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Design and implementation of a measurement system for power station video and environment surveillance system

Zhengwei Chang[a], Dongsheng Cai[b]*, Wei Zhen[a], Qi Huang[b]

[a] Sichuan Electric Power Research Institute, No 24, Qinghua Rd., Chengdu 610072, China
[b] School of Energy Science and Engineering, University of Electronic Science and Technology of China, Chengdu 611731, China

Abstract

The unattended power stations are more and more popular in smart grids. But how to make the unattended power stations visual is a big problem. So the build of video and environment surveillance systems is an effective solution. But due to too many manufacturers the video and environment surveillance systems of power grids have been faced a huge number of problems, such as the issue of interconnection and interworking. In order to solve this problem, we designed a test system of video and environment surveillance system to test the consistency of device communication protocol to ensure interoperability of equipment. The test system is to simulate the real equipment of video and environment surveillance systems, so tests in the laboratory can replace that in the real operating environment.

Keywords: Video and environment surveillance system, communication protocol, simulation measurement, power station

1. Introduction

Video and environment surveillance systems have been one of the focuses of attention to the application of technology. Because of intuitive and abundant information video and environment surveillance systems are widely used in many occasions. The substation video and environment surveillance systems [1]-[2] which could show the targets in real-time, visual and veritable, and monitor them in continues time greatly improve the management efficiency and level of automation. However, too many manufacturers bring in a great challenge for the interconnection between the equipment, and also a great deal of work for the maintenance of substation. To be specific, the challenge and question are reduced to three basic points:

1) There is a variety of image compression technology (such as MPEG4 and H.264), and huge quantities of all kinds of audio and video compression equipment[3], which make it difficult to communicate with each other.

2) Substation surveillance system works independently, resulting in a unique isolated island.

3) Proprietary SDK protocols are used in video and environment equipment, conducing poor compatibility between devices.

In order to solve the problem caused by proprietary SDK protocols, we designed a set of video and environment surveillance test system to create a unified standard for the communication protocol tests of the video and environment surveillance system in the grid. In addition, the test system can simulate the testing device and environment of video and environment surveillance system.

This paper presents the implementations of the video and environment surveillance test system scheme. Section 2 describes the composition and structure of the video and environment surveillance system in order to understand the tested object, Section 3 describes the test methods and Section 4 shows the design details of the test system software. The last section concludes the paper.

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* Manuscript received June 25, 2013; revised August 15, 2013.
Corresponding author. Tel.: +86-28-61830661; *E-mail address*: cai.dsheng@gmail.com.

2. Video and Environment Surveillance System

The architecture [3] shown in Fig. 1 is about the video and environment surveillance system of Sichuan Province Grid Corporation which is consisted of provincial platform, city platform, county platform and power station video and environment surveillance systems. In typical, only the VESP (video and environment surveillance platform) in Chengdu has the county platforms [4]. As shown in Fig.1, the power station video and environment surveillance system is consisted of VESAP (video and environment surveillance assistant platform), NVR (network video recorder), ER (environment recorder) and IPCs (IP camera).

