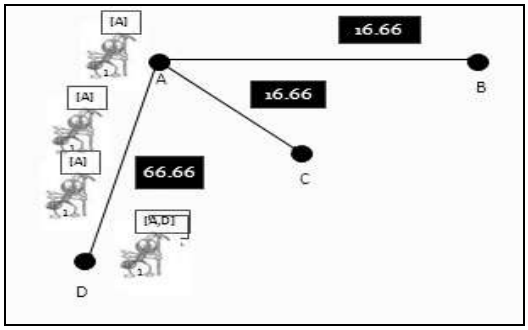

Fig 2 Shows the after calculating probability of pheromone Node A has highest probability

To improve the above algorithm traverse all the nodes to select the path in first iteration and in second iteration select the second path and traverse all the path and find the good paths and after that among the good paths select the best path and modified algorithm will be better as compare to the simple ant algorithm and number of hops will be less in modified algorithm.

IV. EXPERIMENTATION

A. *Ant algorithm*

In this section, the simulation results on 100 nodes are shown.

1) At first simulation in ant colony algorithm

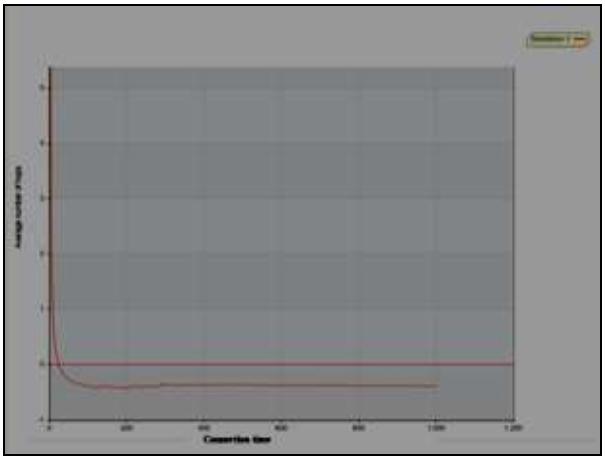

Fig. 3 Average number of hops vs Connection time

Fig 3 shows the average number of hops on connection time with modification of the probability in ant algorithm and number of hops will change according to the modification of the probability in 100 nodes.

2) At second simulation in ant colony algorithm

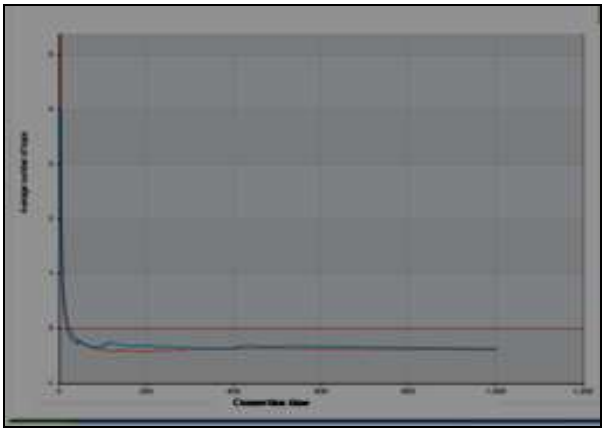

Fig 4 Average number of hops vs connection time

3) At third simulation in ant colony algorithm

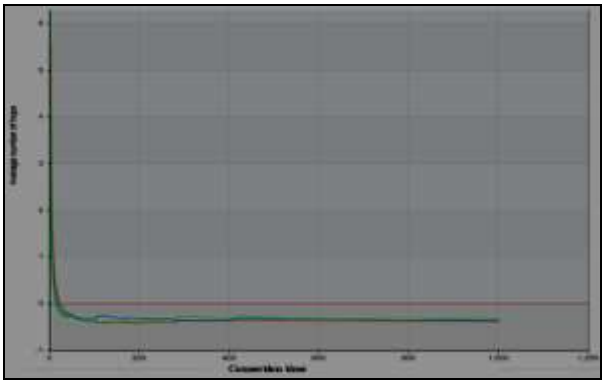

Fig 5 Average number of hops Vs connection time

B. Modified ant algorithm

The probability of some paths that are likely to be selected becomes low gradually when the algorithm is implemented for a certain period. In order to increase the possibility of exploring these paths, choose the path with highest probability. Initially select the path and visit all the nodes from source to destination and then select the good path after that select the next path and visit all the nodes and select the best path from all the good paths. In modified algorithm number of hops will be less.

1) At first simulation in modified ant colony algorithm

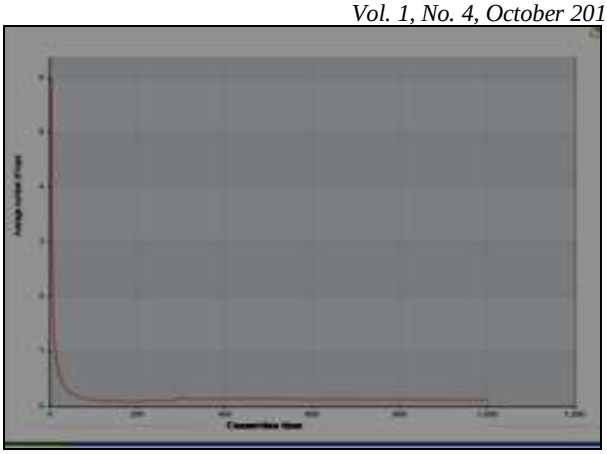

Fig 6 Average number of hops vs Connection time

Fig 6 shows the average number of hops on connection time with the modification of the probability in ant algorithm and number of hops will change according to the updation of the probability in 100 nodes it also shows the comparison between first simulation, second simulation and third simulation.

2) At second simulation in modified ant colony algorithm

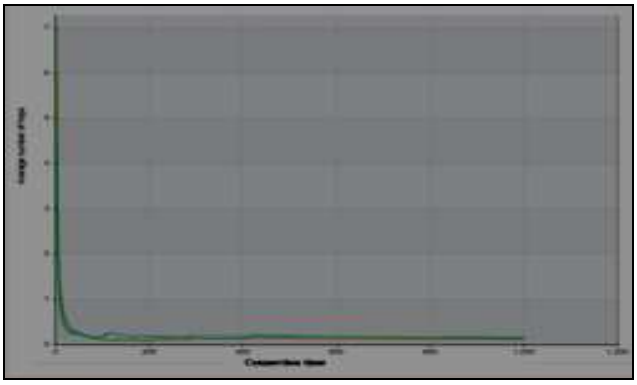

Fig 7 connection time vs average number of hops in modified algorithm for second simulation

3) At third simulation in modified ant colony algorithm

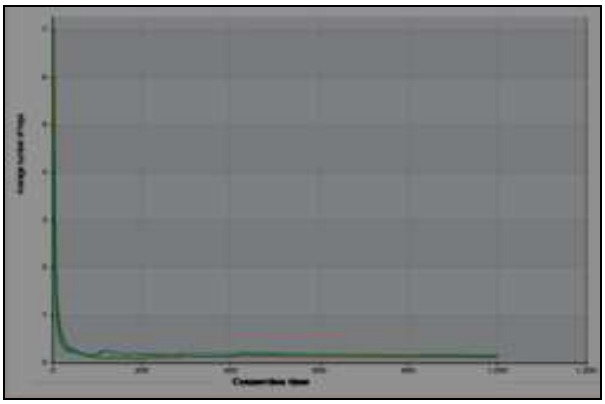

Fig 8 Average no of hops Vs connection time

Fig 8 shows the average number of hops on connection time with the modification of the probability in ant algorithm and number of hops will change in 100 nodes it also shows the comparison between first simulation, second simulation and third simulation.

V. RESULT

A. Comparison of Ant Algorithm and modified Ant Algorithm

TABLE I

S.No	Comparison of ant and modified ant algorithm	
	Ant algorithm	**Modified ant algorithm**
1	Ant will traverse only on single path whose nodes probability will be high based on above formula.	Ant will traverse on all paths and then select the best path from the good paths.
2	With this algorithm we find the good path not the best path.	This algorithm finds the best path from the good paths.
3	In this average number of hops will be more as compared to modified ACO.	In this number of hops will be less, and as number of hops will be less then traversing path will be less.

B. Performance Comparison of Ant Algorithm and modified Ant Algorithm

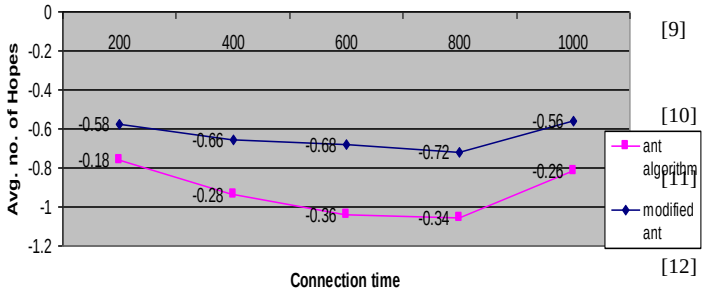

Fig. 9 Comparison between ant and modified ant algorithm

Fig 9 shows the comparison between ant algorithm and modified algorithm. As per the graph it is clearly visible that the modified ant algorithm is much better that ant algorithm.

This graph shows that the difference between ant algorithm and modified ant algorithm.

VI. CONCLUSIONS

Modified ant algorithm explained in this paper solves the problem with a best solution that the other algorithms are easy to fall into the local optimal solution. As it takes probability into consideration the number of hops will be less in modified algorithm as compare to the simple ant algorithm. The result of simulation the experimental simulation shows that the quality and of the improved algorithm is superior to the traditional algorithms, and the improved algorithm solution is closed to the optimal solution. Therefore, the improved algorithm is an efficient way to solve the TSP as well as provide a new idea to solve other typical problems as well.

ACKNOWLEDGMENT

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REFERENCES

[2] Hassin, R.; Rubinstein, S. (2000), "Better approximations for max TSP", Information Processing Letters 75: 181–186,

[3] Kaplan, H.; Lewenstein, L.; Shafrir, N.; Sviridenko, M. (2004), "Approximation Algorithms for Asymmetric TSP by Decomposing Directed Regular Multigraphs", In Proc. 44th IEEE Symp. on Foundations of Comput. Sci., pp. 56–65

[4] PELLEGRINI Paola, FAVARETTO Daniela, MORETTI Elena, "On MAX-MIN Ant System's Parameters," 5th International Workshop, ANTS2006, Brussels, Belgium, September 2006

[5] Marco Dorigo, Maniezzo, Colorni, "positive feedback as a search strategy," Technical Report, pp. 91-106, 1991.

[6] Marco Dorigo, Colorni. "The Ant System: Optimization by a colony of cooperating agents," Systems, Man, and Cybernetics, Part B, IEEE Transactions on System, vol 26. pp.29-41, Feb 1996.

[7] Cerny.V, "A Thermodynamical Approach to the Travelling Salesman Problem: An Efficient Simulation Algorithm," J.Optimization Theory and Appl. 45(1985), pp.41-51.

[8] G. Di Caro, Vasilakos T., Ant -SELA: Ant -agents and stochastic automata learn adaptive routing tables for QoS routing in ATM networks , ANTS'2000 - From Ant Colonies to Artificial Ants: Second International Workshop on Ant Algorithms, Brussels, Belgium, September 2000.

[9] L.F. Escudero, An inexact algorithm for the sequential ordering problem. European Journal of Operational Research 37 (1988), 232–253.

[10] W.J. Gutjahr, A graph-based Ant System and its convergence. Future Generation Computer Systems. 16, 873 - 888, 2000.

[11] PELLEGRINI Paola, FAVARETTO Daniela, MORETTI Elena, "On MAX-MIN Ant System's Parameters," 5th International Workshop, ANTS2006, Brussels, Belgium, September 2006.

[12] Camelia-Mihaela Pintea, D.Dumitrescu. Improving ant systems using a local updating rule[C]. Proceedings of the Seventh International Symposium on Symbolic and Numeric Algorithms for Scientific Computing, 2005, 149~159.

[13] M.Dorigo, T. Stützle, Ant Colony Optimization[M]. MIT Press, Cambridge, MA,2004. P328.

[14] Applegate, D. L.; Bixby, R. M.; Chvátal, V.; Cook (2006), The Traveling Salesman Problem

[15] Bellman, R. (1960), "Combinatorial Processes and Dynamic Programming", in Bellman, R., Hall, M., Jr. (eds.), Combinatorial Analysis, Proceedings of Symposia in Applied Mathematics 10,, American Mathematical Society, pp. 217–249

[16] Bellman, R. (1962), "Dynamic Programming Treatment of the Travelling Salesman Problem", J. Assoc. Comput. Mach. 9: 61–63.

[17] Christofides, N. (1976), "Worst-case analysis of a new heuristic for the travelling salesman problem", Technical Report 388, Graduate School of Industrial Administration, Carnegie-Mellon University, PittsburghM. Shell. (2002) IEEEtran homepage on CTAN. [Online].

[18] Information Processing Letters 82(3): 145-153 (2002).

[19] L.M. Gambardella and M. Dorigo, An ant colony system hybridized with a new local search for the sequential ordering problem, INFORMS Journal on Computing 12(2000), no. 3, 237--255.

[20] L.M. Gambardella and M. Dorigo, Ant -Q: a reinforcement learning approach to the travelling salesman problem, Proceedings of the Twelfth International Conference on Machine Learning, M L-95, Palo Alto, CA, Morgan Kaufmann, Palo Alto, California, USA, 1995.

[21] L.M Gambardella and M. Dorigo M, Solving Symmetric and Asymmetric TSPs by Ant Colonies , Proceedings of the IEEE Conference on Evolutionary Computation, ICEC96, Nagoya, Japan, May 20-22, 1996, pp. 622-627.

Dynamic Reduct and Its Properties In the Object-Oriented Rough Set Models

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***Abstract*—This Paper deals with a new type of Reduct in the object-oriented rough set model which is called dynamic reduct. In the object–oriented rough set models, objects are treated as instances of classes, and illustrate structural hierarchies among objects based on is-a relationship and has-a relationship[6]. In this paper, we propose dynamic reduct and the notation of core according to the dynamic reduct in the object-oriented rough set models. It describes various formal definitions of core and discusses some properties about dynamic core in the object-oriented rough set models.**

Keywords — Rough Set, Dynamic Reduct, Feature Core, Indiscernibility Relations, Discernibility Matrices.

I. INTRODUCTION

Rough set theory [1, 2] deals with approximation and reasoning about data. In the aspect of approximation, the basic concepts are lower approximation, upper approximation by indiscernibilty relations which illustrate set-theoretic approximations of any given subset of data. we can find reducts and decision rules in traditional rough set theory. The object-oriented rough set model is an extension of the "traditional rough set theory" by introducing object-oriented paradigm[4] used in computer science and the Object-oriented rough set models[6] illustrates hierarchical structures between classes, names and objects based on is-a and has-a relationships. Kudo and Murai have extended the object–oriented rough set models to treat incomplete information[8].In the papers [6][8], formulation of the object–oriented rough set model was concentrated to the aspect of approximation, and in the paper[7], reasoning about objects in the object–oriented rough set model by introducing decision rules in the object–oriented rough set model, and revised discernibility matrix for finding reducts in the object-oriented rough set model was discussed. However dynamic reducts and properties in the object-oriented rough set model have not been discussed. In paper [5], deals with a comparison of dynamic and non-dynamic rough set methods for extracting laws from decision tables.

In this paper, we propose dynamic reduct and its properties in the object–oriented rough set models. The Reducts are stable in decision rules are called dynamic reducts in the object-oriented rough set models. Dynamic Reducts define set of classes or set of classes with names are called dynamic core in the object-oriented rough set models. This is the classes or classes with names included in all dynamic reducts in the object-oriented rough set models.

The rest of the paper is organized as follows: In section II, we review the object-oriented rough set model. In section III, we introduce dynamic reduct in the object-oriented rough set models. In section IV, we introduce dynamic core in the object-oriented rough set models. In section V, we introduce (F-λ)–dynamic core in the object-oriented rough set model. In section VI, we introduce generalized dynamic core in the object-oriented rough set model. In section VII, we draw conclusion.

II. THE OBJECT–ORIENTED ROUGH SET MODEL

We briefly review the object–oriented rough set model. First, we describe the concept of class, name and object. Next, we illustrate well-defined structures as a basic framework of the object–oriented rough set model. Moreover, we introduce equivalence relations based on "equivalence as instances". Note that the contents of this section are entirely based on the papers [6][8].

A. Class, Name, Object

Formally, a class structure $\mathbf{C}$, a name structure $\mathbf{N}$ and a object structure $\mathbf{O}$ are defined by the following triples, respectively:

$$\mathbf{C} = (C, \ni_C, \supseteq_C),\ \mathbf{N} = (N, \ni_N, \supseteq_N),\ \mathbf{O} = (O, \ni_O, \supseteq_O),$$

where C, N and O are finite and disjoint non-empty sets such that $|C| \leq N|$ ($|X|$ is the cardinality of X). Each element $c \in C$ is called a class. Similarly, each $n \in N$ is called a name, and each $o \in O$ is called an object. The relation $\ni_X \ (X \in \{C, N, O\})$ is an acyclic binary relation on X, and the relation $\supseteq_X$ is a reflexive, transitive, and asymmetric binary relation on X. Moreover, $\ni_X$ and $\supseteq_X$ satisfy the following property:

$$\forall\ x_i, x_j, x_k \in X,, x_i \supseteq_X x_j, x_j \ni_X x_k \Rightarrow$$

$$x_i \ni_X x_k \quad (1)$$

The class name and object structures have the following characteristics, respectively:

– The class structure illustrates abstract data forms and those hierarchical structures based on part / whole relationship (has-a relation) and specialized/ generalized relationship (is-a relation).

– The name structure introduces numerical constraint of objects and that identification, which provide concrete design of objects.

– The object structure illustrates actual combination of objects.

Two relations $\ni_X$ and $\supseteq_X$ on $X \in \{C, N, O\}$ illustrate hierarchical structures among elements in *X*. The relation $\ni_X$ is called a has-a relation, which illustrates part / whole relationship. $x_i \ni_x x_j$ means "x_i has-a x_j", or "x_j is a part of x_i". For example, $c_i \ni_C c_j$ means that "the class c_j has a class c_j", or "c_j is a part of c_j". On the other hand, the relation $\supseteq_X$ is called an is-a a relation, which illustrates specialized / generalized relationship. $x_i \supseteq_X x_j$ means that "x_i is-a x_j". For example, $\supseteq_C$ illustrates relationship between super classes and subclasses, and $c_i \supseteq_C c_j$ means that "c_i is a super class of c_j", or "c_j is a subclass of c_i".

B. Well–Defined Structures

Each object $o \in O$ is defined as an instance of some class $c \in C$, and the class of *o* is identified by the class identifier function. The class identifier id_C is a p-morphism between O and C [3], that is, the function $id_C : O \to C$ satisfies the following conditions:

1. $\forall o_i, o_j \in O,\ o_i \ni_O o_j \Rightarrow id_C(o_i) \ni_C id_C(o_j)$.
2. $\forall o_i \in O, \forall c_j \in C, id_C(o_i) \ni_C c_j \Rightarrow$
$$\exists\ o_j \in O\ s.t. o_i \ni_c o_j \text{ and } id_C(o_j) = c_j, (2)$$

and the same conditions are also satisfied for $\supseteq_O$ and $\supseteq_C$. $id_C(o) = c$ *means* that the object *o* is an instance of the class *c*.

The object structure **O** and the class structure **C** are also connected through the name structure **N** by the naming function $nf : N \to C$ and the name assignment $na : O \to N$. The naming function provides names to each class, which enable us to use plural instances of the same class simultaneously. On the other hand, the name assignment provides names to every object, which enable us to identify objects by names.

Formally, the naming function $nf : N \to C$ is a surjective p-morphism between **N** and **C**, and satisfies the following name preservation constraint:

-For any $n_i, n_j \in N$, if $nf(n_i) = nf(n_j)$, then $H_N(c/n_i) = H_N(c/n_i) = H_N(c/n_j)$ is satisfied for all $c \in C$, where $H_N(c|n) = \{nj \in N \mid n \ni_N nj, f(nj) = c\}$ is the set of names of *c* that *n* has. The requirement that *nf* is a surjective p-morphism means that there is at least one name for each class, and structures between names reflect all structural characteristics between classes. The name preservation constraint requires that, for any class $c_i, c_j \in C$ such that $c_i \ni_C c_j$, and any name $n \in N$ with $nf(n) = c_i$, all names of the parts of *c* are uniquely determined. Thus, the number of names of c_j is fixed as $m = |H_N(c_j/n)|$, and we can simply say that "the class c_i has *m* objects of the class c_j".

On the other hand, the name assignment $na : O \to N$ is a p-morphism between **O** and **N**, and satisfies the following uniqueness condition:

-For any $x \in O$, if $H_O(x) \neq \phi$, the restriction of *na* into $H_O(x) : na / H_O(x) : H_O(x) \to N$ is injective, where $H_O(x) = \{y \in O / x \ni_O y\}$ is the set of objects that *x* has. $na(x) = n$ means that the name of the object *x* is *n*. The uniqueness condition requires that all distinct parts $y \in H_O(x)$ have different names.

We say that **C**, **N** *and* **O** *are* well-defined if and only if there exist a naming function $nf : N \to C$ and a name assignment $na : O \to N$ such that

$$id_C = nf \circ na, \quad (3)$$

that is, $id_C(x) = nf(na(x))$ for all $x \in O$.

We concentrate well-defined class, name and object structures. In well-defined structures, if a class c_i has *m* objects of a class c_j, then any instance o_i of the class c_i has exactly *m* instances $o_{j1}, \ldots, o_{jm}$ of the class c_j [2].This good property enables us the following description for clear

representation of objects. Suppose we have $o_1, o_2 \in O$, $n_1, n_2 \in N$, and $c_1, c2 \in C$, such that $o_i \ni_o o_2$, and $na(o_i) = n_i, nf(n_i) = c_i$ for $i \in \{1,2\}$. We denote $o_1.n_2$ instead of o_2 by means of "the instance of c_2 named n_2 as a part of o_1".

C. Indiscernibility Relations in the Object – Oriented Rough Set Model

All equivalence relations in object–oriented rough set models are based on the concept of equivalence as instances. In [6], to evaluate equivalence of instances, an equivalence relation ~ on *O* are recursively defined as follows:

$x \sim y \Leftrightarrow$ x and y satisfy the following two conditions:

1. $id_C(x) = id_C(y)$, and,

2. $\begin{cases} x.n \sim y.n, \forall n \in H_N\ (na(x)) & \text{if } H_N(na(x)) \neq \phi \\ Val(x) = Val(y) & \text{otherwise} \end{cases}$ (4)

Where $H_N(na(x))$ is the set of names that $na(x)$ has. $Val(x)$ is the "value" of the "value object" x. Because C is a finite non-empty set and $\ni_C$ is acyclic, there is at least one class c such that c has no other class c', that is, $c \not\ni_C c'$ for any $c' \in C$. We call such class c an attribute, and denote the set of attributes by *AT*. For any object x, if $id_C(x) = a$ and $a \in AT$, we call such object x a value object of the attribute a.

The value object x as an instance of the attribute a represents a "value" of the attribute.

D. Object-Oriented Rough Sets

$x \sim y$ means that the object x is equivalent to the object y as an instance of the class $id_C(x)$. Using the equivalence relation ~, an equivalence relation $\sim_B$ with respect to a given subset $B \subseteq N$ of names is defined as follows:

$x \sim_B y \Leftrightarrow$

x and y satisfy the following two conditions:

1. $B \cap H_N(na(x)) = B \cap H_N(na(y))$, and,

2. $\forall n[n \in B \cap H_N(na(x)) \Rightarrow x.n \sim y.n]$

(5)

$x \sim_B y$ means that x and y are equivalent as instances of the class $id_C(x)$ in the sense that, for all $n \in B \cap H_N(na(x))$, x and y have equivalent instances of the class $id_C(x.n)$. Equivalence classes $[x]_{\sim_B}$ by $\sim_B$ are usually defined. Note that, in the "traditional" rough set theory, all equivalence classes concern the same attributes. On the other hand, each equivalence class of the object–oriented rough set model may concern different classes. In particular, if $B \cap H_N(na(x)) = \phi$, the equivalence class $[x]_{\sim_B}$ is the set of objects that are not concerned any class $nf(n), n \in B$, at all.

Suppose $OORS$ is Object-Oriented Rough Set Model, N is non empty subset of names , and $\sim_B$ be the equivalence relation defined by eq(5) .For any subset $X \subseteq O$ of objects

$$\underline{\sim_B}(X) = \{x \in O \mid [x]_B \subseteq X\}$$

$$\overline{\sim_B}(X) = \{x \in O \mid [x]_B \cap X = \phi\}$$

(6)

are called *B*-lower approximation and *B*-upper approximation respectively. The *B*-lower approximation is also called the position region denoted by $POS_B(X)$.

Note that the contents of this section are entirely based on the paper [7].

III. Decision Rules and Discernibility Matrices in the Object–Oriented Rough Set Model

A. Decision Rule

Let OORS(**C**, **N**, **O**) be the object-oriented rough set model where $\mathbf{C} = (C, \ni_C, \supseteq_C)$, $\mathbf{N} = (N, \ni_N, \supseteq_N)$, $\mathbf{O} = (O, \ni_O, \supseteq_O)$ be the well defined class, name, object structures, respectively. Similar to the decision table in rough set theory, we divide the set of names *N* into the following two parts: the set of names that may appear in antecedents of decision rules (called condition names) N_{CON}, and the set of names that may appear in conclusions of decision rules (called decision names) N_{DEC}. Note that $N = N_{CON} \cup N_{DEC}$ and $N_{CON} \cap N_{DEC} = \phi$. The decision names provide decision classes as equivalence classes $[x]_{\sim N_{DEC}}$ based on the equivalence relation N_{DEC} by (5). Decision rules in the object–oriented rough set model are defined as follows.

Definition 1: A decision rule in the object-oriented rough set model has the following form:

$$c \wedge c.n1 \sim o.n1 \wedge ..... \wedge c.n_i \sim o.n_i \Rightarrow c.m1 \sim o.m1 \wedge ..... \wedge c.m_j \sim o.m_j \quad (7)$$

Where $c \in C, o \in O$ such that $id_C(o) = c, n_1 ..., n_i \in N_{CON} \cap H_N(na(o))(i \geq 0)$ and $m_1, ..., m_j \in N_{DEC} \cap H_N(na(o))(j \geq 1)$. We call this

rule a decision rule of the class c by the object o, and denote DR(C;O) .The decision rule *DR*(*c*; *o*) means that, for any object $o' \in O$, if o' is an instance of *c* and each part $o'.n_k$ is equivalent to $o.n_k$ ($k \le i$), then all parts $o'.m_l$ are also equivalent to $o.m_l$ ($l \le j$), respectively. Thus, *DR*(*c*; *o*) describes a certain property about combination of objects as an instance of the class *c*.

As a special case, we allow rules that have no condition names, that is, the case of *i* = 0 in (7) as follows:

$$c \Rightarrow c.m_1 \sim o.m_1 \wedge \cdots \wedge c.m_j \sim o.m_j .$$

This rule illustrates that all instances o' of the class *c* have some parts $o'.m_k (1 \le k \le j)$ that are equivalent to $o.m_k$, respectively. On the other hand, we require that there is at least one name $m \in N_{DEC}$ such that $m \in H_N(na(o))$ .This means that any object that has no decision name are not the target of decision rule generation.

