Design of Remote Video Surveillance System Based on Cloud Computing

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Abstract. Intelligent mobile network remote video monitoring system is an essential technology in the current society. In order to ensure the operation effect of Intelligent mobile network remote video monitoring system, the design method of intelligent mobile network remote video monitoring system based on cloud computing is proposed, and the system hardware structure and software function are optimized. Finally, the experiment proves that the design of an intelligent mobile network remote video surveillance system based on cloud computing has high practicability in practical application, and fully meets the research requirements.

Keywords: Cloud computing · Mobile network · Video surveillance

1 Introduction

With the rapid development of modern network communication technology, more and more enterprises and groups have shown the development of cross-region, and in this context, the use of network to achieve remote monitoring is beneficial for reducing the production costs of enterprises, improving labor productivity, and then improve production safety; on the other hand, with the expansion of production scale, equipment distribution is becoming more and more discrete, and video monitoring is quickly accepted by the majority of users with its real-time intuitive advantages, it is very easy to achieve web-based remote video monitoring. However, in the past, the video monitoring network usually used the common twisted pair or coaxial cable to realize the remote transmission and monitoring, and the video load of the video image with big data usually can easily cause the congestion of the network. Moreover, the network video monitoring system based on this mode has more complicated maintenance in the later period and is difficult to update the system. Therefore, we must try our best to realize the application of new technology in remote network video surveillance system [1].

Reference [2] designed a video surveillance system based on infrared human body detection. In the hardware part of the system, hc-sr501 infrared sensor is used to monitor the infrared signal of human body, and camera and cortex-a9 chip are used to collect and process video information The software environment is opencv and x265 function library, which are programmed with C ++ language. It can sense, record and compress video and remote monitoring of intruders according to infrared signals under unattended

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conditions. The system has strong flexibility in capturing video, but the data packet loss is large. Reference [3] designed a mobile remote video surveillance system. The system is composed of four modules. The intelligent vehicle based on Arduino system is equipped with a camera, which receives user instructions and is used for mobile video collection. The embedded Linux system realizes the real-time collection of video data through the v4l2 interface. On the one hand, it sends the data to the forwarding server through the network, and on the other hand, it forwards the control instructions from the user to the intelligent vehicle. The server is used to forward video to the client and user control instructions to the Linux system. The system can realize no dead angle monitoring, but the error is large.

The hardware part of the system is composed of the core system platform, the visual display part, the customer control center and the IP network. The software system can be divided into two parts, system layer software and application layer software. Cloud computing is used to analyze the dispersion of distribution characteristics and reduce the monitoring error of the system. Improve monitoring accuracy through cloud computing intelligent device drivers.

2 Intelligent Mobile Network Remote Video Monitoring System

2.1 Hardware Equipment for Intelligent Mobile Network Remote Video Monitoring System

The system can be divided into four parts: the system platform for core management, the visual display part for sensing and control, the customer control center, and the IP network which connects these parts before collecting all kinds of audio-visual data and signal monitoring. The structure of the remote video surveillance system is shown in Fig. 1.

