Conjugate Symmetric Data Transmission Control Method based on Machine Learning

Yao Wang
Chongqing City Vocational College, College of Creative Design,
Chongqing, 402160, China

***Abstract*—In conjugate symmetric data transmission, due to insufficient judgment of congestion during transmission, the amount of data is large and the transmission rate is low. In order to improve the data transmission rate, a conjugate symmetric data transmission control method based on machine learning is designed. Firstly, the data to be transmitted is tracked and determined, and then conjugate symmetric data fusion is completed according to the calculation result of the best tracking signal. According to the fusion results, the framework of the conjugate symmetric data coding system is established, and the data coding is completed. The average congestion mark value is calculated by the machine learning method, and the congestion judgment of data transmission is completed. On the basis of congestion determination, the efficient transmission control of conjugate symmetric data is realized by specifying the conjugate symmetric data transmission protocol. Experimental results show that compared with traditional control methods, this control method has the advantages of a high delivery rate, low message transmission overhead and low data transmission delay. Compared to the traditional two-way path model, the scheduling method proposed in this study increases the transmission delivery rate by 5%, while reducing the transmission cost and delay by 0.7 cost index and 1.1 min delay, respectively. In comparison with the performance of accurate error tracking equalization, the transmission delivery rate of the research method increased by 21%, and in transmission cost index and delay analysis, it also decreased by 3.1 and 2.9 minutes. Based on the above performance comparison analysis, it can be concluded that the machine learning method has more superior transmission control performance.**

Keywords*—Machine learning; conjugate symmetric data; transmission control; data coding; transmission delivery rate

I. Introduction

In the transmission process of conjugate symmetric data, the energy and storage resources of data nodes are limited, and the mobility of nodes and other practical application conditions are limited. At the same time, most of the nodes in the data transmission channel are in motion, and their physical positions often change. The data transmission link is not a very reliable wireless connection, which will also increase the difficulty of conjugate data transmission [1]. Due to the limited communication distance, low connection bandwidth, insufficient energy resources of nodes and other factors, the network connection is frequently interrupted, which cannot guarantee a constant end-to-end connection, which increases the difficulty of conjugate data transmission. At present, the research on data transmission control methods mainly includes two methods, one is based on the two-way path data transmission congestion control method, and the other is based on accurate error tracking equalization data transmission control method.

The congestion control method of data transmission based on a bidirectional path is mainly based on conjugate symmetric data transmission protocol. The congestion control mechanism can well avoid data loss caused by congestion. In this method, the connection is established through three handshakes, and then the congestion control algorithm is started. The application layer data is divided into data packets which are transmitted to the opposite end one by one. Each packet is composed of a byte sequence number and a message size, both of which are little in size. Each time the receiving terminal receives a data message, it will generate a corresponding response message to control the data transmission [2]. The data transmission control method is based on precise error tracking equalization, by constructing the historical record tracking process, adopting the way of threshold control to equalize the sensor data, and reducing the cost of fusion. Then the recursive flow is constructed to control the data transmission by packet tracking [3]. However, due to the large number of conjugate symmetric data that need to be transmitted at present, there are some problems such as transmission delay, low delivery rate and high transmission cost. Yi LA et al. used artificial bee colony algorithm to obtain the shortest path analysis of each cluster head node in the transmission of the Internet of Things. Experiments have shown that this algorithm can effectively reduce the amount of data that sensor nodes transmit to the sink through cluster head node fusion, improve data collection efficiency, energy consumption balance, and network reliability, and extend the network life cycle [4]. Mu et al. reconstructed routing problems such as the limitations of routing protocols under the condition of rapid data growth into a Markov decision process, combining deep reinforcement learning to solve the high blocking probability problem caused by increased data volume. Experiments show that this method can significantly reduce the probability of data congestion and improve network throughput [5]. In order to fully utilize multi-channel video transmission, Li H et al. proposed a joint optimization method for conversational high-definition video services, taking into account the connection between video coding and transmission. Experiments show that this method is superior to existing schemes in terms of data transmission and playback quality [6]. Pyeon D et al. proposed an efficient multipath pipeline transmission (EMP) to support low latency and high energy efficiency large data transmission under various network conditions. Experiments have shown that EMP outperforms existing protocols in terms of transmission time and energy efficiency, and can maintain improved EMP performance regardless of network environment (such as link quality, hop count, and network density) [7]. WANG Zhan Yu et al. designed a distributed communication platform based on P2P network technology to achieve concurrent path transmission on the internet. Experiments have shown that the effectiveness of this method has been verified by actual experiments on a simulation platform [8].

Therefore, a control method of conjugate symmetric data transmission based on machine learning is designed. Machine learning is an interdisciplinary subject, involving probability theory, statistics, approximation theory, convex analysis, algorithm complexity theory and other disciplines. The purpose of this paper is to study how a computer can simulate or realize human learning behavior, acquire new knowledge or skills, and reorganize the existing knowledge structure to improve its performance. Therefore, machine learning is applied to the transmission control of conjugate symmetric data. The conjugate symmetric data is used to provide some information to the learning part of the machine learning system. The machine learning part uses this information to modify the knowledge base, so as to improve the performance of the executive part of the system to complete the task. Firstly, the conjugate symmetric data are tracked, confirmed and fused, and the conjugate symmetric data coding architecture is constructed to code the data. Then, the data transmission congestion value is calculated by the machine learning method, which realizes the accurate judgment of data transmission congestion and provides the basis for the high-speed transmission of conjugate symmetric data. By formulating a conjugate symmetric data transmission protocol, the transmission control of conjugate symmetric data is realized, and the data loss caused by congestion is avoided.