B. Discernibility Matrix

Definition 2: A discernibility matrix of the object-oriented rough set model is a k×k matrix whose elements δ_{ij} at the i-the row and j-the column is defined as follows.

$$\delta_{ij} = \begin{cases} \{id_C(o_i)\} & if\ id_C(o_i) \neq id_C(o_j) and \\ & \exists\ m \in N_{DEC} \cap H_N(na(o_i)) \\ & s.t\ \ o_i.m \not\sim o_j.m \\ \left\{ id_C(o_i).n \middle| \begin{array}{l} n \in H_N(na(o_i)), \\ n \in N_{CON}, \\ o_i.n \not\sim o_j.n \end{array} \right\} & if\ id_C(o_i) = id_C(o_j) and \exists\ m \in N_{DEC} \cap H_N(na(o_i))_{s.t\ \ o_i.m \not\sim o_j.m} \\ \phi & otherwise \end{cases} \tag{8}$$

Where k is the number of objects, that is, $|o| = k.o_i \not\sim o_j.n$ means that $o_i.n$ is not equivalent to $o_j.n$

The element δ_{ij} is the set of classes that we should check to distinguish the object o_i and the object o_j . Thus, when we need to distinguish o_i and o_j, we check the class $id_C(o_i)$ and $id_C(o_j)$ firstly, and if these classes are not equal, we can distinguish these objects. Otherwise, we need to compare parts $o_i.n$ and $o_j.n$ such that *n* ∈ *NCON* $\cap H_N(na(o_i))$. Note that, different from the "traditional" discernibility matrix, we have generally $\delta_{ij} \neq \delta_{ji}$ in the revised discernibility matrix. Similar to the case of calculating reducts by the "traditional" discernibility matrix, we construct reducts of the object–oriented rough set model. First, for each element δ_{ij} in the revised discernibility matrix, we construct the following formula L(δ_{ij}):

$$L(\delta_{ij}) = \begin{cases} c & if\ \ \delta_{ij} = \{c\}, \\ c.n_1 \vee \ldots\ldots\ldots \vee c.n_l & if\ \ \delta_{ij} = \{c.n_1 \ldots\ldots\ldots, c.n_l\}, \\ \tau & if\ \ \delta_{ij} = \phi . \end{cases} \tag{9}$$

The intention of L(δ_{ij}) is that, for example the case of $L(\delta_{ij}) \equiv c.n_1 \vee .. \vee c.n_l$, we can distinguish o_i and o_j by checking at least one of $c.n_s$ ($1 \le s \le l$).

Next, connecting all formulas $L(\delta_{ij})$ by the logical product, we get a formula $\wedge_{i=1}^{k} \wedge_{j=1}^{k} L(\delta_{ij})$. This formula is the conjunctive normal form. Thus, finally, we transform this formula to the disjunctive normal form that is logically equivalent to $\wedge_{i=1}^{k} \wedge_{j=1}^{k} L(\delta_{ij})$ with no redundant expression as follows:

$$\bigwedge_{i=1}^{k} \bigwedge_{j=1}^{k} L(\delta_{ij}) = \bigvee_{s=1}^{m} \bigwedge_{t=1}^{st} c_{st} \ , \tag{10}$$

where each conjunction $\vee_{t=1}^{st} C_{lt}$ describes a reduct of the object–oriented rough set model $R = \{c_{l1}, \cdots, c_{lst}\}$. This is because, for each element δ_{ij} of the revised discernibility matrix, *R* contains at least one expression *c* or *c.n* such that $c \in \delta_{ij}$ or $c.n \in \delta_{ij}$.

C. A Method of Generating Decision Rules

Let *R* be a reduct of the object–oriented rough set model. We consider decision rules from the reduct and each object in decision classes. However, for each object *o* in any decision class $[x]_{\sim NDEC}$, not all classes $c \in R$ and $c.n \in R$ are concerned with *o*. Thus, for each object *o* $\in [x]_{\sim NDEC}$ such that $id_C(o) = c$, we construct a decision rule *DR*(*c*; *o*) in the object–oriented rough set model as follows:

1. Select the class *c* such that $id_C(o)$ = *c* and all classes $c.n_s$ from the reduct *R*.

2. Construct an expression $c.n_s \sim o.n_s$ for each selected $c.n_s$ and the object *o*, and connect the class *c* and these expressions by $\wedge$ follows:

(Antecedents) $c \wedge c.n_1 \sim o.n_1 ..... \wedge c.n_l \sim o.n_l$

3. Construct an expression $c.m_t \sim o.m_t$ for each $c.m_t$ such that $m_t \in N_{DEC} \cap H_N(na(o))$, and connect the class *c* and these expressions by $\wedge$ as follows:

(Conclusions) $c \wedge c.m_1 \sim o.m_1 \wedge ... \wedge c.m_u \sim o.m_u$

4. Construct the decision rule *DR*(*c* : *o*) by connecting antecedents and conclusions by $\Rightarrow$ as follows:

$$c \wedge c.n_1 \sim o.n_1 \wedge ... \wedge c.n_l \sim o.n_l \Rightarrow c \wedge c.m_1 \sim o.m_1 \wedge ... \wedge c.m_u \sim o.m_u \quad (11)$$

IV. Dynamic Reduct in the Object-Oriented Rough Set Models.

Reducts generated from object-oriented rough set models are sensitive to changes in the models. This can be seen by removing a randomly chosen set of objects from the original object set. Those reducts frequently occurring in random sub-object-oriented models can be considered to be stable; it is this object-oriented reducts that are encompassed by dynamic reducts in the object-oriented rough set models.

The reducts stable in decision rules are called object-oriented dynamic reducts. Dynamic reducts define set of classes or set of classes with names are called dynamic core in the object-oriented rough set models. These are the classes or classes with names included in all object-oriented dynamic reducts.

The rules calculated by means of dynamic reducts are better pre-disposed to classify unseen cases, because these reducts in the object-oriented rough set models are in some sense the most stable reducts, and they are the most frequently appearing reducts in sub-object-oriented rough set models created by random samples of a given object-oriented rough set models.

Algorithm 1: Dynamic Reduct in the Object-Oriented Rough Set Model.

DynamicRedOORS(OORS, ε, nts)

OORS, the original object-oriented rough set model;

ε, the dynamic reduct threshold;

nts, the number of iterations.

R $\leftarrow \{\ \}$

T $\leftarrow$ calculateAllReducts(OORS)

for j=1..nts

$OORS' \leftarrow$ deleteRandomRows$(OORS)$

R $\leftarrow$ R $\cup$ calculateAllReducts$(OORS')$

$\forall$ P $\in$ T

If $s_F(P,R) \geq \varepsilon$

Output P.

Firstly, all reducts are calculated for the given object-oriented rough set model, OORS. Then, new sub-object-oriented rough set model $OORS'$ by randomly deleting one or more rows form OORS. All reducts found for each sub-object-oriented rough set model, and the dynamic reducts are computed using $s_F(P,R)$ which denotes the significance of reduct P with all reducts found, R.

Definition 3: Let $OORS(\mathbf{C}, \mathbf{N}, \mathbf{O})$ be the object-oriented rough set model where $\mathbf{C} = (C, \ni_C, \supseteq_C)$, $\mathbf{N} = (N, \ni_N, \supseteq_N)$, $\mathbf{O} = (O, \ni_O, \supseteq_O)$ be the well defined class, name, object structures, respectively. Let $OORS'(\mathbf{C}', \mathbf{N}', \mathbf{O}')$ be the sub-object-oriented rough set model, where $\mathbf{C}' = (C', \ni_C, \supseteq_C)$, $\mathbf{N}' = (N', \ni_N, \supseteq_N)$, $\mathbf{O}' = (O', \ni_O, \supseteq_O)$ be the well defined class, name, object structures respectively. Let $\mathbf{C}' \subseteq \mathbf{C}$, $\mathbf{N}' \subseteq \mathbf{N}$, $\mathbf{O}' \subseteq \mathbf{O}$, $OORS' \subseteq OORS$, $OORS'$ is called sub-object-oriented rough set model of $OORS$. Let $\rho(OORS)$ be the set of all sub-object-oriented rough set model of $OORS$.

Definition 4: Let $OORS(\mathbf{C}, \mathbf{N}, \mathbf{O})$ be the object-oriented rough set model where $\mathbf{C} = (C, \ni_C, \supseteq_C)$, $\mathbf{N} = (N, \ni_N, \supseteq_N)$, $\mathbf{O} = (O, \ni_O, \supseteq_O)$ be the well defined class, name, object structures, respectively. Let $RED(OORS)$ denotes the set which contains all reducts of $OORS$ and $RED(OORS')$ denotes the set which includes all Reducts of $OORS'$. A object-oriented rough set model at least contains one reduct, which is just itself, so the set of reduct in the object-oriented rough set model is not empty.

In many cases, a given object–oriented rough model may exist several reducts. Each reduct can produce a rule set, and it is difficult to justify which the best rule is set. Therefore it

is a important to search the most stable reduct in the object-oriented rough set model, and hence reduct in the object-oriented rough set model is proposed in this case.

Definition 5: Let $OORS(\mathbf{C}, \mathbf{N}, \mathbf{O})$ be the object-oriented rough set model where $\mathbf{C} = (C, \ni_C, \supseteq_C)$, $\mathbf{N} = (N, \ni_N, \supseteq_N)$, $\mathbf{O} = (O, \ni_O, \supseteq_O)$ be the well defined class, name, object structures, respectively. Let $\rho(OORS)$ be the set of all sub-object-oriented rough set model of OORS, $F \subseteq \rho(OORS)$ is called a family of object-oriented rough set model OORS. Let $F \subseteq P(OORS)$ be the dynamic reduct of object-oriented rough set model OORS, denoted by $DR\ (OORS, F)$[5], and

$$DR\ (OORS, F) = RED(OORS) \cap \bigcap_{OORS' \in F} RED(OORS') \quad (12)$$

Any element of $DR(OORS, F)$ is called an F-dynamic reduct, which describes the most stable reducts in object-oriented rough set models. From the definition of dynamic reduct in the object-oriented rough set model, it follows that, it is also reduct of all sub-object-oriented rough set models from a given family F by random sampling.

The concept of dynamic core in the object-oriented rough set model is introduced here.

Dynamic Core in the Object-Oriented Rough Set Model.

Reduct finding is the basic problem in object-oriented rough set models, and the computation of feature core in the object-oriented rough set model is especially important for resolving this problem. All classes with names or classes in the feature core will be presence in any reduct, otherwise revised discernible relation in object-oriented rough set models can not be ensured. According to the feature core one can construct object-oriented reduct heuristically, and the efficiency of reduct can be improved greatly. For dynamic reduct in the object-oriented rough set model, the need for feature core is to be probed.

Definition 4: Let $OORS(\mathbf{C}, \mathbf{N}, \mathbf{O})$ be the object-oriented rough set model where $\mathbf{C} = (C, \ni_C, \supseteq_C)$, $\mathbf{N} = (N, \ni_N, \supseteq_N)$, $\mathbf{O} = (O, \ni_O, \supseteq_O)$ be the well defined class, name, object structures, respectively. Let $OORS'(\mathbf{C}', \mathbf{N}', \mathbf{O}')$ be the sub-object-oriented rough set model, where $\mathbf{C}' = (C', \ni_C, \supseteq_C)$, $\mathbf{N}' = (N', \ni_N, \supseteq_N)$, $\mathbf{O}' = (O', \ni_O, \supseteq_O)$ be the well defined class, name, object structures respectively. Let $\mathbf{C}' \subseteq \mathbf{C}$, $\mathbf{N}' \subseteq \mathbf{N}$, $\mathbf{O}' \subseteq \mathbf{O}$, $OORS' \subseteq OORS$, $OORS'$ is called sub-object-oriented rough set model of OORS. The feature core of object-oriented rough set models in static reduct is

$$CORE(OORS) = \bigcap_{i=1}^{p} C_i \quad \text{or} \quad \bigcap_{i=1}^{p} \bigcap_{j=1}^{q} C_i \,.\, n_j = \bigcap_{R \in RED(OORS)} R \quad (13)$$

Where $C_i\ (1 \le i \le p), C_i.n_j (1 \le i \le p), (1 \le j \le q)$ represents classes and classes with names belongs to reducts in the object-oriented rough set model.

Algorithm 2: Core of the object-oriented rough set model.

Input: object-oriented rough set model OORS.

Output: the core of the object-oriented rough set model.

T ← calculateAllReducts (OORS).

Core ← finding intersection of elements of T.

Output Core.

Definition 5: Let $OORS(\mathbf{C}, \mathbf{N}, \mathbf{O})$ be the object-oriented rough set model where $\mathbf{C} = (C, \ni_C, \supseteq_C)$, $\mathbf{N} = (N, \ni_N, \supseteq_N)$, $\mathbf{O} = (O, \ni_O, \supseteq_O)$ be the well defined class, name, object structures, respectively. Let $OORS'(\mathbf{C}', \mathbf{N}', \mathbf{O}')$ be the sub-object-oriented rough set model, where $\mathbf{C}' = (C', \ni_C, \supseteq_C)$, $\mathbf{N}' = (N', \ni_N, \supseteq_N)$, $\mathbf{O}' = (O', \ni_O, \supseteq_O)$ be the well defined class, name, object structures respectively. Let $\mathbf{C}' \subseteq \mathbf{C}$, $\mathbf{N}' \subseteq \mathbf{N}$, $\mathbf{O}' \subseteq \mathbf{O}$, $OORS' \subseteq OORS$, $OORS'$ is called sub-object-oriented rough set model of $OORS$. Let $\rho(OORS)$ be the set of all sub-object-oriented rough set model of $OORS$, the feature core of sub-object-oriented rough set models in static Reduct is

$$CORE\ (OORS') = \bigcap_{i=1}^{p} C_i \quad \text{or} \quad \bigcap_{i=1}^{p} \bigcap_{j=1}^{q} C_i.n_j = \bigcap_{R \in RED(OORS')} R$$

(14)

Where $C_i\,(1 \le i \le p), C_i.n_j\,(1 \le i \le p), (1 \le j \le q)$ represents classes and classes with names belongs to reducts in the sub-object-oriented rough set model.

Definition 6: Let $OORS(\mathbf{C}, \mathbf{N}, \mathbf{O})$ be the object-oriented rough set model where $\mathbf{C} = (C, \ni_C, \supseteq_C)$, $\mathbf{N} = (N, \ni_N, \supseteq_N)$, $\mathbf{O} = (O, \ni_O, \supseteq_O)$ be the well defined class, name, object structures, respectively. Let $OORS'(\mathbf{C}', \mathbf{N}', \mathbf{O}')$ be the sub-object-oriented rough set model, where $\mathbf{C}' = (C', \ni_C, \supseteq_C)$, $\mathbf{N}' = (N', \ni_N, \supseteq_N)$, $\mathbf{O}' = (O', \ni_O, \supseteq_O)$ be the well defined class, name, object structures respectively. Let $\mathbf{C}' \subseteq \mathbf{C}$, $\mathbf{N}' \subseteq \mathbf{N}$, $\mathbf{O}' \subseteq \mathbf{O}$, $OORS' \subseteq OORS$, $OORS'$ is called sub-object-oriented rough set model of $OORS$. Let $\rho(OORS)$ be the set of all sub-object-oriented rough set model of $OORS$, $F \subseteq \rho(OORS)$ be the Dynamic Core of $OORS$ on a family F is defined by

$$DCORE(OORS, F) = CORE(OORS) \cap \bigcap_{OORS' \in F} CORE(OORS')$$

(15)

$DCORE(OORS, F)$ is called F-Dynamic Core of Object-Oriented Rough Set Model of $OORS$.

V. (F-λ)–Dynamic Core in the Object-Oriented Rough Set Model

F–dynamic core can be sometimes too much restrictive so here applies a generalization of F–dynamic core.

Definition 7:. Let $OORS(\mathbf{C}, \mathbf{N}, \mathbf{O})$ be the object-oriented rough set model where $\mathbf{C} = (C, \ni_C, \supseteq_C)$, $\mathbf{N} = (N, \ni_N, \supseteq_N)$, $\mathbf{O} = (O, \ni_O, \supseteq_O)$ be the well defined class, name, object structures, respectively. Let $\rho(OORS)$ be the set of all sub-object-oriented rough set model of OORS, $F \subseteq \rho(OORS)$ is called a family of object-oriented rough set model OORS, $\lambda \in (0.5, 1]$, and the $(F-\lambda)$-dynamic core of $OORS$ based on Family F is defined by

$$DCORE_\lambda(OORS, F) = \{C \text{ or } C.n \in CORE(OORS) \mid \{ OORS' \in F : C \text{ or } C.n \in CORE(OORS')\}\mid \text{----------} \ge \lambda \left|F\right|$$

λ is precision coefficient and the value of x decides which class or class with name belongs to (F-λ)-Dynamic Core $DCORE_\lambda(OORS, F)$ in the object-oriented rough set model. Let c represents class and c.n represents class with name as λ approaches 1, $DCORE_\lambda(OORS, F)$ will be closed to $DCORE(OORS, F)$, while λ approaches 0.5, $DCORE_\lambda(OORS, F)$ is more rough compared with $CORE(OORS, F)$, but $DCORE(OORS, F)$ will comprise classes or more classes with names.

VI. Generalized Dynamic Core in the Object-Oriented Rough Set Model

According to the definition of dynamic core in the object-oriented rough set model, if some feature classes or classes with names of any sub-object-oriented rough set models in F family are comprised by dynamic core, then it is certainly a feature classes or classes with names of object-oriented rough set model. This notion can be sometimes not convenient because we are interested in useful sets of classes or classes with names which are not necessarily reducts of the object-oriented rough set model. Therefore we have to generalize the notion of a dynamic core in the object-oriented rough set model.

Definition 8: Let $OORS(\mathbf{C}, \mathbf{N}, \mathbf{O})$ be the object-oriented rough set model where $\mathbf{C} = (C, \ni_C, \supseteq_C)$, $\mathbf{N} = (N, \ni_N, \supseteq_N)$, $\mathbf{O} = (O, \ni_O, \supseteq_O)$ be the well defined class, name, object structures, respectively. Let $\rho(OORS)$ be the set of all sub-object-oriented rough set model of OORS, $F \subseteq \rho(OORS)$ is called a family of object-oriented rough set model, then

$$GDCORE(OORS, F) = \bigcap_{OORS' \in F} CORE(OORS')$$

(16)

$GDCORE(OORS, F)$ is called the Generalized Dynamic Core the of object-oriented rough set model $OORS$.

VII. CONCLUSION

We have considered object-oriented rough sets, decision rules and discernibility matrix to find reducts in the object-oriented rough set model. We proposed dynamic reducts in the object-oriented rough set model. We also proposed dynamic core and generalized core in the object-oriented rough set model. We have developed algorithms for dynamic reducts and core.

REFERENCES

[1] Pawlak, Z, "Rough sets." International Journal of Computer and Information Science **11,** 1982, pp.341–356.

[2] Pawlak, Z, "Rough Sets:" Theoretical Aspects of Reasoning about Data. Kluwer, Academic Publisher 1991.

[3] Popkorn, S, "First Steps in Model Logic." Cambridge University Press, 1994.

[4] Budd, T.A, "An Introduction of Object– Oriented Programming," 2nd Edition. Addison Wesley Longman, 1997.

[5] Bazan J, "A Comparison of Dynamic and Non-Dynamic Rough Set Methods for Extracting Laws from Decision Tables[C], In Polkowski and Skowron, (eds) Rough sets in Knowledge Discovery 1:Methodology and Applications, Physica-Verlag, Heidelberg,1998, pp. 321–365.

[6] Kudo, Y., Murai, T, "A theoretical formulation of object–oriented rough set models", Journal of Advanced Computational Intelligence and Intelligent Informatics 10(5),2006, pp.612-620.

[7] Kudo, Y., Murai, T, "A Method of Generating Decision Rules in Object–Oriented Rough Set Models." In:Greco, S.,Hata,Y,, Hirano,S., Inuiguchi,M., Miyamoto,S., Nguyen., Slowinski ,R,(eds) RSCTC 2006, LNCS (LNAI), Springer, Heidelberg, vol.4259,2006, pp.338-347.

[8] Kudo, Y., Murai, T, "A note on treatment of incomplete information in object–oriented rough sets." In: Proceedings of the Joint 3rd International Conference on Soft Computing and Intelligent Systems and 7th International Symposium on advanced Intelligent Systems. G.Wang et.al(Ede),RSKT ,LNAI 5009,2008, pp.115-123.

Parallel Printer Port for Phase Measurement

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***Abstract*-This white paper talks about the measurement of phase angle using Phase Locked Loop and printer port.. The phase detector compares the phase of a periodic input signal against the phase of the output of voltage controlled oscillator and generates an average output voltage V_{out} which is linearly proportional to the phase difference, $\Delta\phi$ between its two inputs. This output voltage is measured using the parallel Printer port of a PC.**

Keywords: Phase detector, voltage controlled oscillator, phase locked loop and parallel printer port.

I. INTRODUCTION

The recent developments of telecommunication systems has brought an increased demand for low-jitter, high-speed phase-locked loops (PLL). The phase detector is a key element in PLL's and has from a historical point of view not been able to handle large input frequency differences [1]. The phase detector compares the phase of a periodic input signal against the phase of the output of VCO, and generates an average output voltage $V_{out,}$ which is linearly proportional to the phase difference, $\Delta\phi$, between its two inputs. In the ideal case, the relationship between V_{out} and $\Delta\phi$ is linear, crossing the origin for $\Delta\phi = 0$ [2,3]. The output frequency of the VCO is directly proportional to input DC level. The VCO frequency is compared with the input frequency and adjusted until it is equal to the input frequency.

In short the PLL works in three states: free running, capture and phase lock. Before input is applied the PLL is in free running state. Once input is applied the VCO frequency starts to change and PLL is said to be in the capture mode. The VCO frequency continues to change until it is equal to the input frequency and phase locked state is obtained. When phase locked, the loop tracks any change in the input frequency through its repetitive action. In many applications the dynamic characteristics of PLL play an important role, mainly in the reduction of acquisition time and improvement in noise immunity.

A PLL operate on the same principle that the quantity fed back and compared is not the amplitude but the phase. VCO adjusts its own frequency until it is equal to that of input sinusoidal signal. At this point the frequency and phase of the signal are in synchronism[4].

PLL has emerged as one of the fundamental building block in electronics technology. The PLL principle is used in FM demodulators, frequency synthesized transmitters and receivers, FSK decoders for the generation of local oscillator frequency.

Phase sensitive detection technique is also used in two terminal ac measurements [5-8]. Phase sensitive detectors were used by Szaro [9] to perform conductance measurements over a wide band of frequency.To measure the phase introduced by capacitors Bruce & West [10] used phase meters. They have used this to analyse the ac conductivity of solid electrolyte in terms of equivalent circuits consisting of resistors and capacitors. Balaya and Sunandana [11] designed an electronic system based on quadrature oscillator and phase sensitive detection for measurement of ac conductivity .

To measure the phase difference between 2 signals upto frequency of 2.5 GHz Cowles and Gilbert [12] used AD8308. From the review of above literature it is evident that most of the available circuits are quite complex. In this work a modest attempt is made to develop a low cost simple circuit for the measurement of phase difference.

Most personal computers today are equipped with a parallel port commonly used to connect the computer to a parallel printer. Because it is available on most personal computers, the parallel port is a perfect choice for connection to other peripheral devices. However, communication to peripherals across the parallel port is limited because the interface is traditionally undirectional and there is no standard specification for the interface.

Additionally, although the performance of the personal computer has dramatically increased, the parallel port has remained the same.

II. EXPERIMENTAL SETUP

Phase locked loop IC is used to detect the phase introduced by the sample. Though there are many phase detectors like diode phase detector, double balanced phase detector etc., phase locked loop is preferred with a view to convert the phase into proportional dc voltage and proportional frequency within a single chip [13,14] . The block diagram is shown in Fig.1.

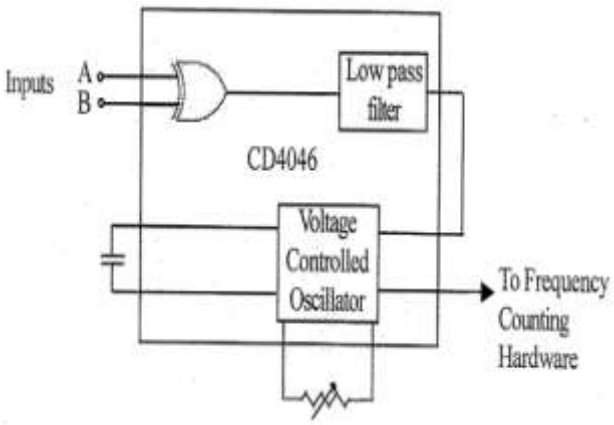

Fig.1. Block diagram of PLL

The IC used here is CD 4046 micropower phase locked loop. It consists of an exclusive OR gate, lowpase filter and a voltage controlled oscillator.

One of the basic and important components of a PLL is the voltage controlled oscillator [15 ,16].The inputs to XOR gate are the outputs from comparators. It produces an output voltage which has a dc component proportional to the phase difference between the input signals, which consists of a dc term and some ac components of input frequency.

The output of low pass filter has dc component, the magnitude of which is a function of the phase angle between two input signals. Voltage controlled oscillator converts the dc voltage from low pass filter into proportional frequency.

If the frequency of input signal changes, a change in phase angle between input signals will produce a change in dc voltage in such a manner as to vary the frequency of voltage controlled oscillator [17]. This change in frequency is measured with the help of frequency counter.

The frequency measuring hardware make use of three stages of 3-tier ICs consisting of 74LS393 (Dual 4-bit binary ripple counter), 74LS374 (8-bit positive edge triggered latch) and 74LS258 (Quad 2-line to 1-line Data Selector/Multiplexer). The counting and frequency measuring hardware is shown in Fig. 2.

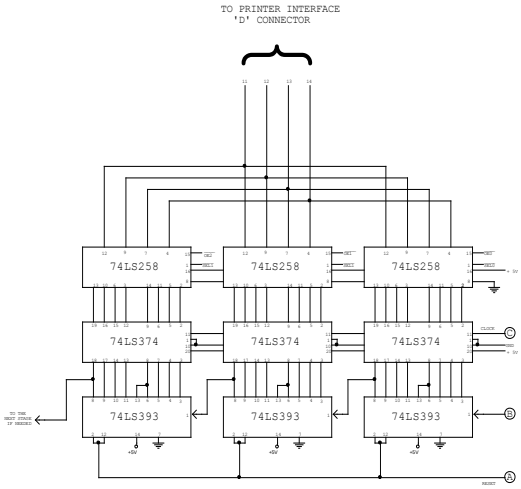

Fig.2.Counting and Frequency measuring circuit

The 3-tier ICs were cascaded to give a 3-stage counting system. Such a system can be used as a frequency counter by handling the signal such as resetting, counting, latching and reading properly. This synchronized behaviour was achieved by using 1 Hz signal in conjunction with logic gates (for gating arrangement) and monoshots to derive the necessary signal [18]. The hardware developed in achieving the above mentioned signals is described below.

To count the incoming pulses, IC 74LS393 was used. It is a dual 4-bit binary ripple counter.. The clock input to the first stage 74LS393 was obtained from the output of an AND gate.

Before the counting starts, all the counters were reset simultaneously to make it ready for counting the pulses. The AND gate was disabled after 1 Sec. Thus, the count registered directly gives the frequency. One can also use IC 74LS161 instead of 74LS393, which can generate a look-ahead carry for faster counting.

The pulses counted have to be latched for reading and before starting of the next cycle. IC 74LS374 was used for this purpose. The outputs of these latches were always enabled. The signal from the monoshot was fed to the cascaded clock-input of the latches. This signal will transfer the date appearing at the input of the latches.

Reading of the data latched at the outputs of 74LS374s was done by the PC. Infact, the 24-bit count appearing at the output of 74LS374 needs three 8-bit ports. Simultaneous reading of 24 bits calls for an add-on card such as digital input output (DIO) card having two 8255s. Further, mounting of such a card on the slot of the motherboard needs the PC to be opened.[19,20].

In the present work, advantage is taken of the Centronics printer port (available at the rear of the PC) to read the register counts (frequency) sequentially [21]. The PC AT (80383 SX) used in the present work had two printer ports: LPT1 and LPT2. One of these ports was used for reading the frequency.

III. EXPERIMENTAL PROCEDURE

The measurement of phase difference between two signals of same frequency was carried out by various methods. The new method adopted in this work is a frequency conversion method using phase locked loop IC CD 4046. The block diagram of the method used is shown in Fig1. The zero crossing detectors convert the input signals into square pulses, which were fed to XOR phase detector.

The XOR gate output voltage has a dc component proportional to phase difference between the input signals. The output of the phase detector was fed to a low pass filter to remove high frequency components. The output dc voltage from the low pass filter was fed as input to the linear voltage controlled oscillator.

The VCO frequency was determined by VR and C values and the maximum frequency was set to 180 kHz, which corresponds to 180^0 phase shift. When the phase difference between the two input signals was 90^0, the VCO output was 90 kHz. Thus the output frequency was directly proportional to the input phase difference.

