Development of Web Apps for Users with Special Needs

Silviya Varbanova, Milena Stefanova, Tihomir Stefanov
Faculty of Mathematics and Informatics, St. Cyril and St. Methodius University, Veliko Tarnovo, Bulgaria

***Abstract*—This study presents software solutions and prototypes of converters designed to assist individuals who suffer from visual impairments or deafness. The prototypes were developed in a laboratory environment using modern programming technologies, with their applicability focused on contexts such as education, employment, and online shopping. The converter prototypes are designed to transform textual information into Braille or sign language, depending on users' needs. Other solutions facilitate auditory interpretation when working with assessment materials, thereby helping the sightless to access information more easily. The research methodology combines synthesis and analysis of existing information from related research works. The choice of programming technologies was carefully considered to ensure the implementation of more accessible functionalities in the developed applications. In the teaching process, the authors of the study motivate their students to develop programming and analytical skills. The results achieved are based on student project work in the design and implementation of software prototypes to assist users with hearing or visual impairments. The prototypes created are aligned with scenarios for use in education and everyday activities, which expand the practical relevance of the study. Importantly, the presented applications also benefit people without disabilities by promoting communication that is more effective and understanding in cases of visually or hearing impaired.**

***Keywords*—Braille; sign language; deafness; visually impaired; software prototypes**

I. Introduction

The mobility, communication, education, and employment of those with hearing or visual impairments are more challenging than those with no impairments. In the past, support for these activities was provided mainly through personal assistants or mechanical aids [1]. Today, however, electronic applications and computer software have significantly enhanced the independence of these users. Modern digital devices have made daily activities – such as navigation, shopping, and communication – progressively more accessible for people with different disabilities [2].

Users with hearing or visual impairments seek to minimize the limitations they encounter in everyday activities such as learning, shopping, and working. To improve existing solutions, many actively collaborate with scientists and developers as part of dedicated teams. In numerous cases, these users themselves propose innovative approaches and more accessible functionalities, directly contributing to the development of software products that better address their needs. Based on the research into the needs of specific user groups, they are now increasingly encouraged to use mobile and computer devices. The convenience that modern specialized applications developed for them offer is also significant. This significantly reduces the difficulties in taking in and passing on information when performing various activities [3].

One of the current challenges being addressed is finding effective solutions to increase the participation of students and workers with special needs. In practice, not all individuals with disabilities can attend specialized educational institutions and subsequently find professional fulfillment. A significant proportion instead study in mainstream educational institutions, where learning is made more accessible through the use of innovative modern technologies. Advancements in digital technologies are occurring at an unprecedented pace and have had a profound impact on education and professional development, including for people with special needs [4]. These technologies empower anyone who seeks to acquire knowledge and succeed in their chosen field.

For example, in the past, visually impaired individuals typically relied on Braille documents and specialized teaching aids for their education. Today, however, modern computers and mobile devices enable them to independently read and write texts in standard formats, beyond just Braille [5]. As a result, users gain greater confidence in accessing and understanding textual, graphical, and semantic information. This advancement is largely made possible by the availability of screen readers, speech synthesizers, and various conversion tools [6]. The development of assistive technology for those with visual impairment is predicted to continue, according to researchers [7]. The authors assert that this growth could have a substantial impact on people's lives in a way that was previously impossible. Since the final decade of the twentieth century, the development and dissemination of such software have played a crucial role in supporting visually impaired users. These software converters transform textual information displayed on a device screen into audio output, allowing blind or visually impaired individuals to listen to and comprehend written content, as well as to review and edit the text they produce themselves.

Software applications are being developed to support individuals with hearing impairments in their education and professional growth. Although the number of such applications remains limited relatively, notable progress has been made in recent years. Software converters can transform gesture-based information displayed on computer or mobile screens into textual content and vice versa [8].

Additionally, to facilitate communication between hearing-impaired individuals and those without hearing impairments, systems are being designed to recognize and translate sign language into audio output and, conversely, convert spoken language into sign language representations. These advancements contribute significantly to improving social interactions, educational opportunities, and professional development for people with hearing impairments [9].

Scientists are working towards the development and implementation of speech and sound visualization systems for people with hearing impairments. Detecting signal events is the main tool for improving the semantic perception of given information. For example, by using other senses to recognize information, such as visual, acoustic, and tactile [10].

Another significant issue for the hearing impaired is the correct perception of musical sounds so that they are not limited when learning or working with music, video or audio data [11]. Scientists are researching, analyzing and searching for more accessible techniques for this purpose. The problem is similar when working or studying with mathematical terminology in areas such as mathematics, physics, and economics [12]. Here, the correct use of sign language by learners and trainers is important. When used incorrectly, semantic errors inevitably occur. For this purpose, more and more analogues are being sought today for better techniques for practicing sign language in communication. The age limit of hearing-impaired users is also important here, which turns out to be a serious barrier.

