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Program platform aiding PTZ cameras operator work in CCTV system – improvement in the scope of functionality and ergonomics of system use

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Summary. The functionality of control system as well as the ergonomics and intuitiveness of its use are the essential factors, except of system operator experience, affecting CCTV video monitoring system management process. An optimal relationship between system functionality, its ergonomic use and the system operator experience makes it possible to quickly adapt the parameters of recorded image to the needs in the scope of currently performed tasks associated with the observation of assigned area. CCTV video monitoring system management mainly consists in the checking of cameras settings and matching of PTZ cameras parameters to current needs in the scope of observation. The article presents the role of ergonomics of work stations and the technical capabilities of program platforms aiding PTZ cameras operator work in CCTV system. The presented program platform was built as an application basing upon LabView environment. Except of control functions available in standard hardware manipulators for PTZ cameras settings, the program platform enables the visualization of object status on the screen and the performance of pre-set control functions in the form of procedures. Particular emphasis has been placed on the practical capabilities of such systems, operators' work aiding, reduction of operation times in case of performance of a task associated with the change of PTZ cameras settings.
Key words: control and supervision systems, video monitoring, CCTV systems, PTZ cameras, communication protocols, management processes ergonomics.

INTRODUCTION

CCTV video monitoring systems are the components of technical equipment used for property protection. Their basic task is to supply comprehensive information on the current condition of the protected area to the competent organizational sections in the object protection system in the form of images. An essential thing is to configure CCTV system in a manner ensuring that the information received by the user is as complete as possible and suitable to the needs at the point of time. The information can be associated with: protected area checking, confirmation that specified zone has been disturbed, invader identification or occurred danger. The factors specified above affect not only the current safety level in the object being protected but also make it possible for competent organizational sections in the object protection system to early react to specified danger as well as to eliminate thereof or to limit its impact on environment and achieved targets of attack [1, 4, 7, 8, 9, 10, 17, 18].

From presented tasks it appears that a monitoring system shall enable the imaging for the largest possible area in order to perform its task. Therefore, the user is given the possibility of close observation of the object being protected. There are detailed and general surveillance zones in surveillance areas monitored by means of CCTV cameras. The detailed surveillance zones (particularly important sensitive zones) are defined as the locations and areas of importance in view of safety to be maintained in the object. In case of the occurrence of danger, the monitoring shall be commenced as soon as possible by means of maximum possible number of cameras. Rotary cameras controlled by means of special consoles with access to cameras functions and presets are applied in order to get to selected area. The settings of selected rotary camera are controlled by operator by means of a hardware console in order to correct the following parameters: positioning, inclination and zooming. In case of an excessive number of cameras in the system it is possible that the system user is unable to set PTZ cameras parameters, simultaneously tracking the object and properly responding to additional dangers occurring in the object. Too many cameras significantly affect the system operation effectiveness and can even cause the system's dysfunction. It is also associated with increased effort of the user during the system's operation and with reduced comfort at work.

The purpose of the present study is to draw the attention to functional capabilities of CCTV systems and to the impact of algorithmic aiding on the work of system operator and

the reduction of its workload during the process control. The study presents the concept of an universal program platform adapted to specified object and making it possible to supervise selected observation zones and areas. The article presents the technical measures enabling the improvement of ergonomic features of the used system by means of IT solutions. The scope of the study encompasses the presentation and analysis of the technical measures enabling the improvement of the system use ergonomics by means of IT solutions. The *attention* was paid to the possibility of utilizing the algorithms of simultaneous control for PTZ rotary cameras, dedicated for specified object and making it possible to limit the necessary activities of the user in course of the performance of its surveillance tasks in the object being protected. The essence of the algorithm consists in the definition and interrelation of presets for multiple cameras accessible in the system.

FUNCTIONALITY AND ERGONOMICS OF CCTV VIDEO MONITORING OPERATOR

The work performed by hardware and CCTV electronic system operator consists in the achievement of assumed security goals. Particularly, the task of the operator is associated with the management of system elements settings including PTZ rotary cameras parameters control, the reaction to recorded events and the checking of CCTV system operation correctness. The communication between the user and system is possible by means of a screen equipped with proper graphical interface. The working conditions at the station equipped with a Video Display Unit should be sufficient to ensure the safety, convenience and comfort in the course of work performed by the operator in order to avoid errors [5, 6, 7, 8, 10].