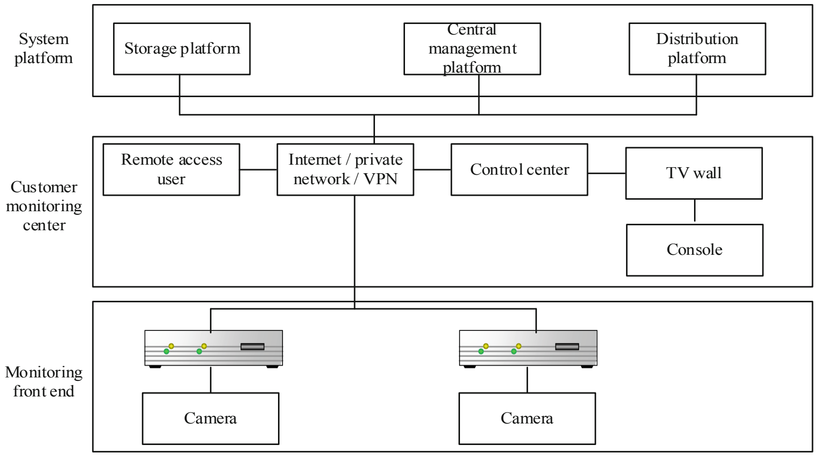

Fig. 1. Remote video surveillance system architecture

For large video-controlled network meters, a special space is usually set up for large mobile display devices for video and control [4]. Call it a customer control center: Generally speaking, for convenience, system platform devices are also placed with display devices. Therefore, there are two functions in the central control center: the system platform and the video sequence control display device. For the convenience of illustration, the "control center" in this paper only refers to the visual centralized control and display center, and the system platform will be described respectively. The core processor is ARM9 (ARM926EJ) processor architecture, adopts DDR2 memory, supports many kinds of Nandflash, and has rich internal resources and interfaces, with the advantages of low power consumption, low cost and high performance. The main hardware resources of the FL2416 development board are shown in Table 1.

Table 1. Main hardware resources for system development

Hardware	Describe
CPU processor	Pentium IV 8
SDRAM memory	32 GB
Flash storage	256M Byte SLC NandFlash
Interface resources	1 network port, 4 USB ports, 2 serial ports, etc

CPU processor is the core accessory of the computer. Its function is mainly to interpret computer instructions and process data in computer software. SDRAM memory is a dynamic random access memory with a synchronous interface. Flash storage is an electronic form of programmable read-only memory, which can be erased and written many times during operation. Interface resources is the channel to obtain resources from the website.

Multi-function network real-time monitoring system is generally divided into two stages, one is the real-time collection of the network, the other is the abnormal data diagnosis. On the basis of these two stages, the optimization of hardware structure and software function of the system is designed [5]. According to the features of multifunctional network, the hardware optimization structure diagram of the monitoring system is designed, as shown in Fig. 2.

As can be seen from Fig. 2, monitoring points 1, 2, 3, and 4 are distributed at various edge positions of the network, and the active monitoring method is adopted to monitor the monitored objects and topological information of the network, so as to facilitate the access of users; the central server refers to the server of the center where the data monitored by different monitoring points are gathered, so as to be able to manage various software configuration information in a timely manner; the data server refers to the data analyzed and monitored, so as to form a data sheet in a uniform format for the convenience of users to inquire; the data receiver refers to the data received by the central server, so as to facilitate the system distribution; the server refers to the important interface that requires users to provide the system with visual graphics, so

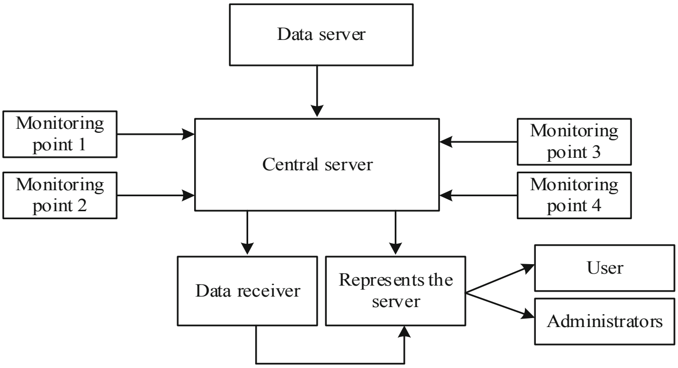

Fig. 2. Hardware optimization block diagram of monitoring system

as to analyze abnormal monitoring results [6]. Front-end equipment refers to the front-end video capture equipment placed in the monitoring site, sometimes including audio equipment and some alarm signal equipment. For a digital video monitoring system, there are generally three types of equipment: the camera, the audio equipment, the alarm equipment, the PTZ, the auxiliary lighting equipment or the infrared equipment and other auxiliary equipment, and the third type is the video server or the coding equipment that is responsible for the analog signals collected for such functions as analog-digital conversion, coding compression, encryption, processing and uploading. The connection structure of the specific front-end equipment of the system is shown in Fig. 3.

