Design of Short-Term Network Congestion Active Control System Based on Artificial Intelligence

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Abstract. Traditional network congestion active control system has the problems of large amount of network congestion data and uneven distribution of main control nodes. Therefore, this paper proposes a short-term network congestion active control system based on artificial intelligence. In the congestion control framework, the network motor and congestion control nodes are connected to complete the construction of the system hardware operating environment. The control strategy of artificial intelligence node is used to determine the congestion location, improve the logic control standard, optimize the system software running environment, and complete the design of short-term network congestion active control system based on artificial intelligence. The results show that, compared with the traditional random detection control technology, the short-term network based on artificial intelligence is feasible. After the design of congestion active control system, the total amount of congestion data is significantly reduced, and the master node presents an ideal uniform distribution state.

Keywords: Artificial intelligence · Network congestion · Active control · Main control frame · A congestion node · Sudden transmission mechanism

1 Introduction

Artificial intelligence is a branch of computer science that attempts to understand the essence of intelligence and to produce a new intelligent machine that responds in a similar way to human intelligence. Research in this field includes robots, language recognition, Image recognition, natural language processing and expert systems. Since the birth of artificial intelligence, the theory and technology have matured day by day, and the application field has also been expanded. It can be assumed that the scientific and technological products brought by artificial intelligence will be the "container" of human intelligence in the future. Artificial intelligence can simulate the information process of people's consciousness and thinking. Artificial intelligence is not human intelligence, but it can be thought like a man Examination, may also exceed human intelligence [1, 2].

In reference [3], a network congestion control system based on random detection algorithm is proposed. Using LAIDS/lids host random detection architecture, the congestion controller and network data filter are adjusted to complete the hardware

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operation environment of the new system. Through the definition of transmission data congestion, the possible congestion in the network is classified, and then the appropriate network congestion control mode is selected according to the specific judgment results, so as to realize the software operation environment of the new system. Combined with the structure of software and hardware, the design of network congestion control system based on random detection algorithm is completed. This method can reduce the network congestion delay, but can not solve the problem of uneven distribution of master nodes. In reference [4], a congestion control algorithm for computer networks with multiple delays is proposed, and a mathematical model of the congestion control system for computer networks is established. Based on the optimal control theory, an optimal congestion control algorithm for multi delay computer networks based on active queue management is proposed. By solving the linear matrix Riccati equation, the state feedback control law is obtained to achieve the optimal performance index. This method can improve the network congestion tracking effect, but the total amount of congestion data is large.

With the progress of science and technology, how to better control the congestion of short-term networks has become the main research direction. The existing control technology makes use of the idea of cloud platform to build an embedded real-time micro-framework, and realizes the timely elimination of congestion network data through the active response of the database. However, this method can solve the congestion data relatively limited, and can not make the host node maintain a uniform distribution state for a long time. In order to solve the above problems, a new type of short-term network congestion active control system based on artificial intelligence is designed. From the aspects of software and hardware, the position information of the control node is defined, and a number of hardware operation modules such as network motor are added. And in the follow-up application process, the effectiveness of the new system is verified.

2 Hardware Design of Short-Term Network Congestion Active Control System

On the basis of the congestion main control framework, the network control motor module and the short-term congestion node are designed to complete the hardware operation environment of the active control system, and the specific operation method thereof can be carried out according to the following steps.

2.1 Network Congestion

Network congestion is a kind of network state. When the load in the network is too low, the data packet transmitted by the network increases with the increase of the network load. When the network load increases to a certain stage, the network reaches the maximum transmission capacity and reaches the optimal state. Along with the rising of the network load is the ideal state of network, network transmission of data is also increasing, but this is clearly impossible, when the network load increasing, the network will enter a state of congestion, the network load transfer, the greater the network congestion state, the corresponding data transmission group showing a negative correlation, began to decrease. The state of the network is shown in Fig. 1.

