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Link Transmission Stability Detection Based on Deep Learning in Opportunistic Networks

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Abstract. In order to solve the low throughput and high delay problems of traditional link transmission stability detection methods, a detection method of link transmission stability in opportunistic networks based on deep learning is proposed. Establish the network link blocking model. Considering the impact of path delay, analyze the network link information to adjust the hierarchical structure, divide the link data into data blocks, and complete the construction of the link model. According to the link transmission data, the ground point coordinates of the network links in the area are obtained. Under the constraint of link carrying capacity, obtain the barcode sent by network transmission. Calculate the number of packets sent by the network source during congestion, extract network level features using deep learning algorithm, select the number of network layers, set hidden layer nodes, implement network training according to the learning rate, achieve the construction of classification prediction model, and complete the link transmission stability detection. The experimental results show that the proposed link transmission stability detection method can effectively improve the throughput of opportunistic network links and reduce the communication delay of opportunistic networks.

Keywords: Opportunistic Network · Deep Learning · Link Transmission · Stability Detection

1 Introduction

With the rapid development of network technology, opportunistic network links are emerging as a new network application and can be widely used in various fields. However, in the opportunistic network link, the phenomenon of packet loss is easy to occur. All the reasons for the packet loss are judged to be caused by network congestion. Therefore, when the packet loss is detected, the opportunistic network link starts the corresponding congestion avoidance. Mechanism [1]. However, in a wireless network, due to the change of the location of the mobile computer, there will also be a high packet loss rate. If the congestion control mechanism is enabled, it will cause the degradation of the opportunistic network link, which has attracted the attention of many experts and

B. Wang et al. (Eds.): ICMTEL 2023, LNICST 534, pp. 110–126, 2024.
https://doi.org/10.1007/978-3-031-50577-5_9

scholars.. The information age is an era in which the Internet is integrated with each other. The integrated network will bring great promotion to all aspects of society. According to the characteristics of opportunistic networks, it is meaningful to improve network performance. Traditional transmission control network links have problems such as low average throughput and large round-trip delay value. The opportunistic network environment has been significantly improved, the traditional old-fashioned switching devices have been gradually replaced by modern program-controlled digital switching devices, and the opportunistic network has entered an all-fiber digital transmission mode. Opportunistic networks have good organization and self-configuration advantages in practical applications, so they are widely used in various regions [2].

Reference [3] proposes a link transmission stability detection method based on the node link evaluation model. This method proposes three indicators, namely, data transmission order, relay link control and transmission energy controllability. By matching the transmission power of nodes, a mobile Internet of things link stability detection method based on data transmission order is designed. Poisson distribution model is used to construct a node stability detection method based on relay link control. Reference [4] proposes a link transmission stability detection method based on virus antibody immune game, which evenly divides the node area in the transmission link, optimizes the divided area by designing the coverage division method and combining the distance and residual energy factors, so as to reduce the link jitter probability. Immune algorithm is introduced to construct a virus antibody immune game mechanism according to the antibody characteristics between link nodes, so as to optimize the clustering effect of nodes and links, and improve the data interaction characteristics between nodes and links through virus antibody training, so as to complete the detection of link transmission stability. Reference [5] proposes a link transmission stability detection method based on the intelligent path finding mechanism. In view of the limitations of the traditional mechanism of selecting only parameters, a regional path transmission stability detection method based on the energy angle stimulation mechanism is designed by comprehensively considering the residual energy of nodes, the transmission scattering angle and other factors.

Although the above method can complete the detection of transmission link stability, but directly applied to the detection of opportunistic network link status, it will lead to problems of low throughput and long delay in opportunistic networks. Therefore, a deep learning-based opportunistic network link stability is proposed. Sex detection method.

2 Opportunistic Network Link Transmission Stability Detection

2.1 Link Node Model

There are many factors that cause the instability of the transmission of opportunistic network links, among which the link blocking problem is the most important one. Therefore, this paper combines big data technology to monitor the blocking of network links and judge the stability of their transmission. Build a link blocking model according to the operating characteristics of opportunistic network links, as shown in Fig. 1.

