Remote control of the PTZ camera system for lecture rooms

R. Jacko, M. Michalko, M. Halászová
Department of Computers and Informatics, Technical University of Kosice, Kosice, Slovakia
richard.jacko@cnl.sk, miroslav.michalko@tuke.sk, maria.halaszova@tuke.sk

***Abstract*— The main goal of this paper is to present a simple and inexpensive software solution for remote management of PTZ camera systems EVI-D70CP. Performed analysis demonstrates the technological solution for control of multiple cameras within lecture room or laboratory. Paper deals with the differences in the various serial communication methods, various functionalities of camera systems, followed by a description of communication protocols. Based on the gained knowledge there has been designed software solution for operating system Windows, which offers all functions required to control camera system, secure authentication and authorization of application users and which can store a camera preset parameters in SQLite database or permit them to be controlled via joystick. Software presented could be used in lecture rooms for remote management of PTZ cameras and possible streaming of video lectures over the Internet.**

I. INTRODUCTION

Large number of different videos are recorded every single day around the world in order to increase security for people, as well as for various objects. Individual objects can be monitored by remote management cameras or by IP cameras, which require a network connection. Applied technology in camera systems evolves constantly and provide for end user simplicity, centralized management, automation and high quality output during the day and night. CCTV systems can be divided into several categories, towards different areas. For the purposes of capturing the image for a larger time are camera systems connected to different servers and controllers, taking care of their handling, storing data or direct data streaming. A large number of conferences and meetings are conducted on a daily basis, with which is associated the requirement of image capturing, recording and subsequent streaming. There are many manufacturers of CCTV systems worldwide and companies that deal with problems mentioned previously, but their solutions are often inefficient and expensive for end-user.

II. ANALYSIS

PTZ (Pan, Title, Zoom) camera systems [1] have become the most popular choice for applications that requires automatic tilting, rotating and zooming in areas of interest. These cameras have discreet appearance, which is a great advantage when thinking about how it would fit to any environment. In addition to the function of rolling in any direction these cameras can change the focal length of the lens as required. These surveillance systems are often used with devices such as DVR and web servers. With these devices it is possible to provide recording and controlling of cameras, which is based on keyboard, joystick or specialized software. A big advantage of these camera systems is that we can connect various detectors to them, due to which the camera can start recording automatically and is subsequently able to zoom in on any subject in order to obtain better details of the occurrence in various unforeseen situations such a fire, robbery and others. The individual detectors are connected directly to the DVR or PTZ systems or computers, with which then communicate and automatically perform the requested action.

A. Communication protocols

The concept of the protocol [2] is well established concepts in communication. Communication protocols define set of rules used for mutual communication between communication devices. PTZ camera systems use more communication protocols, each brand cameras can choose their own. Protocols enable DVR (digital video recorder) devices to communicate with camera systems and send them signals in the desired packet structure. The information contained in the packets of the various protocols are associated with three values: ID of the camera systems, baud rate and communication conditions. Pelco, VISCA, LTC 8560 or Canon VC-C50i belong among the communication protocols used by PTZ systems for ensure their communication.

VISCA protocol

VISCA protocol [3] provides involvement of seven peripheral devices like Sony camera EVI-D70CP to one controller using a standard RS-232C / 422. In case of SONY EVI-D70CP which use VISCA protocol, the structure of the packet is shown on the figure Figure 1.

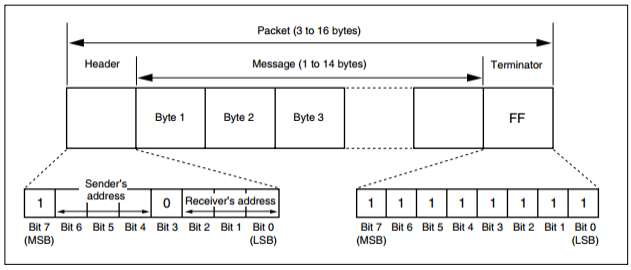

Figure 1. VISCA packet [3]