Today, regional libraries, bookstores, educational institutions, and office centers are increasingly offering audio-electronic catalogs featuring both specialized literature and fiction. Additionally, multimedia video and audio presentation materials are often supplemented with subtitles, thereby partially improving information accessibility for hearing-impaired users.

The authors of this study are actively contributing to developments in this field. The content of the study is organized as follows: The Introduction section outlines the need for software solutions specifically designed for people with hearing impairments or visual disabilities. The Related Work section provides an overview and analysis of relevant articles connected to assistive technologies and software for users with hearing or visual impairments. The Methodology section describes the analysis and discussions conducted on the topic, along with the results of collaborative work involving students, academics and programmers. The Results section presents various projects developed through the phased implementation and testing of program code, highlighting software solutions created for these users. The Discussion section summarizes the main findings of the study and examines the challenges encountered by the authors. Finally, the Conclusion section offers a concise summary of the study's contributions and insights.

II. Related Work

The perception of information from the surroundings could be longer-lasting for individuals with special needs. Software is primarily designed for common users by developers, and people with hearing or vision impairments find it hard to use. Specialized applications have been developed for these user groups to read, hear, or understand graphical information.

For example, electronic readers for computer devices with built-in multilingual text synthesizers such as NVDA, JAWS, VoiceOver [13], [14]. Similar software applications are designed for the Windows OS and support browsers such as Mozilla Firefox and Google Chrome. Their use is associated with facilitating the work of the visually impaired with office programs, in converting text to braille, and in internet communication. According to available statistics, Fig. 1 presents some of the most commonly used text readers, by usage during the period. For each of the screen readers, advantages and disadvantages are reflected [15].

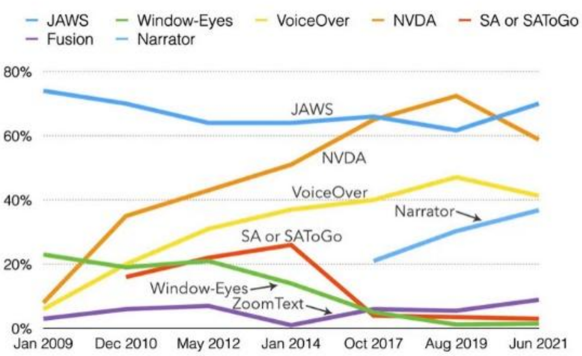

Fig. 1. Screen readers – popularity and usage.

When individuals with visual impairments use text-to-speech synthesizers, some of their built-in features may be difficult to access or not preferred by users. To address this, separate systems are being developed that are simpler to operate and do not require lengthy setup or installation processes. Another emerging trend aimed at helping blind users manage electronic messages more easily is the creation and deployment of systems such as 'talking email' [16], [17].

Currently, there are still relatively few online converters available for transforming text into braille (see Fig. 2) and vice versa [18]. The existing programs, however, are practical and favored by people with low vision who rely on them. One key advantage is that, with access to a Braille printer and suitable paper, the converted text can be printed. This allows visually impaired individuals who are proficient in Braille to independently read printed materials [18], [19].

The reverse process is also achievable through online tools. Braille characters are converted to text, which often has one specific drawback. When the text is converted, the result is displayed mostly in lowercase (Fig. 3, [20]). This problem is solved partially in the prototype described below in Task B1.

Individuals who are blind often encounter difficulties in perceiving typography and color layouts [21]. Although this issue remains an active area of research, efforts continue to identify better solutions. The challenge related to interpreting 2D tactile graphics and 3D models – particularly in fields that involve technical drawings – has been partially addressed through the development of innovative assistive devices. One such device incorporates a camera and plays pre-recorded audio descriptions when the user touches specific parts of a graphic or layout with their fingers. However, despite its potential benefits, this device is currently not widely accessible for personal use due to its high market cost [22].

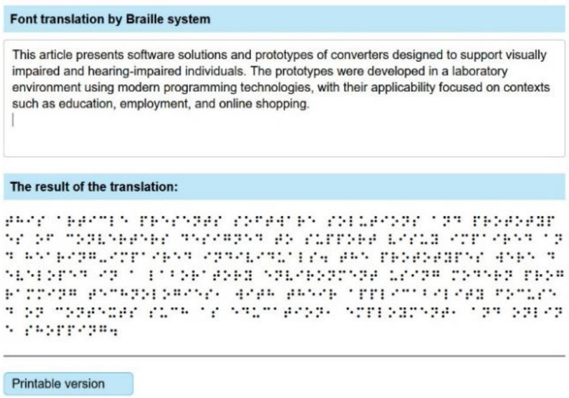

Fig. 2. Transforming text to Braille characters.