This study conducted performance analysis experiments on delivery rate, transmission cost, and transmission delay for the constructed model. Firstly, the delivery rate compares the machine learning method used in this study with the traditional two-way path method and the accurate error tracking and balancing method. In the experiment, the model built in this study was in the delivery rate range of 0.76-0.83 after 6400 simulations, while the delivery rate of two-way paths was in the range of 0.77-0.71. Traditional accurate error tracking and balancing methods have the worst effect, with the highest delivery rate of only 0.52. In the second step of the experiment, the transmission cost was compared, and machine learning methods were also compared with traditional two-way path methods, as well as accurate error tracking and balancing methods. The results show that the cost index of the machine learning method is stable below 1.4, lower than other models. Finally, in the performance analysis of transmission delay, the delay of the machine learning method is controlled below 1.3 minutes, which is lower than other models. The experimental results can prove that the machine learning conjugate symmetric data transmission model constructed in this study has good transmission delivery rates, as well as excellent features such as low latency and low cost. The main purpose of this time is to provide a high-performance transmission scheduling control method for conjugate symmetric links of big data transmission. The proposed conjugate symmetric data transmission scheduling algorithm based on machine learning calculates data transmission congestion values, achieving accurate judgment of data transmission congestion. Therefore, the main contribution of this method is to simultaneously reduce information loss during transmission and increase the performance of transmitted information.

II. Conjugate Symmetric Data Fusion

Before controlling the transmission of the conjugate symmetric data, the conjugate symmetric data to be transmitted is first tracked and confirmed, because the signal strength of the conjugate symmetric data and the strength distribution proportion between the corresponding nodes need to be considered comprehensively in the node tracking. The tracking signal strength of the whole network node has a strong correlation proportion with the communication distance of the node. Therefore, by comprehensively judging the energy threshold and recursively measuring the threshold based on the intensity value, the best tracking signal can be obtained from the signal strength of other nodes. Therefore, the initial tracking of the node can be realized in this way. Assuming that the conjugate symmetric data to be transmitted is q, the preliminary tracking formula is as follows:

$$q = \frac{r}{W} / i \qquad (1)$$

In the formula, W is the joint quadratic probability function, r is the error estimation parameter, i represents the coordinates of the conjugate symmetric data nodes to be tested.

Due to the strong information interaction between the tracking node and the surrounding node, if a node is fully tracked, its tracking is related to the tracking connectivity factor of the node and the surrounding node. By comprehensively considering the tracking connectivity factor of the surrounding node and the node, the chaos inference based on the signal RF strength can effectively achieve the precision of the conjugate symmetric data node Make sure to track. Firstly, the nodes with the best energy surplus are selected as the tracking reference nodes, and the nodes to be tracked are tracked accurately through these nodes. While the nodes to be tracked are connected to other nodes through the broadcast mechanism, they are sorted according to the RF intensity threshold of other nodes. The expression is as follows:

$$y = \frac{qu}{t} * \sqrt{o} \qquad (2)$$

In the formula, t represents the maximum number of data tracking cycles of the tracking node, u is the probability that the node to be tracked can work normally at the next time, o is the coordinate accuracy of the current data to be transmitted.

On the basis of the above transmission data tracking, half of the output data in the conjugate symmetric sequence can be approximately 0. All the data to be transmitted are fused, and butterfly operation is carried out based on frequency decimation 2FFT. The two data with conjugate symmetric values are transformed into imaginary and real numbers at multiple levels, which reduces the computational complexity. The conjugate symmetric transmission data is fused by butterfly operation, and the calculation formula is as follows:

$$P = y \cdot F\left(M\right) / \frac{1}{C} \quad (3)$$

In the formula, P represents all data to be transmitted, F represents the fusion error of the coordinates to be tracked, M represents data fusion parameters, C is the number of data traces.

According to the above process, the conjugate symmetric transmission data fusion is completed.

III. Conjugate Symmetric Data Coding

On the basis of the above-mentioned data fusion of conjugate symmetric transmission, the fused conjugate symmetric data is encoded, and the network coding technology is adopted. In order to realize the application of network coding technology in conjugate symmetric data transmission, a new strategy should be used to realize the anti-entropy transmission of data after two nodes establish a connection. Most existing link prediction studies originate from the resource transmission process of network evolution. Unfortunately, they ignore the impact of the topological stability of the structure around the path on the effectiveness of resource transmission on the path during the resource transmission process. The path topology stability in link prediction refers to the ability of the destination node to receive more resources from the originating node during resource transmission through the path. The stability of the structure around the path can reduce resource losses on the path, making both nodes receive more resources, and making both nodes more similar. The possibility of connecting edges between nodes is analyzed from the perspective of effective path topology stability. Therefore, this study will start with machine learning methods, analyze the transmission stability of conjugate symmetric data links, and conduct control optimization. First of all, we should establish the index of an encoded message rather than a simple message ID; secondly, we should increase the judgment of the value of the encoded message to ensure that the receiving node does not receive too many invalid messages, resulting in waste of storage resources and extra transmission load. The process of coding message anti-entropy transmission is shown in Fig. 1.

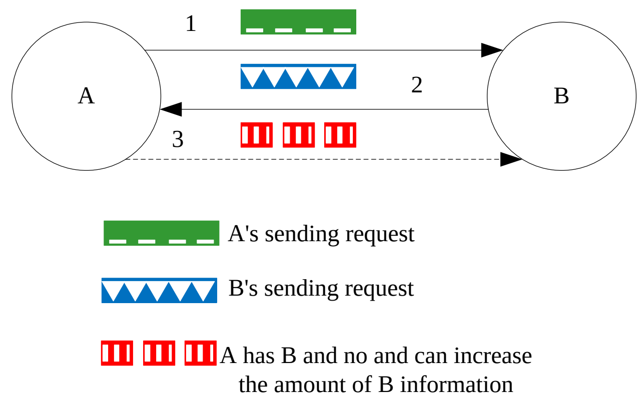

Fig. 1. Anti-entropy transmission process of encoded message.