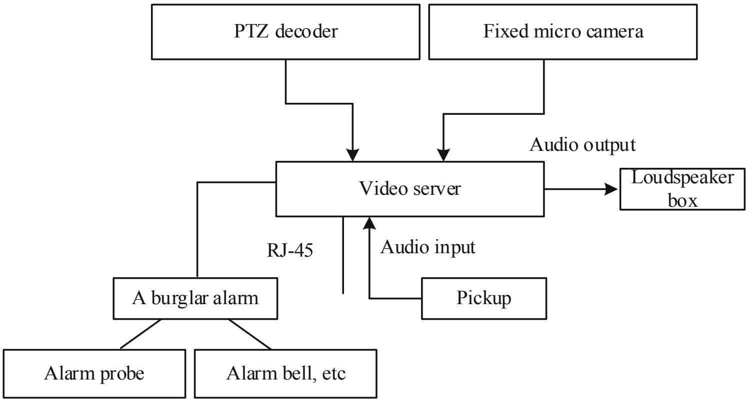

Fig. 3. System front-end device connection diagram

In the map configuration function of the system, it is required to provide the time and video of each video capture device of a certain region for the region attributes, video capture device attributes, alarm device attributes, video capture device group attributes and other functions; provide the video source time, video frequency source device name, video capture device name superposition method; set the backup directory, set the local video directory alarm; in addition, set the sound alarm monitor when the alarm occurs; set the video capture device that needs to be connected when the alarm device alarms; save the local settings in the local configuration file, and obtain [7] from the configuration file when necessary.

2.2 Software Functions of Intelligent Mobile Network Remote Video Monitoring System

The software occupies the core position in the entire intelligent mobile network remote video surveillance system and plays a vital role. The design of software should follow the method of software engineering, analyze the requirements of the whole software system, and then divide the software into different levels according to the functions, so as to make the system structure clear and realize modular design [8]. Based on the idea of software modularization and hierarchical design, the whole software system can be divided into two parts according to its functions: system layer software and application layer software, system layer software is used to separate application program from hardware, and application program operates hardware and controls equipment through the mechanism provided by the operating system. System layer software includes hardware initialization module, embedded operating system module and device driver module [1]. Application-tier software is used to accomplish certain specific tasks for users. The application software can be divided into two parts: video front-end server software and monitoring center client software. The client software includes video image storage module, image display module and video image processing module, in which the video image processing module is divided into video image preprocessing module and moving object detection and display module, as shown in Fig. 4.

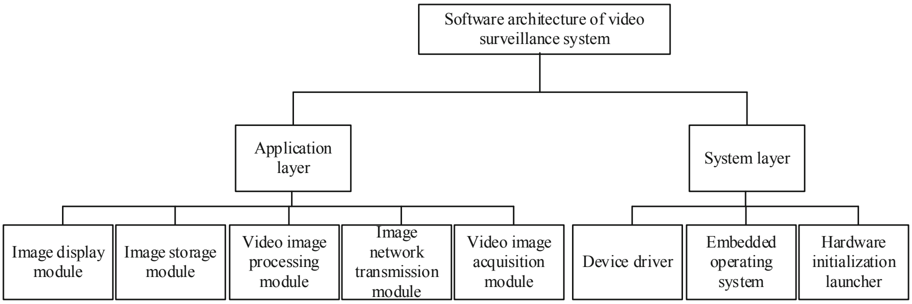

Fig. 4. System software functional architecture diagram

The system has complex implementation functions, and its overall structure shall include several necessary modules, of which the most basic modules are system configuration module, monitoring function and communication module, and the upgrading function module includes equipment management function module, playback function and electronic map module, etc. For example, in the process of MPEG-4 coding, I code and P code are needed to improve the speed and effect of video compression. After the embedded hardware platform is built, the embedded software system can be developed.

The development flow of the intelligent mobile network remote video monitoring system is shown in Fig. 5.

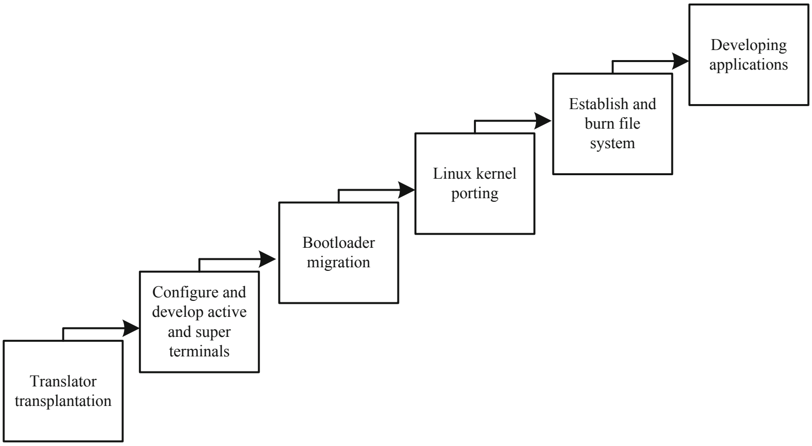

Fig. 5. Intelligent mobile network remote video surveillance system development process