Fig. 3. Transforming Braille characters to text.

A significant challenge remains in the rapid conversion of auditory signals into forms accessible to people with hearing impairments. This issue is not limited to educational institutions, office buildings, or retail spaces, but also extends to vehicles. When there is a delay in responding to warning signals, the risk of accidents increases. The authors, who describe the creation of an application by using Tensor FlowLite, which reduces energy consumption and improves response time [23], present a specific advantage in this.

The focus is on exploring papers about assistive technologies supporting people with hearing or visual impairments. The application of these technologies in the education of these user groups is another important criterion in the selection process of the referenced related works.

The authors' interests in this area are influenced by the nature of their teaching activities. They aim to enhance the skills of their students in building web-based applications, while also developing their critical self-assessment and empathy towards the specific users for whom these applications are meant.

Table I provides a comparison of the study with similar ones and also highlight specific contributions related to educational activities.

TABLE I. COMPARISON OF THE PRESENTED CONTRIBUTIONS AND APPLICABILITY IN EDUCATIONAL ACTIVITIES

Survey	Contributions Described	
	In the Results Section	***Regarding Educational Activities***
Zhu et al., 2025 [4]	The important roles of accessible technologies in 'Blind Colleges', yet also reveal multiple practical challenges due to inaccessibility are highlighted.	The main contribution for HCI communities is raising awareness of the imbalance in educational technology by promoting the importance of their innovation.
Apu et al., 2021 [5]	The offered Refreshable Braille Translator converts text from various languages into Braille characters, enabling those with visual impairments to learn and read in digitally.	Yes, significant benefits in the field of education are presented.
Murthy et al., 2022 [6]	Various tools used for translating Braille documents to English text are evaluated by the authors, applying their work to single-sided Braille documents.	Applicable to individuals with visual impairments who use only Braille documents as a medium for education.
Da Silva Dessbesel et al., 2025 [12]	The findings indicate that teachers' understanding of sign language can have a significant impact on the teaching of mathematics in deaf education.	Yes. The study is examining the role of sign language in teaching and learning mathematics for deaf students.
Nethravathi et al., 2022 [23]	The present application system aims to identify potential daily objects in human surroundings and provide speech feedback to users about the objects around them.	Not specified. Suitable for everyday activities. The created application uses Tensor FlowLite, which enhances response time and requires low power, making it suitable for transferable apps.
Proposed	Several translators and converters are presented to transform information into facial gestures, Braille, audio, and vice versa, personalized to the users' specific needs, aiming to facilitate data perception and communicate.	Mostly prototypes that are developed during student training are described.

Based on research and discussions with visually impaired and hearing-impaired users, the authors of this study propose solutions for developing more accessible applications. Such projects can be implemented both within software companies and in educational institutions and research laboratories, to benefit people with visual or hearing impairments. In this context, practical solutions and projects are currently being developed within computer-oriented disciplines at the Faculty of Mathematics and Informatics at the University of Veliko Tarnovo. These projects primarily focus on creating embedded voice readers, converters that transform text into mimic or Braille information, and tools for facilitating the perception of images and multimedia content.

III. Methodology

The research involves studying various publications, as well as various software and applications, for the benefit of individuals with visual or hearing impairments. The methodology relies on the synthesis and analysis of existing information, as well as the identification of concepts from practice.

The information in this study is summarized on the basis of the collaborative work of faculty members from the University of Veliko Tarnovo and programmers. Based on the meetings, accessible functionalities in prototype software products were planned. In parallel, software application designs were designed and developed in a laboratory environment. Advanced programming techniques and web technologies were used to design the reviewed prototypes. The prototypes were primarily made for individuals who have hearing or visual impairments.

The authors of the study aim to highlight the need for projects and digital applications that support people with hearing or visual impairments, helping them adapt more effectively in both work and education. Their goal is to encourage young professionals and individuals with these impairments to collaborate on developing practical solutions. By involving not only researchers and developers but also IT educators and students, the authors hope to create effective tools to reduce barriers in communication, learning, and employment for people with visual or hearing challenges.

In the Faculty of Mathematics and Informatics, undergraduate and graduate students develop software projects in a variety of subjects, often forming working teams. They actively participate in developing prototypes of electronic applications and web pages. Through their expertise, they help address and mitigate some of the challenges faced by people with disabilities. These applications were created during seminar classes in core disciplines and tested in real-world environments. For the practical implementation of the coding aspects of the projects, modern technologies were employed, including markup and stylesheet languages for adaptive design, scripting languages, frameworks, databases, and high-level programming languages.

IV. Results

This section presents software projects and prototypes designed to assist users with hearing or vision impairments, which were implemented during the training of students in core programming disciplines. Developed in a laboratory environment, the projects were tested using modern software testing tools. Some of the projects require the development of software for working with scientific and literary texts. The implementation of other prototypes in the computer technology field is aimed at conducting training tests. Others are in the field of online shopping.