In Fig. 1, $L_1, L_2, ..., L_n$ represents an input link in an opportunistic network, $C_1, C_2, ..., C_m$ represents an output link in an opportunistic network, and M represents

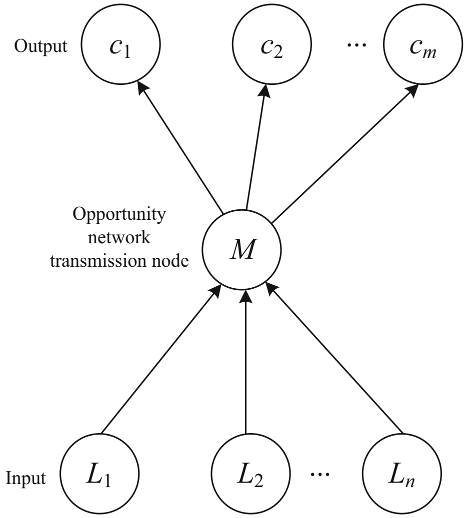

Fig. 1. Opportunistic network link blocking model

an opportunistic network transmission node. Considering the blocking phenomenon generated in the network link transmission process as a random variable, its value should be T or I, indicating that there is no blocking phenomenon and that blocking phenomenon occurs, respectively. In general, when the opportunistic network chain is blocked, the transmitted data traffic will exceed the link carrying capacity. Today, with the development of information technology, people have higher requirements for the accuracy and efficiency of transmission networks. Whether from the perspective of operators or consumers, the transmission delay problem of long-distance communication links is inevitable. The control strategy algorithm of addition, superposition, multiplication and decrement used in the adaptive transmission barcode circulation in long-distance communication links is used for calculation, and the software and monitoring of transmission delay in long-distance communication links are adjusted. Through the real-time monitoring of network quality, the problem of unclear image effect can be quickly solved, and the upgrading of customer computer equipment software can be strengthened. The quality problems of queue delay and link delay can be found in time, and relevant business personnel can view the system report to formulate long-distance communication adjustment plans. Due to the continuous integration of network technology and multimedia technology, adjusting the transmission delay of long-distance communication can be used for video conferencing, remote monitoring, remote education and network telephony, which not only brings benefits to the communication function of families, but also brings convenience to the working mode. The reliability, security and efficiency of long-distance communication links are affected by transmission delay. In order to avoid bad effects. It is necessary to calculate the carrying capacity of opportunity network. The calculation formula of the data volume of the input link and the probability of exceeding the link carrying capacity is:

$$G(Rn(M)) = \begin{cases} \frac{\sum T(M)}{Max(T)} & when \sum T_i(M) \leq Max(M) \\ I & when \sum T(M) > Max(M) \end{cases} \quad (1)$$

Controlling the transmission stability of the opportunistic network link can improve the transmission performance of the network and ensure the normal operation of the opportunistic network link. When controlling the stability of network transmission, it is necessary to determine the status of the opportunistic network link and adaptively adjust the network resource transmission scheme according to the determination result. The principle of the multiplexing model under opportunistic network is to determine the information output path according to the stability of the networks of both communication parties and the handling of network link interruption. This principle should be followed for the subsequent key and process of multiplexing to select the path. Let X and Y be two terminals of communication respectively, there are many communication paths between these two terminals, and $N_1, N_2, ..., N_{i+1}$ in the figure is an intermediate forwarding station on the path. If X and Y use one of the paths to transmit information when communicating, the attacker can obtain all the information of X and Y communication by attacking any intermediate forwarding station on this path; If X and Y communicate When using multiple paths to transmit information, the attacker must attack at least one site on each path to obtain part of the information of X and Y communication. Since the network in the communication link is a network link distributed to various regions, the process of transmitting all network files is random. Due to the limitations of network transmission network link, the actual release of files is carried out through the network transmission path, and the transmission delay is mainly queue delay and link delay [6]. When there is a delay problem in the transmission process, there will be two path delays, one is queue delay, which exists at the device outlet of each network fulcrum, and the other is link delay, which exists at the data compression port. Therefore, in the case of serious network congestion, the transmission network link in the communication link will be delayed, which seriously affects the reliability and synchronization function of the neural network link. The impact of path delay is shown in Fig. 2.

According to the analysis result of the influence of the path delay, according to the distance of the communication distance, the link data of the opportunistic network is divided into 4 levels n1/n2/n3/n4. The network link information adjustment hierarchy is shown in Fig. 3.

Among them, n1 is mainly used for data calculation, and its accuracy can reach 80%; n2 is mainly used for data synchronization, using real-time synchronization network link to upload information; n3 is mainly used for data compression, when When a certain amount of data is stored in the database, it is compressed and transmitted to ensure clear image quality; n4 is mainly used in the detection of network links. When the inner loop of the network link is performed, it is detected whether the files are completely preserved.