Therefore, the task of the person supervising the control process in CCTV system is to check the object condition, to supervise the correctness of registration and control process, to initiate individual phases, procedures and functions and to react in case of any abnormalities. This supervision is particularly characterized by continuous monitoring of instrument readings from images recorded by the cameras and by introduction of corrections in case of deviations from the assumed profile [5, 10].

Computer-aided measuring, control and supervision system enables data acquisition, processing and their presentation to operator through the performance of information and decision making subsystem tasks. The tasks performed by operator consist in monitoring of information occurring on imaging devices screens, in displaying of necessary information about process status, entering supplementary information, evaluation of existing situation, decision making and decision entry into computerized system. The operator's work is aided by the correctly built system performing monotonous repeating activities but the operator is not substituted in the decision making process. The system performs the algorithms and procedures associated with arduous and precisely determined tasks which may take the time of system's operator and divert his attention from the principal goal, i.e. safety management in the supervised object. The information exchange between the operator and system is possible by means of an extended hardware interface (information exchange technology component) supplemented by software creating the graphical user interface (GUI). The work with an incorrectly designed interface can be arduous for the operator and can lead to errors and to non-compliance with requirements in the scope of quality of performed tasks as a result of fatigue or stress perceived after a short period of time [12].

The correctness of decisions made by the operator depends on possibility to receive the signals and ability to understand information contained therein [20]. The purpose of control devices is to make it possible to perform the control process by the operator in an efficient, safe and correct manner through the optimized communication between man and technical system. The operator stations are usually equipped with multiple signalling and control devices. Their correct design solution and working conditions may have significant impact on the number of operator's errors and his fatigue. Currently, control panels have been substituted by computers analyzing the data received from the sensors recording process parameters changes and presenting the information processing results to the operator or correcting the errors basing upon a predetermined program [20].

However, an appropriate manner of information visualization and processes control method is required for operations on synthetic data and processed information. The processes control should not be based upon the regulation of single (partial, detailed) parameters but in the form of determination of resulting (aggregated, total, general) parameters. However the partial parameters should be selected by means of optimizing computer programs. The structures of contemporary testing and measuring systems are characterized by a trend toward the computerization and graphical representation of information. Hence, significant interest has been observed in ergonomic features of the stations provided with visual display terminals (VDT – Visual Display Terminal) [20].

The requirements in the scope of system capability to cooperate with an operator are associated i.a. with the factors resulting from the essence of control process for specified system, tasks to be performed in process control and from established control strategy. Equally essential are the factors associated with man – machine interface design, impact of work station (station layout – i.a. ergonomic features of the devices and their spatial arrangement at the operator station, material environment conditions) and human factors associated with the operator's load in course of work. Therefore, the compliance with requirements in the scope of working conditions may affect the capability of an industrial process control system with the operator [2].

The control room is the basic functional unit in the control centre and in its associated physical structure occupied by operators performing the functions encompassing the centralized control, supervision and guiding. The operator interface located in the vicinity of the equipment or system subjected to supervision and/ or control is called the local control station [3].

The working conditions in the control room shall ensure the safety, human health protection and well being as well as the technical and economical effectiveness. The human factor, machine (hardware and software), working conditions and control functions should be considered in its entirety and subjected to optimization [3, 14].

CAMERAS IN CCTV SYSTEM – FUNCTIONAL MODEL OF PTZ CAMERAS

The camera used in CCTV video monitoring systems are defined as image recording electronic systems. Depending on version, an image converter built in CMOS or CCD technology is their principal element. The cameras can be subdivided into digital cameras (H-264 or MPEG standard) and analogue (TV standard) cameras depending on vision signal transmitted by CCTV camera. Resolution, objective focal range and type of image (monochrome or colour) are the specific features of cameras. There are two types of cameras in view of their construction (Fig. 1): stationary cameras (compact and dome type) and cameras equipped with rotating device (PTZ rotary cameras).

PTZ rotary cameras make it possible to change three settings: P – positioning, T – tilting and Z – zooming. Due to such features, the cameras can record images of various observation areas determined by the operator. The corrections of rotary camera parameters and its setting are most frequently performed by means of a special hardware manipulator. The camera code shall be entered by the operator. It is possible to adapt the image parameters to current requirements and to perform observation tasks by means of special joystick.