The tasks and projects below, which are grouped into three categories, have been implemented and tested in a laboratory environment. For each prototype, the minimum requirements and implementation criteria have been defined beforehand.

A. Projects for the Benefit of Hearing-Impaired Users

As part of their training in core disciplines, student teams also focus on addressing the challenges faced by people with hearing impairments when using software products. Since these users have limited or no ability to hear, solutions that convert speech into text information – or even into facial gestures – can significantly enhance their user experience. Such projects aim to improve accessibility and inclusivity by enabling hearing-impaired users to interact more effectively with digital applications.

Task A1. To implement a web application for converting facial gestures into Cyrillic and vice versa.

Minimum functional requirements:

- Visual interpretation of the text converted into gestures (see Fig. 4), represented by the corresponding images [24].

The team is currently working on projects to implement computer games for users with impaired vision or hearing.

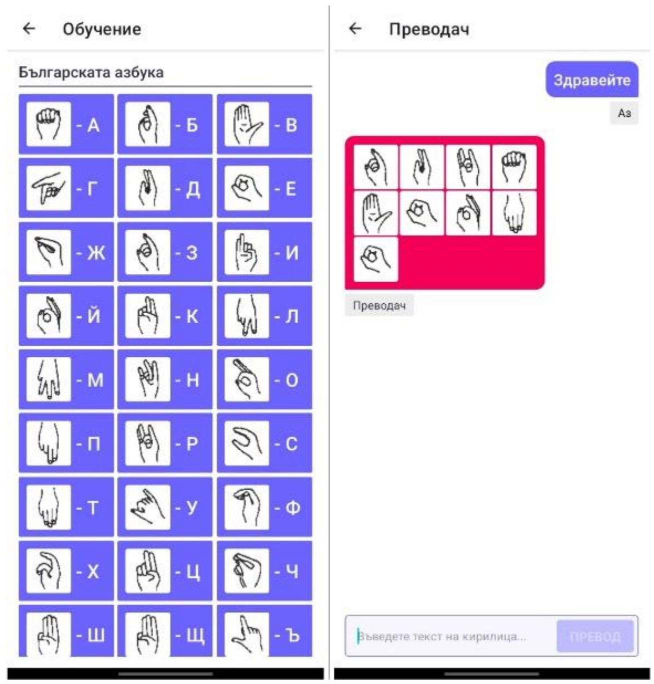

Fig. 4. Screens for visualizing gestures for letters and expressions in Bulgarian.

B. Projects that Meet the Needs of Visually Impaired Users

Task B1. To implement a prototype text-to-speech converter.

After entering a random string, the converter must satisfy the following minimum functional requirements for the final product:

- Count of characters entered, presented by a number;
- Convert text by capitalizing the first letter of each word;
- Splitting the text into paragraphs, which is particularly useful for essays, course projects or theses.

The program implements text recognition from various spoken languages, allowing for an unlimited amount of text to be entered into the field. A web visualization in Fig. 5 shows a specific instance of how the text converter works, with simplified navigation and an input field. Part of the programming code for capitalizing text is presented in Fig. 6.

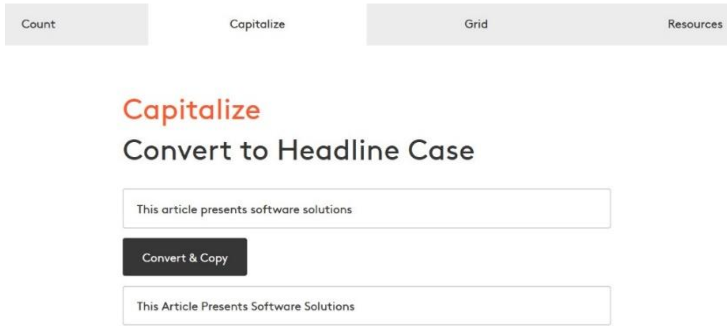

Fig. 5. Web visualization of text converter.

```
<div class="container main">
  <div class="row header">
    <div class="col-sm-8 col-sm-offset-2">
        <h1 class="large">Capitalize</h1>
        <div class="desc">Convert to Headline Case</div>
    </div>
  </div>
  <div class="row">
    <form id="tester" action class="col-sm-8 col-sm-offset-2">
      <input id="untitled" class="input" type="text" placeholder="Paste/type your text here...">
      <!-- <button type="submit1" class="submit" value="Convert">Convert</button> -->
      <button id="copyButton" type="submit2" class="submit">Convert & Copy</button>
      <input id="titled" class="input" type="text">
      <p id="confirmation" class="cap-note">Text has been copied to your clipboard.</p>
    </form>
  </div>
</div>
```

Fig. 6. Text converter – code snippet of realized functionality.