Build an opportunistic network model in the context of big data to ensure data availability. Divide the graph into several data blocks, select k data blocks to form several data groups, and add k data blocks in each data group into forged edges to form K link node small graphs. Select a module from each group of data blocks to form a

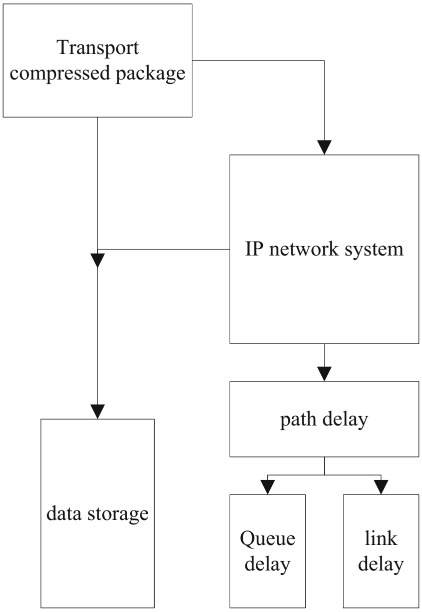

Fig. 2. Schematic diagram of influence of path delay

subgraph, and add edges to form an opportunity network. The specific implementation steps are as follows:

(1) Segmentation: divide the graph into M data blocks randomly according to the link node parameters, select the sparser part of the graph as the cutting point for data segmentation, ensure data availability, count the number, and select a certain probability to calculate the number of edges deleted in each iteration. Although the edges are deleted continuously in the process, because each block node is different, the edges can be added to the data blocks according to the original graph, so as to obtain M block subgraphs;
(2) Group: select K data groups from the data block in sequence to form;
(3) Process link node small graph: for K data blocks in different data groups, select a node to ensure that the same degree contains the same number of nodes, and become a link node according to the degree correspondence;
(4) Add edges: According to the corresponding relationship of nodes, add fake edges to form an opportunistic network.

The steps for establishing the link node model are as follows:

Obtain the original graph → get M subgraphs → select K subgraphs to form a group → K subgraphs of disconnected link nodes → link node model.

According to the above establishment steps, the link node model can be obtained.

Depending on the transmission requirements of opportunistic network links, hardware upgrades for long-distance communications are required. Using the network link in dual frequency mode as the source of the upgrade mainly for long-distance communication ensures good transmission of two-way signals, in which information is transmitted

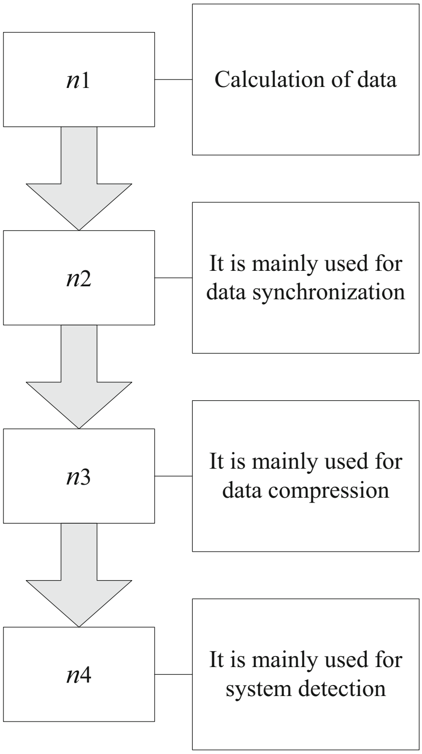

Fig. 3. Network link information adjustment hierarchy

to the CPU of the device, and the signal is transmitted to the link. The different links and different types of data that appear are divided into two paths in total, one is the queue delay, and the other is the link delay. Upgrade the speed of correcting data, improve mathematical formulas according to different data, and achieve smooth and efficient network transmission [7].