To successfully establish the connection is necessary to set the following parameters [3] of each serial line: operating at 9600 bps / 38400bps, data bits 8, start bit 1, stop bit 1 and no parity. CCTV systems EVI-D70CP can be connected in two ways. One of them is a chain form and second one is known like one by one connection,

which is controlling by using serial interface port. In the case of chain connection is the controller associated with the lowest ID 0, therefore different camera systems take the values of ID 1-7. This number specifies the maximum number of cameras in this connection. On the basis of packet structure received by the camera system can distinguish two types of messages, commands and inquiries. In the case of inquiries are messages send by controller to camera system, where camera is able to distinguish the requirement and respond to it. Correct form of the communication is shown on Figure 2.

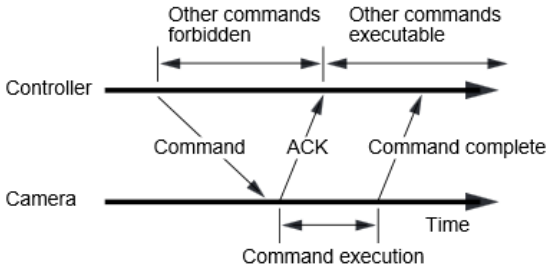

Figure 2. Information transmission [3]

A. Serial communication method

For mutual communication between different devices are used various communication methods. Among the serial communication methods might include [4] standards such as RS232, RS422, RS423 and RS485. RS232 interface provides a method of connection point-point, which represent link to one DTE and DCE device at a maximum speed of 20kbps and distances from 15 to 20 meters. Standard RS422 and RS485 are used mainly in industrial environments for sending control signals. While in the RS232 individual signals are represented by voltage level to the ground, in case of RS422 and RS485 is used differential method. The reason for this method is that for the signal transmission is used twisted pair.

RS232

Communication via standard RS232 [5] is performed by asynchronous manner over a serial communication link. As the title evokes, the method of transmission information takes place through the transmission of bits in real time and without specifying timeframes dispatch. Sending information may occur at any time, which makes it necessary to determine the beginning and the end of each received messages. Information are divided into data words before transmission over the RS232, where the word size may be variable. Their size range is between the values 5 and 8 bits. To ensure synchronization and error checking there are additional bits added to the packet by which sender and receiver of the communication can work with the data in the correct order. Individual bits are transmitted on the basis of predetermined frequency, which is referred as the "bit rate". Voltage level corresponding to the log 0 has a value of +5 to +15 V in the case of transmitter and the value between +3 and +25 V for the receiver. Log 1 correspond to the values of -5 to -15 V at the transmitter and -3 to -25 V at the receiver. The various voltage levels are represented to the ground. As soon as there is a change of voltage level, the device is able to detect the change in the level and react accordingly. Following table **Error! Reference source not found.** shows RS-232 pin assignments.

TABLE I.
RS232 PIN ASSIGNMENTS

RJ45	DB9 Pin No	DB25 Pin No	OUT / IN	Name	Description
1	9	22	IN	RI	Ring Indicator
2	1	8	IN	DCD	Data Carrier Detect
3	4	20	OUT	DTR	Data Terminal Ready
4	5	7	-	GND	Ground
5	2	3	IN	RxD	Received Data
6	3	2	OUT	TxD	Transmitted Data
7	8	5	IN	CTS	Clear To Send
8	7	4	OUT	RTS	Request To Send
-	6	6	IN	DSR	Data Set Ready

B. SONY EVI-D70CP

PTZ Camera System SONY EVI-D70CP [6] provides for user large number of functions, including 18x optical zoom, which is also combined with digital zoom up to 12x. Mode of zoom can be performed in two ways by combined or separate mode. Camera system offers features such as automatic white balance and automatic exposure. Wide Range Pan / Tilt are 340 degrees Pan / Tilt 120 degrees.