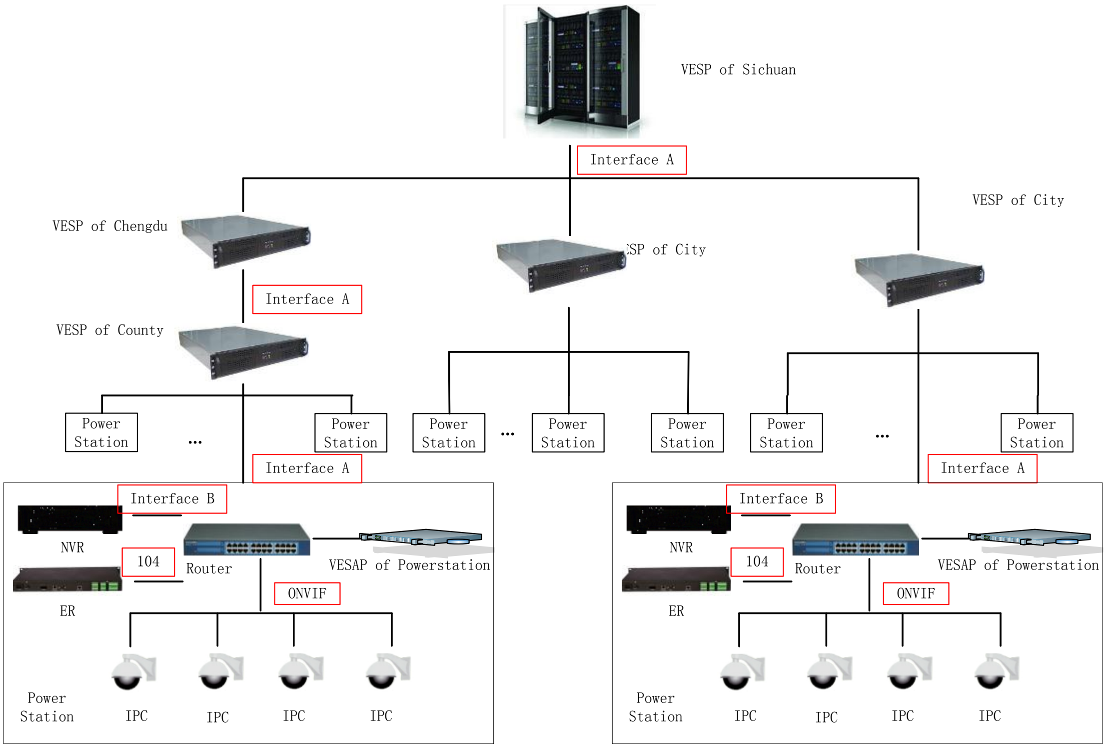

Fig. 1. Architecture of the video and environment surveillance system.

The main task of test system is to complete the testing of the communication protocols between the devices shown in Fig.1. To simplify the description, we define the protocol between the video surveillance platforms Interface A and that between VESAP and NVR Interface B. Besides, 104 telecontrol protocol is used between VESAP and VR. ONVIF (open network video interface forum) protocol connects the NVR and IPCs. All protocols in the system are within the scope of the paper.

3. Test Methods

According to the second part of the paper, the purpose of test system is to verify the communication protocols and functions inside the video and environment surveillance system. To detect the system comprehensively, a simulation method is proposed to design all the components of the system to all kinds of simulators. The method does not use traditional point-to-point test method but creates a simulation environment where only the tested device is real and all the other devices are simulated to reality, as shown in Fig.2. The advantages of the method are that the system could testify the bugs of the video and environment surveillance system in interconnection and interworking and after necessary measurement, the video and environment surveillance system can be deployed in power grids without any problems.