2.2 Network Transmission Sending Barcode Status Detection

First, according to the link transmission data, the ground point coordinates of the network links in the area are obtained:

$$\begin{cases} x = Dx_{s_1} + n_1 x_1 \\ y = y_{s_1} + (n_1 y_1 + d + n_2 y_2)/2G(Rn(M)) \\ z = Dz_{s_1} + n_1 z_1 \end{cases} \tag{2}$$

Among them, x represents the horizontal axis coordinate of the network link ground point in the area, y represents the vertical axis coordinate of the network link ground point in the area, z represents the spatial coordinate of the network link ground point in the area, x_{s_1}, y_{s_1} and z_{s_1} represent The camera position coordinates of the front and rear cameras; x_1, y_1, z_1 and n_1 represent the image space auxiliary coordinates of the front and rear cameras, and D represents the photographic baseline component. After determining the coordinates of the ground point of the network link in the area, it will also be affected by the value of the angle between the optical axis of the front and rear cameras and the front view direction. Proceed to the next step. Assuming that the included angle is 25°, the positioning accuracy of the point probe at the front end of the geometric link is calculated after eliminating other relevant factors [8]. Each component structure of the link network may have the phenomenon of privacy information leakage, and then needs to be protected. The information that sensitive data needs to be protected mainly includes four aspects, namely, data attribute value, existence, re identification and graph structure. In the context of big data, data sensitive attribute values are usually anonymously processed during the transmission process, but sensitive attribute information still has security risks, so these four pieces of information need to be protected.In the process of controlling opportunistic network stability, the state of the network link is judged, the transmission time of network data packets and the relative arrival time of the packets are counted, and the congestion probability of the current data is predicted. The state model controls the transmission stability of the opportunistic network link of the opportunistic network. The specific steps are described in detail as follows: Assume that R represents the moment when the receiving end of the s packet arrives, and δ represents the time between the receiving end receiving two consecutive packets. Time interval, the network transmission capability judgment formula is:

$$\varpi^* = \frac{s \times R^*}{\delta^*(x + y + z)} \cdot F(n) \tag{3}$$

where, $F(n)$ represents the normal link state, and $F(i)$ represents the transmission capacity of the current network packet. The threshold is further set to judge the different packet loss situations of the network: assuming that s represents the network packet transmission time and φ represents the packet loss caused by the sudden transmission error, the congestion probability of the current data is predicted by Eq. (4):

$$P = \varpi^* \cdot \frac{S \cdot \delta}{Ack} \oplus mak(i, t) \tag{4}$$

In the formula, w_i represents the ratio of the total throughput to the congestion packet loss rate, Ack B represents the interval of the latest packet loss rate, and $mak(i, t)$ represents the transmission delay difference between adjacent data packets.

The flow of any link exit E in the opportunistic network is the same as the flow entering the control node and the outgoing flow of the control node. If there are m nodes connected to the central node s (network flow reaches node S) and n nodes (network flow from S node), then there are:

$$\sum_{i=1}^{j} h_m \cdot SX_i^h = P \sum_{i=1}^{j} h_n \cdot NX_i^h \tag{5}$$

Total time slot number definition variable:

$$X_{ij} = \sum\nolimits_{t \in T} \tag{6}$$

In the formula, X_{ij} is the total number of time slots allocated by link e_i in the scheduling period T. this variable satisfies

$$0 \le X_{ij} \le T \tag{7}$$

Due to the limited bearing capacity of the links in the opportunistic network, the limit value of the link throughput cannot be greater than the link capacity, that is:

$$\sum_{i=1}^{N} h_i \cdot X_i^h \le \sum_{i=1}^{N} C \cdot \delta \tag{8}$$

In the formula, C is the capacity of link e_i; δ is the link utilization.

All in all, with high scheduling efficiency and energy consumption as the optimization goals, and synthesizing all the above constraints, the following optimization model can be established:

$$M = \sum T \cdot \bar{y}, \begin{cases} \sum_{i=1}^{j} h_m \cdot SX_i^h = \sum_{i=1}^{j} h_n \cdot NX_i^h \\ 0 \le X_{ij} \le T \\ \sum_{i=1}^{N} h_i \cdot X_i^h \le \sum_{i=1}^{N} C \cdot \delta \end{cases} \tag{9}$$

In the formula, $\bar{y}$ is the average throughput. The transmission in the opportunistic network link generally uses the control strategy of the signaling network link to adaptively transmit the barcode circulation. The control strategy algorithm is mainly dominated by the obtained network signal strength and makes judgments. If it is in a good state, the circulation rate of barcode data will be slowly increased to make the network usage reach a saturated state; If it is in a blocked state, the circulation rate of bar code data is rapidly decreased, and the flow rate of bar code is controlled to minimize the network usage until it is idle.The specific adjustment strategy is: if it is in a good state, use an addition factor x to represent the increase in bar code transmission; If it is in a blocked state, use a multiplication factor n to represent the decrease in bar code transmission. Using mathematical formulas, assuming that $a(x)$ is the current state of the barcode sent by network transmission, it can be represented by the following formula:

$$a(x+1) = Mmax\{n*a(x), amin\} \tag{10}$$

$$t(x) > M - k_3 \min\{a(x) + m, a \max\} \tag{11}$$

In general, the corresponding values are set to the maximum and minimum values of a code stream in the mathematical formula for analysis and comparison. In the state of the maximum value of the barcode stream, the quality of the effect picture transmitted through the network is of course the clearest, but exceeding this maximum value will not have any impact on the clarity of the image quality. Therefore, it can be known that data higher than the maximum value will not have a better effect on the clarity of the image;