PTZ camera is able to use spot metering of exposure. Full automatic exposure mode is automatically calculated for entire screen and the iris and gain are determined optimally. If it chooses spot metering, only small part of the screen is selected, initially the center, on which exposure is calculated. Size of the viewfinder area is in the range 1-5% in built in exposure meters.

Camera support [6] Infra-red cut-filter which allows its use in poor lighting conditions and thus displays images even in dark places. ICR filter is deployed automatically according to the brightness, which allows the camera to be effective during the day and during the night, too. If ICR filter is in the off mode, camera captures image in monochrome and is more sensitive to infrared light.

III. SOLUTION

Based on an analysis of the different communication methods and technology solutions was created a proposal with technologies supported by the used equipment. Within the Technical University of Kosice there are in separate rooms and laboratories deployed PTZ camera systems SONY EVI-D70CP, by which individual technologies and supported interfaces were selected. Serial interface RS232 has been selected for transmission control signals and for video transfer connector s-video in the design phase was elected. The process of mutual communication with the camera system will be performed by VISCA protocol, which defines the structure of each packet. Due to the deployment already purchased equipment the solution is inexpensive. Big advantage of the solution is using well-documented protocol, by which it is possible to add additional functions in the short time. Other components, which

have been discussed within the analytical part of the article will be not applied, because of the inability to use their functionality, respectively that the camera system does not support offered features.

Implementation of the existing solutions consists of two main parts:

1) *Part focused on functionality*
2) *Graphic part*

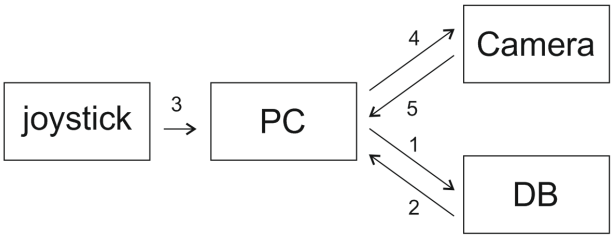

Figure 3. The concept of control camera systems by joystick

Both of these are an integral part for the successful implementation of software solutions. Functionality consists of the management and proper communication between devices with continuous display image capture. Strong emphasis should be placed also to the graphic page, because this part cares about simplicity, intuitiveness and attractive appearance for users. Program part is divided to the number of modules which was created separately and together creates one complete unit. Main part of the program consist of:

- authentication of users,
- image capture,
- establishing a connection by serial standard RS232,
- sending control signals to the camera (management),
- implementation presets,
- control camera systems by joystick.

B. Authentication

User authentication for access to the camera system require enter username and password. All data are encrypted by AES standard before they are stored in local database, thereby the safety of the solution is increased. For storing user data, SQLite database was chosen because of its simple administration and scalability.

C. Image capture

Image capture by a camera system is an essential part of the established system. Image capture from camera system can be obtained in two ways. First possible way is using s-video cable, the second one consists of using the cinch cable. Both of these options were tested and showed no problems. When a camera system is running, user is able to see a list of all currently connected video inputs to the control device (computer) and choose one of them. When the user selects one of the options offered by computer and confirms it, image capture is displayed in the specific part of the system. Functionality of the image capture, which was created in programming language c#, uses two core libraries that provide the desired result:

- AForge.Video,
- AForge.Video.DirectShow.

D. Control commands

One of the most important parts of the system consists of motion control camera systems EVI-D70CP, which is dependent on the transmission of correct commands. Form of the packet is given on the basis of the used protocol. Each control packet designed for PTZ can be divided into two classes, namely:

- control commands for execution required action,
- inquiry sent in order to obtain a response from the camera.

In the case when the camera recognizes the command, which is designed for it, performs the desired action but does not respond message to controller. Commands can include messages for rotating or zooming by camera. However, if it is necessary to obtain certain information, such a current position of the camera, it is necessary to send inquiry command. PTZ camera, depending on the query, sends response to control device, based on which the system is able to evaluate the situation and make correct action.