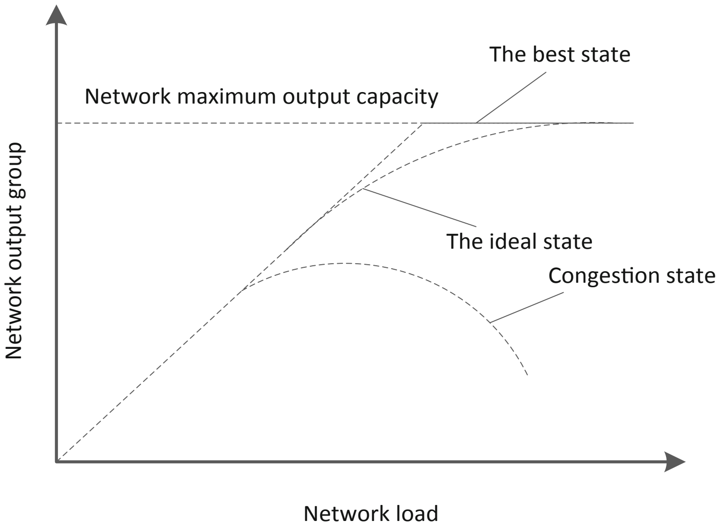

Fig. 1. State of network

Network is a multi - to - one transmission network. In the process of wireless network operation, data fusion, classification and other computing processes are needed, but the processing speed of sensor nodes is very low, so there is a certain possibility of cache overflow. When a sudden event occurs in the WSN, a large number of data streams are generated, and the cache space and available bandwidth of the output stream of these sensor nodes are limited. Meanwhile, the environment also interferes with the network, so the network cannot timely forward the groups in the cache and thus cause congestion. Unbalanced distribution of network resources and network traffic will also increase the probability of WSN congestion.

In summary, the root cause of WSN congestion is the insufficient maximum transmission capacity of the network. Shared bandwidth resources, limited node cache space and multi-hop communication mode all limit the network transmission capacity. The excellent control algorithm can detect the congestion in time and control the congestion, which can prolong the life cycle of the network and take into account the fairness of the network. Due to the particularity of network application, the network congestion algorithm needs to be specially optimized according to the needs of special occasions, and in-depth research needs to be carried out around the two cores of WSN congestion control algorithm, congestion detection and congestion processing.

2.2 Design of Congestion Control Framework

The congestion control framework of the new network system consists of two main parts: microcontroller and core application platform. Among them, the microcontroller can capture the basic connection of the network during the short-term execution time, and establish the mapping space of the network congestion data with the support of the specific hardware IP. According to the existing form of the data, the function model suitable for the data is determined, and the data acquisition operation before the operation of network control processing is completed. The core application platform contains a large number of system connection protocols, and each protocol maintains a one-to-one correspondence with each congestion state data [5, 6]. In order to ensure the short-term network can have a strong ability of timely feedback in artificial intelligence environment, DSP detection equipment is added between the microcontroller and the core application platform in the main control framework of the system. Normally, the detection results are always verified, and the active transmission of the data is always maintained at a higher level. When the detection results are negative, the DSP device takes advantage of its self-regulating function to speed up the operation of the feedback operation. To achieve the purpose of maintaining high efficiency of data transmission. The network congestion control framework is shown in Fig. 2.

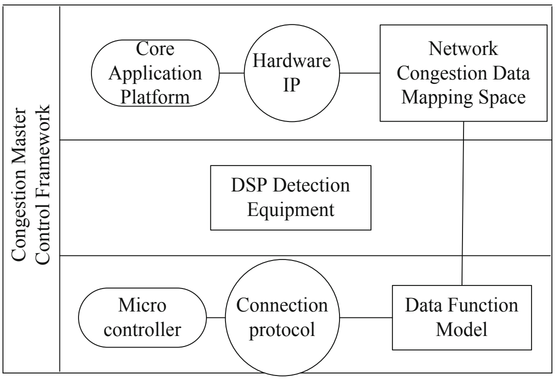

Fig. 2. Congestion control framework architecture

2.3 Network Control Motor Module Design

The network control motor module is connected with a system microcontroller by a remote terminal, and the module is used as a core device by an external motor with a plurality of rated voltages of 380 V and a rated current of 8.4 A. In order to avoid the phenomenon of insufficient power supply of the system, each external motor is connected with a remote electric quantity control device of the DSP. When the short-term network begins to execute the operation instructions, the system enters the active control state, at which time all hardware universal processing layer devices are in standby state. With the increasing running time of the system, the remote terminal processor begins to sense the power request of the system and sends the request to the multi-DC control motor through the incoming device [7–9]. And when the real-time control chip of the motor module senses the request, the real-time control chip of the motor module issues an opening instruction to the connection general switch to enable the network to control the motor module to enter the continuous power supply state. The specific module structure of which is shown in Fig. 3.

