Test method of railway video surveillance system

Zhenyu Zhang*, Yong Qin

[1]*State Key Laboratory of Rail Traffic Control and Safety, Beijing Jiaotong University, Beijing 100044, China*

[2]*School of Traffic and Transportation, Beijing Jiaotong University, Beijing 100044, China*

Received 25 July 2014, www.cmnt.lv

Abstract

Test method of railway video surveillance system was mainly explored in this paper. In order to evaluate accurately railway video surveillance system, based on railway video surveillance system test platform, an objective, direct and effective test system was established for testing equipment requirements, system functionality and performance. In addition, it provides standard of railway video surveillance system and makes field of video surveillance standardization.

Keywords: railway, video surveillance, test method

1 Introduction

As a means of intuitive, real-time and accurate remote monitoring and management, video surveillance plays an important role in social safety, economic development and the construction of all industries. With the development of Chinese railway, the video surveillance system become more and more important in transport scheduling, public security, organization, security monitoring and other aspects [1]. All kinds of railway information system need the video surveillance system urgently. The video surveillance system has been widely used in key areas in railway station, the signal room, rail overpass, it provides better protect for the safety of railway. However, these systems have some problems, such as limited application, small-scale networks, not having the conditions for networking and sharing resources, maintenance management is not standardized. In order to meet Chinese railway leapfrog development of the new requirements, establishing full coverage, three-dimensional, highly reliable railway video surveillance system with height information sharing has become the focus of system and the only way [2].

2 Test purpose and test system

Railway video surveillance system has entered the standardized operation and management stage currently, but as time goes on, the shortcomings in system application process gradually come out, multi-point with long line, multi-equipment model, network technology is more complex, and different technical standard. Testing and acceptance of equipment's' quality and functional performance in railway video surveillance system is not perfect, and lack scientific and effective methods of testing and evaluating system. For these reasons, an objective, direct and effective test system is an urgent need to test the railway equipment quality and overall functionality of railway video surveillance system and accurately evaluate the system.

Based on "Railway video surveillance system technical specifications" and "Video security monitoring system design specification", learn from the previous research [3-8] on railway video surveillance system, the following system was proposed to establish for testing and evaluating railway video surveillance system, shown in Figure 1.

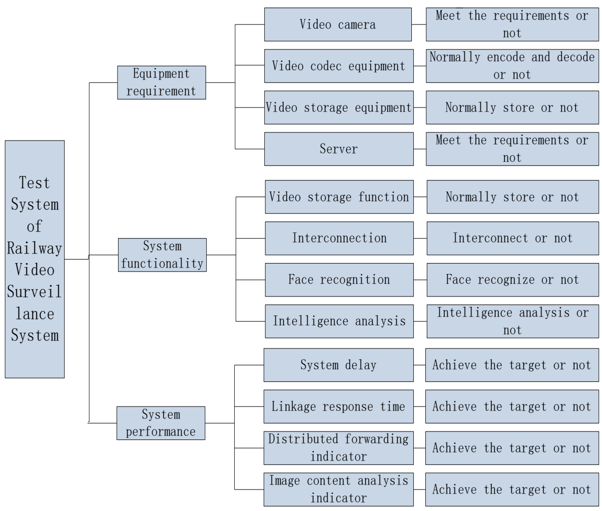

FIGURE 1 Test system diagram of railway video surveillance system

The system mainly focuses on the analysis of equipment requirements, system functionality and system performance in railway video surveillance system.

* ***Corresponding author*** e-mail: zhangzhenyu7@foxmail.com

3 Railway video surveillance system platform test

3.1 TEST ENVIRONMENT

Railway video surveillance system platform test environment topology has been shown in Figure 2.