The scheme was built and tested with a CMOS micro PLL chip CD 4046. It was found that the scheme needs calibration for different frequency settings before a fruitful measurement is made. However, the calibration can be

easily achieved with the help of an inverting amplifier and the variable resistor VR. Before making a measurement, the inputs to XOR were fed from one of the signals and its inverted output employing an inverting amplifier.

It maintains a constant 180^0 phase difference between the two input signals A and B. VR was now adjusted to set the VCO output frequency to 180 kHz. The output of the VCO(X) was fed to the frequency measuring unit .

IV. RESULTS AND DISCUSSION

In order to study the reliability and repeatability of the steup we have used some standard capacitors to introduce the phase difference between the two inputs given to an X-OR gate.

The phase difference obtained theoretically and experimentally is found to be in quiet good agreement. This low cost simple technique can be employed to carry out phase measurements in unknown samples. From this phase angle , one can determine ac conductivity.

REFERENCES

[1] S.Soliman, F.Yuan and K.Raahemifar, An overview of Design Techniques for CMOS detectors, IEEE circuit and Systems, (2002), 457-460.

[2] B.Razavi, Design of Analog CMOS integrated circuits, McGRAWHILL, (2001).

[3] B.Chakraborty and R.R.Pal, Journal of Phy.Sciences, 12, 2008.

[4] B. Chakraborty and R.R.Pal, International Journal of Electronics, vol.94, No.7, 2007.

[5] K.S.Cole and R.H.Cole, J.Chem.Phys., 9, 341, 1949.

[6] B.Ravaine and J.L.Souquet, J.De.Chemie.Physique, 11, 693, 1974.

[7] E.Schouler, A.Hammou and M.Kleitz, Mater.Res.Bull, 71, 693, 1976.

[8] R.K.Cole and D.W.Davison, J.Chem.Phys, 18, 1417, 1915.

[9] L. Szaro, J.Phys.E.Sci.Instrum., 22 1966.

[10] P.G.Bruce and A.R. West, J.Electrochem.Soc., 130, 2, 1983.

[11] P.Balaya and C.Sunandana, Pramana, 33, 627, 1989.

[12] John Cowles and Barrie Gilbert, Analog Dialogue, 35, 5, 2001.

[13] R.Padma Suvarna, M.Phil.dissertation , 1997.

[14] R.Padma Suvarna and K.Subbarangaiah, Bull Material Sci., 25, 7, 2002.

[15] F.Azais, A.Ivanov, M.Renovelle, Y.Bertrand, Proceedings of the Seventh Asian Test Symposium, 1998, 383-87.

[16] B.Razavi, IEEE Press, 1996.

[17] Behzad Razavi, Kwing F.Lee and Ran H.Yan, IEEE Journal of Solid-State Circuits,30, 2 1995.

[18] R.Padma Suvarna, Ph.D. Thesis, 2002.

[19] P.Thimmaiah and K.R.Rao , National Symposium on Instrumentation, cochin, 2005.

[20] Webster, Edward C (2000).Print Unchained: Fifty years of digital printing : A Saga Of Invention and Enterprise. West Dover, VT : DRA of Vermont ISBN 0-9702617-0-5.

[21] " Data products D-sub 50 arallel" Hardware Book , Retrieved 2008-01-25.

Traffic Load based Performance Analysis of DSR, STAR & AODV Adhoc Routing Protocol

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***Abstract*- The wireless adhoc network is comprised of nodes (it can be static or mobile) with wireless radio interface. These nodes are connected among themselves without central infrastructure and are free to move. It is a multihop process because of the limited transmission range of energy constrained wireless nodes. Thus, in such a multihop network system each node (also known as router) is independent, self-reliant and capable of routing the packets over the dynamic network topology and therefore routing becomes very important and basic operation of adhoc network. Many protocols are reported in this field but it is difficult to decide which one is best. In this paper table driven protocol STAR and on demand routing protocols AODV, DSR based on IEEE 802.11 are surveyed and characteristic summary of these routing protocols is presented. Their performance is analyzed on throughput, jitter, packet delivery ratio and end-to-end delay performance measuring metrics by varying CBR data traffic load and then their performance is also compared using QualNet 5.0.2 network simulator.**

Keywords-Adhoc networks; wireless networks; CBR, routing protocols; route discovery; simulation; performance evaluation; MAC; IEEE 802.11; STAR; DSR; AODV.

I. INTRODUCTION

The wireless adhoc network is collection of nodes with wireless radio interface, which can move freely and are connected among themselves without any infrastructure. The adhoc networks are very flexible and suitable for several types of applications, as they allow the establishment of temporary communication without any pre installed infrastructure (fig.1). Due to the limited transmission range of wireless radio interfaces, in most cases, the communication has to be relayed over intermediate nodes. Thus, in mobile multi-hop ad-hoc networks each node also acts as a router [6]. Beside the disaster and military application domain the deployment of mobile ad-hoc networks for multimedia applications is another interesting domain. With newly emerging radio technologies, e.g. IEEE 802.11[10] and bluetooth, the realization of multimedia applications over mobile ad-hoc networks becomes more realistic.

To find a route between the end-points is a major problem in mobile multi hop ad-hoc networks. The problem is further aggravated because of the nodes mobility. Many different approaches are reported to handle this problem in recent years, but it is very difficult to decide which one is best

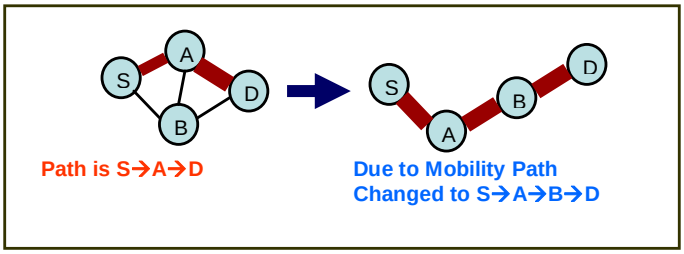

Fig. 1 The dynamic scenario of network topology with mobility

routing algorithm. It is also reported in the performance analysis of different routing protocols [11,12,13] in literature. Other aspects of ad-hoc networks are also subject to current research, especially the dynamic changing network topology of nodes.

In this paper the comparison of STAR a table driven and AODV, DSR on-demand routing protocol based on IEEE 802.11 [10] is analyzed, compared and presented. This paper explores the impact of MAC overhead on achievable data throughput, jitter, end-to-end delay and packet delivery ratio in environments with varying data traffic CBR (Constant Bit Ratio) load over UDP using Qualnet 5.0.2 simulator [2].

II. ROUTING PROTOCOLS: CLASSIFICATION IN BRIEF

Routing is the process of finding a path from a source to some arbitrary destination on the network. The broadcasting [14,15,16] is inevitable and a common operation in ad-hoc network. It consists of diffusing a message from a source node to all the nodes in the network. Broadcast can be used to diffuse information to the whole network. It is also used for route discovery protocols in ad-hoc networks. The routing protocols are classified as follows on the basis of the way the network information is obtained in these routing protocols.

A. Proactive or Table-driven) routing protocol

For example
1. Destination sequenced Distance vector routing (DSDV)[5]
2. Source Tree Adaptive Routing (STAR) [8]

B. Reactive or On-demand routing protocol

For example
1. Ad-Hoc On-demand Distance Vector (AODV) [1]
2. Dynamic Source Routing (DSR) [3,4]

C. Hybrid Protocols

For example
1. Temporally ordered routing algorithm (TORA)[7]
2. Zone Routing Protocol (ZRP)[9]

These classes of routing protocols are reported but choosing best out of among them is very difficult as one may be performing well in one type of scenario the other may work in other type of scenario. In this paper it is observed with the simulation of AODV, DSR and STAR routing protocols. These three protocols are briefly described below. The characteristic summary of these routing protocols is also presented in this paper in table 2.

III. DYNAMIC SOURCE ROUTING PROTOCOL

The key feature of DSR [3,4] is the use of source routing. The source (sender) knows the complete hop-by-hop route to the destination. These routes are stored in a route cache. The data packets carry the source route in the packet header. It is an on-demand routing protocol and composed of two parts:

A. Route Discovery
B. Route Maintenance.

A. Route Discovery

When a node in the ad hoc network attempts to send a data packet to a destination for which route is not known, it uses a route discovery process to find a route. Route discovery uses simple flooding technique in the network with route request (RREQ) packets. Each node receiving an RREQ rebroadcasts it further, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. RREQ and RREP packets are also source routed. The RREQ builds up the path traversed so far. The RREP routes itself back to the source by traversing this path backward, the route carried back by the RREP packet is cached at the source for future use.

B. Route Maintenance

The periodic routing updates are sent to all the nodes. If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed. Also, any forwarding node caches the source route in a packet it forwards for possible future use. Some of the techniques that are evolved to improve it are:

i) Salvaging: an intermediate node can use an alternate route from its own cache, when a data packet meets failed link on its source route.
ii) Gratuitous route repair: a source node receiving a RERR packet piggybacks the RERR in the following RREQ.

This helps cleaning up the caches of other nodes in the network that may have the failed link in one of the cached source routes.

IV. SOURCE TREE ADAPTIVE ROUTING (STAR)

Source Tree Adaptive Routing (STAR) Protocol for adhoc network, is a proactive table driven routing protocol. The network topology is presented in the form of a graph G. The G = (V, E) is a directed graph, where E is the set of edges connecting the vertices and V is the set of nodes. These vertices are called nodes (or Routers) and edges are called links between them. The adjacent nodes are called neighbors and all of them have unique address for identity. In a wireless network, a node can have connectivity with multiple nodes over a single physical radio link.

A. Route Discovery & Maintenance

Each node builds a shortest path tree (source tree) and stores preferred path to destination and so each node discovers and maintains information related to network topology. STAR protocol uses two different techniques to neighbor discovery using hello or update messages. It is energy saving protocol in the sense that every node of it updates about only the changes to its source routing tree when they found changes or breakage in the links. If over a given period of time a node doesn't receive any such message, it assumes that either node is out of its range (node may be dead) or link is broken. Within the finite time frame all the changes like link failures, new neighbor notifications etc. are processed and send to neighbors in their order of occurrences and one at time.

B. Different Operating Modes

The STAR routing protocol operates in two different mechanisms but chooses one at a time. It may work either in the Least Overhead Routing Approach (LORA) mode or Optimum Routing Approach (ORA) mode. With ORA, the routing protocol attempts to update routing tables as quickly as possible to provide paths that are optimum with respect to a defined metric whereas in LORA mode it tries to provide shortest route as per performance and delay metrics.

V. AD-HOC ON-DEMAND DISTANCE VECTOR (AODV)

The brief discussion of the AODV protocol is given here as it analyzed further for the impact of MAC overhead and multiple hops on achievable data throughput and packet delivery ratio using ns2 simulator

A. Ad Hoc On-Demand Distance-Vector Protocol (AODV)

The Adhoc On-Demand Distance-Vector Protocol (AODV)[1] is a distance vector routing for mobile ad-hoc networks. AODV is an on-demand routing approach, i.e. there are no periodical exchanges of routing information.
The protocol consists of two phases:

i) Route Discovery, and
ii) Route Maintenance.

A node wishing to communicate with another node first seeks for a route in its routing table. If it finds one the communication starts immediately, otherwise the node initiates a *route discovery* phase. The route discovery process consists of a route-request message (RREQ) which is broadcasted. If a node has a valid route to the destination, it replies to the route-request with a route-reply (RREP) message. Additionally, the replying node creates a so called *reverse route* entry in its routing table which contains the address of the source node, the number of hops to the source, and the next hop's address, i.e. the address of the node from which the message was received. A lifetime is associated with each reverse route entry, i.e. if the route entry is not used within the lifetime it will be removed. The second phase of the protocol is called *route maintenance*. It is performed by the

source node and can be subdivided into: i) source node moves: source node initiates a new route discovery process, ii) destination or an intermediate node moves: a route error message (RERR) is sent to the source node. Intermediate nodes receiving a RERR update their routing table by setting the distance of the destination to infinity. If the source node receives a RERR it will initiate a new route discovery. To prevent global broadcast messages AODV introduces a local connectivity management. This is done by periodical exchanges of so called HELLO messages which are small RREP packets containing a node's address and additional information

B. The Basic Protocol

Each AODV router is essentially a state machine that processes incoming requests from the SWANS network entity. When the network entity needs to send a message to another node, it calls upon AODV to determine the next-hop.
Whenever an AODV router receives a request to send a message, it checks its *routing table* to see if a route exists. Each routing table entry consists of the following fields:

- Destination address
- Next hop address
- Destination sequence number
- Hop count

If a route exists, the router simply forwards the message to the next hop. Otherwise, it saves the message in a *message queue*, and then it initiates a route request to determine a route. Upon receipt of the routing information, it updates its routing table and sends the queued message(s). AODV nodes use four types of messages to communicate among each other. *Route* Request (RREQ) and Route Reply (RREP) messages are used for route discovery. Route Error (RERR) messages and HELLO messages are used for route maintenance.

VI. SIMULATION SETUP

The Qualnet 5.0.2 simulator is used for the analysis. The animated simulation is shown in fig. 2. The IEEE 802.11[10] for wireless LANs is used as the MAC layer protocol. In the scenario UDP (User Datagram Protocol) connection is used and over it data traffic of Constant bit rate (CBR) is applied between source and destination. The 100 nodes are placed uniformly over the region of 1500mx1500m. The mobility model uses the random waypoint model in a rectangular field. The multiple CBR application are applied over 13 different source nodes – 4,53,57,98,100,7, 5,49,10,93,1,92,9) and destinations nodes - 51,91,94,59,60,96,58,97,100,54,45, 44,38 respectively. The data traffic load is varied as 1, 2, 4, 5, 10 packets per sec to analyze the performance of AODV, DSR and STAR-LORA (STAR with LORA method) routing protocols. The simulations parameters are shown in table 1.

Performance Metrics

Throughput: Throughput is the average rate of successful data packets received at destination. It is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second.

TABLE 1. Simulation Parameters

Parameter	Value
Area	1500mX1500m
Simulation Time	90,120, 200 sec
Channel Frequency	2.4 Ghz
Data rate	2.Mbps
Path Loss Model	Two Ray Model
Mobility Model	Random-Way Point
Packet size	512 bytes
Physical Layer Radio type	IEEE 802.11b
MAC Protocol	IEEE 802.11
Antenna Model	Omni-directional

End-to-End Delay: A specific packet is transmitting from source to destination and calculates the difference between send times and received times. Delays due to route discovery, queuing, propagation and transfer time are included in the delay metric.

Jitter: Jitter is the variation of the packet arrival time. In jitter calculation the variation in the packet arrival time is expected to be low. The delays between the different packets need to be low for better performance in ad-hoc networks. It becomes a matter of concern if it is more that the threshold value which is different for data, voice or video transmission services.

Packet Deliver Ratio (PDR): The (PDR) is defined as the ratio between the amount of packets sent by the source and received by the destination.

VII. RESULTS & DISCUSSION

The Qualnet 5.0.2 network simulator is used to analyze the parametric performance of Dynamic Source Routing (DSR) [3,4], Ad Hoc On-Demand Distance-Vector Protocol (AODV) [1] and STAR [8] routing protocols. The LORA method of STAR is used in this paper for analysis. The animation of broadcasting, nodes mobility and transmission of data is shown in figure 2. The performance is analyzed with varying traffic load. In this analysis thirteen different CBR traffic as described in simulation setup is applied on separate source to destination nodes. The results are shown in figures from 3 to 6.

Packet Deliver Ratio: Performance is analyzed on this parameter and it is observed that AODV routing protocol performs better than both DSR and STAR-LORA but DSR performs better than STAR-LORA initially but as the traffic load is increased more than 2 packets per sec the STSR-LORA protocol outperforms the DSR protocol as shown in figure 3.

Throughput: With the varying CBR data traffic the throughput is analyzed. The successful packet delivery in an adhoc network is observed with increasing MAC based CBR traffic load. It is found that AODV performs better than both DSR and STAR-LORA generally but for traffic of 10 packets per sec STAR-LORA performs better. It is also observed that at low traffic load of 1 packet per sec the DSR protocol perform better than STAR-LORA but as the traffic is loaded heavily the STAR-LORA performs much better than DSR as shown in figure 4.

End-to-End Delay: When a packet is transmitted from source to destination it takes time to reach. This time includes

different delay as described in its definition above. In this analysis it is found as expected the delays are increasing as the traffic load is increasing. The average end-to-end delay is very high in DSR than STAR-LORA and AODV protocols. The AODV also has more end-to-end delay for heavy load than STAR-LORA as shown in figure 5.

Jitter: Jitter, the variation of the packet arrival time, is an important metrics for any routing protocol. In this analysis it is found to vary with the traffic load in case of DSR and is largest when traffic load is 4 packets per sec. But in SATR-LORA case it is uniformly increasing. It is also noted that the jitter of DSR is always more than both AODV and STAR-LORA and the STAR-LORA has least jitter as shown in figure 6.

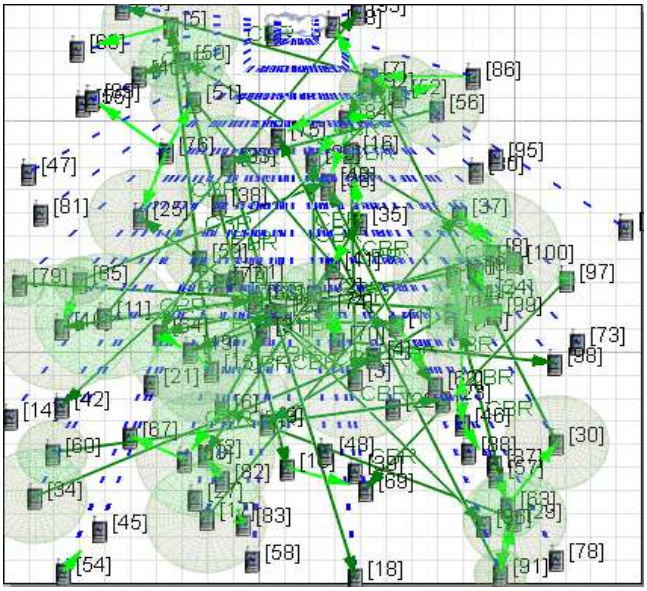

Fig 2 Animation view of simulation

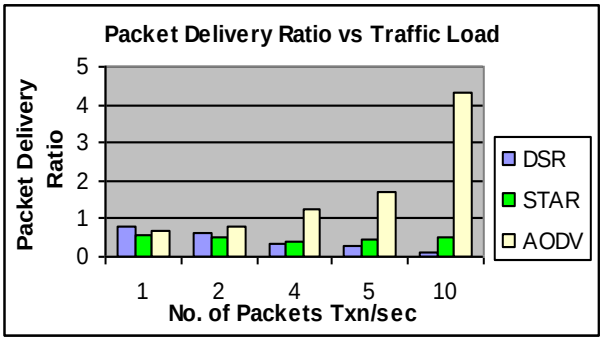

Fig 3: Packet Delivery Ratio vs Traffic Load

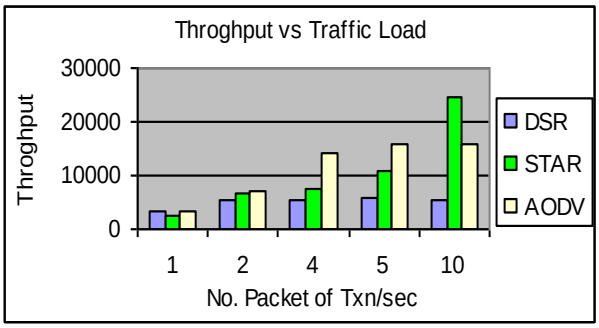

Fig 4: Throughput Vs Traffic Load

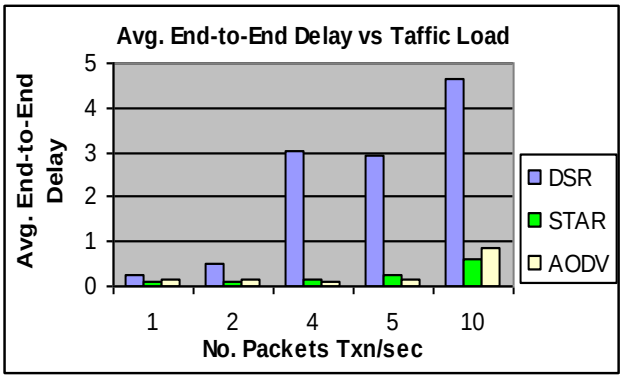

Fig 5: Average End-to-End Delay vs Traffic Load

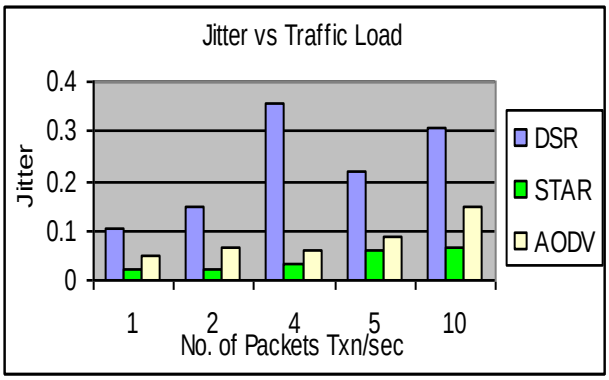

Fig. 6. Average Jitter vs Traffic Load

VIII. CONCLUSION

It is observed that AODV outperforms both of the DSR and STAR-LORA routing protocols in terms of the packet delivery ratio as it uses the fresh routes and STAR-LORA performs poorer as it takes more time to find the routes with LORA method. The throughput is generally good with the AODV but STAR performs better than both when heavy load is applied. The DSR performs poorer than both because of aggressive use of cache. The poor performance of DSR is also because it doesn't have proper mechanism to expire the stale routes and therefore the jitter and the average end-to-end delay is also very high in comparison to AODV and STAR. It is observed that the throughput and Packet deliver is good with the AODV but with increased traffic load the throughput is good in case of STAR routing protocol.

REFERENCES

[1] Charles Perkins, Elizabeth Royer, and Samir Das. "Ad hoc on demand distance vector (AODV) routing". IETF RFC No. 3561, July 2003.
[2] Qualnet Simulator www.scalable-networks.com
[3] Josh Broch, David Johnson, and David Maltz. "The dynamic source routing protocol for mobile adhoc networks for IPv4 IETF RFC 4728, Feb 2007.
[4] D. Johnson and D. Maltz. "Dynamic source routing in ad hoc wireless networks". In T. Imielinski and H. Korth, editors, *Mobile computing*, chapter 5. Kluwer Academic, 1996.
[5] Perkins C, Bhagwat P, "Highly Dynamic Destination-Sequenced Distance-Vector Routing(DSDV) Routing",SIGCOMM'94 Computer Communication Rewiev, vol 24, no. 4,p 234-244, October 1994.
[6] C.-K. Toh. Ad hoc Mobile Wireless Networks: Protocols and Systems, Prentice Hall PTR. 2002:55-77.
[7] V. Park, and S. Corson, "Temporally-Ordered Routing Algorithm (TORA) Version 1 Functional Specification", draft-ietf-manet-tora-spec-04.txt, July 2001.
[8] J.J. Garcia-Luna-Aceves, M. Spohn, "Source-Tree Adaptive Routing in Wireless Networks", Proceedings of the 7th Annual IEEE international conference on Network Protocols, Toronto, Canada. October 31-November 3, 1999. http://www.ieee-icnp.org/1999/ papers/1999-29.pdf.
[9] Zygmunt J. Haas, Marc R. Pearlman, and Prince Samar, "The Zone Routing Protocol (ZRP) for Ad Hoc Networks", draft-ietf-manet-zone-zrp-04.txt, July, 2002.
[10] IEEE, 1997, Wireless LAN Medium Access Control(MAC) and Physical layer PHY) Specifications, IEEE Std. 802.11.
[11] N.S. Yadav, and R.P.Yadav, 2007, Performance Comparison and Analysis of Table- Driven and On-Demand Routing Protocols for Mobile Ad-hoc Networks, International Journal of Information Technology, Vol.4, No. 2, pp 101-109.
[12] A.A. Pirzada, C. McDonald, and A. Datta, 2006, Performance Comparison of Trust-Based Reactive Routing Protocols, IEEE Transactions on Mobile Computing Vol. 5 No.6 pp. 695-710.
[13] Elizabeth Belding, Royer, Routing approaches in mobile ad hoc networks, in: S.Basagni, M.Conti, S.Giordano, I.Stojemenvoic (Eds), Ad Hoc Networking, IEEE Press Wiley, New York, 2003.
[14] S.Y. Ni, Y.C. Tseng, Y.S. Chen, J.P. Sheu, The broadcast storm problem in a mobile ad hoc network, in: Proceedings of the 1999 Fifth Annual ACM/IEEE International Conference on Mobile Computing and Networking, IEEE Computer Society, New York, pp. 151–162, August 1999.
[15] Qi Zhang , Dharma P. Agrawal, Dynamic probabilistic broadcasting in MANETs**,** Journal of Parallel and Distributed Computing 65(2), pp 220-233, February 2005.
[16] B. Williams, T. Camp, Comparison of broadcasting techniques for mobile ad hoc networks, in: Proceedings of the ACM International Symposium on Mobile Ad Hoc Networking and Computing (MOBIHOC 2002), pp. 194–205, 2002.

TABLE 2 Characteristic summaries of DSR, AODV, STAR routing protocols

Protocol	Dynamic Source Routing **(DSR) [3,4]**	Ad hoc On-Demand Distance Vector **(AODV)[1]**	SOURCE TREE ADAPTIVE ROUTING (STAR) **[8]**
Category	Reactive	Reactive	Proactive
Metrics	Shortest path, next available	Newest route, shortest path	Shortest path works in two mode • Least Overhead Routing Approach (LORA) mode or • Optimum Routing Approach (ORA) mode
Route Recovery	New route, notify source	Same as DSR, local repair	Reverse link
Route repository	Route cache	Routing table	Routing table
Broadcasting	Simple	Simple	Simple
Multiple paths	Yes	No	No
Loop freedom maintenance	Source route	Sequence number	Updated messages
Communication Overhead	High	High	High
Feature	Completely on demand	Only keeps track of next hop in route	Control packets localized to area of topology change

Computing the Most Significant Solution from Pareto Front obtained in Multi-objective Evolutionary

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***Abstract*- Problems with multiple objectives can be solved by using Pareto optimization techniques in evolutionary multi-objective optimization algorithms. Many applications involve multiple objective functions and the Pareto front may contain a very large number of points. Selecting a solution from such a large set is potentially intractable for a decision maker. Previous approaches to this problem aimed to find a representative subset of the solution set. Clustering techniques can be used to organize and classify the solutions. Implementation of this methodology for various applications and in a decision support system is also discussed.**

Keywords- Multiobjective,Pareto front ,Clustering techniques

I. INTRODUCTION

Multi-objective optimization is applied to a variety of fields and sufficient computational power exists to generate very large non-dominated sets for these problems. In order to be sufficiently representative of the possibilities and tradeoffs, a non-dominated set may be too large for decision makers to reasonably consider. Some means of reducing or organizing the non-dominated set is needed [1]. Several researchers have dealt with this issue using cluster analysis or filtering. This paper differs from their work in that it intends to not only make the non-dominated set tractable but to do so without removing any elements of the non-dominated set before presenting the solutions to the decision makers.

Cluster analysis can be applied to the results of a multi-objective optimization algorithm to organize or partition solutions based on their objective function values. The goal of clustering is to create an "efficient representation that characterizes the population being sampled" [2]. Such a representation allows a decision maker to further understand the decision by making available the attainable limits for each objective, key decisions and their consequences, and the most relevant variables; this presentation is an improvement on a list of potential solutions and their associated objective function values.

This paper details a k-means cluster analysis approach.

II. MULTIOBJECTIVE OPTIMIZATION AND BACKGROUND DETAILS

Three approaches can be taken to find a solution to multi-objective problems (Benson and Sayin 1997). The first approach entails reformulating the problem as a single objective problem. To do so additional information is required from the decision makers such as the relative importance or weights of the objectives, goal levels for the objectives, values functions, etc. The second approach requires that the decision makers interact with the optimization procedure typically by specifying preferences between pairs of presented solutions. The third approach, Pareto optimization, finds a representative set of non-dominated solutions approximating the Pareto front. Pareto optimization methods, such as evolutionary multi-objective optimization algorithms, allow decision makers to check the potential solutions without a priori judgments regarding the relative importance of objective functions. Post-Pareto analysis is necessary to select a single solution for implementation.