Host is a general purpose computer with powerful software and hardware development resources. Developing embedded application with host environment can greatly improve efficiency. The target board is the actual platform of application program execution, and the software and hardware resources are limited. The host computer and the target computer communicate through a serial port or an Ethernet port. The development flow of embedded server software of video monitoring system is as follows: Firstly, the development environment is configured on PC, such as cross compiler, cross compiler and cross connector, and the application software is developed, then the executable code on the target platform is generated by cross compiling, then the code is downloaded to the target board and analyzed and debugged by cross debugger. The running status of the application on the target board can be seen on the host through the serial communication software, the premise is to connect the host and the target board through the serial port line, and to configure the designated terminal as the serial port when the Linux kernel is cross-compiled. This system uses Secrecrt serial communication software, which has the characteristics of high speed, openness and wide support for all kinds of communication protocols. In this process, frame I has some limitations of its own, in addition, there are other differences between the two, for example, the frame is used forward time, and P frame is two-way time. Background subtraction is a technique that uses the background image as a reference object, stores the background image first, and then subtracts the foreground image and background image to identify moving objects. Generally, because the gray value of the moving object is very different from the gray value of the background, the different image will change greatly only in the region with the moving object. A proper threshold is chosen, when the gray value of the difference image is larger than the threshold value, it is regarded as the moving target point. Otherwise, the background subtraction method is regarded as the background subtraction method. The realization flow chart of moving object detection is shown in Fig. 6.

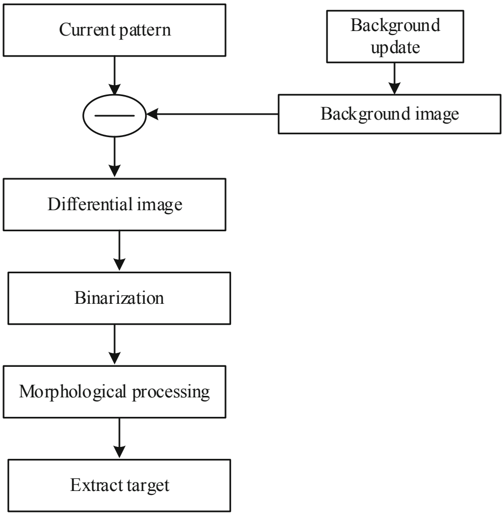

Fig. 6. Realization flow of moving object detection

When the camera is still, the simplest background selection method is to use a fixed frame image as the background, but this method is greatly affected by the external scene, and is not suitable for complex and changing background environment. The acquisition of initial background image plays a vital role in the accuracy of target detection and the update of background image. A good background model requires that the background can be accurately extracted if the target is moved in or out of the background during the initialization process. In this paper, an effective background initialization algorithm is proposed based on the traditional time averaging method. The basic idea is that: in general, the time of moving target in a region is limited, and those points with great difference are caused by the moving target. The moving object region is obtained by the method of difference between adjacent frames, the moving object pixels are discarded, and the non-moving object pixels are averaged by multi-frame cumulation. Firstly, the region of the moving object and the region of the non-moving object are separated by the difference image, and the region of the moving object is invariant. Update the previous background image B_i by binarizing the image B_{i-1}, namely:

$$B_i(x, y) = \begin{cases} B_{i-1}(x, y) \\ \alpha I_t + (1 - \alpha)B_{i-1}(x, y) \end{cases} \tag{1}$$

where, (x, y) is the coordinate of the target point, I_t is the monitoring duration, and α is the number of monitoring points.

Once the network is abnormal, then the IP address and port distribution will change. If the network configuration is wrong, both the original IP address and the destination IP address will increase, resulting in a sharp increase of the host packets. Assuming the feature is A, the total number of samples is B, the number of samples selected is C, and the number of occurrences of i for a particular feature is n_i. Therefore, the feature samples can be defined as follows:

$$F(x) = -\sum_{i=1}^{C} \left(\frac{n_i}{B}\right) \log_2\left(\frac{n_i}{A}\right)$$
$$B = \sum_{i=1}^{C} n_i \quad (2)$$

If the values of all the selected samples are the same, then $F(x) = 0$; if the values of all the selected samples are more scattered, then $F(x) = \log_2^C$. This describes the abnormal behavior of the different characteristics, as shown in Table 2.