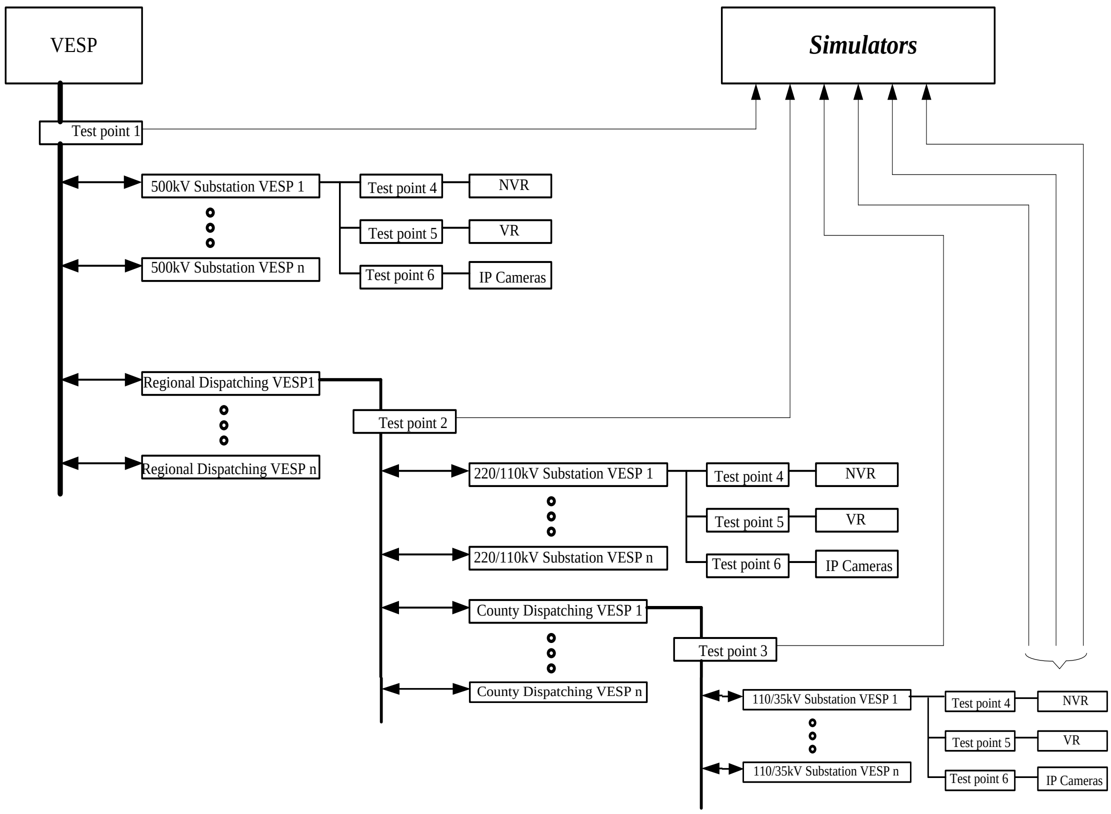

Fig. 2. Structure of simulation test method.

4. Software for Protocol Test System

4.1. Design

The design of the protocol test software system includes the design of the database, test manage module, each functional module, and fault type identification module. SQL (Structured Query Language) server is used to build the database of the test system, and there are three main databases to manage the data including: device configuration, test procedure parameters and fault information. The whole software is developed by Microsoft Visual Studio 2010. In the test management module, the simulator for testing is chosen and the function of it modeled. Each functional modules is designed for each simulator, in addition methods are encapsulated such as black box testing, white box testing, inverse testing, etc., to increase reliability and operability.

In order to ensure the completeness of the test, the test system is divided into the interface A simulator, interface B simulator, 104 telecontrol protocol simulator, camera simulator. Each simulator includes management module, protocol analysis test module, test result report module. The protocol analysis module is divided into communication module, message procedure module, display module and error module.

The process of test software is communication module receives any relevant messages using a unique thread after configuration, and then, procedure module splits, checks, rebuilds the massage and responds to it. The envelope and body of the messages are in the range of detection. Then, display module shows the details of the message received and sent, and test results. In addition, error notes module displays forms and details of error in a section of front page. At last, test reports are automatically generated and show clients the details of the whole process. The paper will detail the designs of each simulator.

A. Interface A simulator

Interface A simulator can simulate the specified protocols such as, the HTTP, SIP (session initiation protocol), RTSP (real time streams protocol), SDP (session description protocol), etc. and is connected to the real video surveillance platform to ensure the connectivity of the testing process. And the test items which are detailed and classified in Fig. 3 are notification of system up and down, search of historical alarms, video retrieval, resources acquisition, PTZ control, inquiry of flow rates, event subscription and notice, real time video, and video replay.

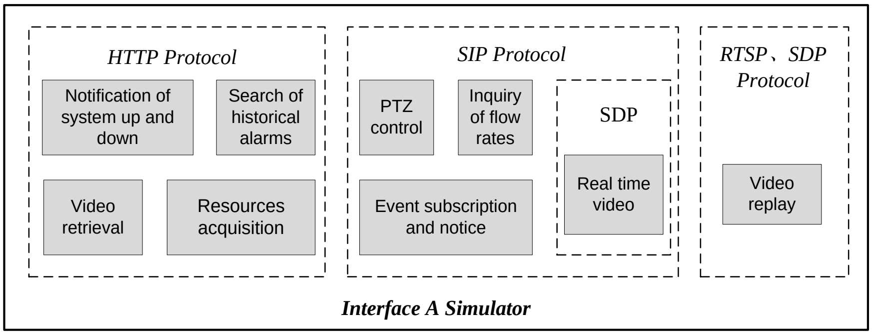

Fig. 3. Architecture & function of interface A simulator.

B. B interface simulator

Interface B simulator can simulate the specified protocols such as, the HTTP, SIP, RTSP, RTCP(Real-time Transport Control Protocol), SDP, etc. and is connected to the real NVR or VESAP of power station to ensure the connectivity of the testing process. And protocol test function block diagram which are detailed and classified in Fig. 4 are represented as register, resources reported, resources acquisition, search of historical alarms, real time video, voice intercom, video retrieval, PTZ control, event subscription and notice, remote parameter query, remote parameter configuration, 3D fixed focus and video replay.