All three approaches to solving multi-objective optimization problems have shortcomings. The solution returned by the single objective approach can be highly dependent on the weights and, in non-convex problems, the responses to changes in weights or goals may be unpredictable. As well, with conflicting and non-commensurate criteria it can be hard to make value judgments such as choosing weights or goals for the criteria. Given decision maker input the first approach returns a single solution. Interactive approaches consider only a small set of non-dominated solutions due to the effort required [3]. Pareto optimization approaches return a potentially large number of solutions for consideration. Selecting a single solution from a large non-dominated set is likely to be difficult for any decision maker. It was proposed that an ideal solution procedure for multi-objective optimization is to provide the decision makers with a globally representative subset of the non-dominated set that is sufficiently small so as to be tractable [4]. This work aims to approach this ideal procedure by accepting the computational effort required for generating a large non-dominated set and subsequently organizing it based on its structure. This approach allows decision makers to tractably consider interesting subsets without a priori removal of any solutions from consideration.

Any Pareto optimization method could be employed in this methodology. Evolutionary multiobjective algorithms apply biologically inspired evolutionary processes as heuristics to generate non-dominated sets of solutions. It should be noted that the solutions returned by evolutionary multiobjective algorithms may not be Pareto optimal, that is, globally non-dominated, but the algorithms are designed to evolve solutions that approach the Pareto front and spread out to capture the diversity existing on the Pareto front in order to obtain a good approximation of the Pareto front.

III. POST-PARETO ANALYSIS

Post-Pareto analysis aids decision makers in choosing a single solution from the potentially large set of Pareto optimization results. Several researchers have applied clustering methods in different ways to non-dominated sets to aid decision makers. Most of these methods use the similarity of elements in the non-dominated set based on their objective function values and remove elements that are too similar to other elements.

The main goal of multi-objective optimization is to seek Pareto-optimal solutions. Over the years there have been various approaches toward fulfillment of this goal. It has been observed that convergence and diversity are two conflicting criteria which must be balanced in trying to generate the entire efficient front [5]. Clearly, there are two different possible principles for generating a set of solutions representing the entire Pareto-optimal front:

- One-at-a-time strategy, and
- Simultaneous strategy

In the former method, a multi-objective optimizer may be applied one at a time with the goal of finding one single Pareto-optimal solution. Most classical generating multi-objective optimization methods use such an iterative scalarization scheme of standard procedures. The main criticism of most of these approaches is that although there are results for convergence, diversity among obtained Pareto-optimal solutions is hard to maintain in the objective space. Moreover, a careful thought suggests that a systematic variation of weight vectors or "parameters in these scalarization techniques does not guarantee a good diversity in the solution sets [6]. Another important issue is that independent applications of a single-objective optimization algorithm to find different Pareto-optimal solutions one-at-a-time do not make an efficient search and the search effort required to solve the problem to optimality this way needs to be found in every single time the algorithm is applied.

Morse (1980) detailed one of the first applications of cluster analysis to a non-dominated set. The multi-objective programs considered were linear programs. A solution was removed from the non-dominated set if it was indistinguishable from another solution based on decision maker-defined thresholds. Morse (1980) evaluated seven hierarchical clustering methods. Ward's method, the group average method, and the centroid method performed very well; the other hierarchical clustering methods considered exhibited chaining which reduced the usefulness of the cluster structure. Ward's method was preferred since the clusters at the same level of the hierarchy were of similar size and shape although it performed only slightly better than the centroid and group average methods (Rosenman and Gero 1985).

Rosenman and Gero (1985) applied complete linkage hierarchical clustering to 'reduce the size of the Pareto optimal set whilst retaining its shape'. This method allowed control of the diameter of the resulting clusters. They distinguished that solutions whose vectors of objective function values are similar may have decision variable vectors that are similar or very different but this idea was not further explored. The objective functions were considered successively in order to avoid the implicit aggregation in applying proximity measures. First, elements of the non-dominated set were clustered using a single criterion. If a solution within a cluster dominated another solution in the cluster on all criteria except the clustering criterion then the dominated solution was eliminated from consideration. The process was repeated for each criterion until the non-dominated set was sufficiently small.

This paper differs from the above wherein partitional (k-means) clustering is used for combinatorial multi-objective problems. Either the most interesting cluster, i.e., the 'knee' cluster, was considered in detail by discarding the solutions in other clusters, or one solution from each of the k clusters was considered to form a representative subset of the non-dominated set.

IV. CLUSTER ANALYSIS

Cluster analysis, also known as unsupervised learning, is one of the most useful methods in the cluster analysis process for discovering groups. Clustering aims to organize a collection of data items into clusters, such that objects within the same cluster have a high degree of similarity, while objects belonging to different clusters have a high degree of dissimilarity. Cluster analysis makes it possible to look at properties of whole clusters instead of individual objects. This is a simplification that is useful when handling large amounts of data [9].

According to the method adopted to define clusters, the algorithms can be broadly classified into the following types: Partitional and Hierarchical [10]. Partitional clustering attempts to directly decompose the data set into a set of disjoint clusters. Probably, one of the most popular partitional methods is the *k-means clustering* algorithm. The *k-means clustering* algorithm is well known for its efficiency in clustering data sets [11]. The grouping is done by calculating the centroid for each cluster, and assigning each observation to the group with the closest centroid. For the membership function, each data point belongs to its nearest center, forming a partition of the data. A recurrent problem that many clustering algorithms encounter is the choice of the number of clusters. Thus, different cluster validity indices have been suggested to address this problem, since this is an important issue for partitional clustering in general. A cluster validity index indicates the quality of a resulting clustering process.

The silhouette plot method is one of these cluster validity techniques [12]. Then, the clustering partition that optimizes the validity index under consideration is chosen as the best partition. The silhouette plot is used to evaluate the quality of a clustering allocation, independently of the clustering technique that is used [13].

V. METHODOLOGY

Proposed Approach

This approach is proper for decision-makers that do not have a prior knowledge of the relative importance of the conflicting objectives in multi-objective optimization problem.

The developed approach is based on the following steps:

1. Obtain the entire Pareto-optimal set or sub-set of solutions by using a multiple-objective evolutionary algorithm (MOEA) or by another means.

2. Apply the *cluster analysis* algorithm to form clusters on the solutions enclosed in the Pareto set.

3. To determine the "optimal" number of clusters, *k*, in this set, silhouette plots are used. A value of the silhouette width, *s*(*i*), is obtained for several values of *k*. The clustering with the highest average silhouette width is selected as the "optimal" number of clusters in the Pareto-optimal set.

4. For each cluster, select a representative solution. To do this, the solution that is closest to its respective cluster centroid is chosen as a good representative solution.

5. Analyze the results. At this point, the decision-maker can either:

5.1 Analyze the "knee" cluster. The suggestion is to focus on the cluster that has solutions that conform to the "knee" region. The "knee" is formed by those solutions of the Pareto-optimal front where a small improvement in one objective would lead to a large deterioration in at least one other objective. Moreover, from this "knee" cluster the decision maker can select a promising solution for system implementation. This would be the solution nearby to the ideal or utopian solution of the multiple objective problems, in a standardized space.

5.2 Analyze the *k* representative solutions and/or select the most promising solutions among this *k* set, selecting the solution closest to the ideal point. By applying the proposed technique, the Pareto-optimal front of a multiple objective problem can be reduced to the "knee cluster" as in 5.1, or to a set of *k* solutions as in 5.2. In both cases the decision maker can choose a superior tradeoff for system implementation by selecting the closest solution to the ideal or utopian solution of the multiple objective problems, in a standardized space.

A Matlab code is developed to perform the steps of the proposed method. From standardized data, the code will run the *clustering* algorithm and from two to a specified number of means it will calculate the average silhouette values and it will return the value of *k* suggesting the most optimal allocation. After this, it will also return the "knee cluster" of the optimal partition, the *k* representative solutions of the Pareto front, and in both cases, the solution closest to the ideal or utopian point.

Multi-Objective Redundancy Allocation Problem

A R.A.P. example was solved to exemplify how data clustering can be of great aid for the decision-maker. The example system configuration consists of 3 subsystems, with an option of 5, 4 and 5 types of available components for each subsystem, respectively. The optimization involves selection from among these component types. The maximum number of components is 8 for each subsystem. Table 1 defines the component choices for each subsystem.

TABLE 1. Component selection for each subsystem.

Design Alternative *j*	Subsystem *i*								
	1			2			3		
	R	*C*	*W*	*R*	*C*	*W*	*R*	*C*	*W*
1	0.94	9	9	0.97	12	5	0.96	10	6
2	0.91	6	6	0.86	3	7	0.89	6	8
3	0.89	6	4	0.70	2	3	0.72	4	2
4	0.75	3	7	0.66	2	4	0.71	3	4
5	0.72	2	8				0.67	2	4

Another way to take advantage of this method is to consider the cluster(s) that contain(s) the most interesting solutions of the Pareto-optimal set, i.e., those where a small improvement in one objective would lead to a large deterioration in at least one other objective. These solutions are often referred as "knees." In this case, as we can see from Figure 4, solutions in cluster 4 are likely to be more significant to the decision-maker. The maximum and minimum values of reliability, cost and weight of cluster 4 are shown in Table 2.

TABLE 2. Maximum and minimum values in cluster 4.

Cluster 4	Reliability	Cost	Weight
max	0.999036	77	55
min	0.961883	38	32

At this point, the decision-maker has two choices: either to choose solution #43 from cluster 4 as a good representative solution of this "knee" region or decide to focus his/her search more intensely on this knee region. Then, the initial 75 solutions have been reduced to only the 30 solutions found in the "knee" region as shown in Figure 1.

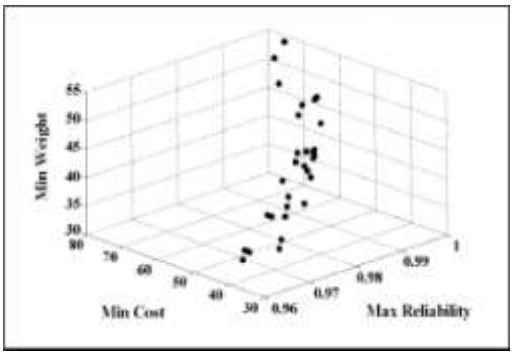

Figure 1. "Knee" of the Pareto-optimal set.

For instance, if the decision-maker decides to further investigate this "knee" region, then the 30 solutions contained in cluster 4 are further investigated. Clustering is again used to find groups just on this reduced space, and with the use of the silhouette plots, 11 was found to be the optimal number of clusters. In this way, one systematically contracts the subspace in the direction of the most relevant solutions for the decision-maker. Figure 2 shows the clusters found on the original cluster 4 from normalized data.

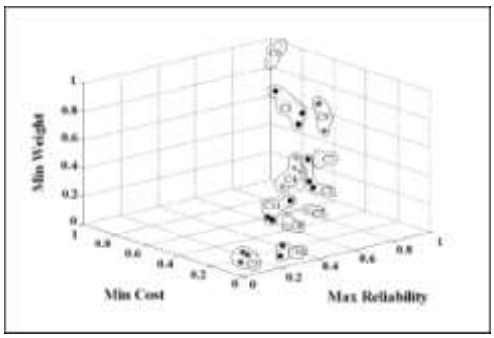

Figure 2. Clusters from original cluster 5.

Since the original cluster 5 already contained promising trade-offs, plotting the solutions in two dimensions can be of graphical support for the decision-maker. Figures 3, 4 and 5 plot reliability vs. cost, reliability vs. weight and cost vs. weight, respectively, from normalized (0 to 1) objective function data.

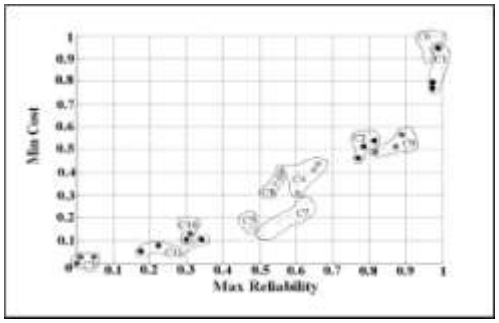

Figure 3. Reliability vs. Cost.

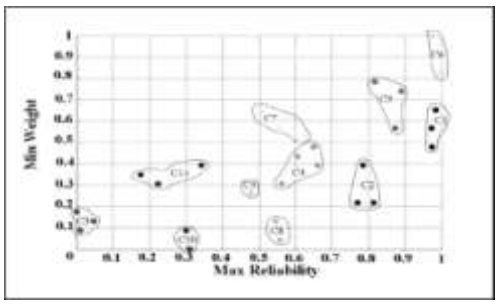

Figure 4. Reliability vs. Weight.

From Figures 3 and 4, clusters 3, 10 and 11, can be considered as undesirable because they do not have a large reliability compared with the other clusters, but in Figure 5, it can be observed that these three clusters are the ones that provides the minimum values for cost and weight. Nevertheless, clusters 1 and 6 in Figures 3 and 4 have large reliability but it is achieved at comparatively high cost and weight.

The analysis of these trade-offs continues until a solution or a small portion of the nondominated set is located. Then, this solution or sub-set will contain the preferred solutions of the overall problem. It is important to note that, even when the space has been reduced to the "knee" region or to the region that contains the most promising solutions, in the absence of information, none of the corresponding trade-offs can be said to be better than the others. Thus, the choice of one solution over the other is going to lie on the capability of the decision-maker and on his/her knowledge of the system's intended usage and the priorities and preferences of the system's intended user/owner.

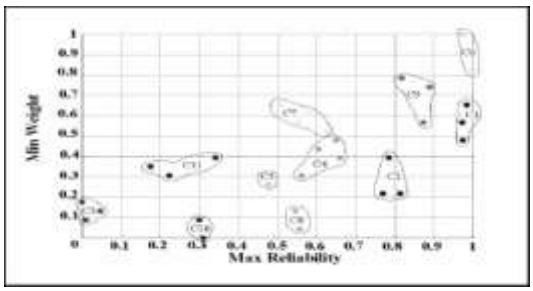

Figure 5. Cost vs. Weight

The representative solutions of these 11 clusters found on the "knee" region are shown in Table 3 with their corresponding values of reliability, cost and weight.

TABLE 3. Clustering results of the "knee"

	# of solutions	Representative solution	Reliability	Cost	Weight
Cluster 1	3	51	0.998043	68	45
Cluster 2	3	47	0.992115	59	37
Cluster 3	3	28	0.963644	39	35
Cluster 4	4	44	0.986416	55	41
Cluster 5	1	34	0.979653	44	38
Cluster 6	2	56	0.999036	77	51
Cluster 7	4	40	0.983483	46	46
Cluster 8	2	36	0.982178	52	35
Cluster 9	3	50	0.994940	60	49
Cluster 10	2	31	0.973035	42	34
Cluster 11	3	30	0.970198	41	39

For this particular multi-objective RAP, clusters 2, 4 and 7 seem to contain desirable solutions. For ease of interpretation and analysis, the 11 representative solutions of this "knee" region are plotted in two dimensions in Figure 6 for reliability vs. cost. From this figure, one can easily notice that solutions #47, #44 and #40 belonging to clusters 2, 4 and 7 respectively are the ones that are presented to the decision-maker as good trade-offs if no previously defined objective function preference have been specified by the decision-maker.

For example, solution #44, shown in Figure 7, achieves a reliability of 0.986416 at a cost of 55 and a weight of 41. For system execution, the configuration is composed of one component of type 1, one component of type 2 and one component of type 5 for subsystem 1; two components of type 1 for subsystem 2, and one component of type 1 and one component of type 3 for subsystem 3.

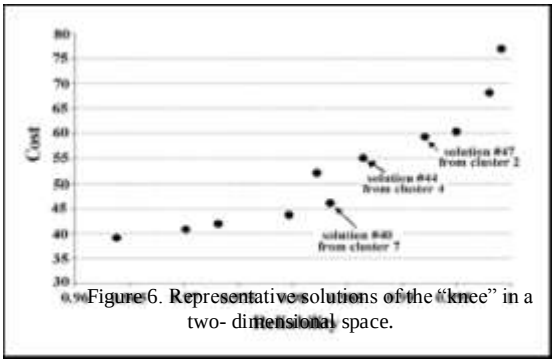

Figure 6. Representative solutions of the "knee" in a two- dimensional space.

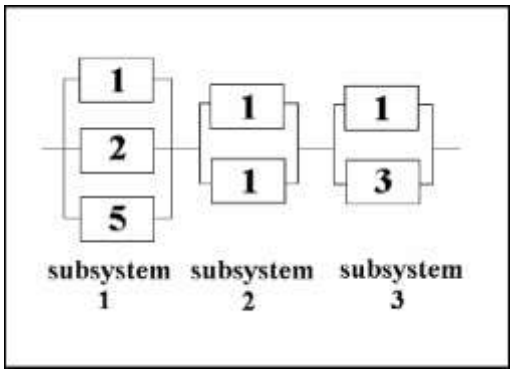

Figure7. The system configuration for solution #44.

VI. CONCLUSION

Pareto optimization methods allow the use of multi-objective optimization models without prior decision maker preferences. The decision makers can consider the possibilities and trade-offs between objectives before selecting a solution for implementation. These methods undergo the limitations of requiring the decision makers to consider many possible solutions resulting from the optimization procedure. This paper developed and evaluated a cluster analysis methodology to address the issue.

REFERENCES

[1] Balling, R. 2004. Applications of Multi-Objective Evolutionary Algorithms: Advances in Natural Computation, Volume 1, City and Regional Planning via a MOEA: Lessons Learned. World Scientific, Singapore, 227–245.

[2] Benson, H.P. and S. Sayin. 1997. Towards finding global representations of the efficient set in multiple objective mathematical programming. Naval Research Logistics, 44, 47–67.

[3] Cormack, R. M. 1971. A review of classification. Journal of the Royal Statistical Society A, 134(3), 321– 367.

[4] Deb, K., A. Pratap, S. Agarak, and T. Meyarivan. 2002. A fast and elitist multiobjective genetic algorithm: NSGA-II. IEEE Transactions on Evolutionary Computation, 6(2), 182–197.

[5] Dubes, R. and A.K. Jain. 1976. Clustering techniques: The user's dilemma. Pattern Recognition, 8, 247– 260.

[6] Dubes, R. and A.K. Jain. 1979. Validity studies in clustering methodologies. Pattern Recognition, 11, 235–254.

[7] Dubes, R.C. 1993. Handbook of Pattern Recognition and Computer Vision, Cluster Analysis and Related Issues. World Scientific Publishing Company, Salem, Massachusetts, 3–32.

[8] Gnanadesikan, R. 1995. Weighting and selection of variables for cluster analysis. Journal of Classification, 12, 113–136.

[9] Jain, A. K., M. N. Murty, and P. J. Flynn. 1999. Data clustering: A review. ACM Computing Surveys, 31(3).

[10] Jain, Anil K. and Richard C. Dubes. 1988. Algorithms for clustering data. Prentice Hall, Englewood Cliffs, NJ.

[11] Mattson, C.A., A.A. Mullur, and A. Messac. 2004. Smart pareto filter: Obtaining a minimal representation of multiobjective design space. Engineering Optimization, 36(6), 721–740.

[12] Milligan, G.W. and M.C. Cooper. 1988. A study of standardization of variables in cluster analysis. Journal of Classification, 5, 181–204.

[13] Morse, J. N. 1980. Reducing the size of the nondominated set: Pruning by clustering. Computers and Operations Research, 7, 55–66.

[14] Roberts, S. A. 2003. Configuration optimization in socio-ecological systems. Ph.D. thesis, Department of Systems Design Engineering, University of Waterloo, Waterloo, ON.

[15] Rosenman, M. A. and J. S. Gero. 1985. Reducing the pareto optimal set in multicriteria optimization (with applications to pareto optimal dynamic programming). Engineering Optimization, 8, 189– 206.

[16] Seo, J. and B. Shneiderman. 2002. Interactively exploring hierarchical clustering results. Computer, 35(7), 80–86.

[17] Small, C.G. 1996. The Statistical Theory of Shape. Springer, New York.

[18] Taboada, H., F. Baheranwala, D. Coit, and N. Wattanapongsakorn. 2007. Practical solutions for multi-objective optimization: An application to system reliability design problems. Reliability Engineering and System Safety, 92(3), 314–322.

[19] Ward, J.H., Jr. 1963. Hierarchical grouping to optimize an objective function. Journal of the American Statistical Association, 58(301), 236–244.

[20] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[21] I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[22] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[23] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[24] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

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Applying Intuitionistic Fuzzy Approach to Reduce Search Domain in an Accidental Case

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***Abstract*—In this paper we are using intuitionistic fuzzy approach to minimize search domain in an accidental case where the data collected for investigation is intuitionistic fuzzy in nature. To handle these types of imprecise information we use intuitionistic fuzzy tolerance relation and translate intuitionistic fuzzy query to reach to the conclusion. Here we present an example of vehicle hit and run case where the accused had fled the accident spot within seconds leaving no clue behind.**

***Keywords- fuzzy sets, Intuitionistic fuzzy relation, Intuitionistic fuzzy database, Intuitionistic fuzzy tolerance*.**

I. INTRODUCTION

A fuzzy database utilizes the fuzzy logic, where fuzzy relational schemas are used to represent imprecise data. But in some application fuzzy sets are found unsatisfactory in capturing the information that includes some hesitation degree. So to deal with such application Intuitionistic fuzzy sets are used. Intuitionistic fuzzy set theory (IFS) is a significant generalization of fuzzy set. It was introduced by Krassimir Atanassov [1-4] in year 1983. Intuitionistic fuzzy sets can be useful in situations when description of a problem by a (fuzzy) linguistic variable, given in terms of a membership function only, seems insufficient to give best result. For example, in decision making problems, particularly in the case of medical diagnosis, sales analysis, new product marketing, financial services, etc.[5-6] there is a fair chance of the existence of a non-null hesitation part at each moment of evaluation of an unknown object.

When the data become intuitionistic fuzzy in nature we need Intuitionistic Fuzzy Databases (IFDB) as the fuzzy database is not appropriate for handling intuitionistic fuzzy data. IFDB was introduced by Biswas, De. and Roy[7-12].

II. BACKGROUND DETAILS

Intuitionistic fuzzy set (IFS), developed by Atanassov is a powerful tool to deal with vagueness. A prominent characteristic of IFS is that it assigns to each element a membership degree and a non-membership degree, and thus, the IFS constitutes an extension of Zadeh's fuzzy set, which only assigns to each element a membership degree. Recently various applications of IFS to artificial intelligence have appeared - intuitionistic fuzzy expert systems, intuitionistic fuzzy neural networks, intuitionistic fuzzy decision making, intuitionistic fuzzy machine learning, intuitionistic fuzzy semantic representations.

The strength of relations as information models in knowledge based system derives from their fundamental ability to describe observed or predicted "connections", expressed as facts or rules, between selected objects of discourse. The use of fuzzy relations originated from the observation that real life objects can be related to each other to a certain degree (just like elements can belong to a fuzzy set to a certain degree); in this sense they are able to model vagueness. They are still intolerant of uncertainty, however, since there is no means of attributing reliability or confidence information to the membership degrees. Various frameworks have been developed to deal with this imperfection, amongst others. Here we will concentrate on the IF approach. A possible semantics for an IF relations taking inspiration from classical possibility theory was presented in [13-14]. Basically, the idea is to treat an IF relation as an elastic restriction that allows us to discriminate between the more or less plausible values for a variable.

For instance, a statement like "John is old" does not allow us to infer John's exact age, yet provides some support in favor of the older ages (allowing that those ages are, to a given extent, possible for him), as well as negative evidence against the younger ones (expressing some certainty or necessity that those ages can't in fact be his). We model this observation by indicating how much the original condition "John is old" needs to be stretched in order for John's age to assume this particular value: we assign two separate [0, 1] valued degrees $\mu_A(u)$ & $\nu_A(u)$ to every age u in the considered domain, the first one indicating the possibility that the john's age assumes this particular value and the second one reflecting our certainty that differ from the given value u. In classical possibility theory symmetry between the two indexes is imposed, however, in a sense that from knowledge it is impossible that john is 25 year old ($\mu(25)=0$), we immediately derive that it is completely certain that he is not 25 i.e. $\nu(25) = 1$), and more generally from $\mu(u)= \alpha$ follows $\nu(u) = 1- \alpha$. Taken together, the various degrees μ (u) give rise to a fuzzy

set. But what if we cannot be sure that the observer is fully credible?

In other words, we can have varying degrees of trust in an observer, ranging from unconditional in confidence to full creditworthiness, and we should be able to model that trust accordingly; which can be done conveniently by letting the certainty degree ν(u) range between 0 and 1- μ(u). This justifies the use of a more general intuitionistic fuzzy, rather than a fuzzy, relation as a model of describing observations.

III. PRELIMINARY

We present some basic preliminaries for the better understanding of our work.

A. Intuitionistic fuzzy sets

Let a set E be fixed. An IFS A in E is an object of the following form:

$A = \{ (x , \mu_A(x) , \nu_A(x)) \; x \in E \},$

When $\nu_A(x) = 1 - \mu_A(x)$ for all $x \in E$ is ordinary fuzzy set.

In addition, for each IFS A in E, if

$\pi_A(x) = 1 - \mu_x - \nu_x$

Then $\pi_A(x)$ is called the degree of indeterminacy of x to A, or called the degree of hesitancy of x to A.

B. Intuitionistic fuzzy relation

Let X and Y are two sets. An Intuitionistic fuzzy relation (IFR) R[15-16] from X to Y is an IFS of $X \times Y$ characterized by the membership function μ_R and non-membership function ν_R. An IFR R from X to Y will be denoted by $R(X \rightarrow Y)$.

$R=\{< (x, y), \mu_R (x,y), \nu_R (x,y) > x \in X \; , y \in Y \}$

Where $\mu_R : X \times Y \rightarrow [1,0]$ and $\nu_R(x) : X \times Y \rightarrow [1,0]$ satisfies the condition

$0 \leq \mu_R (x,y) + \nu_R (x,y) \leq 1$

For every $(x,y) \in X \times Y$

C. Intuitionistic fuzzy Tolerance Relation

An intuitionistic fuzzy relation **R** on the Cartesian product $(X \times X)$, is called: An intuitionistic fuzzy tolerance relation if R is reflexive and symmetric.

1) Reflexive

An IF relation R (X x Y) is said to be reflexive if

$x1, x2 \in X , \mu R (x,x) = 1$

2) Symmetric

An IF relation R (X x Y) is said to be symmetric if $x1, x2 \in X$

$\mu R (x1, x2) = \mu R (x2, x1)$ and

$\nu_R (x1, x2) = \nu_R (x2, x1)$

D. Intuitionistic Fuzzy Database

As an intuitionistic fuzzy set is a generalization of fuzzy set, Buckles and Petry defined fuzzy database [17-21] as a generalization of classical database. There model is based on similarity relation for each domain of fuzzy database. A fuzzy relational database is defined as set of relations where each relation is a set of tuple. If t_i represents the i^{th} tuple it has form $(d_{i1}, d_{i2}, \ldots\ldots\ldots d_{im})$. In a classical relational database each component d_{ij}, of the tuple is an element of the corresponding scalar domain D_j i.e. d_{ij} belongs to D_j. But in case of fuzzy relational database, the element of the tuple consists of either singleton or crisp subset of the scalar domain.

1) Definition 1

An intuitionistic fuzzy database is a set of relation where each pair of such relation R is a subset of the cross product:

$2^{D1} \times 2^{D2} \times \ldots\ldots\ldots 2^{Dm}$

Where $2^{Di} = P(D_i) - \phi$. and $P(D_i)$ is the power set of D_i, here R is called the intuitionistic fuzzy database relation.

2) Definition 2

Let $R \subseteq 2^{D1} \times 2^{D2} \times \ldots\ldots\ldots 2^{Dm}$ be an intuitionistic fuzzy database relation. An intuitionistic fuzzy tuple (with respect to R) is an element of R.

Let t_i=(di1,di2,…,dim) be an intuitionistic fuzzy tuple. An interpretation of t, is a tuple = $(a_1, a_2,\ldots,a_m)$where $a_j \in d_{ij}$ for each domain Dj.