Table 2. Network abnormal behavior characteristics table

Anomaly type	Exception definition	Abnormal characteristics
Wrong configuration	Device failure caused by incorrect configuration of routing port	Large abnormal characteristic value The normal eigenvalue is large
Service attack	Service attack	The abnormal characteristic value is small Normal eigenvalue is small
Burst access	Multiple hosts send to a single host	Large abnormal characteristic value Normal eigenvalue is small
Worm scanning	A small number of ports on the destination host are detected	The abnormal characteristic value is small The normal eigenvalue is large

There are many ways to control the frame rate, for example, by reducing some images and changing the frame rate of the image. To this end, the original frame rate can be reduced to a certain extent, so that the code rate is reduced, and finally can increase the clarity of image monitoring, but also there will be image cassette or jitter. However, in the real operation of monitoring, it is necessary to analyze the actual situation and explore the appropriate solution. The method to adjust the bit rate is called the slow rise and fast fall method. The main strategy is to improve and multiply. This has something in common with TCP, if the stability of the full load rate can be guaranteed, and once the congestion situation is present, the code rate will be reduced, no congestion will continue to increase.

2.3 Realization of Network Video Remote Intelligent Monitoring

Video surveillance system with its real-time, intuitive features, has been favored by the majority of users, in the traffic, environmental protection, electricity, forest fire protection applications. Video surveillance system will be along the "high-definition, mobile, intelligent" direction of development. The video surveillance system transmits the data through wireless, the wireless communication way has WLAN, the mobile communication network, the satellite communication system and so on. Mobile communication network has the advantages of moderate cost and long transmission distance, and is suitable for long-distance data transmission network. For the specific use of network transmission, it depends on the requirements of the monitoring system for the transmission rate, which is related to the video resolution. The main resolutions of the system are CIF, D, 720P, 1080P. The high resolution images are of good quality, and the required bandwidth is large, which is shown in Table 3.

Table 3. Table of requirements for stable transmission bandwidth at different resolutions

Resolution type	CIF(363 × 289)	D1(705 × 577)	720P(1280 × 720)	1080P(1920 × 1080)
Stable transmission bandwidth	251 kbps	At least 522 kbps	At least 1 Mbps	At least 2 Mbps

The database of the video monitoring system of the power substation mainly records the relevant data during the operation of the system, and the relevant constant data of the system itself, for example: the path of the video file is stored in the database, and when it is called, it first queries the database to find out the corresponding file path, and then browses the monitored video through streaming media technology; the database design idea The database design is the process of building a database suitable for the current application on the basis of the database selection, which includes the analysis of the user's needs, and generally, the database design process mainly includes conceptual design, logical design and physical design, as shown in Fig. 7.

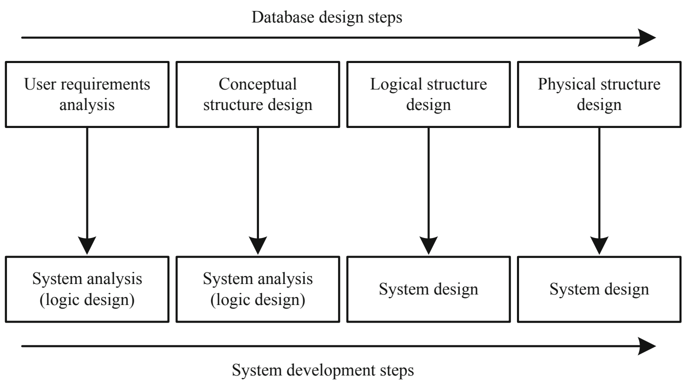

Fig. 7. Relationship between database design and system development

In cloud computing, device drivers are considered to be the interface between kernel and hardware. Cloud computing intelligent device drivers abstract the implementation of specific hardware devices. For users, operating hardware devices and operating files are the same, that is, using standard APIs (system call interfaces) to complete specific operations such as reading, writing, and controlling hardware devices, while device drivers exist to implement these system call functions. The cloud computing smart device driver architecture is shown in Fig. 8.