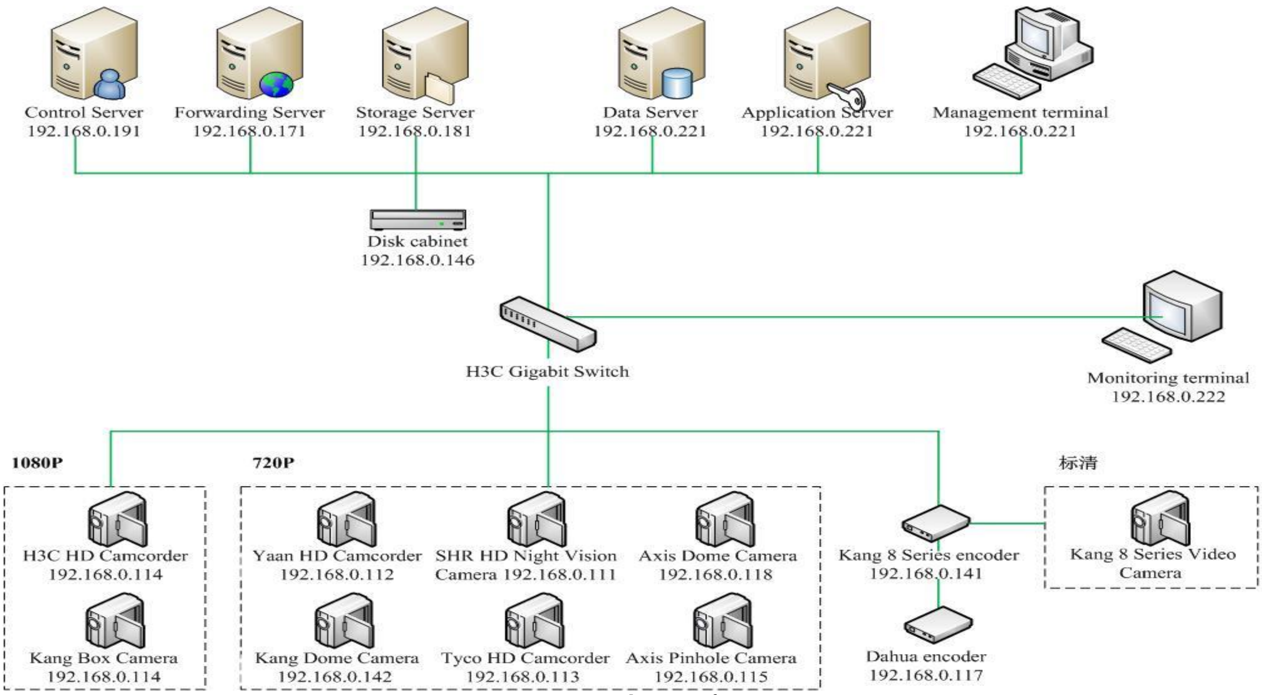

FIGURE 2 Connection diagram of test environment

3.2 EQUIPMENT REQUIREMENTS

The equipment of railway video surveillance system has been no strict requirements of the standard equipment. Different companies have different equipment's and standards, and the equipment is not compatible with each other, which makes the whole system run by a very good big impact. Therefore, in order to make the whole railway video surveillance system to function, to reduce the possibility of error, the railway sector makes hard targets to the equipment of the requirements. These equipment's include cameras, codec's equipment's, storage equipment, servers, etc. Railway video surveillance system platform hardware parameters are shown in Table 1.

TABLE 1 Hardware configuration table of railway comprehensive video surveillance system platform

N	Equipment Name	Equipment Type	Specification	Remark
1	Server	BCECR-N8000	CPU: Intel Core 2 Duo E7500 Memory: 4G	3
2	Lenovo Desktop Terminal	Think Centre	CPU: Intel Core 2 Duo E7500 Memory: 4G Graphics: NVIDIA GeForce G100	2
3	Kang encoder	Kang	Kang 8 Series	1
4	SHR HD Night Vision Camera	SHR	SHR-HLV400HK	1
5	Yaan HD Camcorder	Yaan	HDH5407E-H65-R21	1
6	Tyco HD Camcorder	Tyco	AV1305DN	1
7	Kang Dome Camera	Kang	DS-2CD763PF-E 2.7-9mm	1
8	Kang Box Camera	Kang	DS-2CD877DF	1
9	Axis Pinhole Camera	Axis	Unknown	1
10	Axis Dome Camera	Axis	AXIS P3344 6MM Fixed	1
11	H3C HD Camcorder	H3C	IPC-HIC-5421	1
12	Dahua encoder	Dahua	DH/DVR1604HE	1
13	Disk cabinet	SkySan	SkySan SS1500	1

Seen from Table 1, railway video surveillance system in accordance with the equipment requirements, cameras, video encoding and decoding equipment, video storage equipments, servers and other equipment are essential to meet specified technical requirements. On this basis, the railway video surveillance system built the platform preparing for subsequent system functional and performance testing.