For each domain D_j if T_j be an intuitionistic fuzzy tolerance relation then the membership function is given by:

$\mu_{Tj} : D_j \times D_j \rightarrow [0 ,1]$

And the non membership function is given by

$\nu_{Tj} : D_j \times D_j \rightarrow [0 ,1]$

Satisfying Atanassov's condition

IV. APPLICATION

In this section we present an application or a case that utilizes the intuitionistic fuzzy concept specially intuitionstic fuzzy relation.

Suppose, on a highway an accident has taken place and the accident spot is 15 km away from a check post where the information of all the vehicles that are passed by is recorded on a CCTV camera. Within seconds car driver along with the car fled the spot. Now the source of identification about the accused vehicle is the information given by an eye witness and the record of the vehicles that passed by the check post.

The information given by an eye witness is that the accused vehicle is “more or less full size, somewhat grayish

color, and somewhat similar to SUV type". Now the police match the provided information with the vehicles that passed by the check post within one hour of the accident took place and the resultant database is given by tables presented here.

TABLE I.

Vehicle No	Vehicle - Type	Color	Build
UP-E09XY	SUV	Silver Grey	Mid-size
UP-Y0991	Sedan	Black	Micro
MP-B6799	SUV	Pearl Grey	Sub-compact
AP-GH800	Van	White	compact
MP-B6789	Van	Black	compact
UP-GH688	Jeep	Silver Grey	Full-size
UK-T9654	SUV	Pearl Grey	Sub-compact
MP-B5468	Sedan	White	Compact

Now we constitute the IF tolerance relation of the attributes included in above database to reduce our suspicion domain.

As we know that the eye witness usually has lots of imprecision in their information and we have to consider this fact also.

Example if an eyewitness says it was a midsize car with membership degree 0.08 and non degree 0.02 means that he is 80% sure that this is a midsize car and 20% not sure about it. As the 80% is considerably high figure so we assume that car is mid-size with no hesitation.

Now we ask about his understanding of an attribute like full-size and its similarity with others. According to him similarity between full size and midsize is with a degree of (0.8, 0.1) and hesitation as 0.1.

Similarly the similarity between midsize and compact car is (0.6, 0.4) with no hesitation. We can finally make Intuitionistic fuzzy tolerance relations based on the description provided by him and his understanding about the attributes of the vehicles.

The domain of Vehicle -Type = {Jeep, SUV, Sedan, Van}

The domain of color= {Pearl Grey, Silver Grey, Black, White}

The domain of Build = {Full -size, Mid-size, Compact, sub-compact, Micro}

Consider the IF tolerance relation T_{D1} where D_1 = Vehicle -Type of the Car, given by

TABLE II.

T_{D1}	Jeep	SUV	Sedan	Van
Jeep	(1, 0)	(0.8,0.1)	(0.4,0.4)	(0 , 1)
SUV	(0.8,0.1)	(1, 0)	(0.5,0.4)	(0, 0.9)
Sedan	(0.4,0.4)	(0.5,0.4)	(1 , 0)	(0.4,0.4)
Van	(1, 0)	(0, 0.9)	(0.4,0.4)	(1, 0)

Consider the IF tolerance relation T_{D2} where D_2 = color of the Car, given by

TABLE III.

T_{D2}	Pearl Grey	Silver Grey	Black	White
Pearl Grey	(1, 0)	(0.8,0.2)	(0.2,0.7)	(0 , 1)
Silver Grey	(0.8,0.2)	(1, 0)	(0.3,0.4)	(0.5, 0.2)
Black	(0.2,0.7)	(0.3,0.4)	(0 , 1)	(0.4,0.4)
White	(0.1, 0.7)	(0.5, 0.2)	(0.4, 0.4)	(0, 1)

Consider the IF tolerance relation T_{D3} where D_3 =Build of the Car, given by

TABLE IV.

T_{D3}	Full-size	Mid-size	Compact	Sub-compact	Micro
Full-Size	(1, 0)	(0.7,0.3)	(0.5,0.4)	(0.3, 0.6)	(0, 1)
Mid-Size	(0.7,0.3)	(1, 0)	(0.6,0.4)	(0.4, 0.5)	(0, 0.9)
compact	(0.5,0.4)	(0.6,0.4)	(1, 0)	(0.6,0.3)	(0.3, 0.6)
Sub-compact	(0.3, 0.6)	(0.4, 0.5)	(0.6, 0.3)	(1, 0)	(0.8, 0.2)
Micro	(0, 1)	(0. 0.9)	(0.3, 0.6)	(0.8, 0.2)	(1.0)

Next target is to find the accused vehicle which is according to the eyewitness is "more or less full size, somewhat grayish color, and somewhat similar to SUV type". We can translate this intuitionistic fuzzy query into relational algebra form:

(Project (select (VEHICLE DATA)

where VEHICLE TYPE ='SUV',

COLOR='GREY',

BUILD='FULL-SIZE'

with LEVEL (VEHICLE TYPE) = .8

LEVEL (COLOR) =.7

LEVEL (BUILD) =.8)

with LEVEL (NAME) = 0.0

LEVEL (VEHICLE TYPE) = .8

LEVEL (COLOR) =.7

LEVEL (BUILD) =.8)

giving LIKELY ACCUSED VEHICLE).

Result: The above query giving rise to the following relation.

TABLE V : Accused Vehicle

Vehicle No	Vehicle - Type	color	Build
UP-E09XY	SUV	Silver Grey	Mid-size
UP-GH688	Jeep	Silver Grey	Full-size

So from the result based on eyewitness information and checkpoint data it is concluded that two vehicle (UP-E09XY, UP-GH688) should be put under surveillance.

V. CONCLUSION

This paper deals with the application of Intuitionistic fuzzy approach to find out ran away accuse of a car accident. Here we consider the information of an eye witness and constitute IF tolerance relation based on information provided.

It has been shown that how the use of IF tolerance relation and description about the vehicle which is finally translated into an IF query reduces the search domain.

REFERENCES

[1] Atanassov, K., "Intuitionistic fuzzy sets", Fuzzy sets and Systems, 20 (1986) 87-96.

[2] Atanassov, K.,"New operation defined over Intuitionistic fuzzy sets", Fuzzy sets and Systems, 61 (1994) 137-142.

[3] Atanassov, K, "More on Intuitionistic fuzzy sets", Fuzzy sets and Systems, 33 (1989) 37-46.

[4] Atanassov, K, "Remark on Intuitionistic fuzzy sets-III", Fuzzy sets and Systems (1995) 401-402.

[5] Szmidt, E. and Kacprzyk, J., "Group decision making under Intuitionistic fuzzy preference relations", Proceedings of the 7th IPMU Conf., Paris, (1998) 172-178.

[6] Szmidt, E. and Kacprzyk, J., "Decision making in an intuitionistic fuzzy environment", Proceedings of the Joint 4th EUROFUSE and 2nd SIC Conf., Budapest, (1999) 292-297.

[7] De, S.K., Biswas, R. and Roy, A.R., "On Intuitionistic fuzzy Databases, Proceedings of the second International Conference on IFS", Sofia, 3-4 October(1998) NIFS (4) 34-356.

[8] De, S.K., Biswas, R. and Roy, A.R., "An application of intuitionistic fuzzy sets in medical diagnosis", Fuzzy Sets and Systems 117 (2001) 209–213.

[9] De, S.K., Biswas, R. and Roy, A.R., "On Intuitionistic fuzzy sets", NIFS 3(4)(1997) 14-20.

[10] De, S.K, Biswas, R. and Roy, A.R., "Multicriteria based decision making using Intuitionistic fuzzy set theory", Journal of Fuzzy Math, 6(4)(1998)837-842.

[11] Alam, M.A., Sharfuddin, A. and Biswas, R., "On Intuitionistic Fuzzy Database", Proceedings of the 6 Joint Conference on Information Sciences, North Carolina(USA), March 8-13(2002) 92-96.

[12] Alam, M.A., Sharfuddin, A. and Biswas, R. , "Normalization of Intuitionistic Fuzzy Relational Databases", Proceedings of the seventh International Conference on IFS, Sofia, 23-24 October(2003) NIFS 19 (2003) 77-82.

[13] C. Cornelis, E.E. Kerre "Reliability of Information: Motivation for an Intuitionistic Theory of Possibility" Submitted to Fuzzy Sets and Systems.

[14] P. Burillo, H. Bustince, "Intuitionistic fuzzy relations (Part I)", Mathware Soft Comput. 2 (1995) 5–38.

[15] Burillo, P. and Bustince, H., "Intuitionistic fuzzy relations (Part I)", Mathware Soft Computing. 2 (1995) 5–38.

[16] Bustince, H. and Burillo, P., "Structures on intuitionistic fuzzy relations", Fuzzy Sets and Systems, 78 (1996) 293–303.

[17] Buckles, B. P. and Petry, F. E.,"A fuzzy representation of data for relational Databases," Fuzzy Sets & Systems, 7(3) (1982) 213-226.

[18] Buckles, B. P. and Petry, F. E. , "Fuzzy Databases and their application", Fuzzy Information and Decision Processes, (1982) 361-371.

[19] Prade, H. and Testemale C, "Generalizing database relational algebra for the treatment of incomplete/uncertain information and vague queries." , in Proceedings qf2nd NAFIPS Workshop, Schenectady, NY 1983, Information Science, Vol 34, pp. 1 15-143 (1984).

[20] Baldwin J. F. and Zhou, S. Q, "A fuzzy relational inference language" Fuzzy Sets & Systems, Vol. 14, pp. 155-174 (1984)

[21] Chen, G. Q. , "A step towards the theory of fuzzy relational database design", In Proceedings qf/FSA'91 World Congress, pp. 44-47, Brussels (1991).

Search Technique Using Wildcards or Truncation: A Tolerance Rough Set Clustering Approach

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***Abstract*- Search engine technology plays an important role in web information retrieval. However, with Internet information explosion, traditional searching techniques cannot provide satisfactory result due to problems such as huge number of result Web pages, unintuitive ranking etc. Therefore, the reorganization and post-processing of Web search results have been extensively studied to help user effectively obtain useful information. This paper has basically three parts. First part is the review study on how the keyword is expanded through truncation or wildcards (which is a little known feature but one of the most powerful one) by using various symbols like * or! The primary goal in designing this is to restrict ourselves by just mentioning the keyword using the truncation or wildcard symbols rather than expanding the keyword into sentential form. The second part of this paper gives a brief idea about the tolerance rough set approach to clustering the search results. In tolerance rough set approach we use a tolerance factor considering which we cluster the information rich search result and discard the rest. But it may so happen that the discarded results do have some information which may not be up to the tolerance level; still they do contain some information regarding the query. The third part depicts a proposed algorithm based on the above two and thus solving the above mentioned problem that usually arise in the tolerance rough set approach . The main goal of this paper is to develop a search technique through which the information retrieval will be very fast, reducing the amount of extra labor needed on expanding the query.**

Keywords: Clustering, Tolerance Rough Set, Search Engine, Wildcard Truncation

I. INTRODUCTION

With rapid development of Internet technologies and Web explosion, searching useful information from huge amount of Web pages becomes an extremely difficult task. Currently Internet search engines are the most important tools for Web information acquisition. Based on techniques such as Web page content analysis, linkage analysis, etc., search engines locate a collection of related Web pages with relevance rankings according to user's query. However, current search results usually contain large amount of Web pages, or are with unintuitive rankings, which makes it inconvenient for users to find the information they need. Therefore, techniques for improving the organization and presentation of the search results have recently attracted a lot of research interest. The typical techniques for reorganizing search results include Web page clustering, document summarization, relevant information extraction, search result visualization, etc. Wildcards are one of the searching techniques which are further improved to provide an effective way of searching according to the user's specification. One approach to manage large results set is by clustering. Tolerance Rough Set Model (TRSM) was developed [1,2] as basis to model documents and terms in information retrieval, text mining, etc. With its ability to deal with vagueness and fuzziness, tolerance rough set seems to be promising tool to model relations between terms and documents.

The earliest work on clustering results were done by Pedersen, Hearst et al. on Scather/Gather system [12], followed with application to web documents and search results by Zamir et al. [15,19] to create Grouper based on novel algorithm Suffix Tree Clustering. Inspired by their work, a Carrot framework was created to facilitate research on clustering search results. This has encouraged others to contribute new clustering algorithms under the Carrot framework like LINGO, AHC. Other clustering algorithms were proposed for, Semantic Hierarchical Online Clustering using Latent Semantic Indexing to cluster Chinese search results or Class Hierarchy Construction Algorithm by Schenker et al [20].

In this paper, we propose an algorithm based on the search results obtained by using wildcards or truncations and then applying the Tolerance Rough Set concept for clustering the search results. The rest of the paper is arranged like this, Section I gives the introductory concepts of Web acquisition concepts with the keyword searching with it's advantages and truncation mechanism , In section II, we present the abstracted view of the document clustering with it's definition, information retrieval , vector space model and other models. Section III focuses on Tolerance Rough Set Model, Section IV describes our proposed algorithm and finally section V depicts the conclusion.

A. Keyword Searching

Keyword searching permits you to search a database for the occurrence of specific words or terms, regardless of where they may appear in the database record. For example, even if the word appears in the middle of the title of an article, or anywhere in the abstract, you can still search for it. Keyword searching was made possible by computers; essentially, the computer looks for any group of characters that has a space on either side of it, considers it a "word,"

and indexes it. The computer takes this task very literally. Even typos, ("philosophy"), incorrect spellings ("archaeology"), or words that were accidentally typed together without a space between them ("for example"), will be found by the computer and indexed, exactly the way they appear.

B. Advantages of Keyword Searching

There are many advantages to keyword searching [4, 5]: you can locate a very specific reference, even if it is only mentioned a single time. You can use the most current terminology, jargon, or "buzzwords" being used in a discipline, even when no official subject headings exist yet for the concept. You can combine keywords in various ways to create a very detailed and specific search query; the actual search as you enter it is known as a search statement. As you begin to search for information on your topic, develop a list of keywords and phrases that represent the most important aspects of your topic. Background information located in books and reference sources can be useful sources for these keywords. Try to come up with at least three words to describe each concept, grouping the keywords by concept. You can then use these keywords to "ask" the computer to search for the specific words and phrases on your list.

For example, if you were researching the effect of the media on body image and eating disorders, your keyword lists might look like this:

TABLE I: Keyword List

Concept #1	Concept#2	Concept#3
Media* Mass me $ ia Television$ TV Advertis! Film Movies	Body image Self-esteem	Eating Disorders Anorexia Bulimia

C. Truncation

Truncation [9, 10,11] allows you to search for alternate forms of words. Shorten the word to its root, then add a special character (*, $, l). When truncating, be sure to include enough of the search word to make it meaningful. For Example, if you wanted to search for alternative forms of the word advertising, a good choice would be to truncate it as "advertis." This will search words such as advertise, advertising, and advertisement. You wouldn't, however, want to truncate after the adv. If you did, your search would include words such as advantage, advance, adventure, advice, etc.

Different indexes and databases [3] use different symbols after the root word to accomplish truncation. If you are unsure of the truncation symbol for the database you are using, consult the help section for that resource. The most common truncation symbols are: *, $, !.

TABLE II: Truncation List

Symbol	Database	Example
*	• CONSORT/Ohio LINK • Web of Science • Yahoo	advertis*
$	• Periodical Abstracts • Humanities Abstracts • Biological Abstracts • MLA Bibliography	Advertis$
!		Advertis!

II. DOCUMENT CLUSTERING

A. General Definition

Clustering is an established and widely known technique for grouping data. It has been recognized and found successful applications in various areas like data mining [6,7], statistics and information retrieval [1, 8].

Let D =$\{d_1, d_2, d_3 \ldots\ldots d_n\}$ be a set of objects, and $\delta(d_i, d_j)$ denote a similarity measure between objects d_i , d_j *Clustering* then can be define as a task of finding the decomposition of *D* into *K* clusters $C = \{c_1, c_2, \ldots\ldots c_k\}$ so that each object is assigned to a cluster and the ones belonging to the same cluster are similar to each other (regarding the similarity measure *d*), while as dissimilar as possible to objects from other clusters.

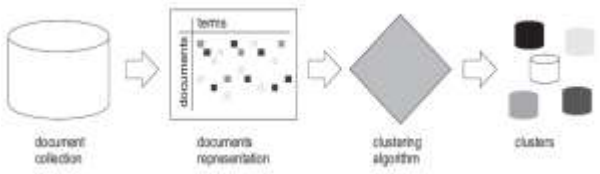

Figure 1. Document Clustering Process

There are numerous clustering algorithms ranging from vector-space based, model-based (mixture resolving) to graph-theoretic spectral approaches. However, when concerning application to text, algorithms based on vector space are the most frequently used. In this work we will concentrate on vector space and provide a detail analysis of vector-based algorithms for document clustering. A readers interested in other clustering approaches is referred to [6,7,10].

B. Clustering in Information Retrieval

In the figure 1 while clustering has been used in various task of Information Retrieval (IR) [11, 13], it can be noticed that there are two main research themes in document clustering: as a tool to improve retrieval performance and as a way to organizing large collection of documents. Document clustering for retrieval purposes originates from the *Cluster Hypothesis* [15] which states that *closely associated documents tend to be relevant to the same requests.* By grouping *similar* documents together, one hopes that relevant documents will be separated from irrelevant ones, thus performance of retrieval in the clustered space can be improved. The second trend represented by [6, 10] found clustering to be a useful tool when browsing large collection of documents. Recently, it has been used in [15, 16] for grouping results returned from web search engine into thematically related cluster.

Several aspects need to be considered when approaching document clustering.

C. Vector Space Model and Document Representation

While in some domain such as data mining, objects of interest are frequently given in the form of feature/attributes vector, documents are given as sequences of words. Therefore, to be able to perform document clustering, an appropriate representation for document is needed. The most popular method is to represent documents as vectors in multidimensional space. Each dimension is equivalent to a distinct term (word) in the document collection. Due to the nature of text documents, the number of distinct terms (words) can be extremely large, counting in thousands for a relatively small to medium text collection. Computation in that high-dimensional space is prohibitively expensive and sometimes even impossible (e.g. memory size restriction). It is also obvious that not all words in the document are equally useful in describing its contents. Therefore, documents needs to be preprocessed to determine most appropriate terms for describing document semantic - *index terms*.

Assume that there are *N* documents d_1, d_2, d_3 ……..d_n and *M* index terms enumerated from 1 to *M*. A document in vector space is represented by a vector:

$d_i = [w_{i1}, w_{i2}, \ldots\ldots w_{iM}]$ Equation (1)

where w_{ij} is a weight for the *j*-th term in document d_i.

D. Term Frequency - Inverse Document Frequency Weighting

The most frequently used weighting scheme is TD*IDF [2] (term frequency - inverse document frequency) and its variations. The rationale behind TD*IDF is that terms that has high number of occurrences in a document (*tf factor*), are better characterization of document's semantic content than terms that occurs only a few times. However, terms that appears frequently in most documents in the collection will have little value in distinguishing document's content, thus the *idf factor* is used to downplay the role of terms that appears often in the whole collection.

In our work, we can construct a table containing the potential query refinement terms are selected from the top search results returned by the underlying Web search engine. However, rather than collecting the actual document contents, the frequency statistics are based only on the title and snippet provided by the underlying search engine. The title is often descriptive of the information within the document, and the snippet contains contextual information regarding the use of the query terms within the document. These both provide valuable information about the documents in the search results.

Let t_1 ……. t_m denotes terms in the document corpus and d_1 ….. d_n are documents in the corpus. In TD*IDF, the weight for each term t_j in document *di* is defined [13] as

$w_{ij} = tf_{ij} * \log (n / df_j)$ Equation (2)

where tf_{ij} (term frequency, *tf*) - number of times term *tj* occurs in document d_i, df_j (document frequency) - number of documents in the corpus in which term tj occurs. The factor log (N/df_j) is called *inverse document frequency* (*idf*) of term.

III. TOLERANCE ROUGH SET MODEL

Tolerance Rough Set Model (TRSM) was developed [17, 18, 19] as basis to model documents and terms in information retrieval, text mining, etc. With its ability to deal with vagueness and fuzziness, tolerance rough set seems to be promising tool to model relations between terms and documents. In many information retrieval problems, especially in document clustering, defining the relation (i.e. similarity or distance) between document-document, term-term or term-document is essential. In Vector Space Model, is has been noticed [18, 20] that a single document is usually represented by relatively few terms. This results in zero-valued similarities which decreases quality of clustering. The application of TRSM in document clustering was proposed as a way to enrich document and cluster representation with the hope of increasing clustering performance.

A. Tolerance Space of Terms

Let $D = \{d_1, d_2, d_3 \ldots d_n\}$ be a set of document and $T = \{t_1, t_2, \ldots\ldots t_M\}$ set of *index terms* for *D*. With the adoption of Vector Space Model each document d_i is represented by a weight vector $[w_{i1}, w_{i2} \ldots w_{iM}]$ where w_{ij} is a weight for the *j*-th term in document d_i. In TRSM, the tolerance space is defined over a universe of all index terms:

$U = T = \{t_1, t_2 \ldots t_M\}$ Equation (3)

The idea is to capture conceptually related index terms into classes. For this purpose, the tolerance relation *R* is determined as the co-occurrence of index terms in all documents from *D*. The choice of co-occurrence of index terms to define tolerance relation is motivated by its meaningful interpretation of the semantic relation in context of IR and its relatively simple and efficient computation.

B. Tolerance Class of Term

Let $f_D(t_i, t_j)$ denotes the number of documents in *D* in which both terms t_i and t_j occurs. The uncertainty function *I* with regards to threshold θ is defined as

$I_\theta(t_i) = \{ tj \mid f_D(t_i, t_j) \geq \theta \} \cup \{ t_i \}$ Equation (4)

Clearly, the above function satisfies conditions of being reflexive: $t_i \in I_\theta(t_i)$ and symmetric: $t_j \in I_\theta(t_i) \Leftrightarrow t_i \in I_\theta(t_j)$ for any t_i , $t_j \in T$ .Thus, the tolerance relation $I \subseteq T \times T$ can be defined by means of function I:

$t_i I t_j \Leftrightarrow t_j \in I_\theta(t_i)$ Equation (5)

where $I_\theta(t_i)$ is the tolerance class of the index term t_i .

In context of Information Retrieval, a tolerance class represents a concept that is characterized by terms it contains. By varying the threshold θ (e.g. relatively to the size of document collection), one can control the degree of relatedness of words in tolerance classes (or in other words the preciseness of the concept represented by a tolerance class).

To measure degree of inclusion of one set in another, vague inclusion function is defined as:

$$\upsilon(X, Y) = |X \cap Y| \ / |X| \qquad \text{Equation (6)}$$

It is clear that this function is monotonous with respect to the second argument. The membership function μ for $t_i \in T$, $X \subseteq T$ is then defined as:

$$\mu(t_i, X) = \upsilon(I_\theta(t_i), X) = |I_\theta(t_i) \cap X| \ / \ |I_\theta(t_i)| \qquad \text{Equation (7)}$$

With the assumption that the set of index terms T doesn't change in the application, all tolerance classes of terms are considered as structural subsets: $P(I_\theta(t_i)) = 1$ for all $t_i \in T$.

Finally, the lower and upper approximations of any subset $X \subseteq T$ can be determined with the obtained tolerance $R = (T, I, \upsilon, P)$ respectively as:

$$L_R(X) = \{ t_i \in T \mid \upsilon(I_\theta(t_i), X) = 1 \} \qquad \text{Equation (8)}$$
$$U_R(X) = \{ t_i \in T \mid \upsilon(I_\theta(t_i), X) > 0 \} \qquad \text{Equation (9)}$$

One interpretation of the given approximations can be as follows: if we treat X as a concept described vaguely by index terms it contains, then $U_R(X)$ is the set of concepts that share some semantic meanings with X, while $L_R(X)$ is a "core" concept of X.

TITLE	Econ Papers: Rough sets bankruptcy prediction models versus auditor
DESCRIPTION	Rough sets bankruptcy prediction models versus auditor rates. Journal of Forecasting, 2003, vol.22, issue 8, pages 569-586. Thomas E. McKee…..

C. Extended Weighting Scheme for Upper Approximation

To assign weight values for document's vector, the TF*IDF weighting scheme is used. In order to employ approximations for document, the weighting scheme need to be extended to handle terms that occurs in document's upper approximation but not in the document itself (or terms that occurs in the document but not in document's lower approximation). The extended weighting scheme is defined as:

$$w_{ij} = \begin{cases} (1 + log(f_{d_i}(t_j)) * \log \frac{N}{f_{D(t_j)}} & \text{if } t_j \in d_i \\ \min_{t_k \in d_i} w_{ik} * \frac{\log \frac{N}{f_{D(t_j)}}}{1 + \log \frac{N}{f_{D(t_j)}}} & \text{if } t_j in \mathrm{U}_R(d_i) \backslash d_i \\ 0 & \text{if } t_j \notin in \mathrm{U}_R(d_i) \end{cases} \qquad \text{Equation (10)}$$

where *wij* is the weight for term *tj* in document *di*.

The extension ensures that each terms occurring in upper approximation of *di* but not in *di*, has a weight smaller than the weight of any terms in *di*. Normalization by vector's length is then applied to all document vectors:

$$w_{ij} = \frac{w_{ij}}{\sqrt{\sum_{t_k \in d_i} (w_{ij})^2}} \qquad \text{Equation (11)}$$

IV. IV PROPOSED ALGORITHM

Our proposed algorithm works as follows:

- In the first step, the user gives the initial term or a long query using wildcard or truncation symbols (placing it anywhere in the term or query).
- Then in the second step the first 20 results are viewed and scanned thoroughly.
- The third step is to represent the result into a table. The term or the entire query occurring for highest number of times are calculated and are placed accordingly in the table.
- After displaying the table we would use the Tolerance Rough set approach and select the most appropriate or nearest search result and cluster them into one group according to the priority order.
- Then rather than discarding all the discarded search result we would again apply tolerance rough set approach to cluster them further as some more appropriate search result could be obtained. We can name it as "Rough search result".

Step 1

Since this algorithm is applied in the post processing phase so any kind of Information Retrieval tool can be used. This returns a list of documents like Google or Yahoo.

Step2

a. The first 20 results are taken into consideration.
b. In this step the search result produced can contain the whole term or a part of the term along with some other relevant terms for which we have used the symbols(* ,?).

TABLE III: Weight of terms

Document vector			
Original		**Using Upper Approximation**	
Term	**Weight**	**Term**	**Weight**
auditor	0.567	auditor	0.564
bankruptcy	0.4218	bankruptcy	0.4196
signaling	0.2835	signaling	0.282
EconPapers	0.2835	EconPapers	0.282
rates	0.2835	rates	0.282
versus	0.223	versus	0.2218
issue	0.223	issue	0.2218
Journal	0.223	Journal	0.2218
MODEL	0.223	MODEL	0.2218
Prediction	0.1772	Prediction	0.1762
Vol	0.1709	Vol	0.1699
		applications	0.0809
		Computing	0.0643

Step 3

a. Now the weight of each data or term is calculated that has occurred for highest number of times.
b. A table is formed having the frequency value along with the specific term with the type of data, which has occurred for the highest number of times.
c. The table can contain highest frequency value first with the lowest term value at last or vice-versa.

Step 4

a. Here we use the Tolerance rough set approach. We consider a global similarity threshold or tolerance factor or level and determine the required level of similarity for inclusion within a tolerance class and the remaining search results are simply discarded. After that we can apply various clustering methodologies to cluster them into appropriate groups of different meanings.
b. Once the table is displayed now it is up to the user to decide which particular or nearest data he/she is willing to view. A user can view the data by simply clicking on it.

Step 5

Now here the main factor is taken into consideration. It may happen the discarded results do contain some meaningful information that the user might want to refer or have.

Here again use the tolerance rough set approach to the discarded results and again use a global threshold similarity function and cluster the appropriate results and name them as "Rough Search result".

These "Rough search results " are then displayed in a different section but in the same page where the Original tolerance set was displayed ,so that a user can also have a quick reference to get some or other needed information.