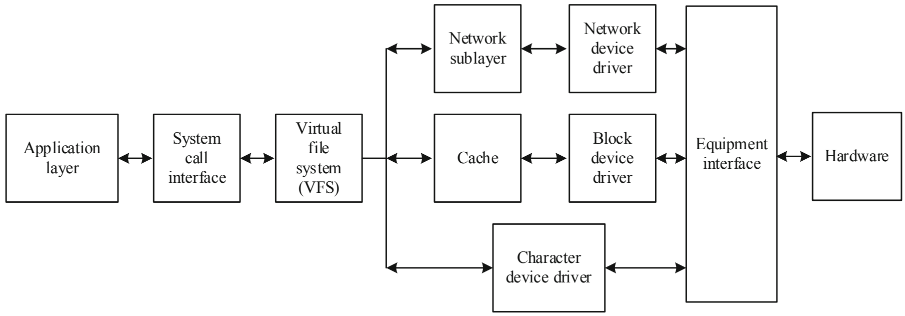

Fig. 8. Cloud computing smart device driver architecture

Writing and implementing cloud computing applications is an important step in the overall system. After the system development environment is built and customized, the development environment and running environment of cloud computing application are established. In this system, a camera driver is added to the core, and the user application program can complete the collection of video image data through the video device programming function of the system. This system video frequency monitoring terminal mainly realizes the video frequency module the collection and the transmission function. According to the software design and server-side program design of the monitoring system, the video image collection and transmission design is implemented by the embedded streaming media server. The JPEG image is first collected and compressed by the streaming media server, and then forwarded to the HTTP server. The HTTP protocol is used to transmit the image data through the TCP connection, which is parsed and displayed by the browser.

3 Analysis of Experimental Results

In order to verify the feasibility of multi-function network real-time monitoring system optimization, under the same experimental conditions, the multi-functional network real-time monitoring optimization system and the traditional system are tested. Taking the network anomaly monitoring error as the experimental object, the traditional monitoring system and the multifunctional real-time monitoring optimization system are compared to the network anomaly monitoring error, PC host: the main function is to establish a cross-compiling environment, compile and transplant embedded Linukou operating system and other applications, as well as development and debugging work. The software environment is as follows: A. Operating system: Windows 7; B. Virtual machine: Vmware 10; C. Linux operating system: Ubuntu 12.04/Linux3.2.0–23 kernel; D. serial debugging tool: remote management software Recrect; E. Java operating environment: JRE 1.6, server: FL2416 development board and its peripheral devices. All application programs on the server side are running on the FL2416 development board. The operating environment configuration is shown in Table 4.

Table 4. System run environment configuration

To configure	Parameter table
CPU	Inter(R) Core(TM) i5-2430M 2.4 GHz
SDRAM	16G
FLASH	NandFlash 256 MB
Chip card	DM9000
USB camera	Hamedal
USB wireless network card	Wing joint EDUP
Peripheral memory card	SDHC card 16G
Embedded operating system	Linux3. 1.8 kernel

The compatibility test of browsers is mainly to test whether the interface function is realized normally when the system uses different browsers. The compatibility of different browsers is tested using different mobile terminals with different operating systems (Windows, Android, iOS). The test results of several browsers in common use are shown in Table 5.

Table 5. Browser test results

Browser type	Interface display	Function operation	Test result
Internet Explorer	Normal	Normal	Normal
360 browser	Normal	Normal	Normal
QQ browser	Normal	Normal	Normal
Firefox browser	Normal	Normal	Normal
Sogou browser	Normal	Normal	Normal

The test results show that the system works well in most browsers. The results can be used as the basis for evaluating the feasibility of system optimization. If there is noise interference in the network monitoring, the whole system will be affected and the accuracy of monitoring will be greatly reduced. In the process of system optimization, the monitor is optimized and the abnormal output signal is amplified by the amplifier with larger resistance, which can effectively reduce the impact of noise interference and thus reduce the monitoring error. In view of the abnormal monitoring of the network, the output signal trend is analyzed, as shown in Fig. 9.