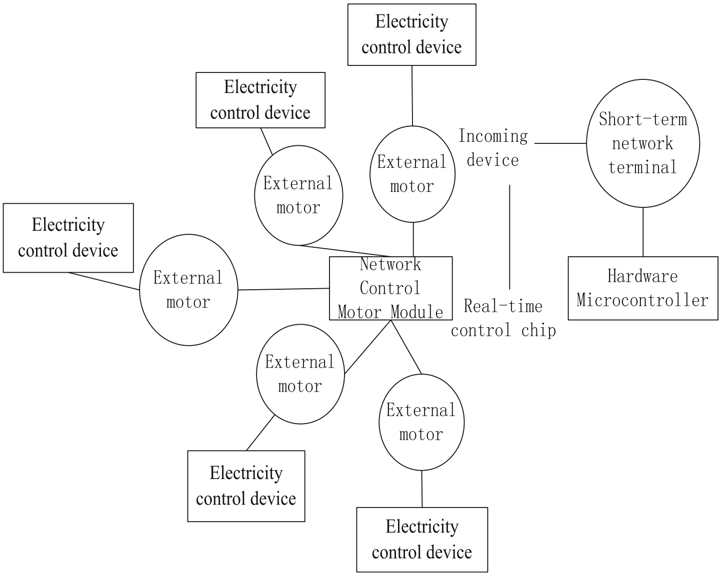

Fig. 3. Structure diagram of network control motor module

2.4 Short-Term Congestion Node Design

On the basis of the main control framework of the system, the short-term congestion node establishes the service connection between the network terminal and the active control client by integrating the three transmission protocols of CAN, UART, SRAM. When the system input module collects the execution state data of the short-term network congestion, the related operation module will change the number of real-time control nodes of the connected system according to the real-time feedback information of the input system. With the delay of the running time of the system, the congestion control data collected by the system input module also increases. In order to ensure that each data can be effectively recorded, the number of short-term control nodes of the system must also increase. All three transport protocols of CAN, UART, SRAM have high data dependency. A large number of short-term network congestion control state data are connected to real-time control nodes under the three protocols mentioned above, which improves the feedback efficiency of the system to a certain extent [10, 11]. When the network congestion control state changes, the feedback data received by the relevant operation module also changes. In order to ensure the stable running state of the system, the control motor in the congestion active control framework structure is not affected. Under the regulation of real-time control node, it is always in the state of variable frequency power supply, and the output current and voltage amplitude are always proportional to the number of nodes.

3 Software Design of Active Control System for Short-Term Network Congestion

According to the definition of artificial intelligence control node, congestion packet burst mechanism is determined, logical control standard is perfect operation flow, software running environment of the system is built, and the hardware operation conditions are combined and stable. To realize the short-term network congestion active control system based on artificial intelligence running smoothly.

3.1 Definition of Artificial Intelligence Control Node

Artificial intelligence control node (AI) means that when congestion occurs in short-term network, the congestion can be alleviated by increasing the supply of resources in the congestion area, that is, forming an additional path to share the load on the original path. After congestion occurs, multiple paths are established for data transmission, and the new paths are removed after congestion relief. This node control method costs a large amount of storage and communication, and the start-up time is long. When routing is established, two forwarding nodes are configured for each node, the default parent node and the alternate parent node [12]. When a node sends data, the alternate parent node listens for and caches packets. Once the default parent node becomes congested, the alternate parent node forwards the received packet. This method is simple, but the spare parent node consumes more energy. Priority mechanism is a method to alleviate congestion by first transmitting, delaying or dropping packets according to the importance of packets after congestion is detected. According to the idea of priority scheduling, the data is divided into three kinds of priorities. When congestion occurs, data with the highest priority is sent first. The nodes with high priority can get more speed and bandwidth by assigning different priority to the data stream. The purpose of the protocol is to ensure the transmission effect of high-priority data on the main path. After the congestion is detected, the low-priority data is forwarded through other paths to alleviate the congestion on the main path. Let U representing the artificial intelligence identification condition of the control node, w represents the maximum order of magnitude parameter of the control node, simultaneous U, w results of the definition of the artificial intelligence control node can be represented as:

$$\lambda = U \cdot \left(\frac{qt}{w} + p\right) \tag{1}$$

Where q area range coefficient representing congestion for short-term networks, t represents the basic congestion vector, p represents congestion control conditions.