Task B2. To design and develop a text-to-speech converter.

Minimum functional requirements – for randomly entered text, the software solution should allow users to do independently:

- Start hearing the text readings aloud by selecting a button;
- Stop the playback/listening of the text by pressing a button.

Additional convenience of the program implementation offers users the opportunity to work in other windows on other tasks, while at the same time they can listen to the voice reader. The prototype being developed does not need a web version. The JavaScript fragment code for an example implementation of this task can be seen in Fig. 7.

Task B3. To implement a sample test in the discipline Web Technologies with audio recognition.

Functional requirements:

- Convenient interface – presence of buttons, designed for the user to independently move to the next page or question;
- Voice playback of the question, as well as the possible answers;
- Calculation and display of the final result – after filling in the answers.

The test's programmatic implementation can vary depending on whether each question with possible answers is presented on a separate page or not.

If the questions are displayed on distinct pages, there are still possibilities for the final prototype. Case 1: when starting the test, from the current page, each question should be played out in voice in advance, as well as the possible answer options. The user is given no limit on the time they have to choose a response. Clicking on a button takes the user to the next page after indicating their answer (see Fig. 8).

By selecting the answer to the last question, the result of the Test is automatically displayed which is realized with program code shown on Fig. 9.

```
/* Stop speaking */
const stopSpeaking = () => {
    synth.cancel();
    stopButton.disabled = true;
    speakButton.disabled = false;    };

/* Provide voice feedback for button hover */
const speakHint = (message) => {
    const hint = new SpeechSynthesisUtterance(message);
    hint.voice = synth.getVoices()[0];
    hint.rate = 1;
    hint.pitch = 1;
    synth.speak(hint);
};

/* Announce current slider value */
const announceRangeValue = (type, value) => {
    const message = `${type} is set to ${value}`;
    const utterance = new SpeechSynthesisUtterance(message);
    utterance.voice = synth.getVoices()[0];
    utterance.rate = 1;
    utterance.pitch = 1;
    synth.speak(utterance);     };

/* Announce limit when sliders reach min or max */
const announceLimit = (type, value, min, max) => {
    if (value == min) {
        speakHint(`${type} is at minimum`);
    } else if (value == max) {
        speakHint(`${type} is at maximum`);
    }      };
```

Fig. 7. Text-to-speech converter – JavaScript fragment code.

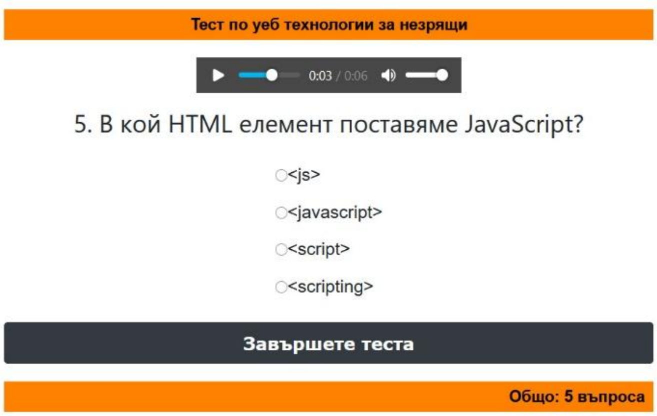

Fig. 8. Preview of the last question in the test for Case 1.

```
<form class="questionForm" id="q5" data-question="5">
    <audio controls>
        <source src="audio/въпрос5.mp3" type="audio/mp3">
    </audio>
    <h3 title="5. В кой HTML елемент поставяме JavaScript?">5. В кой HTML елемент поставяме JavaScript?</h3>
    <ul class="main-ul-list">
        <li class="5-1" title="js"><label><input type="radio" name="q5" value="a" alt="js"/>&lt;js&gt;</label></li>
        <li class="5-2" title="javascript" ><label><input type="radio" name="q5" value="b" alt="javascript" />&lt;javascript&gt;</label></li>
        <li class="5-3" title="script"><label><input type="radio" name="q5" value="c" alt="script"/>&lt;script&gt; </label></li>
        <li class="5-4" title="scripting"><label><input type="radio" name="q5" value="d" alt="scripting"/>&lt;scripting&gt;</label></li>
    </ul>
    <button id="submit" class="btn btn-dark btn-lg btn-block" title="Завършете теста">Завършете теста</button>
        <audio preload="auto" id="5-1"class="d-none">
        <source src="audio/5-1.mp3" controls></source>
    </audio>
    <audio  preload="auto" id="5-2" class="d-none">
        <source src="audio/5-2.mp3" controls></source>
    </audio>
    <audio  preload="auto" id="5-3" class="d-none">
        <source src="audio/5-3.mp3" controls></source>
    </audio>
    <audio preload="auto"  id="5-4" class="d-none">
        <source src="audio/5-4.mp3" controls></source>
    </audio>
</form>
```

Fig. 9. Program code to display test result for Case 1.