Example of control messages which are needed by camera system via serial communications link looks like:

- byte [] right = {129, 01, 06, 01, 20, 20, 02, 03, 255};
- byte [] {left = 0x81, 0x01, 0x06, 0x01, 0x14, 0x14, 0x01, 0x03, 0xff};

E. Implementation of the presets

Remote management of CCTV systems allows users to set the coordinates of any objects, but in the case that these positions are repeatedly selected few times manually, it would be inefficient and unnecessarily lengthy. Just for this purpose PTZ EVI-D70CP offers storage for six coordinates without need to create any supplementary program. In this case the user needs only to send message called “CAM_Memory” to camera systems, where the structure of the packet is the following: “8x 01 04 3F 01 0p FF”. The letter "p" indicates the number in the range 0-5, which represents one possible preset position chosen by user. However, if the user needs more than only six preset values, it would be necessary to resolve the problem by complementary systems respectively by program. In our case this functionality is solved programmatically, where each of the retained positions will correspond to one record in SQLite database. Stored data will be still available even after turning off the program and users are able by SQL statements freely modify the records.

F. Motion control by joystick

User by left stick and control buttons on the gamepad or joystick is able to transmit control signals via USB cable to computer. These signals are translated by the created program and then sent to the selected camera. Functionality is turned off when the program is initial running, but the switch on is very simple and intuitive. User is able to control only one camera system by the joystick at one time, which is provided programmatically. Controlling camera systems by joystick is carried out in a newly created thread. User is able to choose one of the

provided way for controlling cameras, by buttons or by joystick.

Structure of the created and implemented system is the following:

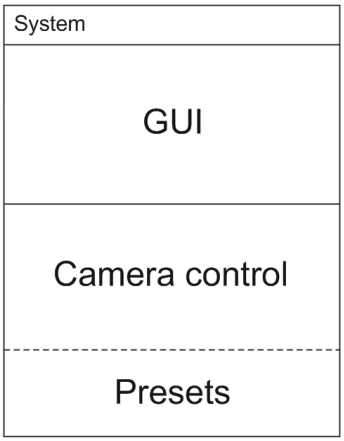

Figure 4. Structure of the camera

IV. Integration into Educational Environment

As mentioned above this solution is part of the university environment where lectures are streamed over the internet to students. As central management is required to maintain certain level of quality all cameras should be controlled from central management system. This solution allows to control cameras in multiple lectures room in very simple way. Software solution is offered as open source to community as freeware. Technical maintenance is covered by Computer Networks Laboratory at Technical University of Košice [7].

V. Conclusion

Main idea of this work is to provide for users ability to remote control PTZ camera systems from one place with simultaneous image capture. Based on the analysis, which formed the initial phase to obtain sufficient knowledge of camera systems and their mutual communication, simple and effective software solution was designed. Solution has been developed and consists of parts like creation of a serial port for the purpose of communication, mutual communication between the control unit and peripherals via VISCA communication protocol or view of the scanned image directly to an existing program. In the world there exist several software solutions which provide remote control of different PTZ camera systems. Control can be operated by buttons in created software as well as hardware controllers that provide connection of multiple camera systems, setting presets or rotating with them as required. These solutions are often impractical due to their size, limited functions and high price. Could be also part of the similar educational resources [8] [9].

Presented solution was developed to offer all the required functions necessary for successful management of cameras, but for access to system authentication and authorization process is necessary. Created solutions in the world often do not offer the possibility for users to choose a number of presets for different camera systems, which is limited in number of 6. In our case the users are able to choose number of presets and this functionality is provided programmatically by sending queries to CCTV system, which then responds back to controller. All of the responses are processed immediately into the desired form and stored in a selected row in SQLite database. This method of data storage doesn´t requires the installation of SQL database, which makes the solution easier to apply. Program was created using programming language c#, whereby the solution can be deployed on any version of Windows. Thus formed solution can be deployed in any lecture room and control PTZ camera systems EVI-D70CP remotely via VISCA protocol.

Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.

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