The anti-entropy transmission process of encoded messages is shown in the figure above. When two nodes A and B establish a connection, in the first step, one node A sends the digest vector ACSV of the encoded message in its cache to another B; the second step node B performs an inverse operation on the digest vector of the encoded message in its own cache, and determines that the message is beneficial to increase the amount of information. Through the above process, the conjugate symmetric data is encoded. After the conjugated symmetric data is encoded, the amount of information contained in it differs from the source message. Multiple conjugate symmetric data encoded messages compare with multiple source messages. The amount of information is also different. The conjugate symmetric data encoding node evaluates the amount of information contained in the encoded message in its cache and determines whether it is necessary to encode a new message. This can greatly reduce the burden of node encoding calculation in the implementation of encoding. At the same time, it can avoid unnecessary "redundant" interference of encoded messages in the network, and can reduce the complexity of final decoding.

In order to evaluate the amount of information contained in the coded generation message and whether the new message contributes to the increase in the amount of information in the coded generation, it is proposed to use the concept of redundancy to characterize the number of coded sources messages and the number of generated coded messages in the coded generation. The relationship between them, and through this relationship to determine whether the newly received message can increase the amount of information in the current encoding generation, thereby determining whether it is necessary to encode the information, which can increase the effectiveness of the encoding result. From the perspective of whether the message in the encoding generation is sufficient to decode, consider the relationship between the dimension of the encoding generation (the number of messages in the generation) and the number of source messages (the number of messages originally generated in the encoded message contained in the generation before the encoding). The redundancy of an encoding generation is defined as the ratio between the dimension of the encoding generation and the number of source messages, and the calculation formula is:

$$w = P\frac{S}{D+Z} \quad (4)$$

In the formula, w represents the relationship between the number of initially generated and the number of messages contained in the encoded message, D represents the redundancy of an encoding generation, Z represents the number of messages, S represents the number of copies.

Redundancy can represent the relationship between the number of dimensions in a coding generation and the number of source messages. It can control the number of effective copies of messages in a coding generation. From a mathematical point of view, it is the relationship between the number of equations and the number of unknowns in a multivariate linear system. Mathematically, if the individual equations in the system of equations are linearly independent, only the unknown number of equations can be used to solve all the unknowns; and in the delay-tolerant network with network coding, the message is encoded through multiple paths. Sent to the target node, on one of the paths, the intermediate node does not need to obtain enough messages to reach the decodable condition. On the other hand, the message is stored with a new id after encoding. Under the infection routing strategy, another node will request this new message after seeing the message with this new id. Degree control can solve this problem. In order to realize the application of the network coding technology, this paper refers to the implementation method of the constrained protocol, and proposes an implementation method of inserting the "network coding layer" as the "overlay layer" between the application layer and the transmission layer. The framework of the conjugate symmetric data encoding system is shown in Fig. 2.

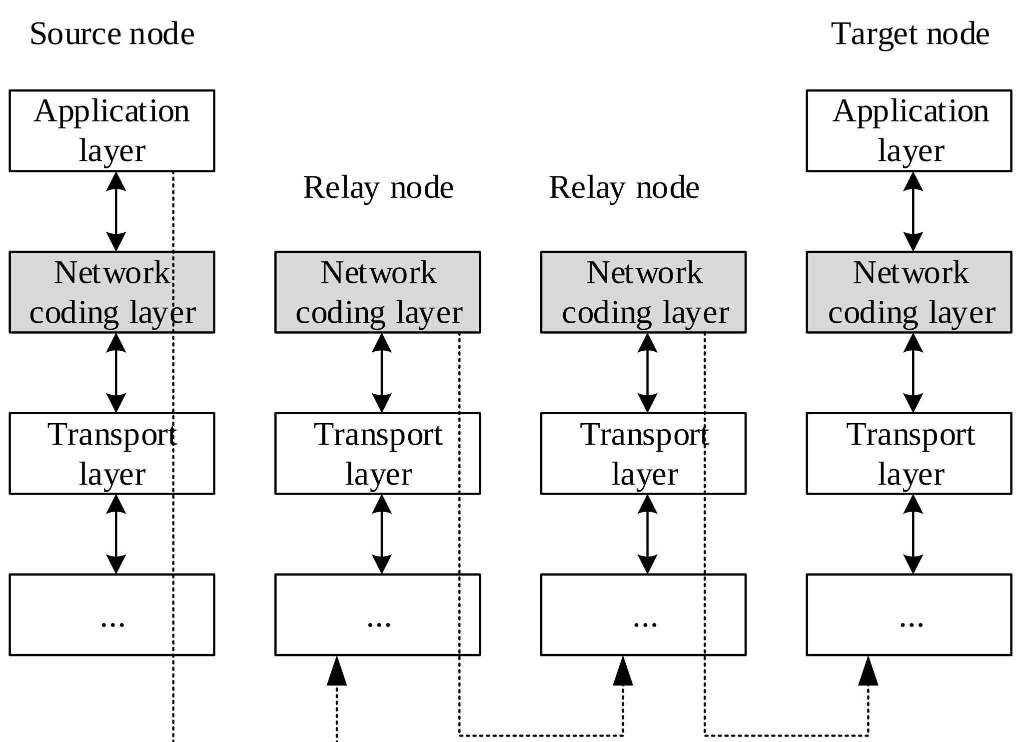

Fig. 2. Framework of conjugate symmetric data encoding system.

Regardless of the heterogeneous network environment, the relay node only needs to consider the transmission layer of a single mode, and does not need to consider compatibility with multiple network structures. For the source node, the conjugate symmetric data generated by the application layer is sent to the network coding layer. The network coding layer encodes the conjugate symmetric data and hands it to the bottom layer to complete the data transmission. The relay node uploads the message to the network coding layer after receiving the message. The network coding layer stores the message and encodes the conjugate symmetric data at the appropriate time. The network coding layer judges whether the remaining space of the current coding matrix is greater than zero when it receives the data packet sent to the receiving end by the transmission control protocol TCP layer. If so, it puts the data packet into the current coding matrix and performs linear coding to generate a linear-coded combined packet. The header of the combined packet includes the coefficient of this linear coding, the index number of the coding matrix and the serial number of the data packet. When the current node establishes a connection with other nodes, the encoded message is handed over to the bottom layer to complete the transmission of the conjugate symmetric data encoded data. The receiving node is the target node of the message. After receiving the encoded message, the network encoding layer of the target node stores the message in the local cache and uploads the successfully decoded message to the application layer to complete the encoding of conjugate symmetric data.