In the minimum state of the barcode stream, the quality of the effect picture transmitted through the network is the lowest, and the resolution is also the lowest at this time. But below this minimum value, the clarity of the image quality has reached the point where it can not be directly viewed. Therefore, it can be known that the transmission in the communication path will be terminated if it is below the minimum value [9]. The barcode in the transmission process can be updated according to the change of the real-time status of the network.

2.3 Link Backpack Box Simulation

The specific steps of reading, writing and service permission values for transmission security are as follows:

(1) Unauthorized network users need to get permission to reduce the harm to the host to zero, that is, $Null=0$;
(2) To gain the right to read, write and service without authorization, the host needs to be irrecoverably paralyzed. At this time, the harm to the host is the greatest, that is $read_{root} = 1, write_{root} = 1, service = 0.5$;
(3) Quantify the remaining permission value, that is, x_{a-b} indicates that the degree of harm to the host caused by an unauthorized network user obtaining this permission is consistent with the $read_{root}$ value of the read permission, and there is $x_{a-b} \in (0, 1)$;
(4) Calculate the average value of different permission values;
(5) Integerize the calculated average value for use in subsequent designs.

Considering the priority of information and data, design different data transmission queues in the link network. Suppose that in the network, a certain data A obtains the right to use the transmission channel during the transmission process, and can freely send B-related data to the data B endpoint. A information data; when the B end receives the relevant information sent by the A end data, it will calculate the forwarding value based on its own remaining energy, and calculate the distance from A and B to node C in the network, so that data forwarding can be obtained. Value, the specific calculation formula is as follows:

$$S_B = \frac{d_A - d_B}{D} + \frac{e_B - e_{nb}}{e_{nb}} \tag{12}$$

In the formula: d_A represents the distance from the A-end of the link network data to the sink node C; d_B represents the distance from the B-end of the link network data to the sink node C; D is the distance from the A-end to the B-end; e_B is the link network data B-end The energy when there is no data transmission; e_{nb} is the energy of the nodes around the link network data B.

All the data that meets the formula is backup data, and those that do not meet it will enter sleep after transmission. Selecting backup data can improve the reliability of sensitive data transmission, ensure the safety of sensitive data on the link during transmission, and prevent data from being stolen. Given the routing requirements of the opportunistic network, it is necessary to find an optimal scheduling scheme for data information interaction, and calculate the maximum throughput that the link can withstand, So that the scheduling scheme can meet the transmission needs of all nodes in the opportunistic network topology and obtain the shortest scheduling period, the link scheduling optimization problem of multi-channel opportunistic network can be expressed as:

$$\min = \begin{cases} S_B - T \\ \sum X_i^h \end{cases} \tag{13}$$

In the formula, T is the scheduling period.

$$X_{ij}^T = \begin{cases} 1, \\ 0, \end{cases} \tag{14}$$

In the formula, X_{ij}^T is the total number of time slots allocated by link e_i in the scheduling period.

The goal of multi-channel opportunistic network link scheduling optimization is to maximize the throughput of each opportunistic network link, improve link scheduling efficiency, and reduce scheduling energy consumption. In the process of controlling the transmission stability of the opportunistic network link, based on the obtained network packet loss rate judgment threshold, the weighted average rate sampling of each congestion period is dynamically adjusted according to different types of packet loss states and the duration of the congestion period. The parameters are fed back to the sender, which effectively completes the control of the transmission stability of the opportunistic network link. The specific steps are described in detail as follows: Assuming that in a stable network state, the network is in the congestion avoidance phase, represented by W. The maximum value of the network window in the congestion period, and the duration of the congestion period represented by k does not change, p represents the weighted average number of congestion periods, R represents the sum of the duration of the congestion period and the packet loss event, and calculates the duration of the congestion period. The number of packets sent by the network source over time:

$$T = \sum_{R=0}^{W/2} \left(\frac{W}{2} + k \right) \cdot \frac{P}{R} \cdot \frac{8(p+R)}{3W} - S_B \tag{15}$$