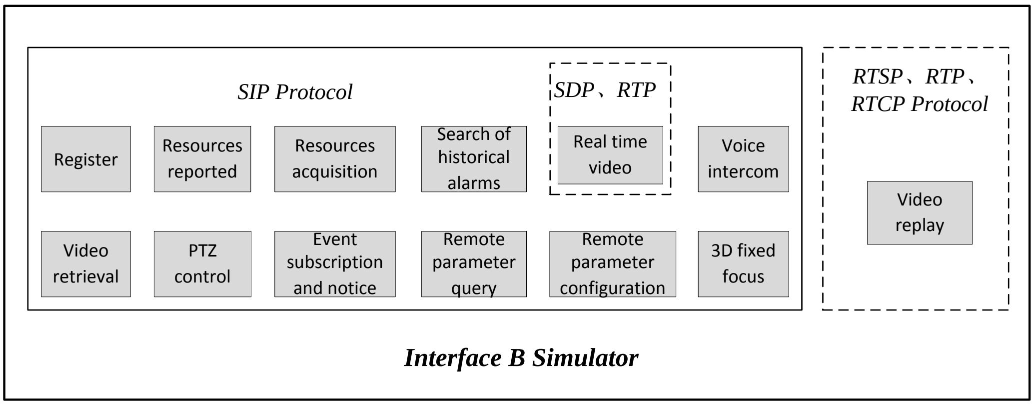

Fig. 4. Architecture & function of interface B simulator.

C. 104 interface simulator

104 interface simulator is to test the NR and VESAP of power station. It is composed of message sending module and message receiver module. Message sending module simulates VESAP to send control commands, such as starting data transmission, station general call, clock synchronization, control command to NR and after opening the sending thread create a sending function socket for message transmission. Message receiving module analyzes the response messages of VESAP that is to open a receiving thread monitoring the message packets, and then analyze the details of messages.

Table 1. Data structure of ADPU.

Test	Description
APCI Header	Starter: 68H Length of APDU(maxima 253)
Control Domain of I Format	BS1[1]=0 Transmit sequence Receive sequence
Control Domain of S Format	BS1[1]=1,BS1[2~8]=0 Receive sequence NR
Control Domain of U Format	BS1[1]=1,BS1[2]=1 STARTDT=BS1[3~4], ACT=BS1[3]=1,CON=BS1[4]=1 STOPDT=BS1[5~6], ACT=BS1[5]=1,CON=BS1[6]=1 TESTFR=BS1[7~8],ACT=BS1[7]=1,CON=BS1[8]=1

The type of 104 protocol database [6], [7] is APDU (applied protocol data unit). A typical APDU is consisted of APCI (applied protocol control information) header and one kind of I format data, S format data and U format data. The 104 protocol simulator simulates those data and testifies them for telemetering, telecommand and telecontrol. The control domain of different formats is presented, as shown in Table 1.

D. Camera simulator

A camera simulator can at least imitate 16 channels IP cameras and possesses the ability of creating and modification of camera parameters and models, video resources library, protocol simulation, video stream and frame simulation, H.264 compress technology and movements simulation. A typical simulation process is shown in Fig. 5 that is firstly, logging in camera configuration library, selecting a camera template and after modifying some parameters for a type of camera, generating a camera. Video streams are infused into the camera and after packeted, the streams are sent to NVR using RTP(Real-time Transport Protocol), RPCP and RTSP.

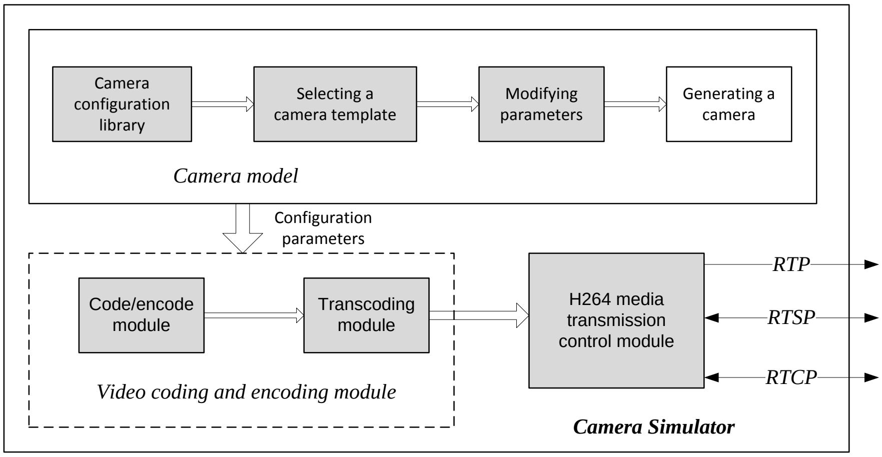

Fig. 5. Architecture & flow of the camera simulator.

4.2. *Test*

In this section, a test case is processed between NVR and VESAP using Interface B protocol, and Interface B simulator running in a DELL Alienware notebook simulates the VESAP, besides, NVR is real equipment, as shown in Fig. 6. The operation interface of Interface B simulator is shown in Fig. 7. After configuration of IP, port and code for Interface B simulator, the test can be executed in single step, multiply steps or automatically. Message description and test results are shown attached to test items. When error occurs, error is detailed in the lower right corner. At last, test report can be exported in excel or word format.