Due to possibility of adjustment and changes of image parameters based upon changes of position, tilting and zooming, the functional model of PTZ rotary camera can be described on the basis of spherical coordinate system. The spherical coordinate system is based upon three coordinates f, q, ri making it possible to adapt the regulation parameters of PTZ rotary camera (Fig. 2). The coordinate f corresponds to parameter associated with the camera positioning (*P*), q coordinate – tilting (*T*), and *r* coordinate – zooming (*Z*).

Fig. 2 illustrates the relations making it possible to convert from coordinates in rectangular coordinate system (x, y, z) to spherical coordinate system (f, q, r). The most frequent is the situation when CCTV system operator tracking a moving object (movement in rectangular coordinate system) has to adapt the actions to the specific features of rotary camera control system (spherical coordinate system). Fig. 3 illustrates the situation when the operator is tracking an object moving along a straight line. Attention should be paid to changes of multiple parameters in order to maintain the same image parameters for the object being monitored. Fig. 4 illustrates the situation when an object is moving along a circular path, with constant distance from one of the cameras but it is monitored by two cameras. The necessity of adaptive correction of PTZ rotary camera parameters by the operator in order to achieve the assumed observation goals is also shown in this situation.

The situations presented above have been selected as the examples of problems experienced every day by CCTV video monitoring systems operators operating PTZ rotary cameras in the system. The principal problems experienced by operators and inconveniences resulting from the applied observation method by means of PTZ camera and having essential impact on quality and effectiveness of continued monitoring activities are:

– mismatch between the control system based upon spherical coordinate system (f, q, r) and the behaviour of per-

Fig. 1. Cameras of CCTV system [22] a) compact camera, b) dome camera, c) PTZ rotary camera

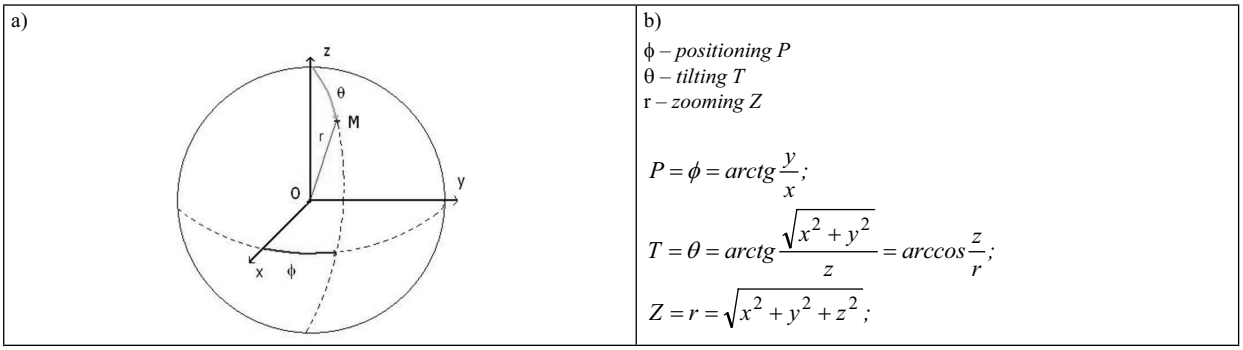
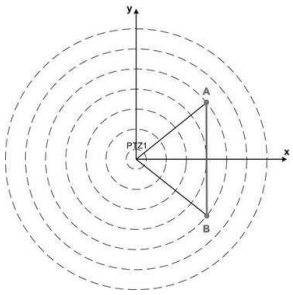


Fig. 2. Functional model of rotary camera a) spherical coordinate system, b) relations between coordinates in spherical coordinate system and in rectangular coordinate system

a)



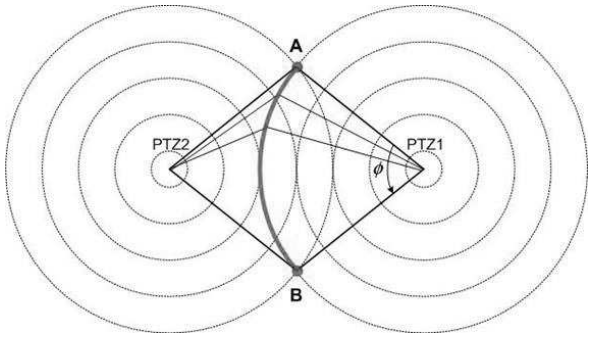
b)

object movement
(rectangular coordinate system)
X = f(x) = const; ΔX = 0;
Y = f(y) = var; ΔY = const;
Z = f(z) = const; ΔZ = 0;

control PTZ 1
(spherical coordinate system)
P = f(ϕ) = var; ΔP=var;
T = f(θ) = var; ΔT=var;
Z = f(r) = var; ΔZ=var;