V. CONCLUSION

This paper has presented an interactive method for term or query Expansion using wildcards or truncation searching techniques (*.l, $) based on term weighting , tolerance rough set model and later clustering the roughness found. The method is found on the fact that documents contain some terms with high information content, which can summarize their subject matter. Those terms can be found out efficiently through this proposed algorithm. This particular algorithm helps us to save much some useful information that we generally omit during rough set analysis. But each day is passing and new advancements are coming into light. So, our future aspects would be to implement this strategy and make it more efficient to deal with. Also, our target would be to implement this strategy into various fields and industry to see how efficiently it works and also comparing it with other searching techniques so that we can make this as one of the best searching technique ever used till date.

REFERENCES

[1] S.Kawasaki , N.B.Nguyen, "Hierarchical document clustering based on tolerance rough set model", *In Principles of Data Mining and Knowledge Discovery, 4th European Conference, PKDD,* Lyon, France, 2000.
[2] S.Mishra, S. K. Satapathy, D.Mishra,"Improved search technique using Wildcards or Truncation ", *In the Proc .of Intelligent Agent & Multi – Agent systems , Published at IEEE Explore 978-1-4244-4711-4/09/,* 2009 .
[3] C.Silverstein, M. Hen zinger, H.Marais, M. Moricz, "Analysis of a very large AltaVista query log", *In the Proc. of Tech. Rep. 2008-014, Digital SRC,* 2008.
[4] Google-Information literacy tutorial- Searching Techniques
[5] Google-Duke Libraries-Searching Techniques.
[6] J .Han, "Data Mining: Concepts and Techniques ", 1st ed. Morgan Kaufmann, 2000.
[7] B.Larsen, C.Aone, "Fast and erective text mining using linear-time document clustering", In *Proceedings of the fifth ACM SIGKDD International conference on Knowledge discovery and data mining*, pp. 16(22), 1999.
[8] A. K.Jain, M. N. Murty, P. J.Flynn, "Data clustering: a review", *In the Proc. of ACM Computer. Survey. 31*, 3, 264(323), 2009.
[9] R.Baeza-Yates, B.Ribeiro-Neto, "Modern Information Retrieval", *1st ed. Addison Wesley Longman Publishing Co*. Inc., May 2007.
[10] S.Chakrabarti,"Mining the Web", *Morgan Kaufmann*, 2003.
[11] D.R.Cutting, D.R.Karger, J.O. Pedersen, J.W.Tukey, "Scatter/gather: a cluster-based approach to browsing large document collections", *In Proceedings of the 15th annual international ACM SIGIR conference on Research and development in information retrieval*, pp. 318(329), 1992.
[12] M. A.Hearst , J. O.Pedersen,"Reexamining the cluster hypothesis: Scatter/gather on retrieval results", *In Proceedings of SIGIR-96, 19th ACM International Conference on Research and Development in Information Retrieval* ,Zürich, CH,pp. 76(84), 2007.
[13] T. Honkela , S.Kaski, Kohonen, T.Websom,"Self-organizing maps of document collections", *In Proceedings of WSOM'97, Workshop on Self-Organizing Maps, Espoo, Finland, June 4-6 1997, Helsinki University of Technology, Neural Networks Research Centre, Espoo, Finland.* pp. 310 (315), 2007.
[14] V. Rijsbergen, "Information Retrieval", *In the Proc. ACM Digital London, 2007.*
[15] O.Zamir, O. Etzioni, "Grouper: a dynamic clustering interface to web search results", *In the proc. of the Computer Networks*, Amsterdam, Netherlands, *31*(11), 2008.
[16] Chen Wu, J. Dai , "Information Retrieval Based on Decompositions of Rough Sets Referring to Fuzzy Tolerance Relations", *In the Proc . of IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.3, March 2009.*
[17] R.Slowinski , D.Vanderpooten ,"Similarity Relation as a Basis for Rough Approximations", *In Proceedings of the Second Annual Joint Conference on Information Science, Wrightsville Beach, N Carolina ,USA, also ICS Research Report 53,1995:249-250* ,2009
[18] Tu Bao Ho, N. B. N. "Nonhierarchical document clustering based on a tolerance rough set model", *In the Proc. of International Journal of Intelligent Systems 17*, 2 199(212),2002.
[19] O.Zamir, O.Etzioni,,"Web document clustering: A feasibility demonstration",*In Research and Development in Information Retrieval* (1998), pp. 46-54.
[20] A.Schenker, M.Last, "Design and implementation of a web mining system for organizing search engine results", *In Data Integration over the Web (DIWeb), First International Workshop, Interlaken, Switzerland, 4 June 2001.* (2001), pp. 62-75.

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Measuring Semantic Similarity between Words Using Web Documents

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***Abstract*— Semantic similarity measures play an important role in the extraction of semantic relations. Semantic similarity measures are widely used in Natural Language Processing (NLP) and Information Retrieval (IR). The work proposed here uses web-based metrics to compute the semantic similarity between words or terms and also compares with the state-of-the-art. For a computer to decide the semantic similarity, it should understand the semantics of the words. Computer being a syntactic machine, it can not understand the semantics. So always an attempt is made to represent the semantics as syntax. There are various methods proposed to find the semantic similarity between words. Some of these methods have used the precompiled databases like WordNet, and Brown Corpus. Some are based on Web Search Engine. The approach presented here is altogether different from these methods. It makes use of snippets returned by the Wikipedia or any encyclopedia such as Britannica Encyclopedia. The snippets are preprocessed for stop word removal and stemming. For suffix removal an algorithm by M. F. Porter is referred. Luhn's Idea is used for extraction of significant words from the preprocessed snippets. Similarity measures proposed here are based on the five different association measures in Information retrieval, namely simple matching, Dice, Jaccard, Overlap, Cosine coefficient. Performance of these methods is evaluated using Miller and Charle's benchmark dataset. It gives higher correlation value of 0.80 than some of the existing methods**

Keywords – Semantic Similarity, Wikipedia, Web Search Engine, Natural Language Processing, Information Retrieval, Web Mining.

I. INTRODUCTION

Semantic similarity is a central concept that finds great importance in various fields such as artificial intelligence, natural language processing, cognitive science and psychology. Accurate measurement of semantic similarity between words is essential for various tasks such as, document clustering, information retrieval, and synonym extraction. For a machine to be able to decide the semantic similarity, intelligence is needed. It should be able to understand the semantics or meaning of the words. But a computer being a syntactic machine, semantics associated with the words or terms is to be represented as syntax. For this various approaches are proposed till now. Word semantic similarity approaches or metrics can be categorized as: (i) *Pre-compiled database based metrics*, i.e., metrics consulting only human-built knowledge resources, such as ontologies, (ii) *Co-occurrence based metrics using WWW*, i.e., metrics that assume that the semantic similarity between words or terms can be expressed by an association ratio which is a function of their co-occurrence (iii*) Context based metrics using WWW*, i.e., metrics that are fully text-based and understand and utilize the context or proximity of words or terms to compute semantic similarity.

Several Precompiled database based methods have been proposed in the literature that use, e.g., WordNet, for semantic similarity computation. WordNet is an on-line semantic dictionary—a lexical database, developed at Princeton by a group led by Miller. Edge counting methods consider the length of the paths that link the words, as well as the word positions in the taxonomic structure [4]. Information content methods compute similarity between words by combining taxonomic features that exist in the used resource, e.g., number of subsumed words, with frequencies computed over textual corpora [3]. Semantic similarity between words changes over time as new words are constantly being created and new meaning is also being assigned to the existing words. Also there can be a problem with person name detection and alias detection. One person may have multiple names to identify. So there are some problems with the precompiled databases. The new senses of words can not be immediately listed in any precompiled database. Maintaining an up-to-date taxonomy of all the new words and new usages of existing words is difficult and costly. A solution to this problem is : "*The Web can be regarded as a large-scale, dynamic corpus of text*". Danushka Bollegala [6] has proposed similarity measures using page count returned by the search engine for the given word pair. These similarity measures are modified four popular co-occurrence measures; Jaccard, Overlap, Dice, and PMI (point-wise mutual information). Page-count-based metrics use association ratios between words that are computed using their co-occurrence frequency in documents. The basic assumption of this approach is that high co-occurrence frequencies indicate high association ratios and high association ratios indicate a semantic relation between words.

Cilibrasi and Vitanyi [7] proposed a page-count-based similarity measure, called the Normalized Google Distance.

$$G(w_1, w_2) = \frac{\max\{A\} - \log|D|w_1, w_2)}{\log|D| - \min\{A\}} \qquad (1)$$

As the semantic similarity between two words increases, the distance computed by (1) decreases. This metric is

considered to be a dissimilarity measure. The metric is also unbounded, ranging from 0 to ∞. J. Gracia [5], proposed a variation of Normalized Google Distance that defines a similarity measurement. This variation is typically referred to as "Google-based Semantic Relatedness":

$$G'(w_1, w_2) = e^{-2G(w_1,w_2)} \quad (2)$$

The next approach is using TF-IDF representation to represent semantics of a word. Here Term Frequency (TF) is the ratio of number of occurrences of the considered term (t_i) in document d_j, and the total number of occurrences of all terms in document d_j.

$$tf_{i,j} = \frac{n_{i,j}}{\sum_k n_{k,j}} \quad (3)$$

Inverse Document Frequency (IDF) is the ratio of total number of documents and the number of documents having the term t_i .

$$idf_i = \log \frac{|D|}{|\{d : t_i \in d\}|} \quad (4)$$

TF-IDF is

$$(tf - idf)_{i,j} = tf_{i,j} \times idf \quad (5)$$

Elias Iosif [8] proposed text-based or context based similarity metrics. The basic assumption behind these metrics is that "*similarity of context implies similarity of meaning"*, i.e., words that appear in similar lexical environment (left and right contexts) have a close semantic relation. For each occurrence of a word w a left and right context of size K is considered. i.e. $[t_{K,L}...t_{2,L}t_{1,L}]w[t_{1,R}t_{2,R}...t_{K,R}]$ where,

$t_{i,L}$ and $t_{i,R}$ represent the i[th] word to the left and to the right of w respectively. Each word is represented as a feature vector as $F_{w,K} = (v_{w,1}, v_{w,2}, ..., v_{w,N})$. There are various feature weighting schemes for computing the value of $v_{w,i}$, some of them are :

Scheme	Acronym
Binary	B
Term Frequency	TF
Add-one TF	TF1
Log of TF	LTF
Add-one LTF	LTF1
TF-Inverse Document Freq.	TFIDF
Log of TFIDF	LTFIDF
Add-one LTFIDF	LTFIDF1

This paper presents five different semantic similarity methods. The methods proposed here understand the semantics associated with the word by making use of snippets returned by the Wikipedia or Britannica Encyclopedia for the given word pair. The snippets obtained are preprocessed. The preprocessing involves three different steps. First step is elimination of stop words. Second step is suffix removal & stemming . This task is achieved by applying Porter's Stemming Algorithm [2]. Third step involves keywords or index terms selection based on the frequency of occurrence of terms in the given snippet. In the proposed methods syntactic representation of the semantics associated word is achieved by following theses three steps. The set of keywords is used as syntactic representation of the snippet. Similarity between words is decided using this set of keywords.

II. PROPOSED SEMANTIC SIMILARITY METHOD

A. Snippet Extraction

Wikipedia is the world's largest collaboratively edited source of encyclopedic knowledge. It provides semantic information for every word or term. Semantics associated with each word is very well described by Wikipedia. Firstly, we must decide which part in Wikipedia for a word is useful for us. For example, if we search word "*car*" in Wikipedia, we can get much information about "*car*", such as car's history, its production and its safety, and so on. Use of this complete information may mislead the task of deciding semantic similarity. Usually, Wikipedia return some top result for the word for which we search information in Wikipedia. These snippets use simple vocabulary to explain the word, or give simple definition or some description about the word. These snippets are very much suitable to measure semantic similarity between words.

B. Snippet Preprocessing

The snippets downloaded from Wikipedia can not be directly used. There are lot of semantically unrelated words. Also the words in different form may bring in negative impact on similarity computation. So preprocessing of snippets is needed. Preprocessing of snippets involves three steps: removal of high frequency words, suffix stripping, detecting equivalent stems.

Stop Word Removal

Luhn [1] proposed that *"the frequency of word occurrence in an article furnishes a useful measurement of word significance*". Luhn used Zipf's Law [1] as a null hypothesis to specify two cut-offs, an upper and a lower (see Figure 2.), thus excluding non-significant words. The words exceeding the upper cut-off were considered to be common and those below the lower cut-off rare, and therefore not contributing significantly to the content of the article. He

thus devised a counting technique for finding significant words. The same is shown by using a plot of frequency versus rank:

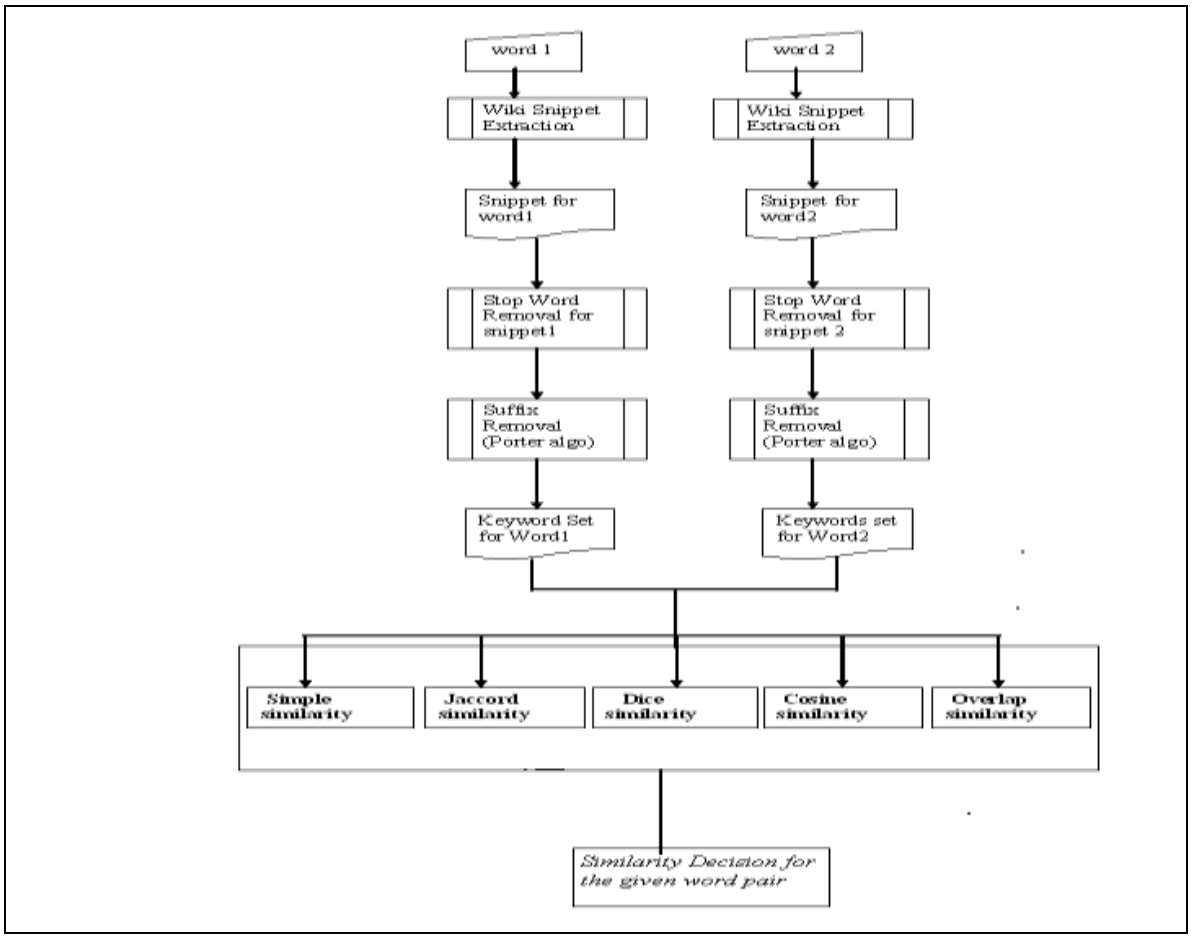

Figure 1: Flow of Similarity Computation Algorithm

The removal of high frequency words, 'stop' words or 'fluff' words is one way of implementing Luhn's upper cut-off. This is normally done by comparing the input text with a 'stop list' of words which are to be removed. The advantages of the process are non-significant words are removed so that they will not interfere during retrieval, also the size of the total text can be reduced by between 30 and 50 per cent.

Suffix Stripping And Stemming

Terms with a common stem will usually have similar meanings, for example: CONNECT, CONNECTED, CONNECTING, CONNECTION, CONNECTIONS. Performance of an IR system will be improved if term groups such as this are conflated into a single term. This may be done by removal of the various suffixes -ED, -ING, -ION, -IONS, etc to leave the single term CONNECT. In addition, the suffix stripping process will reduce the total number of terms in the IR system, and hence reduce the size and complexity of the data in the system, which is always advantageous.

Algorithm

An algorithm is proposed by M.F. Porter [2] for suffix stripping. Assumption for the algorithm is: a '*consonant*' in a word is: "*a letter other than A, E, I, O or U, and other than Y preceded by a consonant".*

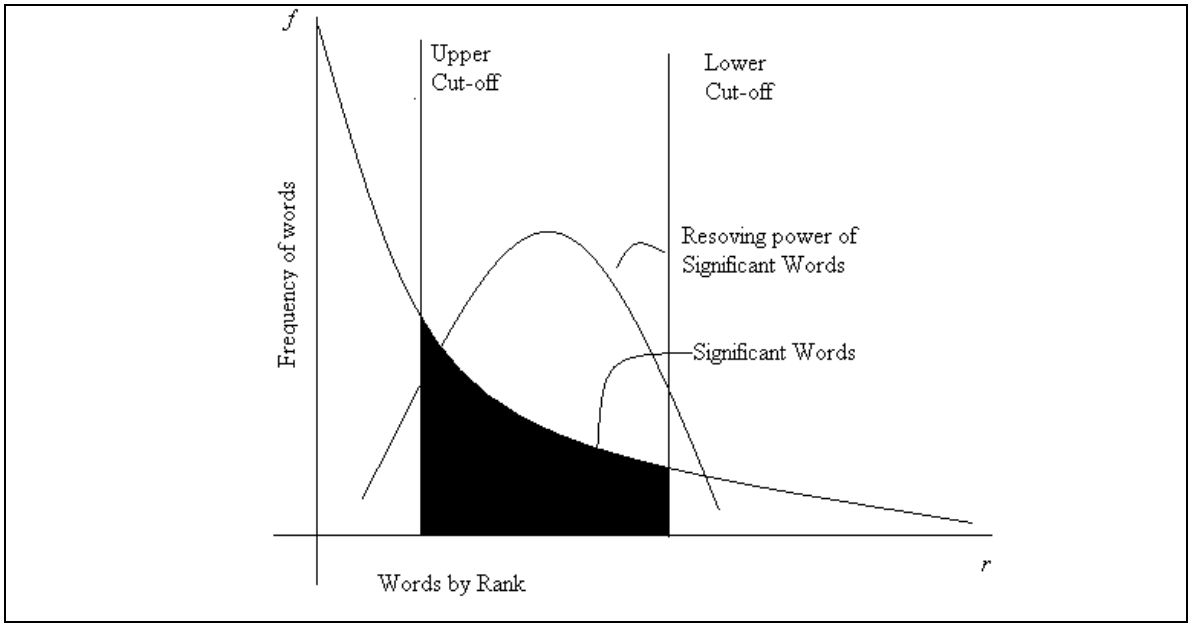

Figure 2 : Relation between frequency of word and significance of word [1]

A *'vowel'* in a word is :"*if a letter is not a consonant it is a vowel"*. Every consonant is represented by 'C' and every vowel is represented by 'V'. A list CCC.... of length greater than 0 will be denoted by C, and a list VVV... of length greater than 0 will be denoted by V. Any word, or part of a word, therefore has one of the four forms:

CVCV ... C
CVCV ... V
VCVC ... C
VCVC ... V

These all may be represented by the single form : [C]VCVC ... [V]. Where, the square brackets denote arbitrary presence of their contents. Using (VC){m} to denote VC repeated m times, this may again be written as :

[C](VC){m}[V]

'm' will be called the 'measure' of any word or word part when represented in this form. Here are some examples:

m=0 TREE, ME, BY.
m=1 TROUBLE, OATS, TREES, IVY.
m=2 TROUBLES, PRIVATE, OATEN, ORRERY.

The 'rules' for removing a suffix will be given in the form:

(condition) $S_1 \rightarrow S_2$

This means that if a word ends with the suffix S1, and the stem before S1 satisfies the given condition, S1 is replaced by S2. The condition is usually given in terms of m, e.g.:

(m > 1) EMENT →

Here S1 is `EMENT' and S2 is null. This would map REPLACEMENT to REPLAC, since REPLAC is a word part for which m = 2.

TRANSPORTING
CCVCCCVCCVCC
CVCVCVC
[C](VC){3}

After stop word removal and suffix stripping, on the basis of frequency count of each term of the snippet, a set of keywords for the snippet is extracted. Figure given below explains the procedure of keyword extraction from the given Wikipedia snippet.

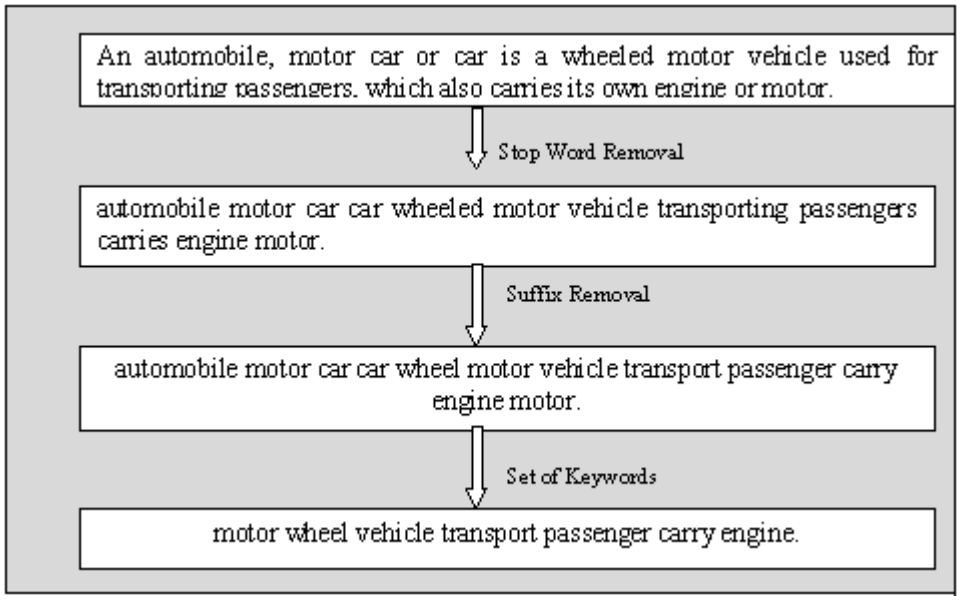

Figure 3 : Extracting the Set of Keywords from the Wikipedia Snippet

C. Similarity Measures

Five different strategies are proposed in this paper to find out the semantic similarity results. Word pairs in Table 2 are used in investigating the suitability of individual strategies. For each of the proposed strategies, we carried out the experiments with two steps. Using the set of keywords, which are obtained from snippets by preprocessing them, semantic similarity values of the word pairs are calculated. Then, the correlation coefficient between the computed semantic similarity values and the human ratings of Rubenstein-Goodenough's is calculated. This correlation coefficient is used to judge the suitability of the particular strategy comparing to other strategies and previously published results.

The five similarity measures proposed here are based on the five commonly used measures of association in information retrieval. Snippets used here are represented by a set of keywords and the counting measure $|.|$ gives the size of the set. For the word w_1, $K|w_1|$ is the set of keywords obtained from snippet and for the word w_2, $K|w_2|$ is the set of keywords obtained from the snippet.

Strategy 1: The Strategy 1 is based on *Jaccard index*, also known as the Jaccard similarity coefficient is a statistic used for comparing the similarity and diversity of sample sets. The Jaccard coefficient measures similarity between sample sets, and is defined as the size of the intersection divided by the size of the union of the sample sets:

$$J(w_1, w_2) = \frac{|K|w_1| \cap K|w_2||}{|K|w_1| + K|w_2| - K|w_1| \cap K|w_2||} \quad (6)$$

Strategy 2: The Strategy 2 is based on *Dice's coefficient*, named after Lee Raymond Dice and also known as the Dice coefficient. It is a similarity measure related to the Jaccard index. For sets *X* and *Y* of keywords used in information retrieval, the coefficient may be defined as:

$$D(w_1, w_2) = 2\frac{|K|w_1| \cap K|w_2||}{|K|w_1| + K|w_2||} \quad (7)$$

Strategy 3: Strategy 3 is based on Overlap Coefficient.The *overlap coefficient* is a similarity measure related to the Jaccard index that computes the overlap between two sets. If set *X* is a subset of *Y* or the converse then the overlap coefficient is equal to one.

$$O(w_1, w_2) = \frac{|K|w_1| \cap K|w_2||}{\min(|K|w_1||, |K|w_2||)} \quad (8)$$

Strategy 4: Strategy 4 is based on Cosine Similarity measure. *The Cosine similarity* is a measure of similarity between two vectors of *n* dimensions by finding the angle between them. It is often used to compare documents in text mining.

$$C(w_1, w_2) = \frac{|K|w_1| \cap K|w_2||}{sqrt(|K|w_1||) \times sqrt(|K|w_2||)} \quad (9)$$

Strategy 5 : Strategy 5 based on Simple matching coefficient, which is the number of shared index terms. This coefficient does not take into account the sizes of *X* and *Y*.

The following coefficients which have been used in document retrieval take into account the information provided by the sizes of *X* and *Y*. $S(w_1, w_2) = |K|w_1| \cap K|w_2||$ (10)

III. RESULTS

TABLE 1 : Comparison of Similarity Methods for Miller-Charles Data Set

Method	Type						Correlat
		Word Ontology	Corp	Search engine	Page Count	Wikipedia/ Encyclopedia	
Edge counting	Edge Counting	✓	✓	×	×	×	0.664
Information Content	Information Content	×	✓	×	×	×	0.745
Jiang & Conarth	Hybrid	✓	✓	×	×	×	0.848
Lin	Information Content	×	✓	×	×	×	0.821
Yuhua Li	Hybrid	✓	✓	×	×	×	0.891
WebSim	Web Based	×	×	×	✓	×	0.834
By Danushka							
Google Similarity	Web Based	×	×	×	✓	×	0.66
Relational Sim By Danushka	Web Based	×	×	✓	×	×	0.834
Elias Iosif	Web Based	×	×	✓	×	×	0.88
Proposed Measures	Web Based	×	×	×	×	✓	0.80

For deciding whether a specific method has performed better or has not, we calculate the correlation coefficient of the semantic similarity results of the method and human judgment for the benchmark dataset. For two datasest X and Y correlation coefficient is computed by:

$$\rho = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{X_i - \mu_x}{\sigma_x}\right)\left(\frac{Y_i - \mu_y}{\sigma_y}\right) \quad (11)$$

Performance of semantic similarity methods proposed here is assessed by making use of benchmark datasets given by Rubenstein- Goodenough [9] and a word set given by Miller and Charles [9]. Rubenstein- Goodenough's Benchmark dataset consists of 65 word pairs. These 65 word pairs are divided into sets called as dataset D_0 and D_1. The dataset D_0 is utilized by Miller and Charles in his experiment. They have rated similarities between words from "0 to 4". "0" – semantically unrelated and "4" – highly similar / highly synonymous. Before presenting the achieved results of the above mentioned five strategies the Table 2 lists various similarity methods.

IV. CONCLUSION

This paper presents a new approach for measuring semantic similarity between words using the Snippets returned by Wikipedia and the five different similarity measures of association. Snippets in Wikipedia are used to measure semantic similarity between words. The result demonstrates that the snippets in Wikipedia have a significant influence on the accuracy of semantic similarity measure between words.

Table 1 summarizes various similarity methods and compares the approaches followed by them. Table 2 gives results of five different similarity methods proposed in this paper. Table 3 summarizes the correlation coefficient of the proposed methods using MC replica and RG ratings

The major contributions of this paper are:

1. Measuring semantic similarity between words using Keywords obtained from Wikipedia Snippets is proposed in this paper.
2. Luhn's idea for deciding the significant words is applied for preprocessing of snippets.