IV. Congestion Determination of Conjugate Symmetric Data Transmission Channel based on Machine Learning

Based on the above data fusion and data coding, machine learning methods are used to determine the congestion of the conjugate symmetric data transmission channel. In the research of multi-rate congestion control mechanisms, a key question is how to judge the current transmission path congestion [9].

Random early detection is performed first. Early detection means that the router detects congestion by monitoring the average queue length of the output queue. When congestion is found to be approaching, it randomly discards the data packets arriving at the queue to indicate that the terminal is congested and causes the source to overflow the queue the sending rate was reduced before to ease network congestion. The expression of random early detection is:

$$J = w\sqrt{e}/q + b \tag{5}$$

In the formula, e represents the probability of dropping the packet, q represents the weight of the current queue length, b represents the actual queue length when sampling and measuring.

Through early detection, "filter" out the short-term queue length changes caused by data bursts, and try to reflect the long-term congestion. The relationship between drop probability and average queue length is shown in Fig. 3.

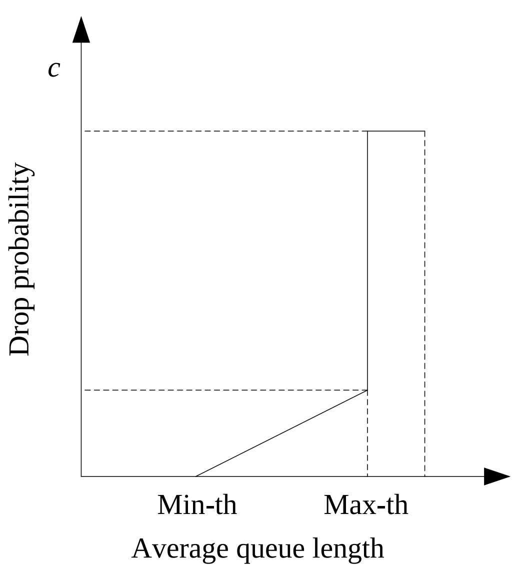

Fig. 3. Relationship between drop probability and average queue length.

In Fig. 3, c represents the probability of packet loss, and Min-th and Max-th respectively represent the thresholds related to queue length.

According to the relationship between the obtained drop probability and the average queue length, a deep learning algorithm is used to calculate the initial judgment weight:

$$\alpha = \frac{1}{2}\ln\left(\frac{1-\varepsilon}{\varepsilon}\right)J \tag{6}$$

In the formula, ε represents the normalized judgment factor.

The calculation formula for weight update is:

$$conf(i) = \sum_{i=1}^{I} \alpha\gamma(i) \tag{7}$$

In the formula, $\gamma(i)$ represents the weight update training function.

On this basis, the available bandwidth is estimated. In multi-rate congestion control, each receiver needs to determine whether the current subscription level conforms to the available bandwidth of the transmission path, so estimating the available bandwidth is an important part of multi-rate congestion control. For the congestion mark statistical value marking, the receiving end only counts the congestion mark values collected in the synchronization interval after receiving the synchronization mark packet, considering that the mark value carried by the recent packet can better reflect the current network congestion status, So a machine learning algorithm is used to calculate the average congestion marker value, First, calculate the window value decline ratio. When packet loss occurs in congestion, three repeated ACK are received continuously, and the window threshold will drop by a certain ratio. Different congestion algorithms adopt different ratios, for example, RENO is 0.5, while CUBIC is 0.8. According to the ratio of congestion window values before and after the packet loss point, the window value reduction ratio can be determined. Then calculate the congestion avoidance window growth function. In the stage of congestion avoidance, for the functional characteristics of window growth, the difference between the window values at two-time points in this stage and the starting point window value in the stage of congestion avoidance is used, and the relative value is used to express the function curve characteristics in this stage. Then, the fast recovery window growth function is calculated. In the fast recovery stage, when the server receives three DUPACK in succession, different algorithms process differently, such as waiting for retransmission after the timeout, or constantly increasing the window value until the retransmitted packet is received. In this paper, this feature is expressed by the difference between the window value and the starting point value at a certain time point in this stage. As shown in the following formula:

$$k(a) = conf(i)(1-d)*R \tag{8}$$

In the formula, $k(a)$ represents the congestion mark value carried by the a packet, d represents the statistical value of the congestion mark, R represents the weight of the congestion mark value carried by the packet. When the statistics are completed, the congestion mark value collected in the synchronization interval is cleared to avoid interference with the statistics of the next synchronization period [10].

Determine the transmission channel congestion according to the average congestion flag value obtained. When $k(a)>0$, it means that the transmission channel is in a congested state. When $k(a)<0$, it means that the transmission channel is in a non-congested state. When $k(a)=0$, it means that the transmission channel at this time is just saturated.

V. Formulation of Conjugate Symmetric Data Transmission Protocol

Because the data collected by the transmission data itself has high redundancy, the direct communication between the single node and the cluster head in the cluster has little effect on the reliability of the data communication of the entire network, and consumes a lot of resources to maintain the data collected by the node is not worth the gains. Due to the limited communication range of the conjugate symmetric data cluster head, the cluster head can only forward the request message to the base station through the adjacent cluster head. This data packet can record the node information traversed during the forwarding process and the reception at each node for signal strength parameters, when the data packet reaches the base station, the base station analyzes and calculates the information recorded in the data packet to perform path generation. Convert all the data request messages that need to be transmitted, the expression is:

$$L=\beta / I+\frac{\lambda}{O}k(a) \quad (9)$$

In the formula, β represents the set of the head node and base station node of the transmission data cluster, I is the set of communication links between any two transmission data cluster heads, which can also be considered as the edge set corresponding to the node set, O is the signal strength received by the node, λ A is the transmitted signal strength of the parent node when forwarding the packet, the signal strength is related to the transmission power and the communication distance.