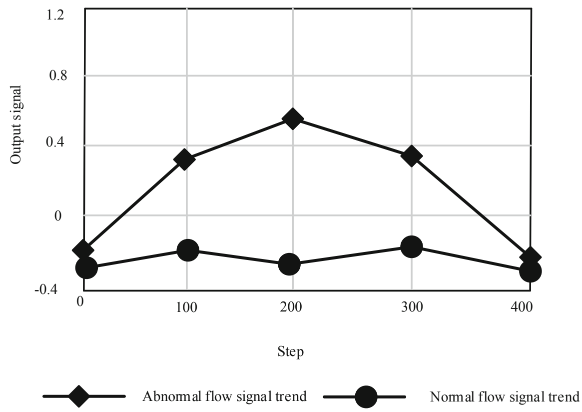

Fig. 9. Abnormal or not monitoring output signal trend

The monitoring error value is an important indicator to measure whether the system can accurately capture data. The smaller the error value, the higher the accuracy of capturing data. Under the influence of noise, the error of network anomaly monitoring is compared between traditional monitoring system and multi-function network real-time monitoring optimization system, and the result is shown in Fig. 10.

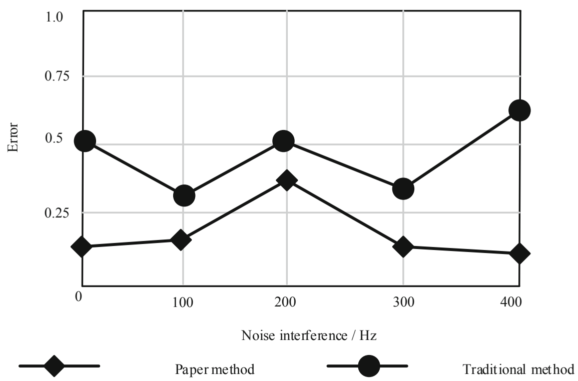

Fig. 10. Comparison of monitoring error between two systems under noise

As can be seen from Fig. 10, the maximum monitoring error of the multi-function system is 35%, and the maximum monitoring error of the traditional monitoring system is 50%. In the case of noise interference, the monitoring error of multi-function system is small. The traditional network monitoring system can't accurately capture the data, resulting in a large increase in the loss of data packets. Therefore, when optimizing the system, the packet capture function is designed. Packet capture is to intercept, retransmit, edit, transfer and other operations of data packets sent and received by network transmission, and is also used to detect network security. Packet capture is also often used to intercept data.

In order to verify the effectiveness of this function, the error of network monitoring between the traditional monitoring system and the multifunctional real-time monitoring optimization system is compared, and the result is shown in Fig. 11.

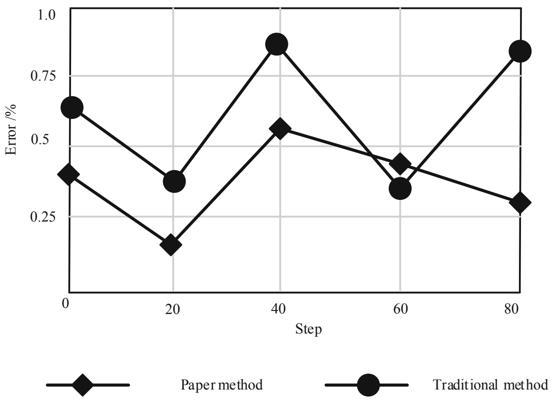

Fig. 11. Comparison of error of network anomaly capture in two systems

As can be seen from Fig. 11, the maximum error rate of the multi-functional network real-time monitoring optimization system is 55%, and the maximum error rate of the traditional monitoring system is 90%, which proves that the optimal design of the grabbing function has less error in real-time monitoring the abnormal network problems. Based on the above experimental contents, the experimental conclusion can be drawn: under the condition of noise interference, the error of multi-function system is small. After the optimization design of monitoring function, the error of multi-function system is small. Therefore, the method of this paper is feasible.

4 Conclusion

Embedded network video monitoring system based on cloud computing technology has more advantages than traditional remote network video monitoring system, such as suitable for long distance transmission, simplifying system structure and development cost. Therefore, in recent years, the mobile intelligent network video surveillance system based on cloud computing technology has been widely used, so the network video surveillance system based on cloud computing technology has become the inevitable trend of the development of network remote surveillance system. This paper discusses the development and realization of network remote video monitoring system in detail with cloud computing technology. It has a good guiding significance for the research of network remote video monitoring. Of course, the embedded network video surveillance system designed in this paper is only designed from the embedded point of view. With the improvement of mobile network transmission speed, the performance of intelligent mobile network remote video monitoring system should be constantly improved. Which need to be the joint efforts of the majority of technical personnel, can finally realize the rapid development and application of network video surveillance technology based on cloud computing.

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