3.3 FUNCTIONALITY TEST

Railway video surveillance system functions include video acquisition, processing, real-time monitoring, storage, playback, PTZ control, video distribution / forwarding feature, the video content analysis, alarm, linkage, system interconnection, system management and user management.

Because the system function contains the complex and multiple contents, real-time video viewing, PTZ control, video playback and video storage were selected as test objects, and then evaluated the railway video surveillance system.

1. Real-time video viewing. All access equipment's can normally browse images (single-screen, multi-screen). Through the HD camera's configuration, the terminal can display text, time and other OSD overlay information.

2. PTZ control. All access cameras only Yaan HD cameras, SHR HD night vision cameras and Kang 8 Series SD PTZ camera support PTZ control, the above three kinds of equipment's are able to achieve PTZ call, zoom and focus functions.

3. Video playback. The platform used storage server for video. The video stored on disk cabinet and can playback history through monitoring terminal.

4. Video storage. The merits of storage equipment's and storage mode are important to video surveillance system. Good storage equipment's are helpful to improve operational efficiency and stability of the video surveillance system and greatly enhance its overall performance. Here Iometer software was used to test the performance of storage equipment's.

Iometer is a tool used to measure and describe the I/O subsystem work in single and clustered systems. It is responsible for the determination of the control system performance under load.

In order to obtain the performance value of the storage equipment, the storage performance under different conditions were tested, such as the load, sequential random percentage, read and write percentage.

TABLE 2 Performance value of storage equipment under different loads

Project / Load	IPOS	MBS	Average Response Time	Maximum Response Time	CPU Utilization
4K	22362.95	87.36	0.72	18.48	31.26%
8K	11775.55	92	1.36	33.43	22.38%
16K	5982.97	93.48	2.67	63.8	13.75%
32K	3346.82	104.59	4.78	57.7	9.42%
64K	1750.95	109.43	9.14	61.22	7.73%
128K	878.62	109.83	18.21	90.92	7.38%
256K	447.46	111.86	35.76	110	6.61%
512K	224.28	112.14	71.35	127.14	6.05%
1024K	111.6	111.6	143.27	168.15	6.34%

IOPS is capabilities of read and write per second, MBS is the amount of data transmitted per second.

Table 2, respectively, describes the 5 performance indicators of the storage equipment's, showed that read and write per second and CPU utilization decreased as the load increased, the average IO response time and the maximum IO response time increased significantly as the load increased and the amount of data transmitted per second change little while load changed. It can be seen that the data transmit capability of the storage equipment's is strong. In the condition of high load, the read and write capacity per second become weak and both the average IO response time and the maximum IO response time are longer, which are limited to the equipment only in the low load operation.

TABLE 3 The performance value of read and write percentage of different storage equipment

Project / Read and write	IPOS	MBS	Average Response Time	Maximum Response Time	CPU Utilizatio n
80%	111.53	111.53	143.38	274.03	9.06%
60%	111.07	111.07	143.94	316.1	11.17%
40%	112.66	112.66	141.92	301.66	12.92%
20%	115.49	115.49	138.48	468.86	16.54%

As is shown in Table 3, the read and write percentage have few impacts on read and write capacity, the amount of data transmitted per second and the average response time of IO.

TABLE 4 Performance value of storage equipment's under different sequential random percentage

Project / Sequence	IPOS	MBS	Average Response Time	Maximum Response Time	CPU Utilization
80%	110.52	110.52	144.66	283.32	6.55%
60%	109.82	109.82	145.58	235.26	6.5%
40%	109.47	109.47	146.19	247.71	7.08%
20%	109.89	109.89	145.6	262.29	6.6%

In the 5 performance indicators of the storage equipment described in Table 4, the sequential random percentage changes a lot, the indexes of storage equipment's changed little, it is stable within a certain range. The equipment can work efficiently under different sequential random percentage.