In order to maximize the multi-path routing from a node to the base station, the idea of breadth-first algorithm is applied in the path generation process. The algorithm process is as follows:

step1: Initialization, input all cluster head and base station node sets into the transmission data set;

step2: Calculate the number of all neighbor nodes of this node;

step3: If the number of neighbor nodes is empty, go to step1, otherwise go to the next step;

step4: Input all neighbor nodes into the set to make the following judgment: if there is a node and it is the same as the parent node of the input node, delete it; if there is a node and the energy has been excessively consumed, delete it; if there is a node Export the path.

The above process generates a transmission path, but due to the limitation of the transmission channel energy, the stored energy is also limited, and the output power of the sensor node increases exponentially with the increase of wireless coverage. At the same end-to-end distance, if each link uses limited transmission power, the power consumption of multi-link transmission is lower than the power consumption of directly transmitting information on a long link. In order to verify the survival time of the entire transmission channel, the multi-hop method is used when the long-distance transmission is required.

Based on the above analysis, the conjugate symmetric data transmission path is optimized. In the actual data transmission process, the energy consumption between the same distance and different links will be different due to the influence of objective factors, so energy-based the path optimization method adds transmission consumption weights to each link, so that the network can better integrate with the objective environment in which it is located, thereby better improving the reliability of data transmission [11-14]. The transmission consumption weight matrix is as follows:

$$H=\sqrt{L} * \frac{x}{K} \quad (10)$$

In the formula, K represents the set of transmission link, x represents the number of nodes transmitted in conjugate symmetric data.

It is also known that the relationship between energy consumption and communication distance during data transmission is:

$$U=\frac{i}{I} / \frac{l}{H} \quad (11)$$

In the formula, l represents the signal attenuation coefficient.

Combining the above two formulas, a link energy consumption matrix consisting of transmission energy on the corresponding link is obtained:

$$T=z(V)/n \quad (12)$$

In the formula, T represents the transmission energy consumption, z represents the signal strength parameter, V represents the transmission consumption weights, n represents the number of nodes.

Calculate and sequence the energy consumption of all available paths, and the transmission path with the lowest energy consumption is taken as the optimal path, followed by the other paths. If there are paths with equal transmission energy consumption, they are sorted according to the sum of the consumption weights of the entire path. The smaller T is, the better the transmission environment is, that is, the higher the transmission reliability, so the higher the priority of this path.

Through the above process, the route optimization is completed. Since the data transmission workload undertaken by each cluster head is different, the data transmission workload of the cluster head close to the base station is much larger than the workload of the cluster head far from the base station, so the network the energy consumption rate of the cluster head is different. At the same time, because the network will consume a large amount of node energy consumption and generate a large number of redundant data packets during large-scale reselection, frequent reselection requires a lot of networks running time. The efficiency of the network in collecting and transmitting data is reduced, so multi-path updates and transaction processing are required in time. The remaining energy of the cluster head is low, and it cannot continue to assume the current role. The number of nodes in the area under the jurisdiction of the cluster head is exhausted. In order to facilitate routing updates and effectively handle network transactions, the following standards are set. Ordinary nodes indicate to the cluster head that their remaining energy is below the threshold and cannot continue to work. Calculate the total number of energy-depleted nodes at the same time as the base station, and then perform data transmission [15-20].

VI. Experimental Comparison

In order to verify the application performance of the proposed conjugate symmetric data transmission control method based on machine learning, a comparative experiment was carried out. This experiment was carried out on the ONE simulation platform. The ONE simulation platform is a very widely used simulator in tolerant network simulation. It can effectively simulate the routing and transmission of messages in the tolerant network and give detailed results reports. In addition to generating statistical message status reports and node connection status reports after the simulation is completed, it also supports separate reports on message generation, relaying, successful transmission, abnormal interruption, and connection time between nodes. The experimental platform is graphical. The real-time monitoring and event display interface are shown in Fig. 4.

The main parameter settings of the simulated scene are shown in Table I.