3.2 Determination of the Transmission Mechanism of the Congestion Package

When the data congestion occurs in the short-term network, the control node listens to the busy situation of the surrounding media through the carrier sensing mechanism. If listening to the channel state is busy, the sending node delays sending data until the channel state is idle. If the monitored channel state is idle, in order to avoid conflicts and collisions with other nodes sharing the channel, the node enters a random Backoff state before sending network congestion data. The competitive window value has an important effect on the Backoff time, and thus realizes the active control and adjustment of congestion behavior [13–15]. When congestion occurs, multiple packets are cached in the cache queue of the node that occurs congestion. These congestion data nodes use the congestion control mechanism of packet burst to make the detected congestion node compete to the channel. In the current cycle, multiple packets can be sent continuously. According to the congestion condition, the node determines the number of continuous control instructions sent by the node in a working cycle. Let y control parameters representing packet burst mechanism, e on behalf of congestion control coefficient, the simultaneous formula (1) can express the result of congestion packet burst mechanism as follows:

$$R = \frac{\lambda\sqrt{\frac{yd\cdot|f|}{se}}}{g^2} \tag{2}$$

Where g represents a shared condition for short-term network congestion data,d representing the underlying control of the packet burst mechanism,$|f|$ represents the maximum capacity of the congestion control channel,s represents the maximum active control vector of a short-term network.

3.3 Perfect Logical Control Standard

Short-term networks do not have a separate transport layer. The functions of current transport protocols, such as reliable transmission and congestion control, are transferred to applications, supporting libraries and forwarding policy modules. When the application needs reliable transmission, the application itself or its support library monitors the status of the sent interest packets and retransmits them if necessary. Logical control standards can be used for congestion control. This control standard means that a network congestion packet forwarded across a link causes the link (in the opposite direction) to forward a packet that matches it, because the PIT records the incoming port of the interest packet. When a router receives a matching packet, it forwards the packet to the incoming port of the interest packet based on the information recorded in the PIT. Unlike TCP/IP, where the terminal is responsible for security, the publisher of logical control standard content encrypts and signs each packet to directly protect the data itself. The publisher's signature ensures the integrity of the data, which enables the user to determine the origin of the data and separate the user's trust in the data from the manner in which the data is obtained and the location of the data. Let β representing the logical coefficient condition of a short-term network, the simultaneous formula (2) defines the logical control criteria as:

$$M = R\sum_{x=1}^{c}[\beta(Lk) + G] \tag{3}$$

Where c, x represents the top of the system control domain, L representing data congestion molecules in short-term networks, k representing the initiative control factor, G represents the fault-tolerant vector of the system channel. The design of short-term network congestion active control system based on artificial intelligence is completed by integrating all the above-mentioned numerical and hardware execution conditions.

4 Experiment and Discussion

In order to verify the practicability of short-term network congestion control system based on artificial intelligence (AI), a comparative experiment is designed as follows. Supported by the basic platform of Linux, two virtual computers with the same configuration are used as the experimental objects, and recorded in the same experimental environment, after applying the new active control system and the common control technology, respectively. The change of data parameters in short-term network environment, the former as the experimental group and the latter as the control group.

4.1 Pre-experimental Preparation

For the sake of authenticity, the configuration of relevant experimental equipment and preparation of experimental parameters can be completed according to the following Table 1.

Table 1. Lab preparation table

Experimental parameters	Numerical condition	Experimental parameters	Numerical condition
Classification of simulation platform	Linux Foundation Platform	Experimental time	100 min
Control Node Distribution Coefficient	0.69	Basic congestion coefficient	0.43
Maximum Distribution Uniformity	About 70%	Limit congestion data volume	7.59×10^9T

In order to ensure the authenticity of the experimental results, the experimental group and the control group always keep the same experimental parameters.