Seen from the test results, the performance values meet all the normal operating needs and storage equipment's performance is good. But the equipment's in a high load condition, the reading and writing literacy per second decline, the average IO response time, maximum IO response time and the CPU utilization all increase. This shows that there are certain problems of the stability of equipment when it works under high load. The read and write percentage and the sequential random percentage have few impacts on performance of storage equipment's. The equipment can work effectively under different read and write percentage and sequential random percentage, the disruption is small. As the equipment's' limited, this test cannot test a variety of equipment's in contrast, so only one single equipment to be tested.

3.4 PERFORMANCE TEST

System performance tests include video network performance, network bandwidth, response latency, distribution and forwarding capabilities, stability and reliability, quality and assessment of system images and other aspects.

1. System delay. System delay is the time from the monitoring platform issuing commands to the time front-end equipment executing the command. By monitoring and analysing network signalling processes, the time of terminal issuing the command and the time of the recipient response to the confirmation message are easy to obtain, the relative difference between the two is test delay. The results show that, the case of automated testing tools simulate 200 users simultaneously request to video, first packet video data is received taking 3.728 seconds maximum, minimum taking 0.035 seconds, average time is 0.438 seconds.

2. The forwarding server. As Gigabit Ethernet performance is not good, the server configuration is low. In 110-way store and 200 users simultaneously request to single-channel video, then forwarding server CPU utilization is 38% and bandwidth is 294.1Mbits/s.

3. Storage server. Because the test conditions cannot afford to multiple users simultaneously requesting and browsing video, so this test use automated testing tools simulate multiple (200) users for real-time video viewing. Iometer was used to simulate the 100-way video source, and the storage server videoed and stored. Because of lower server configuration, the CPU utilization is 40% and bandwidth is 245.1Mbits/s when the storage server video 110-way (HD + simulation, where HD 108-way, SD 2-way).

Note: The total bandwidth is low, due to Axis HD camera with a better coding algorithm. Without reducing the image quality to lower image stream, Axis is helpful to transmit image data.

4. Network bandwidth. Video network bandwidth was decided by the number of user terminals, real-time video images large ones that each user terminal allows simultaneous transfer to see, network flow control mechanisms, storage mechanism, image quality requirements of each real-time video, historical image quality requirements.

Based on the platform, six types of cameras were tested for single-screen, multi-screen (dual-screen, three screens, four screens) real-time image viewing, analysis its monitoring terminal static and dynamic image occupy computer performance (CPU, bandwidth). Test configuration has been shown in Figure 3.

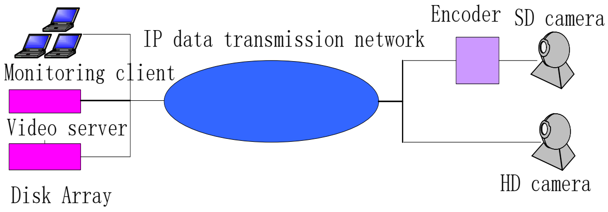

FIGURE 3 Test diagram of network bandwidth configuration

Table 5 shows the CPU and bandwidth:

TABLE 5 CPU, bandwidth consumption of single-screen, multi-screen static and dynamic images

	Single screen	Dual screen	Three screens	Four screen	Explanation
Video camera1	(10%, 4M)	(21%, 6.9M)	(25%, 10.4M)	(38%, 13.7M)	Static images
	12%, 4.8M)	(26%, 9.1M)	(36%, 13.3M)	(51%, 17.5M)	Dynamic images
Video camera 2	(9%, 4.5M)	(16%, 9.0M)	(34%, 13.4M)	(44%, 18.0M)	Static images
	15%, 4.4M)	(27%, 8.5M)	(49%, 15.8M)	(65%, 22.3M)	Dynamic images
Video camera 3	10%, 4.5M)	(25%, 9.2M)	(39%, 13.5M)	(55%, 18.2M)	Static images
	11%, 4.4M)	(33%, 9.7M)	(43%, 14.3M)	(56%, 16.8M)	Dynamic images
Video camera4	(11%, 18.3M)	(23%, 43M)	(36%, 63.4M)	(53%, 85M)	Static images
	(12%, 20.9M)	(26%, 39.5M)	(40%, 58M)	(47%, 79M)	Dynamic images
Video camera5	(18%, 180K)	(39%, 336.1K)	(55%, 524.5K)	(78%, 700.5K)	Static images
	21%,1.3M)	(43%, 3.3M)	(61%, 3.2M)	(85%, 5.6M)	Dynamic images
Video camera6	(19%, 700.6K)	(41%, 1.4M)	(56%, 2.1M)	(80%, 2.8M)	Static images
	19%, 1.3M)	(55%, 6.8M)	(73%, 9.6M)	(92%, .1M)	Dynamic images

After the system performance test, system latency, forwarding servers, storage servers, network bandwidth meet the requirements. It has good platform compatibility and can access 8 types of equipment's, including six types of high-definition and two types of standard definition. Terminal interface on the platform can browse all types of real-time image and playback the history images normally.