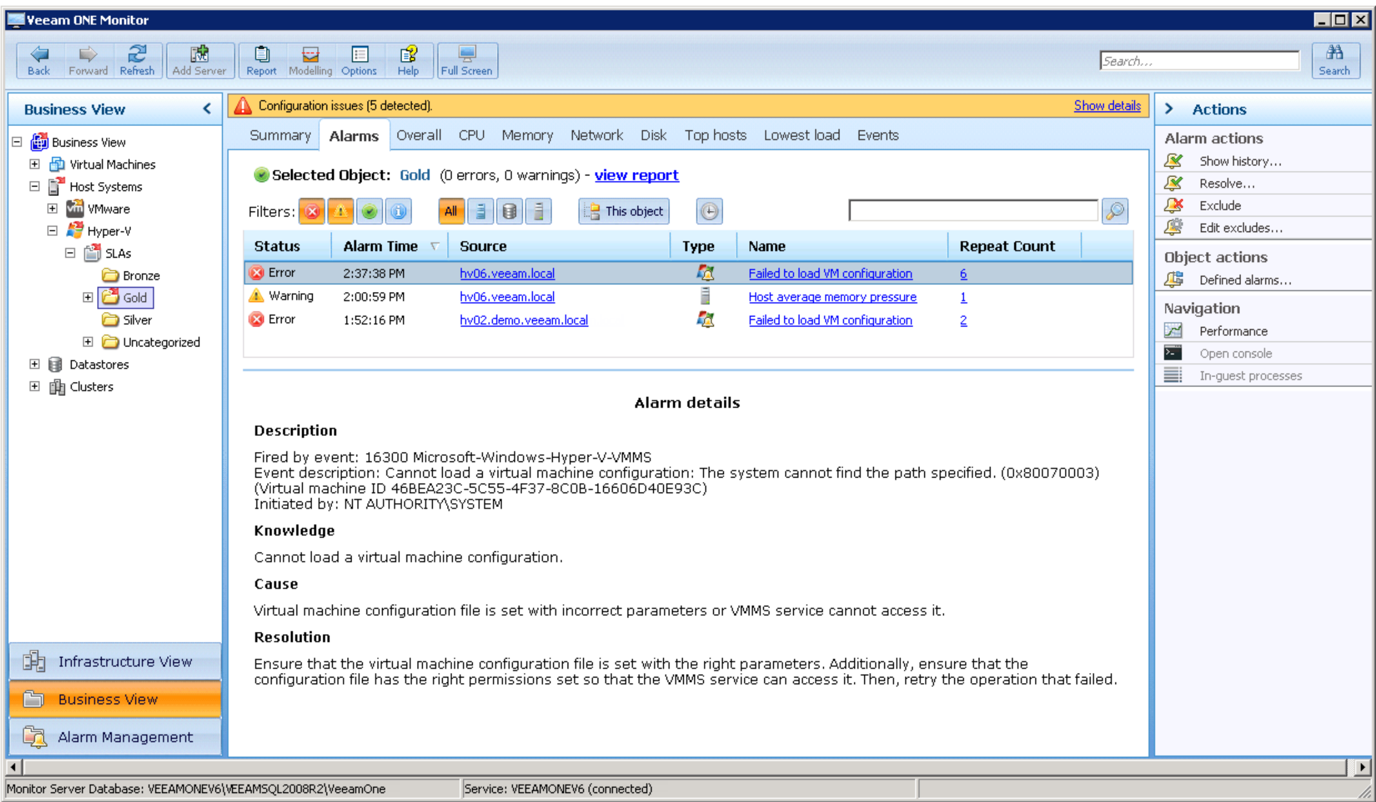

Fig. 4. Graphical interface of the experiment platform.

TABLE I. MAIN PARAMETER SETTINGS OF EXPERIMENTAL SIMULATION SCENARIOS

Classification	Main content	Specification
Simulation scene	Simulation space size	5000 m×5000 m
	Number of nodes	20
	Data transfer model	Infection routing/NTC
	Nodal motion model	Random Way Point
Common node parameters	Movement speed	Random change between5m/s-10m/s
	Communication bandwidth	2Mbps
	Cache size	5M
	Communication distance	100 m
Message parameters	Size	500K–1M
	Number	200
	Production methods	Randomly generated within 1000 seconds
Datasets	IMDBDatasets	52.4MB

The experimental environment configuration for this study is as follows: The experiment was completed using the MATLAB platform, with a running memory of 16g, a computer operating system of WIN10, and a CPU of AMD Ryzen 7 4800U. The following points need to be explained about the parameter setting:

First: 20 nodes are evenly distributed and randomly move in a 5000m×5000m plane space. The communication distance of the nodes is 100m, so the network connection rate is low and belongs to sparse network.

Second: Only when the two nodes reach the communication distance of each other can the connection be established, and then the information exchange can be carried out.

Third: It is convenient for comparative analysis. The message event adopts a fixed configuration, and 200 unicast messages are randomly generated in 1000 seconds with a tool in advance. Each node has 10 messages sent to other nodes. The messages are random sizes of 500K to 1M. Since the node cache is only 5M, the network load is heavy.

A. Evaluation Index of Conjugate Symmetrical Data Transmission

The experimental comparison methods are the conjugate symmetric data transmission control method based on machine learning, the data transmission congestion control method based on the bidirectional path and the data transmission control method based on accurate error tracking equalization. From the perspective of the message delivery rate, three indicators are used to measure the data transmission effect of the tolerant network, including the message delivery rate, message transmission overhead, and average message transmission delay.

The delivery rate refers to the ratio of the number of successfully delivered messages to the total number of messages generated by the network. The expression is:

$$deliverRatio = \frac{N}{E} \quad (13)$$

In the formula, E represents the total number of messages generated in the experiment, N represents the number of successfully delivered messages.

In the case of multiple copies, the number of the same message is recorded as 1, regardless of the number of copies. The delivery rate indicates how many messages can be sent by the entire delay-tolerant network, and can measure the network data transmission capability. Increasing this value is the main goal of the delay-tolerant network data transmission problem.

Transmission overhead refers to the ratio of the total number of message transmissions in the network to the number of successfully transmitted messages. The expression is:

$$deliverOverhead = \frac{n_i}{\partial} \quad (14)$$

In the formula, $deliverOverhead$ represents the transmission overhead, ∂ represents the number of successfully transmitted messages, n_i represents how many times the message i has been transmitted during the transmission process. In the case of multiple copies, the transmission of each message copy must be included.

The average transmission delay represents the statistical average of the transmission delays of all successfully transmitted messages. The expression is:

$$AverageDelay = \frac{\varphi}{t_Q} \quad (15)$$

In the formula, t_Q represents the transmission delay of the message, φ represents a successfully transmitted message. The average transmission delay is a statistical average value that characterizes the efficiency of the network to transmit messages.

B. Delivery Rate Comparison

The results of the three methods of delivery rate comparison are as Fig. 5.

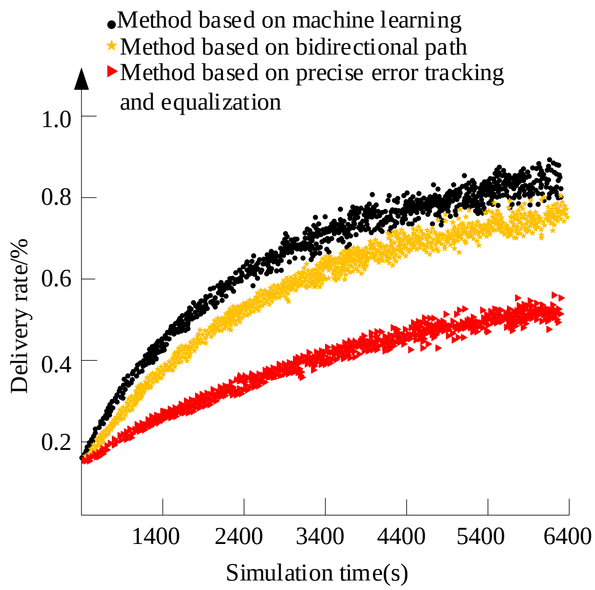

Fig. 5. Delivery rate comparison results.