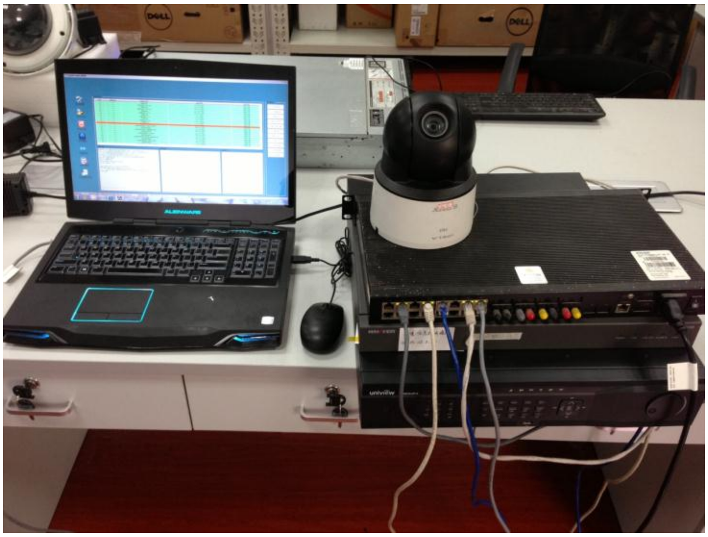

Fig. 6. Test environment built in the library.

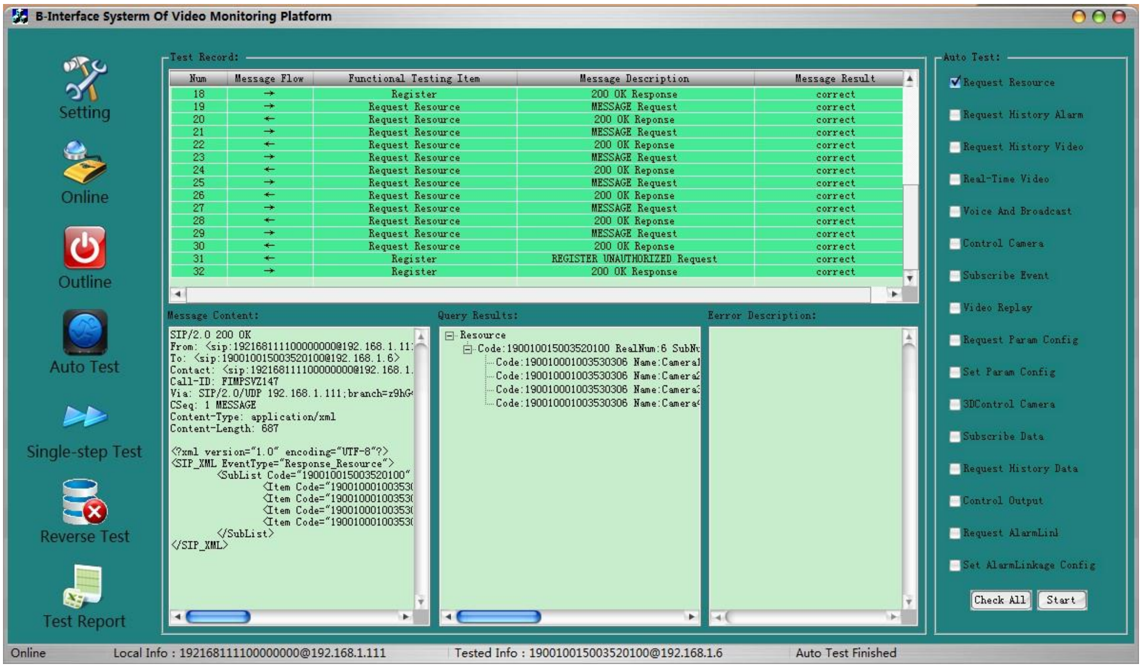

Fig. 7. An operation example of test process.

5. Conclusion

The test system designed in the paper, is composed of a series of simulators to test the consistency and interoperability protocols for surveillance platform, video and environment surveillance assisted platform inside the station, environment recorder, network video recorder, IP cameras and so on. Experiments indicate that the simulator and simulation methods are efficient way to finish the test work. After a systematic test, the interconnecting and intercommunication problems between devices can be solved in the video and environment surveillance system. The designed test system, not only can be used for test before bids, can also be used for periodic spot check of the equipment, in addition to the manufacturers for product development.

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