Fig. 3. Object movement between A and B points – situation 1; a) layout sketch b) description of relations specific for the object movement and corresponding relations of changes of PTZ rotary camera settings

a)



b)

object movement
(rectangular coordinate system)
X = f(x) = var; ΔX = var;
Y = f(y) = var; ΔY = var;
Z = f(z) = const; ΔZ = 0;

control PTZ 1
(spherical coordinate system)
P = f(ϕ) = var; ΔP=const;
T = f(θ) = const; ΔT=0;
Z = f(r) = const; ΔZ=0;

control PTZ 2
(spherical coordinate system)
P = f(ϕ) = var; ΔX=var;
T = f(θ) = var; ΔY=var;
Z = f(r) = var; ΔZ=var;

Fig. 4. Object movement between A and B points – situation 2; a) description of relations specific for the object movement and corresponding relations of changes of PTZ rotary cameras settings

sons moving in the area under observation (rectangular coordinate system x, y, z),
– necessity of continuous switchovers of control options on hardware manipulator in case of supervision over specified zone by means of large number of cameras;
– mismatch between the standard procedures of calling for individual functions and specific features of specified object.

The factors presented above are procedural factors. Therefore, it is possible to improve the operator's activity effectiveness by means of IT tools used in order to make the control process more efficient.

CCTV VIDEO MONITORING SYSTEMS

CCTV (closed circuit television) video monitoring system is defined as the system to be used for observation by means of proper equipment, a determined zone under surveillance [1]. The closed circuit television (Fig. 5) consists of basic system elements used for image recording (video monitoring subsystem), vision signal transmission (signal transmission subsystem) and for its displaying (receiving subsystem) as well as supplementary elements (subsystems) used for archiving of recorded image and controlling of individual system elements settings (cameras, rotary devices etc.)

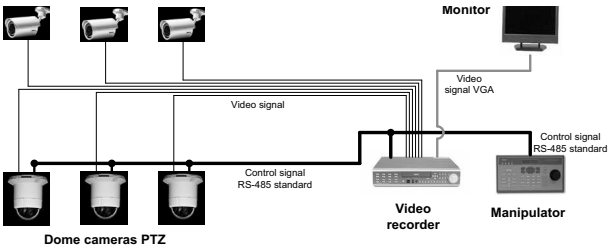


Fig. 5. Diagram of a conventional CCTV video monitoring system

Detailed guidelines for CCTV video monitoring system should encompass the following scope:
– presentation of the required system safety level (assessment of hazards);
– subdivision into zones and determination of manner of surveillance for individual zones (Fig. 6);
– determination of spaces (zones) supervised by the system (coverage);
– characteristics of the range of system operations environment conditions;
– description of tasks and procedures associated with the performance of surveillance functions;
– determination of manner of video signal and control signal transfer;
– presentation of tasks associated with system elements control.

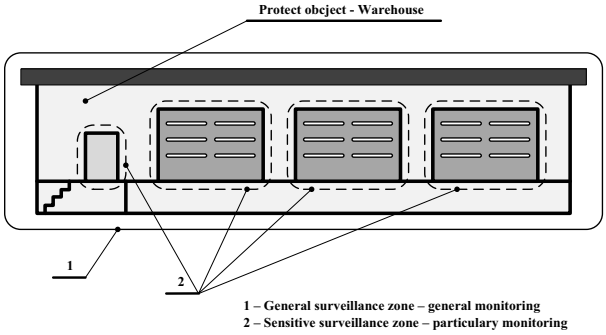


Fig. 6. Subdivision into surveillance zones in the object to be protected

A camera is the basic element of each CCTV system. Two types of cameras can be specified in the view of their functional capabilities, role performed in the system and costs: stationary and rotary cameras. The stationary cameras are usually used for the observation of general surveillance zones and the rotary cameras due to their increased capabilities in the scope of settings are used for the surveillance of particularly important (sensitive) zones in the object being protected. Their functions make it possible, through the change of camera optical parameters and camera position, to match the size of the surveillance zone under observation to current needs of the user.