Case 2: when starting the test, a voice is heard playing the specific question. Then, when the mouse is moved over each answer, it is spoken accordingly. In this way, the user has the opportunity to indicate an answer that he or she judges to be correct, after careful consideration and repeated listening to the choices. Users move self-directed to the next page. The result of the test is calculated and displayed only after the last question is answered and the 'Finish quiz' button is clicked (see Fig. 10 and Fig. 11).

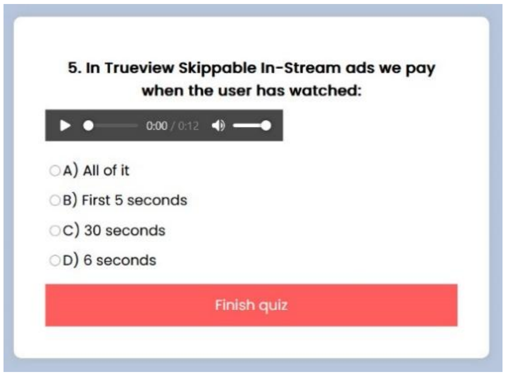

Fig. 10. Preview of the quiz question in Case 2.

```
<form class="questionForm" id="q5" data-question="5">
    <h3>5. In Trueview Skippable In-Stream ads we pay when the user has watched:</h3>
    <audio controls>
        <source src="question5.mp3" type="audio/mp3">
    </audio>
    <ul>
        <li><input type="radio" name="q5" value="a" />A) All of it</li>
        <li><input type="radio" name="q5" value="b" />B) First 5 seconds</li>
        <li><input type="radio" name="q5" value="c" />C) 30 seconds</li>
        <li><input type="radio" name="q5" value="d" />D) 6 seconds</li>
    </ul>
    <button id="submit">Finish quiz</button>
</form>
```

Fig. 11. Fragment of the program code for Case 2.

If the test questions and their possible answers are presented on a single page, the program can guide users through the following process: all questions, along with the answer options, should be read aloud using text-to-speech functionality. Users would then select their answers with voice assistance or other accessible input methods. After completing the selection, users can press a designated button to calculate and display the results. Fig. 12 below shows an example of the code used to check the correctness of the answers, implemented with JavaScript-based technologies.

```
function checkAnswer(q){
    if(q=="q1"){
        var submitted=$('input[name=q1]:checked').val();
        if(submitted==sessionStorage.a1){
            score++;}}
    if(q=="q2"){
        var submitted=$('input[name=q2]:checked').val();
        if(submitted==sessionStorage.a2){
            score++;}}
    if(q=="q3"){
        var submitted=$('input[name=q3]:checked').val();
        if(submitted==sessionStorage.a3){
            score++;}}
    if(q=="q4"){
        var submitted=$('input[name=q4]:checked').val();
        if(submitted==sessionStorage.a4){
            score++;}}
    if(q=="q5"){
        var submitted=$('input[name=q5]:checked').val();
        if(submitted==sessionStorage.a5){
            score++;}
        $('#results').html('<h3>You answered '+score+'/5 questions correctly.</h3>
        <a href="index.html">Reload Quiz</a>');}
    return false;
}
window.addEventListener('load',setAnswers,false);
```

Fig. 12. JavaScript code to check answers in case all questions are on one page.

C. *Projects for the Benefit of Users with Impaired Hearing or Vision*

Task C1. To implement an adaptive version of an online store for mobile devices.

Functional requirements:

- Easy access to the navigation menu (see Fig. 13);
- Voice playback of a description or functionality for an element (image or text) in the online store – when hovering over this element with the mouse;
- The included multimedia elements should also be adapted for people with hearing impairments.

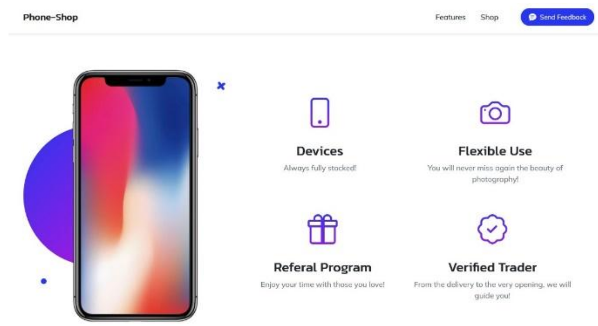

Fig. 13. Online store home screen preview on desktop version.

Below are selected prototypes of student projects, developed in laboratory settings and tested in real-world environments.