It can be seen from the above figure that the application of conjugate symmetric data transmission control method based on machine learning to data transmission is beneficial to improve the delivery rate of the message, because the method designed this time applies the encoding technology to encode the transmission rate of the transmission data. It is very close to the infection route, and sometimes even lower than the infection route. This is mainly because the target node has not collected enough messages to complete the decoding when the time is short, which shows that the delivery rate is slightly lower; when the simulation reaches a certain time, the delivery rate of the method no longer changes significantly with time. At this time, the target node can decode the source message with a sufficient number of encoded messages. Therefore, as the time continues to increase, the message delivery rate in the strategy of applying network encoding continues to increase. The delivery rate of the traditional data transmission congestion control method based on the two-way path and the data transmission control method based on accurate error tracking equalization is lower than the method designed this time, mainly because the traditional method cannot store more information. Even if there is a connection opportunity between the nodes of the transmission network, more messages cannot be transmitted, thereby reducing the data delivery rate.

C. Transmission Cost Comparison

The transmission cost comparison results of the conjugate symmetric data transmission control method based on machine learning, the data transmission congestion control method based on the bidirectional path and the data transmission control method based on accurate error tracking equalization are as Fig. 6.

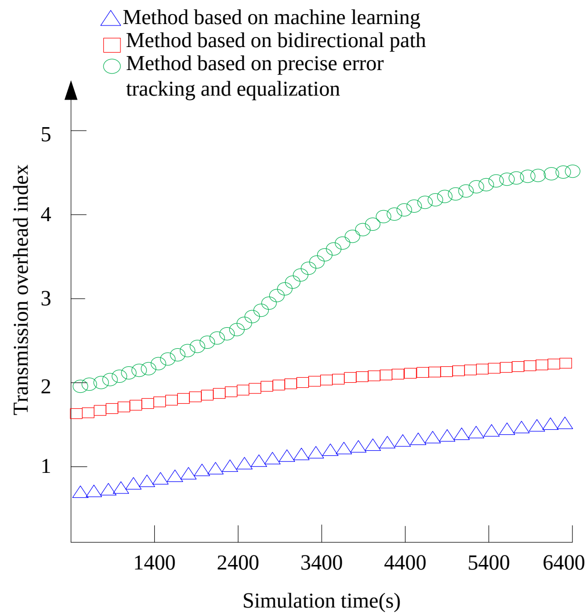

Fig. 6. Comparison of transmission overhead.

As can be seen from the above figure, from the comparison of the transmission costs of the three methods, in the initial data transmission, the transmission overhead of the three methods is lower, and as the time increases and the number of messages increases, the messages transmitted between the nodes also change. However, the message transmission overhead is closely related to the number of network transmissions. Therefore, in the later stage of simulation, the message transmission overhead becomes very large. However, it can be seen from the comparison that the transmission cost of the traditional two methods is much higher than the proposed method.

D. Comparison of Average Propagation Delay

The comparison results of the data transmission congestion control method based on the bidirectional path and the data transmission control method based on accurate error tracking equalization and the conjugate symmetric data transmission control method based on machine learning designed this time are shown in Fig. 7:

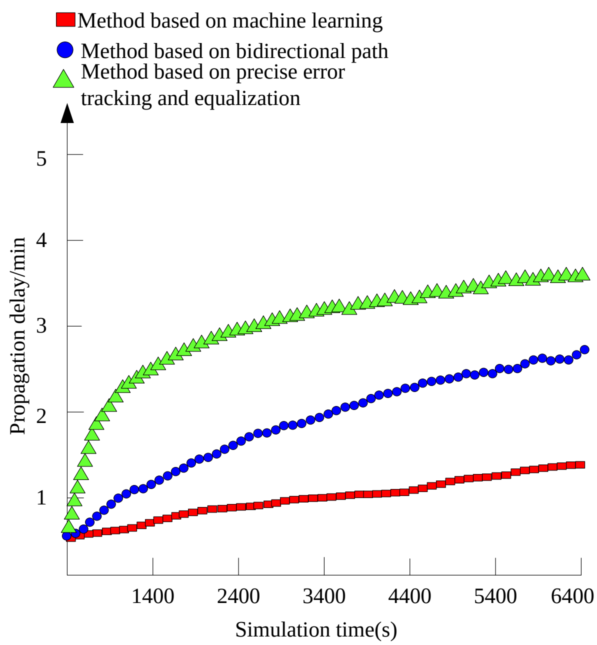

Fig. 7. Comparison of average transmission delay.

It can be seen from the above transmission delay curve that the transmission delay of the data transmission congestion control method based on the bidirectional path and the data transmission control method based on accurate error tracking equalization are higher than the transmission method designed this time. The reason for the low transmission delay of this design method is that the designed method can identify the congestion degree of the transmission channel and can encode the data, thereby improving the transmission efficiency of the message.

VII. Conclusion

In conjugate symmetric data transmission, the transmission path will be congested when the amount of transmitted data is large. This paper studies a conjugate symmetric data transmission control method based on machine learning, which tracks the target data, fuses conjugate symmetric data according to the calculation result of the best tracking signal, encodes the data, calculates the average congestion mark value by machine learning, and judges the congestion of data transmission. Transmission control of conjugate symmetric data is realized by transmission protocol. Experimental results show that the proposed method has low transmission cost, low transmission overhead and short transmission delay. The research method can identify the congestion degree of transmission channel and realize the efficient transmission of conjugate symmetric data.