The video signal in conventional video monitoring systems is transmitted between cameras as well as recording and imaging elements by means of coaxial cables (so called coax). The technical limitations resulting from applied signal transfer medium by means of coaxial cable are associated with the cable length. Maximum recommended lengths of coaxial cables in CCTV systems are included between 250m (RG-59 cable) and 800m (RG-15 cable) [15]. The signal amplifiers are required in case of signal transfer by means of cables with the length exceeding recommend values.

However, in case of control system, the system in RS-485 standard is the most common control signal transfer system. RS-485 standard has been introduced as developed version of RS-422A standard. RS-485 standard consists of a differential (symmetrical) transmitter, dual – circuit transmission path and a differential receiver. It is allowed to connect multiple transmitters and receivers on single line. Due to possibility to transfer only one signal (chain of commands) at the same time, these systems must be equipped with interlocking systems. The systems equipped with so called tri-state gates. In said gates, except of output signals corresponding to the states of logic 1 and logic 0, high impedance state of gate output is possible. The devices in RS-485 system are usually characterized by hierarchy of importance i.e. devices performing master or slave functions to each other [15, 16].

THE CONCEPT OF PROGRAM PLATFORM ENABLING THE CHANGE OF PTZ CAMERAS SETTINGS AIDING CCTV SYSTEM OPERATION WORK

The conventional CCTV video monitoring system illustrated in Fig. 5 is an autonomous system built of elements used only in this type of systems. Exclusive hardware and functional features are a disadvantage of such solutions. The purpose of modernization of a conventional CCTV video monitoring system (Fig. 7) is to increase the system functionality. Therefore, a program platform has been created in LabView environment in the form of an application enabling simultaneous control for multiple rotary PTZ cameras settings. The principal task of this application is to generate a message signal (instruction code string) to the control system. PTZ cameras control is carried out by the calling of procedures triggering predefined presets of cameras. Due to lack of RS-485 interface in standard equipment of PC computers, it is necessary to provide RS-232/RS-485 or USB/RS-48 signal converter in the system.

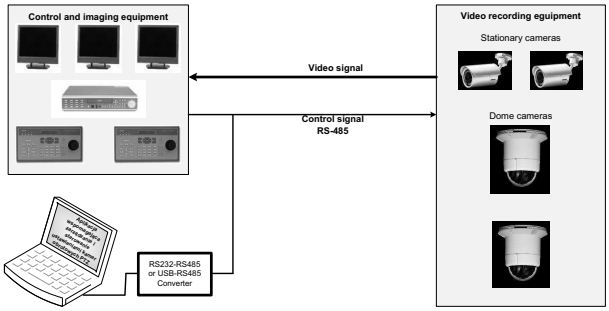


Fig. 7. Schematic diagram of monitoring system with built-in module enabling simultaneous control for multiple rotary PTZ cameras settings by means of computer application

The determination of surveillance of zones in the area of protected infrastructure is an Essentials element of CCTV system designing phase, in the scope of general surveillance zones (Fig. 8) as well as detailed surveillance zones (Fig. 9). The determination of certain sensitive areas shall be based upon analysis of potential hazards occurring therein or upon the performance of control of or supervision over the flow of persons and property. Therefore, it is important to arrange CCTV system elements (particularly rotary cameras) in a manner ensuring the performance of said tasks in the best possible manner. Additional factors limiting excessive extension of CCTV system are the system costs and possibility of transfer of the Signac recorded by camera and its archiving. Not always and additionally simultaneously, it is necessary to provide detailed surveillance for all sensitive zones. Such observation should be carried out in precisely determined conditions only (e.g. as a result of occurred hazard). Therefore, one rotary camera can be used for surveillance of several sensitive zones.

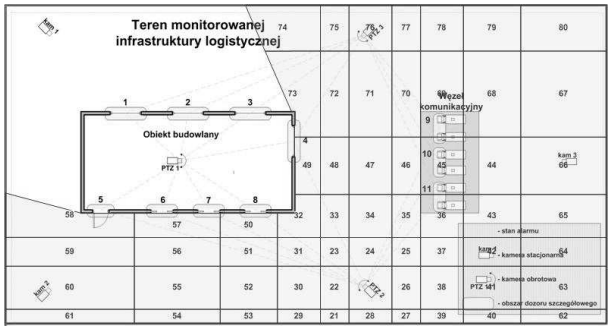


Fig. 8. Field diagram of an object with marked general surveillance zones for PTZ2 camera including their corresponding presets