Project one. Specialized test for the level of HTML proficiency, aimed at users with hearing or vision impairment.

A specialized test has been developed for the benefit of people with hearing impairment. Each of the questions is on a separate page and has four answers. After selecting an answer, the participant is automatically taken to the next page.

As a final result of the Test, a report of accuracy is generated, combined with a bright color scheme that hearing-impaired users can see. The result is also presented as a voice report/message with audio layout for correct or incorrect answer – for visually impaired users. The text part of the Test is in Bulgarian, and it is possible to translate it into other languages. The following Fig. 14 shows the result of the indicated answers to two of the questions in the test, respectively – for correct or incorrect answer.

Project two. A Web Design test for the benefit of users with hearing or visual impairments.

A similar test to the ones presented in the study above has been developed, but with a different design. Each of the questions is on a new page and is read with a voice embedded reader. Users have a choice of three possible answers. As a result of taking the Test, a text message or an audio signal is generated indicating truth or falsity. The text part of the Test is in English (see Fig. 15), and the program code fragment is shown in Fig. 16.

(a)

```
<body>
    <h1 class="entry" data-entry="">НАЧАЛО НА ТЕСТ</h1>
    <div class="test-wrapper hidden" data-test="wrapper">
        <p data-test="question"></p>
        <div class="option-answers" data-test="answers">
          <input type="radio" id="answer1" name="answer">
          <label for="answer1"></label><br>
          <input type="radio" id="answer2" name="answer">
          <label for="answer2"></label><br>
          <input type="radio" id="answer3" name="answer">
          <label for="answer3"></label><br>
          <input type="radio" id="answer4" name="answer">
          <label for="answer4"></label>
        </div>
        <input type="hidden" data-test="correct-answer">
    </div>
    <div class="answer-state" data-answer="state">
    </div>
    <span class="answer-state-bg hidden" data-answer="state-bg"></span>
    <div class="final-results-wrap hidden" data-answer="final">
      <span class="final-results"></span>
      <a href="javascript:void(0)" data-test="retake">Опитай пак</a>
    </div>
</body>
```

(b)

Fig. 14. Project one: (a) Answer options; (b) Part of the program code.

Fig. 15. Project two – version of answers.

```
<audio id="startsound">
  <source src="assets/audio/start.mp3" />
</audio>

<script type="text/javascript">
                    var callTimeout = function () {
                            setTimeout("location.href = 'test.html';",1500);
                    }
                    window.onload=function() {
                            const mySound = document.getElementById("startsound");
                            const startButton = document.getElementById("startb");
                            startButton.addEventListener("click", function() {
                                    mySound.play();
                            })
                    }
</script>
```

Fig. 16. Project two – program code fragment.

We believe that the implementation of the tasks set in this way has helped to improve the knowledge and practical skills of the students both in programming and in more successful communication in their contacts with people with hearing or vision problems.

V. Discussion

The rapid development of technology today is transforming and being applied across all areas of society. Despite this progress, significant limitations remain for people with special needs. There is a pressing need for appropriate technologies and software applications to support visually and hearing-impaired individuals in both education and employment.

For some, the process of perceiving and processing information can be time-consuming and challenging. Moreover, not all individuals have the opportunity to study in specialized institutions or resource centers staffed by experienced teachers and researchers. Securing permanent employment is also often a lengthy and difficult journey. Contributing to these challenges are various barriers, including financial constraints, geographical distance, transportation difficulties, family responsibilities, and other personal or societal factors.

This study describes working solutions for a more accessible perception of text or audio information for people with visual or hearing difficulties. The prototypes are mainly intended for training, work, or communication with individuals without disabilities. These activities are significantly facilitated by the availability of modern computer devices and web applications. Thus, the visually-impaired and the hearing-disadvantaged adapt better to society and communicate more easily. Ordinary users could understand the reverse process of converting Braille or mimicking information into text or audio through the few existing software converters.

Individuals with visual impairments and partially sighted individuals often have trouble understanding multimedia information. When it comes to studying or applying for a job online, for instance. It is common for the websites for these activities to be not fully accessible to text-to-speech software in many cases. The issue is significant, and to reduce it, teams are incorporating web developers who are visually impaired, scientists, or people with hearing impairments.

The results of this study can be summarized in several key areas corresponding to the main stages of the work process. Fig. 17 shows a high-level diagram of the overall study. The primary stages involve designing the tasks and functionalities of the prototypes created by students. As a result of critical analysis and in an effort to overcome identified gaps, ideas for the team's future work are determined.

In future research, the author's team will focus on specialized empirical studies, similar to those presented in [25], [26], with teams of students participating in the development of software applications for the studied group of users. In future developments, the authors plan to focus on improving voice control functionality for users with visual impairments. For the benefit of users with color blindness, the team's efforts will be directed at improving the adaptive design for color layout. This would also limit the problems for users with color blindness when using control buttons and navigating in applications. Another issue that will be addressed in future research is related to functionalities for users with motor delays, aimed at working without using a computer mouse.