The research on conjugate symmetric data transmission control is still in its preliminary stage, and there is still much work to be discussed and carried out. Further work mainly includes:

First: In the current congestion control algorithm based on asymmetric links, the fairness of data packets in bidirectional data transmission is still a problem that needs further research.

Second: Establish a reasonable data transmission model to theoretically analyze the characteristics of data transmission between nodes. The movement of nodes in the network is very random, and the connections between nodes are also opportunistic. The modelling of the entire network is very complicated, but the data transmission model between nodes can be mathematically modeled using random processes and probability theory, the mathematical description of the problem, and then theoretically evaluate the data transmission.

Third: Study the security problem of data transmission based on network coding. The transmission mechanism of this study is only applicable to the process of node "storing-carrying-forwarding" messages. It fails to consider how to ensure the security of messages in data transmission using network coding technology Transmission problems. If malicious messages are involved in the encoding, all subsequent encoded messages based on this message will carry the malicious message information. The spread of such malicious messages poses challenges to the security requirements of system data integrity. The security mechanism should contain guarantee mechanisms against such attacks.

Fourth: In-depth study of the problem of code generation management using network coding in the Rongchi network. Separate airspace coding is the preferred organization strategy when the network is small in scale, short in running time, and has few message events. However, when the large-scale network runs for a long time and there are many message events, it will bring about the problem of expansion of the coding generation space, so you need to consider "Time domain" encoding. That is, when the coding generation is divided, the message is divided into different generations according to a certain period of time. Although the time-domain coding is simple and looks like the superposition of several spatial coding processes, there are many problems that are very different from the simple superposition analysis, especially the problems of cache management and message receipt caused by multiple time-domain coding generations. The time-domain coding of messages also needs further study.

References

[1] I. A. Badruddin, N.J.S. Ahmed, A.E. Anqi, S. Kamangar, “Conjugate heat and mass transfer in a vertical porous cylinder,”Journal of Thermophysics and Heat Transfer, 2019, 33(2), 548-558.

[2] K. Zhou, “Simulation of data integrity detection method for long-distance wireless hybrid transmission,”Computer Simulation, 2019, 36(12), 447-450.

[3] N. A. Kuznetsov, D.V. Myasnikov, Semenikhin K.V., Optimal control of data transmission over a fluctuating channel with Unknown State, Journal of Communications Technology and Electronics, 2018, 63(12), 1506-1517.

[4] Yi L A , Peng Y B . Internet of Things transmission and network reliability in complex environment. Computer Communications, 2020, 150:757-763.

[5] Mu S , Wang F , Xiong Z , et al. Optimal path strategy for the web computing under deep reinforcement learning. International Journal of Web Information Systems, 2020, 16(5):529-544.

[6] Li H , Lei W , Zhang W , et al. A joint optimization method of coding and transmission for conversational HD video service. Computer Communications, 2019, 145(SEP.):243-262.

[7] Pyeon D , Yoon H . An efficient multi-path pipeline transmission for a bulk data transfer in IEEE 802.15.4 multi-hop networks. Wireless Networks, 2019, 25(1):117-130.

[8] WANG Zhan-Yu,LIU Guo-Ping. Performance Improvement of NCSs Under Complex Network via Concurrent Paths.System science and complexity,2019,032(002):453-478.

[9] C. M. Buldun, J. X. Jean, M. R. Bedford, M. Howarth, "Snoopligase catalyzes peptide-peptide locking and enables solid- phase conjugate isolation,"Journal of the American Chemical Society, 2018, 140(8), 3008-3018.

[10] X. Li, X. Fan, H. Ren, et al., "Data-driven feature analysis in control design for series-compensated transmission systems," IEEE Transactions on Power Systems, 2019, 34(4), 3297-3299.

[11] H. Han, K. A. Shore, "Dynamical characteristics of nano-lasers subject to optical injection and phase conjugate feedback, Iet Optoelectronics, 2018, 12(1), 25-29.

[12] C. Paroma, P. Anamitra, J. S. Thorp, et al., "Error reduction of phasor measurement unit data considering practical constraints, IET Generation," Transmission & Distribution, 2018, 12(10), 2332-2339.

[13] T. Fu, B. Jiang, Z. Li, "Approximation algorithms for optimization of real-valued general conjugate complex forms,"Journal of Global Optimization, 2018, 70(1), 99-130.

[14] H. Yamazaki, M. Nagatani, H. Wakita, et al., "IMDD transmission at net data rate of 333 Gb/s Using Over-100-GHz-Bandwidth Analog Multiplexer and Mach–Zehnder Modulator," Journal of Lightwave Technology, 2019, 37(8), 1772-1778.

[15] W. El-Shafai, S. El-Rabaie, M. M. El-Halawany, et al., "Effective multi-stage error control algorithms for robust 3D video transmission over wireless networks, "Wireless Networks, 2019, 25(4), 1619-1640.

[16] M. Pourali, J. A. Esfahani, S. A. Fanaee, Two-dimensional analytical investigation of conjugate heat transfer in a finite-length planar micro-combustor for a hydrogen-air mixture, International Journal of Hydrogen Energy, 2019, 44(23), 12176-12187.

[17] L. Li, H. Long, L. Zhao, et al., "Retransmission scheme for contention-based data transmission systems," Iet Communications, 2018, 12(2), 144-151.

[18] G. Singh, P. Goswami, R. V. Anand, "Exploring bis-(amino)cyclopropenylidene as a non-covalent bronsted base catalyst in conjugate addition reactions,"Organic & Biomolecular Chemistry, 2018, 16(3), 384-388.

[19] R. Zhang, D. Zeng, J. H. Park, et al., "A new approach to stabilization of chaotic systems with nonfragile fuzzy proportional retarded sampled-data control," IEEE Transactions on Cybernetics, 2018, 49(9), 3218-3229.

[20] A. P. Perkki, "Conjugates of integral functionals on continuous functions,"Journal of Mathematical Analysis and Applications, 2018, 459(1), 124—134.