3. Porter's algorithm is used for suffix removal in preprocessing snippets.
4. Five association measures of Jaccord, Dice, Overlap cosine and simple matching are used to measure semantic similarity between words.

TABLE 2 : Similarity Results from Different Measures on Miller Charle's Benchmark Dataset

WORD PAIR	RG Rating	MC Replica	Resnik Replica	S1	S2	S3	S4	S5
cord-smile	0.02	0.13	0.1	0.00	0.00	0.00	0.00	0.00
Rooster-voyage	0.04	0.08	0	0.00	0.00	0.00	0.00	0.00
noon-string-	0.04	0.08	0	0.00	0.00	0.00	0.00	0.00
glass-magician	0.44	0.11	0.1	0.00	0.00	0.00	0.00	0.00
Monk-slave	0.57	0.55	0.7	0.00	0.00	0.00	0.00	0.00
coast-forest	0.85	0.42	0.6	0.44	0.80	1.33	0.87	1.00
monk-oracle	0.91	1.1	0.8	0.40	0.73	0.80	0.73	1.00
lad-wizard	0.99	0.42	0.7	0.80	1.33	1.33	1.33	1.00
forest- graveyard	1.00	0.84	0.6	0.31	0.57	0.57	0.57	1.00
food-rooster	1.09	0.89	1.1	0.00	0.00	0.00	0.00	0.00
coast-hill	1.26	0.87	0.7	0.44	0.80	1.33	0.87	1.00
car-journey	1.55	1.16	0.7	0.44	0.89	1.33	0.94	1.00
crane-implement	2.37	1.68	0.3	0.86	2.18	4.00	2.45	3.00
brother-lad	2.41	1.66	1.2	1.71	3.43	4.00	3.46	3.00
bird-crane	2.63	2.97	2.1	0.00	0.00	0.00	0.00	0.00
bird -cock	2.63	3.05	2.2	0.00	0.00	0.00	0.00	0.00
Food-fruit	2.69	3.08	2.1	0.00	0.00	0.00	0.00	0.00
Brother-monk	2.74	2.82	2.4	0.00	0.00	0.00	0.00	0.00
asylum-madhouse	3.04	3.61	3.6	4.00	4.00	4.00	4.00	2.00
furnace-stove	3.11	3.11	2.6	1.33	2.00	2.00	2.00	1.00
magician-wizard	3.21	3.5	3.5	4.00	4.00	4.00	4.00	1.00
Journey-voyage	3.58	3.84	3.5	4.00	4.00	4.00	4.00	3.00
coast-shore	3.60	3.7	3.5	4.00	4.00	4.00	4.00	2.00
implement-tool	3.66	2.95	3.4	4.00	4.00	4.00	4.00	3.00
Boy-lad	3.82	3.76	3.5	3.00	4.00	4.00	4.00	3.00
automobile-car	3.92	3.92	3.9	4.00	4.00	4.00	4.00	5.00
midday-noon	3.94	3.42	3.6	4.00	4.00	4.00	4.00	6.00
gem-jewel	3.94	3.84	3.5	4.00	4.00	4.00	4.00	4.00

TABLE 3 :Correlation of Different Strategies against Human Similarity Judgements on Benchmark Dataset

Strategy	S_1	S_2	S_3	S_4	S_5

Correlation (MC Replica)	0.8006	0.7958	0.7465	0.7910	0.6401
Correlation (RG Rating)	0.7974	0.7955	0.7609	0.7934	0.6968

REFERENCES

[1] C.J. Rijsbergen, "Information Retrieval", (www.dcs.gla.ac.uk)

[2] M.F.Porter, "An algorithm for suffix stripping", Originally published in \Program\, \14\ no. 3, pp 130-137, July 1980.

[3] J. Jiang and D. Conrath, "Semantic similarity based on corpus statistics and lexical taxonomy," in *Proc. of International Conference on Research on Computational Linguistics*, 1997.

[4] Yuhua Li, Zuhair A. Bandar and David McLean, "An Approach for Measuring Semantic Similarity between Words Using Multiple Information Sources", IEEE Transactions On Knowledge And Data Engineering, Vol. 15,No.4,July/August2003

[5] J. Gracia, R. Trillo, M. Espinoza, and E. Mena, "Querying the web: A multiontology disambiguation method," in *Proc. of International Conference on Web Engineering*, 2006, pp. 241–248

[6] D. Bollegala, Y. Matsuo, and M. Ishizuka, "Measuring semantic similarity between words using web search engines," in *Proc. of International Conference on World Wide Web*, 2007, pp. 757–766.

[7] Rudi L. Cilibrasi and Paul M.B. Vita´ nyi, "The Google Similarity Distance", IEEE Transactions On Knowledge And Data Engineering, Vol. 19, No. 3, March 2007

[8] Elias Iosif and Alexandros Potamianos, "Unsupervised Semantic Similarity Computation Between Terms Using Web Documents", IEEE Transactions On Knowledge And Data Engineering

[9] Lu Zhiqiang, Shao Werimin and Yu Zhenhua, "Measuring Semantic Similarity between Words Using Wikipedia", 2009 International Conference on Web Information Systems and Mining

Classification of Self-Organizing Hierarchical Mobile Adhoc Network Routing Protocols - A Summary

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***Abstract*— MANET is a special kind of wireless network. It is a collection of mobile nodes without having aid of established infrastructure. Mobile Adhoc network removes the dependence on a fixed network infrastructure by treating every available mobile node as an intermediate switch, thereby extending the range of mobile nodes well beyond that of their base transceivers. Other advantages of Manet include easy installation and upgrade, low cost and maintenance, more flexibility, and the ability to employ new and efficient routing protocols for wireless communication. In this paper we present four routing algorithm, classifications, discuss their advantages and disadvantages.**

***Keywords*- MANET, Routing Protocols, Routing Topology , Routing Algorithms and QoS.**

I. INTRODUCTION

Suppose it is required to easily and effectively connect two office floors using short range wireless communication devices. Every employee has one of these mobile devices, and some fixed devices- computers, printers, and so on-have the same capability.

It is possible to connect these devices to the existing wired infrastructure using access points, but this option offers limited mobility, adds load on the wired networking and relies on existing protocols for wired communication. Another possibility is to build a network of dedicated and mutually connected base stations that enable cellular communication, but this is expensive with respect to time, installation, and maintenance.

The best solution is to create a mobile Adhoc network using surrounding electronic devices as intermediate switches when they are idle and if they are capable of performing this task. For example, the packet from one device can hop to the mobile phone of a person passing through the corridor in front of the office, then from the mobile phone to the shared laser printer in the next office, then to someone's digital wristwatch on the floor below, then from the wristwatch to the coffee machine, and, finally, from the coffee machine to its ultimate destination – say another colleague's device or computer. To date, MANETs have been used primarily for military purposes, while commercial applications are just beginning to emerge. One of the potential practical usage scenarios of MANETs is in a conference room where a group of people that possibly have not met before come together for an Adhoc meeting. They may wish to exchange data securely with their notebook computers or PDAs without any additional infrastructure support [1].

Small scale MANETs are also effective for emergency search and rescue, battlefield surveillance and other communication application in hazardous environments. For example, robots or autonomous sensors deployed in an area inaccessible to humans could use simple MANET routing protocols to transmit data to a control centre. Even if many robots or sensors are disabled or destroyed, the remaining ones would be able to reconfigure themselves and continue transmitting information.

II. ROUTING IN MANETS

The major challenges that a routing protocol designed for Adhoc wireless networks faces are mobility of nodes, resource constraints, error-prone channel state, and hidden and exposed terminal problems.

Due to the issues in an Adhoc wireless network environment mentioned above, wired network routing protocols cannot be used in Adhoc wireless networks. Hence Adhoc wireless networks require specialized routing protocols that address the challenges described above. A routing protocol for Adhoc wireless networks should have the following characteristics [2].

- It must be fully distributed, as centralized routing involves high control overhead and hence is not scalable. Distributed routing is more fault-tolerant than centralized routing, which involves the risk of single point of failure.
- It must be adaptive to frequent topology changes caused by the mobility of the nodes.
- Route computation and maintenance must involve a minimum number of nodes. Each node in the network must have quick access to routes, that is, minimum connection set up time is desired.
- It must be localized, as global state maintenance involves a huge state propagation control overhead.

- It must be loop-free and free from stale routes.
- The number of packet collisions must be kept to a minimum by limiting the number of broadcasts made by each node. The transmissions should be reliable to reduce message loss and to prevent the occurrence of stale routes.
- It must converge to optimal routes once the network topology becomes stable. The convergence must be quick.
- It must optimally use source resources such as bandwidth, computing power, memory power, and battery power.
- Every node in the network should try to store information regarding the stable local topology only. Frequent changes in local topology and changes in the topology of parts of the network with which the node does not have any traffic correspondence, must not in any way affect the node, that is, changes in remote parts of the network must not cause updates in the topology information maintained by the node.
- It should be able to provide a certain level of quality of service (QoS) as demanded by the applications, and should also offer to support for time-sensitive traffic.

III. CLASSIFICATION OF ROUTING PROTOCOLS

Routing protocols for Adhoc wireless networks can be classified into several types based on different criteria. The routing protocols for Adhoc wireless networks can be broadly classified into four categories based on

- Routing information update mechanism
- Use of temporal information for routing
- Routing topology
- Utilization of specific resource

A. Based on the Routing Information Update Mechanism

Adhoc wireless network routing protocols can be classified into three major categories based on the routing information update mechanism. They are

1) Proactive or Table-Driven Routing Protocols

In table-driven routing protocols, every node maintains the network topology information in the form of routing tables by periodically exchanging routing information. Routing information is generally flooded in the whole network. Whenever a node requires a path to a destination, it runs an appropriate path-finding algorithm on the topology information it maintains. The table-driven protocols are

DSDV – Destination- Sequenced Distance-Vector [3]

WRP – Wireless Routing Protocol [4]

CGSR – Clustered Head Gateway Switch Routing [5]

STAR – Source Tree Adaptive Routing [6]

OLSR – Optimized Link State Routing [7]

FSR – Fisheye State Routing [8]

HSR – Hierarchical State Routing [8]

GSR – Global State Routing [9]

2) Reactive or On-demand Routing Protocols

Protocols that fall under this category do not maintain the network topology information. They obtain the necessary path when it is required, by using a connection establishment process. Hence these protocols do not exchange routing information periodically. Some of the existing routing protocols that belong to this category are given below.

DSR – Dynamic Source Routing [10]

AODV – Adhoc On-Demand Distance Vector Routing [11]

ABR – Associativity Based Routing [12]

SSA – Signal Stability Based Adaptive Routing [13]

FORP – Flow-Oriented Routing Protocol [14]

PLBR – Preferred Link-Based Routing [15]

3) Hybrid Routing Protocols

Protocols belonging to this category combine the best features of the above two categories. Nodes within a certain distance from the node concerned, or within a particular geographical region, are said to be within the routing zone of the given node. For routing within this zone, a table-driven approach is used. For nodes that are located beyond this zone, an on-demand approach is used. Some of the protocols in this category are

CEDAR – Core Extraction Distributed Adhoc Routing [16]

ZRP – Zone Routing Protocol [17]

ZHLS – Zone-Based Hierarchical Link State Routing [18]

B. Based on the Use of Temporal Information for Routing

This classification of routing protocols is based on the use of temporal information used for routing. Since Adhoc wireless networks are highly dynamic and path breaks are much more frequent than in wired networks, the use of temporal information regarding the lifetime of the wireless links and the lifetime of the paths selected assumes significance. The protocols that fall under this category can be further classified into two types:

1) Routing Protocols Using Past Temporal Information

These routing protocols use information about past status of the links or the status of the links at the time of routing to make routing decisions. For example, the routing metric based on the availability of wireless links (which is the current / present information here) along with a shortest path-finding algorithm, provides a path that may be efficient and stable at the time of path-finding. The topological changes may

immediately break the path, making the path undergo a resource-wise expensive path reconfiguration process. Some of the protocols in this category are given below.

DSDV – Destination- Sequenced Distance-Vector [3]

WRP – Wireless Routing Protocol [4]

STAR – Source Tree Adaptive Routing [6]

DSR – Dynamic Source Routing [10]

AODV – Adhoc On-Demand Distance Vector Routing [11]

FSR – Fisheye State Routing [8]

HSR – Hierarchical State Routing [8]

GSR – Global State Routing [9]

2) Routing Protocol That Use Future Temporal Information

Protocols belonging to this category use information about the expected future status of the wireless links to make approximate routing divisions. Apart from the life-time of wireless links, the future status information also includes information regarding the lifetime of the node (which is based o the remaining battery charge and discharge rate of the non-replenish able resources), prediction of location and prediction of link availability. The protocols in this category are

FORP – Flow-Oriented Routing Protocol [14]

RABR – Route-Lifetime Assessment –based Routing [19]

LBR - Link Life-time based Routing Protocol [20]

C. Based on the Routing Topology

Routing topology being used in the Internet is hierarchical in order to reduce the state information maintained at the core routers. Adhoc wireless networks, due to their relatively smaller number of nodes, can make use of either a flat topology or a hierarchical topology for routing.

1) Flat Topology Routing Protocols

Protocols that fall under this category make use of a flat addressing scheme similar to the one used in IEEE 802.3 LANs. It assumes the presence of a globally unique (or atleast unique to the connected part of the network) addressing mechanism for nodes in an Adhoc wireless networks. These are

DSR – Dynamic Source Routing [10]

AODV – Adhoc On-Demand Distance Vector Routing [11]

ABR – Associatively Based Routing [12]

SSA – Signal Stability Based Adaptive Routing [13]

FORP – Flow-Oriented Routing Protocol [14]

PLBR – Preferred Link-Based Routing [15]

2) Hierarchical Topology Routing Protocols

Protocols belonging to this category make use of a logical hierarchy in the network an associated addressing scheme. The hierarchy could be based on geographical information or it could be based on hop distance. Some of these protocols are

CGSR – Clustered Head Gateway Switch Routing [5]

FSR – Fisheye State Routing [8]

HSR – Hierarchical State Routing [8]

D. Based on the Utilization of specific Resources

1) Power-aware Routing

This category of routing protocols aims at minimizing the consumption of very important resources in the Adhoc wireless networks: the battery power. The routing decisions are based on minimizing the power consumption either locally or globally in the network.

PAR – Power-Aware Routing Protocol [21]

2) Geographical Information Assisted Routing:

Protocols belonging to this category improve the performance of routing and reduce the control overhead by effectively utilizing the geographical information available.

LAR – Location-aided routing [22]

IV. CONCLUSION

In this paper, the major issues involved in the design of a routing protocol and the different classifications of routing protocols for Adhoc wireless networks were described. The classifications of the Adhoc routing protocols is given in Table 1 in the Annexure. Comparison of Unipath routing protocols and the Multipath routing protocols are given in Table 2 and Table 3 respectively in the Annexure. The major challenges that an Adhoc wireless routing protocol must address are the mobility of nodes, rapid changes in topology, limited bandwidth, hidden and exposed terminal problem, limited battery power, time-varying channel properties, and location-dependant contention. The different approaches upon which the protocols can be classified include the classification based on the type of topology maintenance approach, the routing topology used, the use of temporal information, and the type of specific resource utilization considered for making routing decisions.

ANNEXURE

TABLE I. CLASSIFICATION OF THE ADHOC ROUTING PROTOCOLS

	Routing Proactive Protocol	Routing Reactive Protocol	Routing Hybrid Protocol	Temporal Past Information	Temporal Future Information	Flat Topology	Hierarchical Topology	Power Aware Routing	Hierarchical InformationAssisted Routing
DSDV	√			√					
WRP	√			√					
CGSR	√						√		
STAR	√			√					
OLSR	√								
FSR	√			√			√		
HSR	√			√			√		
GSR	√			√					
DSR		√		√		√			
AODV		√		√		√			
ABR		√				√			
SSA		√				√			
FORP		√			√	√			
PLBR		√				√			
CEDAR			√						
ZRP			√						
ZHLS			√						
RABR					√				
LBR					√				
PAR								√	
LAR									√

TABLE II. COMPARISON OF THE UNIPATH ROUTING PROTOCOLS

	Proactive Routing Protocol	Reactive Routing Protocol	Periodic Update	Flood Control	Beaconing	QOS Support	Multicast Support	Security Support	Power Management
DSDV	Yes	No	Yes	No	Yes	No	No	No	No
WRP	Yes	No	Yes	No	Yes	No	No	No	No
GSR	Yes	No	Yes	No	Yes	No	No	No	No
FSR	Yes	No	Yes	Yes	Yes	No	No	No	No
AODV	No	Yes	No	Yes	Yes	No	Yes	No	No
DSR	No	Yes	No	Yes	Yes	No	No	No	No
CBRP	No	Yes	No	Yes	Yes	No	No	No	No

TABLE III. COMPARISON OF THE MULTIPATH ROUTING PROTOCOLS

	Routing Protocol Proactive	Routing Protocol Reactive	Loop Free Paths	Overhead Routing Control	Node Disjoint Paths	Routes Complete Known at Source	used Paths simultaneously	QOS Support	Multicast Support	Power Management	Security Support
AOMDV	No	Yes	Yes	No	No	No	Yes	No	No	***No***	***No***
AODVM	No	Yes	Yes	No	Yes	No	Yes	No	No	***No***	***No***
SMR	No	Yes	Yes	No	No	Yes	Yes	No	No	***No***	***No***
MSR	No	Yes	Yes	No	Yes	Yes	Yes	No	No	***No***	***No***

REFERENCES

[1] Keng Seng NG, Winston K.G.SEAH, "Routing security and Data Confidentiality for Mobile Adhoc Networks", Proceedings of the 5th IEEE conference on Mobile and Wireless Communication Networks, pp 821-25.

[2] C.Siva Ram Murthy and B.S.Manoj, "Adhoc Wireless Networks Architecture and Protocols", Prentice Hall 2004.

[3] C.E.Perkins and P.Bhagawat, "Highly Dynamic Destination-Sequenced Distance-Vector Routing(DSDV) for Mobile Compuetrs", Proceedings of ACMSIGCOMM 1994, pp 234-244, August 1994.

[4] S.Murthy and J.J.Garcia-Luna-Aceves, "An efficient Routing Protocol for Wireless Networks", ACM Mobile Networks and Applications Journal, Special Issue on Routing in Mobile Communication Networks, Vol.1, No.2, pp 183-197, October 1996.

[5] C.C.Chiang, H.K.Wu, W.Liu and M.Gerla, "Routing in Clustered Multi-Hop Mobile Wireless Networks with fading Channel", Proceedings of IEEE SICON 1997, pp 197-211,April 1997.

[6] J.J.Garcia-Aceves and M.Spohn, "Source-Tree Routing in Wireless Networks", Proceedings of IEEE ICNP 1999, pp 273-282, October 1999.

[7] T.H.Clausen,G.Hansen, Christensen and G.Behrmann, " The Optimized Link State Routing Protocol, Evaluation through experiments and simulation", Proceedings of IEEE Symposium on Wireless Personal Mobile Communications 2001, September 2001.

[8] A.Iwata, C.C.Chiang, G.Pei, M.Gerla, and T.W.Chen, "Scalable Routing Strategies for AdHoc Wireless Networks",IEEE Journal on selected Areas in Communications, Vol 17, no 8, pp1369-1379, August 1999.

[9] T.W.Chen and M.Gerla, "Global State Routing : A New Routing Scheme for Adhoc Wireless Networks", Proceedings of IEEE ICC 1998, pp 171-175, June 1998.

[10] D.B Johnson and D.A Maltz, "Dynamic Source Routing in Adhoc Wireless Networks", Mobile Computing, Kluwer Academic Publishers, Vol 353, pp 153-181, 1996.

[11] C.E.Perkins and E.M.Royer, "Adhoc On-Demand Distance Vector Routing", Proceedings of IEEE Workshop on Mobile Computing Systems and Applications 1999, pp 90-100, February 1999.

[12] C.K.TOH,"Associativity-Based Routing for Adhoc Mobile Networks", Wireless Personal Communications, Vol.4, no.2, pp. 1-36, March 1997.

[13] R.Dube, C.D.Rais, K.Y.Wang, and S.K.Tripathi, "Signal Stability-Based Adaptive Routing for Adhoc Mobile Networks," IEEE Personal Communications Magazine, pp.36-45, February 1997.

[14] W.Su and M.Gerla, "IPV6 Flow Handoff in Adhoc Wireless Networks Using Mobility Prediction", Proceedings of IEEE GLOBECOM 1999, pp. 271 -275, December 1999.

[15] R.S.Sisodia, B.S.Manoj and C.Siva Ram Murthy, "A Preferred Link-Based Routing Protocol for Adhoc Wireless Networks",Journal of Communications and Networks, Vol.4, no.1, pp.14-21, March 2002.

[16] P.Sinha, R.Sivakumar, and V.Bharghavan, "CEDAR: A Core Extraction Distributed Adhoc Routing Algorithm", IEEE Journal on selected areas in Communications, Vol.17, no.8, pp. 1454-1466, August 1999.

[17] Z.J.Haas, "The Routing Algorithm for the Reconfigurable Wireless Networks", Proceedings of ICUPC 1997, Vol.2, pp. 562-566 October 1997.

[18] M.Joa-Ng and I.T.Lu, "A Peer-to-Peer Zone-Based Two-Level Link State Routing for Mobile Adhoc Networks", IEEE Journal on Selected Areas in Communications, Vol.17, no.8, pp.1415-1425 August 1999.

[19] S.Agarwal, A.Ahuja, J.P.Singh, and R.Shorey, "Route-Lifetime Assesment-Based Routing(RABR) Protocol for Mobile Adhoc Networks," Proceedings of IEEE ICC 2000, Vol.3, pp.1697-1701 June 2000

[20] B.S.Manoj, R.Anandapadmanabha, and C.Siva Ram Murthy, "Link Life-Based Routing Protocol for Adhoc Wireless Networks", Proceedings of IEEE ICCCN 2001, PP.573-576, October 2001.

[21] S.Singh, M.Woo and C.S.Raghavendra, "Power-Aware Routing in Mobile Adhoc Networks", Proceedings of ACM MOBICOM 1998, pp.181-190 October 1998.

[22] Y.Ko and N.H.Vaidya, "Location-Aided Routing(LAR) in Mobile Adhoc Networks", Proceedings of ACM MOBICOM 1998, pp.66-75 October 1998.

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Clustering Methods for Credit Card using Bayesian rules based on K-means classification

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Abstract **- K-means clustering algorithm is a method of cluster analysis which aims to partition n observations into clusters in which each observation belongs to the cluster with the nearest mean. It is one of the simplest unconfirmed learning algorithms that solve the well known clustering problem. It is similar to the hope maximization algorithm for mixtures of Gaussians in that they both attempt to find the centers of natural clusters in the data. Bayesian rule is a theorem in probability theory named for Thomas Bayesian. It is used for updating probabilities by finding conditional probabilities given new data. In this paper, K-mean clustering algorithm and Bayesian classification are joint to analysis the credit card. The analysis result can be used to improve the accuracy.**

Keywords : Clusters, Probability, K-Means, Thomas Bayesian rule, Credit Card, attributes, banking.

I. INTRODUCTION

Since the data mining is the synthetic product of multi-subjects, it has drawn the advantages from all of these subjects including database technique, artificial neural network nets, statistical methods, mode identification, information searches, database visualization and so on. A commonly acknowledged definition is a complex process of picking the cryptic, unknown, potentially great useful and valuable models, rules or some practical knowledge from the database. It is actually a kind of deep-layer data analysis method. In order to improve the conciseness of basic Bayesian classification, many literatures have made advancements in broadening the independence of the conditions. In fact the elements that affect the conciseness is not only the relativity among the attributes but also the completeness. In response to this reason, the introduction of the clustering arithmetic for the K average into the Bayesian classification method is aimed to improve this paper is supported by Leading Academic Discipline Program , 211 Project for Shanghai University of Finance and Economics (the 3rd phase) conciseness. K-means clustering has been used in many fields [1-2], Bayesian rule is a theorem in probability theory named for Thomas Bayesian. It is used for updating probabilities by finding conditional probabilities given new data. It has been used in many fields [3-4]. Credit card is the fastest-growing banking industry of the financial business. In order to prevent risks, many methods are developed to mine or analysis the customers [5]. In this paper, K-mean clustering algorithm and Bayesian classification are combined to analysis the credit card. The analysis result can be used to improve the accuracy and shows that the method is feasible.

II. K-MEANS RULES

The key point in the K-means clustering rule is to divide the data into different clusters through iterative method. The ultimate aim is to get the target function minimized, the cluster produced will be as close and independent as possible.

Input: expected number of clusters: k, the database of n objects.

Output: k clusters which make the square error criteria function to be the minimal one.

Steps:

(1) Selecting k as the of the original cluster centroid.

(2) Calculating the distances between the objects and every cluster centroid, then divide the objects to the closest cluster.

(3) Re-calculating the average of the every new Cluster.

(4) Keep doing this until the centroid tends to be Unchangeable.

Features:

(1) A pre-fixed k;

(2)Creating a initial division ,then using the position relocation technique of the interactive

(3) The distances and matrixes can be unsure

(4)Less calculating than the hierarchical clustering method and it is suitable for dealing with huge sampledatabase.

(5) It is suitable for the discovery of the ball-like ones.

The K-Means algorithm has the advantages of fast clustering and easy realization. But there is a pre-fixed number k of the clusters. This condition has affected and the origin cluster is stochastic which may bring instability to the result. Hence it is of high value to improve the quality and stability in the cluster analysis.

III. BAYESIAN RULE

Bayesian rule is a method belonging to the statistics.They can forecast the rate of whether some target data belongs to some certain category. Bayesian rule makes a hypnosis that the of all attributes are independent from each other. This hypnosis is also be named as: independent, it helps to effectively reduce the calculation work when the Bayesian classification rule is found.The basic Bayesian classifier is described as the following. Suppose a variable quantity collection {A1,A2,...,An, C}. Among them, A1,A2,.,An is the variable attribute quantity in the practices. Bayesian

classifier The results of the study in comparing the classification methods show that the Bayesian classifier has the same function as neural net work. And in analyzing the large database, the Bayesian classifier has shown high conciseness and calculating function.The Bayesian classifier has the features as following:

(1) It doesn't assign an object to a certain category unconditionally. Instead, it works out the rate through calculation. The category which has the largest rate is the one that object belongs to.

(2) Commonly, all the attributes function invisibility. It means it not that several attributes that determine the classification but all the attributes.

(3) The attributes of the objects can be discrete, consecutive and mixed also. Compared to other classification methods, the Bayesian classifier has the lowest mistake rates.

A. Bayesian Theories

Suppose x to be a sample database whose belonging is unknown, Suppose H as a hypothesis, for example, sample database X belongs to a specific category C. As for the classification, our goal is to fix P(H|X)---fixing a observed sample database X and the rate when H is supposed to be right. P(H|X) is posterior probability which is the rate of the rightness of H under condition X. For example, Suppose the sample database is fruit, the attributes described are colors and shapes. Suppose X signifies red color and round shape, H is the hypothesis that X are apples. So P(H|X) presents the rate of the fact that X are apples when fruit X are known as red and round.To the contrary, P(H) is the priori probability, in the examples above, P(H) signifies the rates of the fact that the sample is apple no matter what color it is and what shape it is. P(H|X) is based on more information. While P(H) has no relation with X. Similarly, P(X|H) is the after-rate of the foundation of X under conditions H. Which means, if it is already known that H is apple, the rate of X being red and round can be signified as P(X|H). P(X) is the priori probability of X, which is also the rate of picking up a sample which is red and round from the collection. Bayesian rule describes how to work out the P(H|X) according to the P(X),P(H) and P(X|H). Among which, the rate of P(X),P(H) and P(X|H) can be get from the data collection.

B. The basic Bayesian classification procedure

(1) Every sample database uses n-dimension vectors to signify the specific number of its n attributes.