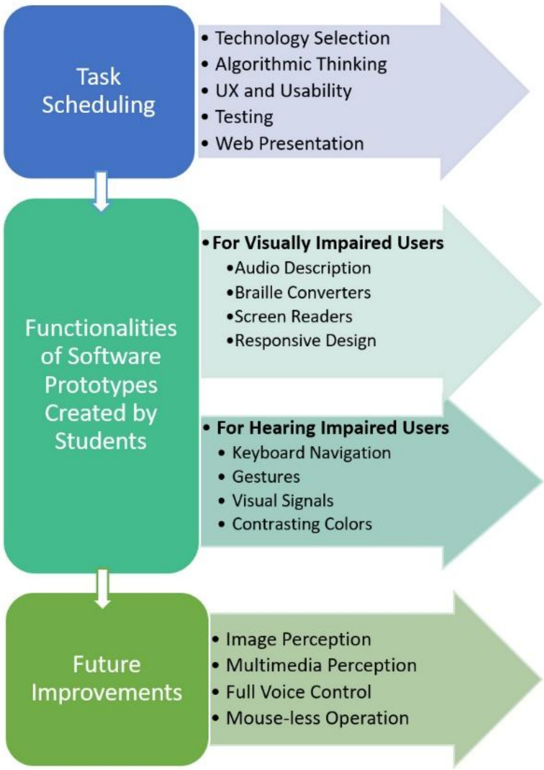

Fig. 17. Flowchart of the research workflow.

An important problem that is being worked on is the inability to accurately perceive images, graphics, or video data by people with 100% blindness or deafness. Currently, there is no standard technology that permits the perception of images, diagrams, or video data through hearing or sight alone. Software applications are still unable to accurately 'describe' the meaning/semantics of a given image or video. The SnapStick authors in this direction are making significant progress [26]. The SnapStick application, approbated by Shafique et al. (2025), enables the description of images of people, interiors, or outdoor environments. The authors evaluate the software using the System Usability Scale (SUS) methodology, focusing on completeness, accuracy, relevance, consistency, and photographs' details. They demonstrate that the application successfully handles object description from a photograph, even recognizing different human emotions from images of people [26]. However, usually in the content of web pages that include images, screen readers or speech synthesizers pronounce them as 'picture', or read out the text set by the developers in the 'alt' / 'title' attributes in the code part. Only with the help of another person – an assistant, can the visual information of a visually impaired person be described. In many cases, an accurate or complete description is impossible.

Another significant obstacle that people with low vision face is when using online shopping sites. For example, when specifying an address and delivery date, the inability to ignore advertising banners or to view images.

Nowadays, work is also being done on the reverse process – to generate an image from a description. For this purpose, AI-based image-to-text generators are used [27].

VI. Conclusions

This study aims to promote current applications and software designed for groups of users with impaired vision or hearing. Working prototypes and solutions are offered that support the work and training of people with disabilities, as well as their ability to better communicate and socialize in society. For people with hearing impairments, auditory information is not fully accessible; they have difficulty perceiving spoken communication. Instead, they rely more on visual information and sign language. Conversely, people with visual impairments face difficulties in accessing visual content. To address this, various translators and converters have been created to transform information into Braille, facial gestures, audio, and vice versa – tailored to the user's specific needs. This facilitates communication and data perception. Nowadays, every user aims to get the required information with as few mouse clicks as possible. This is especially relevant for users with special needs. For them, it would be beneficial to reduce clicks to a minimum, as is the case for people without disabilities. The software prototypes presented are notable for this key feature, and this is one of the contributions to the development. Screen readers and Braille to text converters are being developed for visually impaired users to make them easier to use via computer and mobile devices.

To improve quality of life and facilitate social inclusion, scientists from various fields continue to explore better solutions for people with hearing or visual impairments. We will continue the studies in this area in future academic activities with our students. Based on thorough analysis, research, and identified needs, new functionalities and software solutions are being developed to create more accessible products for diverse users. By understanding the challenges faced by these users, programmers, researchers, and educators continuously refine and enhance these specialized products. The prototypes incorporate features such as speech output and text descriptions, making software interfaces easier to navigate. The focus of the study is on designing and implementing assistive software prototypes, particularly through student-focused projects. Various scenarios for application in education, employment, and everyday activities are outlined, which expand the practical significance of the research.

A widespread application of Artificial Intelligence and the Internet of Things is anticipated in the design and development of electronic devices and applications in the near future. This trend is expected to drive the creation and enhancement of increasingly sophisticated solutions that benefit users with hearing or visual impairments.

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