In the terminal configuration, the monitoring terminal maximum decoding is 4-way 720p, CPU utilization is about 38%, while 1-way 1080p, CPU utilization is about 48%. In the condition of the server configuration, forwarding server maximum support 310 channels video data forwarding, storage server supports 110 channels storing. The server CPU utilization reached 40% in the moment, far exceeding the requirements of engineering applications (10% -20%),it is recommended for servers and terminal hardware configuration upgrade (Note: engineering applications generally require the terminal CPU utilization below 40%, the server CPU utilization below 20%). Delay indicator of asking video showed no significant impact on HD mixing with SD test.

4 Conclusions

In this paper, mainly using Imoeter software tested on equipment requirements, system functionality and performance, including video storage equipment's, network bandwidth in a variety of states. The results show that this method can be applied to the various functional and performance testing of the railway video surveillance system, and can achieve better results.

Through research and test, a set of railway video surveillance system testing methods is initially formed to accurately evaluate the railway video surveillance system to ensure that the system can stably and efficiently run.

Acknowledgments

The authors would like to express their thanks to the editor and anonymous reviewers for their help in revising the manuscript. This research is sponsored by National Key Technology R&D Program of China (2011 BAG01B05).

References

[1] Qin Y, Peng H J, Zhu L X 2010 Design and implementation of interoperable platform of railway integrated video monitoring system *Railway Signalling & Communication Engineering* **7** China Railway Publishing House Beijing 17-20 (*in Chinese*)

[2] Huang Z H 2012 Railway video surveillance engineering testing technical analysis *Railway Signalling & Communication Engineering* **9** China Railway Publishing House Beijing 26-9 (*in Chinese*)

[3] Lin H W, Tu D, Li G H 2003 Based on cutting off background technology moving target detection method *Journal of the National Defense University* **25** National Defense University Press Changsha 66-9 (*in Chinese*)

[4] Liu X, Liu H, Qiang Z P, Geng X T 2008 Adaptive background modeling based on mixture gaussian model and frame subtraction *Journal of image and graphics* **13** Science Press Beijing 729-34 (*in Chinese*)

[5] Wang J 2010 Research on detection technology of railway video surveillance system *Railway Signalling & Communication Engineering* **7** China Railway Publishing House Beijing 10-2 (*in Chinese*)

[6] Chang C-c, Lin L-k, Tsai C-h 2010 A real-time surveillance system of electric multiple units (EMUs) in Taipei MRT *Proceeding 2010 Sixth International Conference on Natural Computation IEEE Piscataway* 4425-9 (*in Chinese*)

[7] Bocchetti G, Flammini F,Pragliola C, Pappalardo A 2009 Dependable integrated surveillance systems for the physical security of metro railways *Third ACM/IEEE International Conference on Distributed Smart Cameras(ICDSC) IEEE Computer Society Piscataway* 7-10

[8] Xie Z Y, Dong B T, Chen Y L, Yang Y F 2011 Comparative study on moving detection method of video surveillance system in China high-speed railway transport hub *Key Engineering Materials* v467-469 *Trans Tech Publications Elsevier Switzerland* 503-8

Authors

Zhenyu Zhang, born in 1991, Nanchang, China

Current position: Master student of Beijing Jiaotong University, China.
Scientific interest:: transportation safety, intelligent transportation, reliability of urban rail vehicle.

Yong Qin, born in 1971, Xuzhou, China

Current position: Doctor of Traffic information engineering and control, professor and doctoral supervisor in Beijing Jiaotong University, China.
University studies: Transportation signal and control in Shanghai Tiedao University.
Scientific interest: intelligent transportation system, transportation safety, transportation information system, intelligent control.