The change of the opportunistic network environment can be inferred based on the change of the duration of the congestion period. The network receiver will maintain the duration of the historical n congestion periods, and compare the duration of the last n periods with the duration of the current n periods of congestion. Compared. If the current opportunistic network congestion period has not ended, and the duration is 1.5 times higher than the weighted average duration of n congestion periods in history, it can be judged that the degree of network congestion has eased and is satisfied with n = 8 condition. When the duration is 2 times higher than the weighted average duration of n congestion periods in history, it means that the degree of network congestion is constantly easing [10]. On the contrary, at the end of the current congestion period, if the duration is less than 0.5 times the weighted average of the durations of n periods in history, it is judged that the congestion degree is increased to satisfy the condition of n = 8. According to the calculation results of the positioning accuracy of the front-end point probes of the geometric link, the operation requirements of the opportunistic network link are grasped, and the link simulation backpack is designed based on this. The block diagram of this device is shown in Fig. 4.

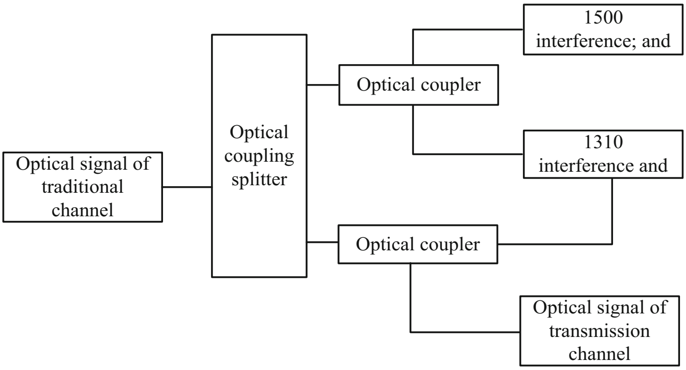

Fig. 4. Link simulation backpack overall structure

2.4 Building a Multi-Layer Deep Learning Detection Model

Deep learning is an interdisciplinary field of pattern recognition, neural network, signal processing, artificial intelligence and other research. It is believed that this technology is based on machine learning. Deep learning intends to use multi-layer and nonlinear transformation to extract features from data and abstract data. It can simulate complex relationships between data. The main idea of deep learning lies in "layer by layer initialization". Assuming that there is a system Z with hierarchical characteristics, and the inputs and outputs are I and O respectively, the learning process of deep $Z_1, Z_2, ..., Z_n$-degree learning is described by the following formula:

$$I \Rightarrow Z_1 \Rightarrow Z_2 \Rightarrow \cdots \Rightarrow Z_n \Rightarrow O \tag{16}$$

By adjusting the parameters, the input value I can be processed to obtain an output O that is as close to 1 as possible, so that the hierarchical features of the input I can be obtained, so as to achieve accurate data detection. In this study, the network link similarity index is used as the basic sample, and the network data is trained through the constructed detection model to realize the detection of link transmission stability. The target network link prediction weight matrix is defined as:

$$Q = \sum_{i=1}^{n} f^{n-i} \cdot k \tag{17}$$

In the formula: f is an adjustable parameter in the range; n represents the total number of network snapshots; k represents the similarity index matrix obtained according to the hierarchical feature $Z_1, Z_2, ..., Z_n$. The weights are sorted according to the matrix nodes, and the sample space of the prediction model is generated. Considering stacking multi-layer conditional restricted Boltzmann machines, a multi-layer conditional depth belief network model for classification is designed, as shown in Fig. 5.

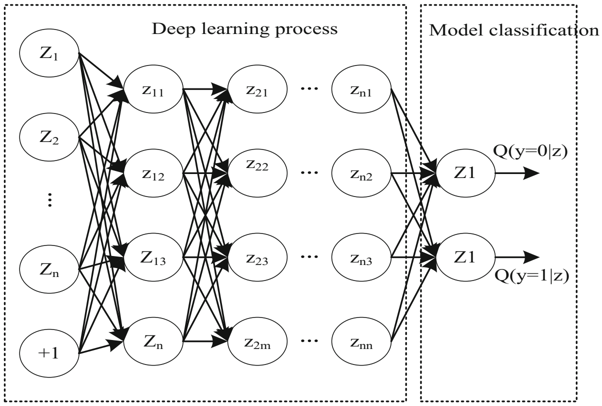

Fig. 5. Deep learning multi-layer classification prediction model

In order to improve the feature extraction effect of the conditional depth belief network model, it is necessary to set the parameters of the network, such as the selection of the number of network layers, the number of hidden layer nodes and the number of past time series in the model. In this paper, different from the traditional method, the model should not stack more than 5 layers in combination with the computational time complexity. Like the selection of the number of network layers, the selection of the number of hidden layer nodes is also one of the important conditions affecting the classification and detection effect of the model. The following formula is used to select the number of hidden layer nodes:

$$P = \sqrt{a + b} + \gamma \tag{18}$$

In the formula: a represents the dimension of the input value I; b represents the number of nodes that output O; γ represents an integer in the range of [1, 10][1, 10]. The deep learning algorithm determines the number of hidden layer nodes for the model according to the above formula. Finally, considering the relationship between the gradient of a single layer and the learning rate, the classification prediction model is obtained by training the learning rate. The learning rate formula is:

$$q_c^{(t)} = q^{(t)}\left(1 + \log\left(1 + \frac{1}{\left\|T_c^{(t)}\right\|_2}\right)\right) \tag{19}$$

In the formula: t represents the number of iterations; c represents the number of network layers; $q^{(t)}$ represents the global learning rate; $T_c^{(t)}$ represents the gradient of the current iteration of the current layer. When the gradient of the front layer is large, the learning rate is almost the same as the global learning rate. As the gradient becomes smaller, the gradient drops to the low curvature point. At this time, the influence of the gradient value on the learning rate gradually increases, which speeds up the training speed of the network, so that the model can reach a stable state faster and realize the detection of link transmission stability.

Through the above calculation, under the influence of path delay, adjust the information structure level of the network link and build the link model. According to the ground coordinates of the link, the data packets in the congestion period are calculated under the link carrying capacity. Finally, the deep learning algorithm is used to extract the hierarchical features of the network, complete the construction of the classification prediction model, and obtain the link transmission stability detection results.

3 Analysis of Experimental Results

In order to verify the effect of the deep learing-based opportunistic network link stability detection method proposed in this paper in practical application, the opportunistic network in a certain region is selected as the experimental object, and the movement speed of sensor nodes is set as 5m/s, 10m/s, 15m/s, 20m/s and 25m/s, and the same transmission content is transmitted through the opportunistic network link. The detection method proposed in this paper, the method of reference [3] and the method of reference [4] are respectively used to detect the stability of the link, and the integrity of the link detection of the three detection methods is compared. In order to facilitate verification, the hardware and software environment used in the experiment should be set up, and the specific conditions are set up as shown in Table 1.

Table 1. Experimental condition settings

Name	Describe	Remarks
Hardware equipment	CPU	Pentium(R)Dual-Core CPUE5200@2.5 GHz
	Memory Hard disk	5GB
		35GB
Software network link	Windows 8	-
Programming environment	Visual studio2016	-
Code generation tool	Code Warrior IDE	-
Integrated development environment	-	Visual studio2016

The transmission stability control experiments are carried out by using the methods in this paper, reference [3] and reference [4]. Under the same data volume, the transmission time of the three methods is compared, and the results are shown in Fig. 6.

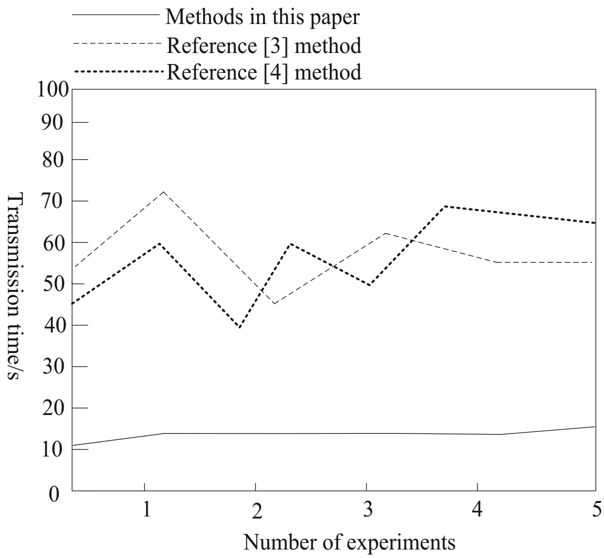

Fig. 6. Time-consuming comparison results of transmission

It can be seen from Fig. 6 that the transmission time of the two literature comparison methods fluctuates with the increase of the number of times, but the transmission time is always higher than that of the method in this paper. However, the speed of the method in this paper increases with the increase of the number of experiments, and its transmission time shows a slight upward trend, and the final transmission time does not exceed 20s. Therefore, the transmission rate of the method designed in this paper is faster. The reason why the method in this paper has shorter transmission time is that the method in this paper directly carries out link transmission under the constraint of link bearing capacity, and can transmit as much data as possible under the maximum link bearing capacity, thus reducing the time of data transmission.