(2) Suppose there are m different categories, C1,C2....Cm .An unknown data sample X is given. The classifier, when X is known, predict the category which X most likely belongs to. Which is, when the basic Bayesian classifies the unknown sample X into category Ci, only when (1) is true.

$$P(C_i \mid X) > P(C_j \mid X) \qquad 1 \le j \le m, j \ne i \quad (1)$$

Which is also that $P(C \mid X)$ *i* is largest. The category *Ci* is called the supposition of the largest after-rate.

$$P(C_i \mid X) = P(X \mid C_i)P(C_i) / P(X) \qquad (2)$$

Suppose there are m different categories, c1 , c2,… *cm* . A sample database X whose category is still unknown is given (3).Since P(X) is the same to all the categories, it will be ok with the largest P(X/Ci)P(Ci) .And because that the pre-rate of each category is unknown, the occurrence rates of each categories are supposed to be the same, that is P(*C1*)=P(*C2*)=…=P(*mC*). This way, formula (2) chose the maximum then it turns out to seek the largest P(X|Ci),otherwise the largest P(X|Ci) and P(Ci) must be largest. While the pre-rate of the pre-rate can be estimated through using formula P(Ci)=si/s, the si is the number of the Ci category in the sample collection. S is the size of the training sample collection. (4) If according to the offered database which includes a few attributes, there will be quite a large amount of computation to work P(X|Ci) out directly. In order to estimate P(X|Ci) effectively, Bayesian classifier usually suppose that each category is independent from each other. Which means, the attribute values are independent.For a certain category, its attributes are independent of each other. There are :

$$P(x \mid C_i) = \prod_{j=1}^{n} P(x_j \mid C_i) \qquad (3)$$

Values of P(x1|Ci), P(x2| Ci),…,P(xn| Ci) can be estimated according to the training samples. Detailed explanation of the method is as followed:

If Ak is a symbol quantity, P(xk|Ci)=sik/si, sik is the sample's number when the category is Ci and Ak's value is vk. And it is also the sample's number which falls in the Ci category. If Ak is a consecutive quantity, and suppose the attributes are in line with Gaussian distribution property, hence there will be:

$$P(x_k \mid C_i) = g(x_k, \mu_{C_i}, \sigma_{C_i}) = \frac{1}{\sqrt{2\pi}\sigma_{C_i}} \exp\left(-\frac{(x_k - \mu_{C_i})^2}{2\sigma_{C_i}^2}\right) \qquad (4)$$

In order to predict the category of an unknown sample X,we can estimate the corresponding value of P(X|Ci)P(Ci).

Sample X will belong to category Ci, only when

$$P(C_i \mid X) > P(C_j \mid X) \qquad 1 \le j \le m, j \ne i \quad (5)$$

IV. CLUSTERING METHODS

In this paper we used the naïve bayes concept in clustering. With the assumption of K clusters, the objects are grouped based on the maximum posteriori probability. Theprocess of clustering starts with K clusters each with one object as a

member. Considering this as prior information, posteriori probability is computed for other objects, and the object is placed in the cluster with maximum posterior probability. The objects are read one by one and placed in the respective clusters.The proposed method is based on the concept of K-modes. Number of clusters and the initial set of modes are given as input. *K* distinct records are selected as initial values for *K* clusters.

Algorithm:

Input: Data set T, K-number of clusters.

i. Select K distinct records as initial objects for each cluster.

ii. Read the tuple X.

iii. Compute $P(C_i / X)$, $1 \le i \le K$.

iv. Place the object in the cluster which results in maximum

posteriori probability.

v. Repeat (ii) to (iv) until all the objects in the dataset have been placed.

V. SIMULATION

Computation method of K average and the integration of Bayesian classification integrationAs we all know, banks as the pillar of a nation's finance industry, a large amount of the interest comes from the banks' loan business. And the credit risk of the loaners make many money can't be repaid, we call this kind of money "bad money". Thus great lost will be caused to the bank. In order to prevent this lost from happening and lower banks' potential risk of de collection, we can use the data digging to make analysis of the old debt collection cases thus help banks do the credit rating. As a result, we can prohibit the come-intobeing of the bad money ahead. The paper is conducted against the background of banks' credit problems. Some practical examples will be cited to show how to use the new computation method which has combined the K average computation with Bayesian classification to deal with those data. The picture beyond represent the tabular form of dealing with the data.

Table 1.

Age	Income	Assets	Debts	Credit	Risk	On-time
40	24530	1324500	2567000	Red	High	1
33	358000	240500	2347600	Green	Low	1
25	54000	346500	7655700	Red	Medium	0
34	760030	568000	654000	Red	High	1
44	23500	436000	865000	Green	Low	1
58	75000	587000	349000	Red	High	0
28	42000	540000	563000	Green	Low	1
			|| || ||			

In order to improve the conciseness of Bayesian computation method, the data will be classified through K-means computation method. The conditions for the classification is shown as following :

Data classification:

Table 2.

Age	values	Debts	values
[20,30)	0	[0.25000)	0
[30,40)	1	[25000,50000)	1
[40,50)	2	[50000,100000)	2
[50,60)	3	[100000,200000)	3
[60,60+)	4	[200000,200000+)	4
Income	values	Want	values
[0,10000)	0	[0,3200)	0
[10000,50000)	1	[3200,6400)	1
[50000,90000)	2	[6400,9600)	2
[90000,130000)	3	[9600,12800)	3
[130000,130000+)	4	[12800,12800+)	4
Assets	values	Credit	values
[0,30000)	0	red	0
[30000,80000)	1	green	1
[80000,140000)	2	amber	2
[140000,270000)	3	Risk	values
[270000,270000+)	4	high	0
		medium	1
		low	2

Using the 500 data of more than 600 lines of data given as the modal, and the rest will only be used in authentication and modification. Using the former two lines of data as the central point, we will do the K average analysis one by one. The data will be classified into two categories after several times of repetition. For the sake of convenience, the ability conception is referred in this paper which equals the sum of income and assets, than minus debts. We can use the ability to pay as the criteria. We can conclude the table 3. Table3.

Age	Want	Credit	Risk	On-Time	Ability

24	1500	Red	High	1	34406

Finally, Bayesian computation will be conducted to every group of data, as the following icon shows:
P(On-time=1)=0.95
P(On-time=0)=0.04
P(Age=4|On-time=1)=0.05
P(Age=3|On-time=1)=0.09
P(Age=2|On-time=1)=0.25
P(Age=1|On-time=1)=0.59
P(Age=0|On-time=1)=0.01
P(Age=0|On-time=0)=0.08
P(Age=1|On-time=0)=0.67
P(Age=2|On-time=0)=0.08
P(Age=3|On-time=0)=0.08
P(Age=4|On-time=0)=0.08
P(Want=0|On-time=0)=0.83
P(Want=1|On-time=0)=0
P(Want=2|On-time=0)=0.17
P(Want=3|On-time=0)=0
P(Want=4|On-time=0)=0
P(Want=4|On-time=1)=0.004
P(Want=3|On-time=1)=0.03
P(Want=2|On-time=1)=0.07
P(Want=1|On-time=1)=0.17
P(Want=0|On-time=1)=0.72
P(credit=0|On-time=0)=0.25
P(credit=1|On-time=0)=0.25
P(credit=2|On-time=0)=0.5
P(credit=0|On-time=1)=0.1
P(credit=1|On-time=1)=0.61
P(credit=2|On-time=1)=0.28
P(Risk=0|On-time=0)=0.58
P(Risk=1|On-time=0)=0.08
P(Risk=2|On-time=0)=0.42
P(Risk=0|On-time=1)=0.14
P(Risk=1|On-time=1)=0.026
P(Risk=2|On-time=1)=0.83
P(Ability2Pay=0|On-time=0)=0.75
P(Ability2Pay=1|On-time=0)=0.25
P(Ability2Pay=1|On-time=1)= 0.86

The simulation of the established model is extremely necessary. This paper picked one data from the left data and used this model to confirm the correctness of this model. The results are shown as following.

P(On-time=1)=0.95
P(On-time=0)=0.04
P(Age=1|On-time=1)=0.59
P(Want=0|On-time=1)=0.72
P(Age=1|On-time=0)=0.67
P(Want=0|On-time=0)=0.83
P(Ability2Pay=0|On-time=1)=0.13
P(Ability2Pay=0|On-time=0)=0.75
P(Risk=2|On-time=1)=0.83
P(Risk=2|On-time=0)=0.42
P(credit=2|On-time=1) =0.28
P(credit=2|On-time=0)=0.5
P(X|On-time=1)=0.01
P(X|On-time=1)*P(On-time=1)=0.01
P(X|On-time=0)=0.09
P(X|On-time=0)*P(On-time=0)=0.004
We can conclude that the result of On-time is 1.

The upper right corner is the original value of the On time. While the final result is concluded using models. After computation, the conclusion is living up to our model. Which means that the model is feasible.

VI. CONCLUSION

On the bases of basic Bayesian classification, this paper raise the Bayesian classification model set up on the K average computation method. Its function and conciseness are better than the traditional basic Bayesian classification. While further consideration should be given to the matter whether it is better than other classification method. The bank credit rating system though comprehensive in functions and conveniences in operation, still has some problems in the details of its practical use. This is needed to be further solved.

REFERENCES

[1] M.Y.Kiang, A.Kumar, “A comparative analysis of an extended SOM network and K-means analysis”, International Journal of Knowledge-based and Intelligent Engineering Systems, IOS Pres, 2004, pp.9-15.

[2] Sergio M. Savaresi, Daniel L. Boley, “A comparative analysis on the bisecting K-means and the PDDP clustering algorithms”, Intelligent Data Analysis 8 (2004),pp.345-362.

[3] Hiroyuki Kashima, “An application of a minimax Bayesian rule and shrinkage estimators to the portofolio selection problem under the Bayesian approach”,Statistical Papers 46, 2005, pp. 523-540.

[4] Lili Liu, Andrew K. C. Wong, Yang Wang, “A global optimal algorithm for class-dependent discretization of continuous data”, Intelligent Data Analysis 8,2004, pp.151-170.

[5] Tian Xiaoguang, Kong Dejing, “The Application of Data Mining on Credit Card Issuing”, Science &Technology Information, No.5. 2008, pp.64-66.

[6]Ge Jike, Zhao Yongjin, Wang Zhenhua, Yu Jianqiao,“Application of Data Mining Technique to Personal Credit Evaluating Model”, Computer Technology and Development, Vol. 16, No.12, 2006, pp.172-177.

[7] Hua Bei, “Research on credit card approval models based on data mining technology”,Computer Engineering and Design, Vol.29, No.11,2008,pp.2989-2991.16

Flow Controlling of Access at Edge Routers

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***Abstract* - It is very important to allocate and manage resources for multimedia type of data traffic flows with real-time performance requirements in order to guarantee quality-of-service (QoS). In this paper, we develop a scalable architecture and an algorithm for access control of real-time flows. Since individual management of each traffic flow on each transit router can cause a fundamental scalability problem in both data and control planes, we consider that each flow is classified at the ingress router and data flow is aggregated according to the class inside the core network as in a DiffServ framework. In our approach, access decision is made for each flow at the edge routers, but it is scalable because per-flow states are not maintained and the access algorithm is simple. In the proposed access control scheme, an admissible bandwidth, which is defined as the maximum rate of a flow that can be accommodated additionally while satisfying the delay performance requirements for both existing and new flows, is calculated based on the available bandwidth measured by edge routers. The admissible bandwidth is a entry for access control, and thus, it is very important to accurately estimate the acceptable bandwidth. The performance of the proposed algorithm is evaluated by taking a set of simulation experiments using bursty traffic flows.**

Keywords - bandwidth, Traffic, edge-routers, routers, decision, multimedia, Quality of Service, framework, algorithm, domain.

I. INTRODUCTION

Although the capacity of core networks has increased tremendously due to advanced optical transmission equipments and high-speed routers/ethernet switches, quality-of-service (QoS) is not well guaranteed in the current P networks. Integrated Services (IntServ) is one of the approaches proposed to address this problem. While IntServ is capable of providing QoS within a domain, it is not scalable since every router is required to manage per-flow information.

On the other hand, DiffServ scales well since core routers treat not per-flow information, but only class-level traffic aggregate. There are two types of approaches for supporting QoS under DiffServ framework: reactive and preventive approaches. In the reactive approaches, QoS is supported by adaptively changing the source traffic load based on the network status. Resource is usually not reserved, but this reactive approach may not be directly applicable to the applications which do not change the traffic rate adaptively. Access control is a typical preventive approach. The traffic rate does not need to be adjusted adaptively in this case and we focus on this preventive approach. There are two important goals of access control algorithms. The first one is to guarantee the contracted QoS for real-time flows, and the other one is to achieve high network utilization. We propose a new access control scheme to achieve these goals. We consider delay as a QoS target because real-time flows are more sensitive to delay than loss. In our proposed access control scheme, each ingress router manages admissible bandwidth, which is a threshold for access control, for each relevant egress router. Access decision is made for each flow by comparing the peak rate of the flow with the admissible bandwidth. We derive a simple equation for admissible bandwidth considering the delay QoS based on the available bandwidth, which is estimated by the egress router through monitoring probing packets. our scheme can perform access control even for the requests arriving at the rate of up to the link rate. In addition, both edge and core routers need not manage any per flow state. Thus, our scheme is scalable in terms of both the number of flow requests and the number of flows.

II. RELATED WORKS

Access control algorithms for internet flows can be assified into two categories. The first one is a traffic-model based approach and the second one is a measurement based approach. In the traffic-model-based approach input traffic is usually mathematically modeled and access is determined based on the model. The accuracy of model based approaches depends on the reliability of the assumed source models. If we calculate the effective bandwidth just based on the parameters of long-range dependent traffic considering some QoS such as loss probability, the utilization of the bandwidth can be very low due to huge rate fluctuation. However, if we monitor the network status periodically, we can increase the bandwidth utilization by capturing the dynamic network status and allocating the resource accordingly. Measurement-based access control algorithms (MBACs) can achieve a much higher utilization than traffic-model-based algorithms while providing somewhat relaxed QoS.

We can classify the MBAC schemes into two categories depending on the location of access decision. First, access decision is made at ingress end hosts. The end host probes the network by sending probe packets at the data rate it wants to reserve and recording the resulting level of packet losses. The host then admits a flow only if the loss percentage is below some threshold value. This kind of access control is called as *endpoint access control*. Here routers keep no per-flow states and do not process reservation requests, and routers drop or mark packets in a normal manner. Thus, the endpoint access control avoids the scalability problem of per-flow state management at each router. However, probing inherently

involves a rather long set-up delay, on the order of seconds. In addition, probing overhead can cause a non-negligible problem especially when the network utilization is high. Endpoint access control has a scalability problem in terms of the number of flow requests. Second, access decision is made at network nodes. Several measurement-based access control algorithms belonging to this type have been proposed and our scheme also belongs to this category. Since it is difficult to predict future behavior accurately with traffic measurements, MBAC can lead to occasional violation of the contracted QoS.

III. SYSTEM ARCHITECTURE

Consider an autonomous system as depicted in Fig. 1. Routers A, E, F, G, and I are edge routers, and B, C, D, and H are core routers. Routers which provide interface to access networks are edge routers, and core routers do not operate as an interface. In the proposed architectural solution, an ingress router manages admissible bandwidth for the path to each relevant egress router. For example, Edge Router A manages admissible bandwidths for Egress Nodes E, F, G, and I, individually. Traffic arrivals at ingress routers of DiffServ domain are differentiated by the given QoS requirements. All arriving traffic with the same QoS requirements is treated as the same class.

Admissible bandwidth is managed separately according to the classes. Admissible bandwidth between a specific ingress/egress node pair is defined considering the level of services that can be provided. In this paper, we consider only delay bound violation probability as a QoS requirement. Let R'_j denote the admissible bandwidth for the j-th class between Ingress Router A and Egress Router E. Let d_j and ε_j be the delay bound and the threshold for the delay violation probability, respectively. $D_j(0)$ is a random variable representing the current end-to-end delay, and $D_j(R)$ is a random variable representing the end-to-end delay which the total traffic of class j experiences after admitting a flow with a rate of R. Then, the admissible bandwidth R'_j is defined by:

$$R'_j = \max\{R : P(D_j(R) > d_j) \leq \varepsilon_j\}.$$

Thus, R'_j is the maximum available bandwidth that can be supported additionally satisfying the delay constraint.

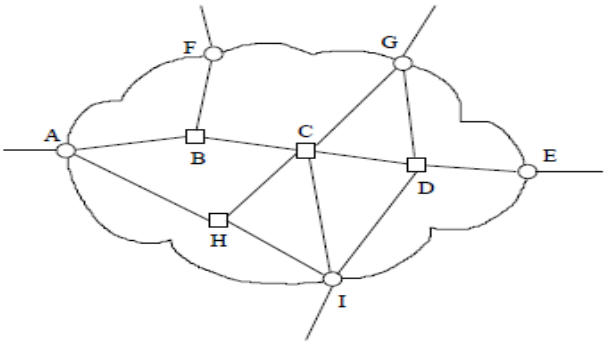

Fig. 1. Reference network model.

In order to support QoS for a new flow while guaranteeing the contracted QoS for the existing flows, a negotiation is needed between the network and a new end- point application.

The network determines whether to admit a new flow or not according to an access control policy/algorithm assuming that the user complies with the contract. The characteristics of the new flow should be included in the contract because the network cannot determine whether the required QoS will be satisfied or not if it does not know how much traffic will be offered by the new flow. Thus, we assume that the contract is made just based on the peak rate r_p of a flow. Peak rate r_p is the only traffic parameter used in our access algorithm, and we assume that each flow is policed so that the instantaneous traffic rate can be maintained less than or equal to the peak rate r_p. If the request from a new flow, which is destined to Router E and has a peak rate of r_p, arrives at Edge Router A, then Router A can accept the flow as the j-th class if the following condition is satisfied:

$$r_p < R'_j.$$

Then, the delay constraint can be satisfied for both the existing and the new traffic. Since the proposed access control algorithm is simple and ingress routers determine whether it accepts the new flow or not, access control can be performed very quickly for real-time flows. In this scheme, ingress routers need not calculate the admissible bandwidth whenever a new flow arrives. An ingress router sends probing packets to relevant egress routers to monitor the condition of each path, especially the available bandwidth for the path and calculates the admissible bandwidth $R'j$ for each ingress/egress node pair in advance.

IV. PRELIMINARIES

Before the access control scheme is proposed, we need to introduce an important concept of minimal backlogging, because this concept plays an important role in the proposed access control scheme. Calculation of the admissible bandwidth considering the delay QoS is the key problem in the proposed access control scheme. We need to distinguish available bandwidth from admissible bandwidth reflecting QoS. For example, we consider a queueing system with a First-Come-First-Served(FCFS) service policy. C and λ denote the service rate in bits per second and the arrival rate of data packets in packets per second, respectively. Let L'denote the average length of the packets. Then, for the queueing system, available bandwidth Ca is defined as $Ca = C(1 - \rho)$;where $\rho = \lambda L'/C$. This available bandwidth is the maximum spare service rate that the server can provide while maintaining stability of the system. In case of accepting a new flow with a rate of C_a, the desired QoS is usually not satisfied. Thus, the admissible bandwidth reflecting QoS is usually lower than the available bandwidth. However, we need to know the available bandwidth in order to obtain the admissible bandwidth. we proposed a probing scheme to estimate the available bandwidth of a single server. We briefly introduce the probing scheme and the available bandwidth estimation mechanism.

Definition 1: Suppose that we send probing packets into a queueing system so that there exists only one probing packet

in the system. This probing method is called a *minimal backlogging method*. If we send a new probing packet into a queueing system just at the departure time of the previous probing packet, then there exists only one probing packet in the system. In order to introduce an estimator for available bandwidth, we define available service as follows:

Definition 2: The available service $\tilde{Y}_{s,t}$ is the amount of probing packets served in a time interval $[s,t]$ when probing packets are sent to the queueing system according to the minimal-backlogging method. Suppose that the size of probing packets is fixed to L. Then, we obtain that for a $G/G/1$ queueing system,

$$\lim_{t\to\infty} E[\,|\, Y_{s,t}/(t-s) - C(1-\rho)\,|\,] = 0 \;;\; 0 < q < \infty :$$

Thus, the service rate of probing traffic is equal to the available bandwidth of the queueing system probed by the minimal backlogging method for an infinite duration, which implies that the service rate of minimally backlogging probing traffic can be used as an estimator of the available bandwidth.

V. ACCESS CONTROL SCHEME

As described in the previous sections, calculation of the admissible bandwidth is a crucial part of the proposed access control scheme. If the calculated value is larger than the real available capacity, then delay QoS may not be guaranteed due to excessive amount of input traffic. On the other hand, if the calculated value is smaller than the real capacity, the utilization of the network resource decreases. In order to evaluate the admissible bandwidth between a specific ingress/egress router pair, we derive a relation that predicts the delay distribution if a new flow with rate R is accepted. If the new delay distribution can be predicted, then the admissible bandwidth can be calculated. We also investigate a method to estimate the available bandwidth for a path between a given ingress/egress node pair by sending probing packets. We state a simple access control scheme and discuss the complexity and scalability issues of the proposed scheme.

A. Model

We assume that there are only two classes of flows in the core network. The first is the premium class in which all flows abide by their peak rate constraints and have delay QoS requirements. This is the only class that is subject to access control. The second is the best-effort class. Intermediate routers are assumed to give a strict priority to the premium class in managing two classes so that the delay of the premium class traffic is not affected by the best-effort traffic. Traffic is served according to the first-come-first-service (FCFS) policy in the same class. We model a network path from a specific ingress router to an egress router as a simple path which is a concatenation of a fixed delay component (D_f) and a virtual server S. In this model, the end-to-end delay of a packet De is decomposed as $D_e = D_f + D;$ where D is the delay experienced by the packet at the virtual server. Suppose that a probing packet p arrives at the path at time a_p and departs from the path at time d_p. Then, the packet arrives at S at time $a^s_p = a_p + D_f$. When the packet arrives at the destination node, it departs from both the path and the virtual server

B. Evaluation of Admissible Bandwidth

In this subsection, we propose how to evaluate the admissible bandwidth when we know the available bandwidth. The amount of input traffic to a network path can be treated as being continuous in high speed communication networks. We assume $X_{u,v}(X^e_{u,v}, X^n_{u,v})$ and $Y_{u,v}(Y^e_{u,v}, Y^n_{u,v})$ to be continuous in this subsection. Let D^n_t be the virtual delay of the new flow at time t. Since there is no priority between the existing flow and the new flow, the server treats the two traffic streams from the existing and new flows as if they come from the same flow. This implies that there is no difference in virtual delay at a given time no matter whether the virtual bit is of new flow or not. Thus, it follows: *Proposition 1:* Suppose that a new flow starts at time $t > 0$.Then, $D^n_t = D_t$, $t > t$: For the virtual server with the arriving traffic amounts of $X^e_{u,v}$ and $X^n_{u,v}$ and the service amounts of $Y^e_{u,v}$ and $Y^n_{u,v}$, if we focus only on the arrival and service traffic of the new flow, we can know that a virtual bit arriving at time t from the new flow can be served just after the traffic arriving from the new flow during the interval $[0,t]$, $X^n_{0,t}$, is served completely under the assumption that $X^n_{0,s}$ $(s>0)$ is increasing. Thus, D^n_t can be interchangeably expressed as $D^n_t = \min\{s : s\geq 0, X^n_{0,t} \leq Y^n_{0,t+s}\}$.

C. Estimation of Available Service

In this subsection, we describe how to estimate the parameters a and σ of the available service $\sim Y^n_{t,t}$ by using probing packets. We can obtain the value of $\sim Y^n_{t,t}$ if we can provide the minimally backlogging probing traffic exactly. However, this is not possible in real networks. Instead, we send the probing packets by the scheme, which enable the probing packets to be offered to the virtual server of the network path satisfying the minimal backlogging condition approximately.

D. Access Control Algorithm

Let's consider an access control algorithm for a specific ingress/egress router pair. The egress router calculates the lower bound of the admissible bandwidth R^* once every T seconds and sends it back to the ingress router. Then, the ingress router performs access control according to the algorithm described in Fig. 2. If the ingress router has not given access to any flow in the previous window, the ingress router admits the request of a new flow with a peak rate of r_p if the following condition is satisfied:

$r_p < R^* - r_s;$ where r_s is the sum of the peak rates of the flows admitted in the current window before the current request.

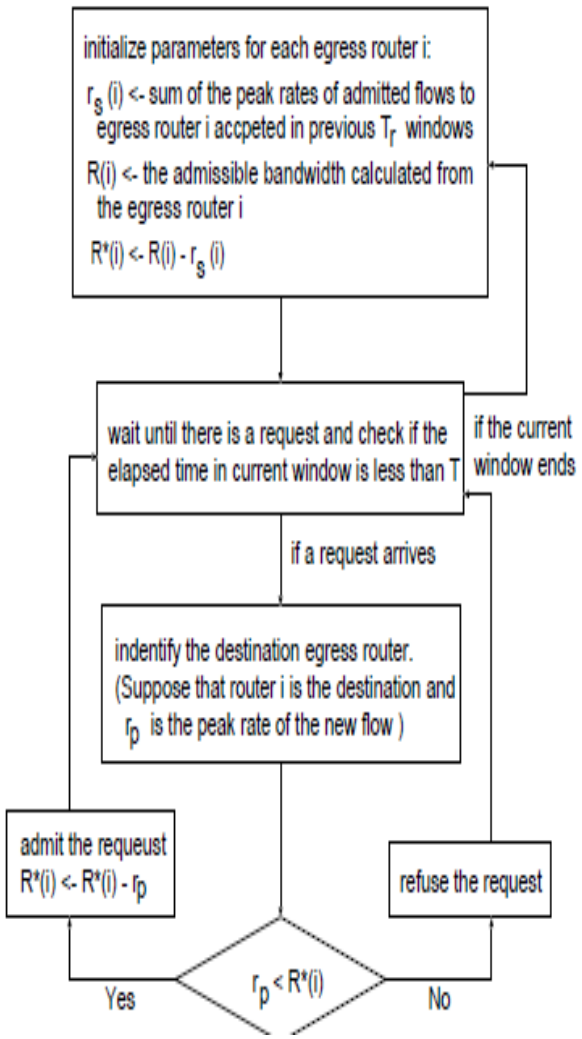

Fig. 2. Access control algorithm for an egress router *i*

E. Complexity and Scalability Issues

The admissible bandwidth is calculated and the access decision is made by just comparing the peak rate of the requesting flow with the admissible bandwidth. In addition, the admissible bandwidth is not calculated on demand, but it is calculated periodically in an interval of at least one second. Thus, the proposed scheme has a low complexity and can perform per-flow access control even at a high request arrival rate through high speed links. We now investigate scalability issues of the proposed access control scheme. Our scheme does not require per-flow state management or processing at the core routers except the class-level scheduling. The class-level scheduling, especially priority scheduling, can be implemented in the framework of DiffServ. Since even the edge routers do not manage per-flow states, our scheme is scalable in terms of the number of flows.

VI. CONCLUSION

In this paper, we proposed a new access control scheme. In the proposed scheme, access decision is made for each flow at the ingress routers, but it is scalable because per flow states are not managed and the access algorithm is simple. An ingress router manages the admissible bandwidth, which is a threshold for access control, for each relevant egress router. Since the admissible bandwidth is calculated considering the delay QoS, it is possible to guarantee the delay performance by the proposed access control scheme.

REFERENCES

[1] R. Branden, D. Clark, and S. Shenker, "Integrated services in the Internet architecture: an overview," IETF RFC 1633, June 1994.

[2] S. Blake, D. Black, M. Carlson, E. Davis, Z. Wang, and W. Weiss, "An architecture for differentiated services," IETF RFC 2475, Dec. 1998.

[3] A. Bose, M. E. Gendy, and K. G. Shin, "Sapphire: Statistical characterization and model-based adaptation of networked applications," *IEEE Trans. Parall. Distrib. Syst.*, vol. 17, no. 12, pp. 1512-1525, Dec. 2006.

[4] E. Lochin, L. Dairaine, and G. Jourjon, "gTFRC, a TCP friendly QoSaware rate control for DiffServ assured service," *Telecommunication Systems*, vol. 33, no. 1-3, pp. 3-21, Dec. 2006.

[5] S. Jamin, P. B. Danzig, S. J. Shenker, and L. Zhang, "A measurementbased access control algorithm for integrated services packet networks," *IEEE/ACM Trans. Netw.*, vol. 5, pp. 56-70, Feb. 1997.