4.2 Total Congestion Data Comparison

Under the condition that the basic congestion coefficient is equal to 0.43, 100 min is used as the experimental time to record the change of the short-term network congestion data after the application of the experimental group and the control system. The experimental comparison details are shown in Table 2.

Table 2. Total congestion data comparison Table

Experimental time/(min))	Control group total congestion data/($\times 10^9$T)	Total congestion data volume of experimental group/($\times 10^9$T)
10	7.12	3.42
20	7.15	3.21
30	7.19	3.18
40	7.23	3.07
50	7.28	3.03
60	7.36	3.35
70	7.47	3.36
80	7.55	3.29
90	7.64	3.24
100	7.79	3.24
Average value	7.38	3.24

It can be seen from Table 2 that when the experimental time is 10 min, the total congestion data of the experimental group is 3.42×10^9T, and that of the control group is 7.12×10^9T。 When the experiment time is 50 min, the total congestion data of the experimental group is 3.03×10^9T, and the total congestion data of the control group is 7.28×10^9T. When the experimental time is 80 min, the total congestion data of the experimental group is $3.24 \times$ 109t, and the total congestion data of the control group is 7.55×10^9T. The total congestion data of the designed system is significantly lower than that of the control group. With the increase of experimental time, the total amount of short-term network congestion data in the experimental group shows a trend of decline, rise, decrease and stability, and the average level in the whole experimental process is far below the ideal maximum value. The total amount of short-term network congestion data in the control group showed an upward trend, and the maximum value of the whole experiment was 7.79×10^9T, which was much higher than that of the experimental group.

4.3 Comparison of Distribution Uniformity of Main Control Nodes

Under the condition that the distribution coefficient of the control node is equal to 0.69, the change of the distribution uniformity of the main control node is recorded in the experiment group and the control group by using 100 min as the experimental time and the control system respectively. The details of the experiment are shown in Fig. 4.

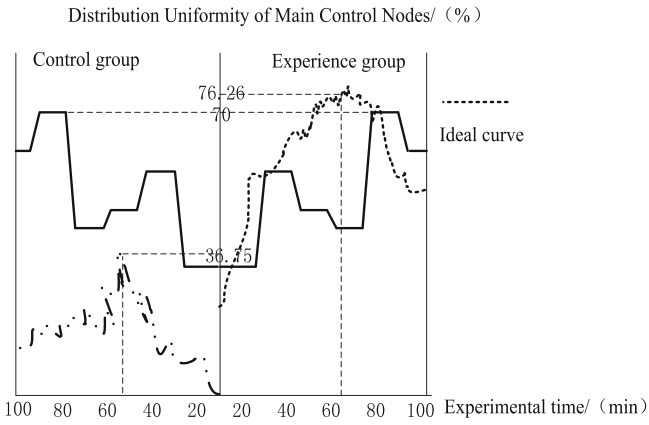

Fig. 4. Comparison of master node distribution uniformity

Figure 4 shows that the distribution uniformity of the main control nodes in the experimental group keeps a high level all the time, and the maximum value of 76.26% exceeds the ideal extreme value of 70%. The distribution uniformity of the main control nodes in the control group was relatively low, and the maximum value was only 36.75%, which was much lower than that of the experimental group.

5 Conclusions

The short-term network congestion active control system based on artificial intelligence aims to reduce the total congestion data and improve the distribution uniformity of the master node. It fully connects hardware execution devices such as motor modules, and determines the packet burst mechanism based on the definition of control nodes. The following conclusions can be drawn from the experiment.

(1) When the experimental time is 80 min, the total congestion data of the experimental group is 3.24×10^9T, and the total congestion data of the control group is 7.55×10^9T. The total congestion data of the design system is significantly lower than that of the control group, which shows that the system in this paper can effectively reduce the total congestion data.
(2) The distribution uniformity of the main control nodes of the system in this paper always keeps a high level, the maximum value of 76.26% exceeds the ideal extreme value of 70%, indicating that the distribution uniformity of the master nodes in this system is high.

From the perspective of practical application, the system has higher coordination ability and higher application and promotion value.

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