Simulation experiments can be carried out according to the network topology. In the topology, S2-D2, S3-D3, and S4-D4 are all data streams sent in the UDP background. Under the same topology, set the background stream unchanged, and set the bit error rate. is 0. Taking the throughput as the experimental index, the method of Reference [3], the method of Reference [4] and the method in this paper are used for comparison and verification. The experimental results are shown in Fig. 7.

It can be seen from the figure that when the bit error rate is 0, the average throughput of this method is greater than that of the two literature comparison methods. And the throughput results of this method are relatively stable, and the throughput results of the two literature comparison methods have strong fluctuations, which shows that the transmission link of the opportunistic network detected by this method can maintain

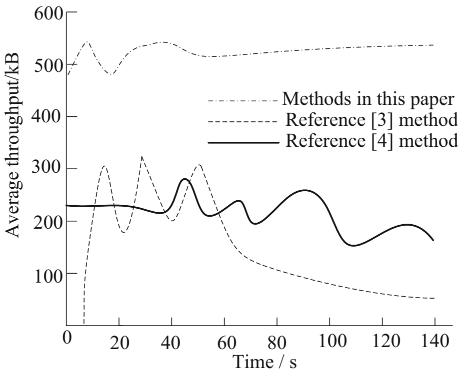

Fig. 7. Average throughput comparison results and analysis

a stable throughput level, and the transmission performance of the link is relatively reliable. This is because the method in this paper can transmit more data per unit time by carrying out data transmission under the constraint of the maximum link capacity, thus improving the throughput of data transmission in this paper.

The round-trip delay of reference [3] method, reference [4] method and the method in this paper are respectively used for comparative experiments. The experimental results are shown in Table 2.

Table 2. Round-trip delay comparison results and analysis

Time/s	Round trip delay / ms		
	Reference [3] method	Reference [4] method	Methods in this paper
10	0	0	0
20	25	30	20
30	40	35	30
40	60	50	45
50	65	60	50
60	75	70	55
70	75	70	55

It can be seen from Table 2 that in order to clearly see the change of round-trip delay, the network stability of this method and the two traditional methods are analyzed. With the increase of transmission time, there is a significant difference in the round-trip delay of the three methods. However, the round-trip delay of this method is always lower than that of the two literature comparison methods. This is because the method in this paper can calculate all the data sent by network sources in the cycle, and adopt a fast transmission strategy for these data, thus reducing the round-trip delay.

Complete the experiment according to the above steps, record the data detected by the two detection methods, and draw the relevant data generated during the experiment into the experimental result comparison table shown in Table 3.

Table 3. Overall transmission stability test results

Moving speed of sensor node (m/s)	Actual value (MB)	Methods in this paper (MB)	Reference [3] method (MB)	Reference [4] method (MB)
5	450	452	321	411
10	450	449	312	409
15	450	451	330	380
20	450	448	324	391
25	450	450	318	372

According to the data in Table 3, the amount of link data detected by the method in this paper is significantly higher than that of the two literature comparison methods. The difference from the actual amount of link transmission data is only 2 ~ 3MB, which meets the requirements of link transmission data. While the traditional detection method can only detect the amount of data in the opportunistic network link, the detection results obtained may have low accuracy. Therefore, through experiments, it is proved that the opportunistic network link stability detection method based on deep learning proposed in this paper effectively improves the integrity of the network link stability detection in practical applications, and the detection results obtained are more in line with the actual operation of the link. The reason why the method in this paper has high transmission stability is that the method in this paper carries out multiple iterative training through deep learning algorithm, and realizes network training according to the learning rate, thus improving the stability of network transmission.

4 Conclusion

By carrying out research on the detection method of opportunistic network link stability, combined with deep learning algorithm, a new detection method is proposed, and the practical application effect of this method is proved through experiments, and it will not be affected by other related factors in the network environment. Ensure the accuracy of test results. Applying the method in this paper to the field of actual opportunistic network supervision can provide a basis for judging the stable operation of the network.

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