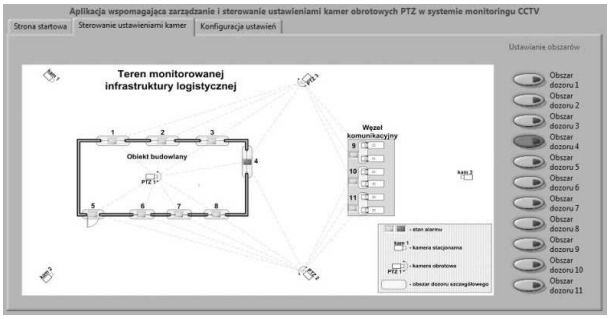


Fig. 9. Field diagram of an object with marked detailed surveillance zones

In a manner identical to the distributions of detailed and general surveillance zones illustrated in Fig. 8 and Fig. 9, the areas associated with presets are created for all PTZ cameras contained in CCTV system. Individual areas are the field areas corresponding to certain areas of dialog window of the system displayed on the screen display. Therefore, to each pixel assigned on the synoptic map (field diagram) of the protected object, there are assigned relations referring to the implementing procedures performing the calling of precisely determined presets for all the cameras contained in CCTV system.

The task of the operator is not to change the settings of successive cameras manually any more but to call corresponding procedure on the screen by means of computer mouse. It is also possible to provide CCTV system operator station with a touch screen. In such case it is possible to call any procedure directly on the screen. The purpose of the presented solution is to support the operator's work. It is possible as a result of his release from arduous manual process associated with calling of successive settings. Individual field areas are called by the operator in presented solution on the synoptic map of the protected object. The areas correspond to real areas in the field. Therefore, an additional advantage of this solution consists in its intuitiveness associated with simple calling of certain functions.

APPLICATION FOR PTZ CAMERAS OPERATION MANAGEMENT IN CCTV SYSTEM

An application aiding PTZ rotary cameras settings management and control in CCTV system has been created on the basis of LabView programming environment. This environment is characterized by large capabilities associated with technological processes support in the scope of checking and control as well as individual approach to the process of creating the system operated by users [9, 11, 13, 19].

The program enabling simultaneous control of settings for PTZ rotary cameras operating in CCTV system in an object under surveillance, contains the following principal elements of the system:

– user interface – enabling (depending on user rights) control, configuration change or checking the system operation;
– organizational diagram – internal relation between individual application elements enabling the performance of tasks assigned by the user on control panel;
– I/0 operation (communication port operation) – system component responsible for generation of actuators operation control signal in PTZ rotary cameras.

In case of a correctly operating system managing the operation and control of settings of individual elements of video monitoring CCTV system, it is necessary to apply a recognizable control protocol. Selected protocol standard does not have to be identical for all the system elements. It is possible to use various protocols in the system. It is important to ensure the correlation (protocol conformity) in the time between the controlling and controlled device. There are many protocol standards applied in practice; but the most popular are PTZ protocols: Pelco-D and Pelco-P. The messages formats (format of generated instruction) in Pelco-D and Pelco-P standard have been presented in Tab. 1 and Tab. 2.

Table 1. Format of message in Pelco-D standard [21]

Bajt 1	Bajt 2	Bajt 3	Bajt 4	Bajt 5	Bajt 6	Bajt 7
Start byte (FF)	Camera No	Instruction code (direction, zoom, sharpness etc.)		Camera movement speed	Camera tilting speed	Checksum

Byte 7 (Checksum) is the result of „modulo 100" operation from logic sum of bytes 2÷6.

Table 2. Format of message in Pelco-P standard [21]

Bajt 1	Bajt 2	Bajt 3	Bajt 4	Bajt 5	Bajt 6	Bajt 7	Bajt 8
Start byte (A0)	Camera No	Instruction code (direction, zoom, sharpness etc.)		Camera movement speed	Camera No	Stop byte (AF)	Checksum

Byte 8 (Checksum) is the result of logic sum XOR operation of byte 1÷7.

The messages (instruction codes) informing about completion of two operations in the system: the first one enabling the movement with maximum speed (Turbo) to the RH side of the camera (rotary device) No 8 and the second one: stopping of the performance of the first operation in Pelco-D and Pelco-P protocol standard (hexagonal code) are presented in Tab. 3.

Table 3. Control messages (instruction codes) in Pelco-D and Pelco-P standard

Operation number	Instruction codes in PelcopD standard	Instruction codes in PelcopD standard
1	FF 08 00 02 FF 00 09	A0 08 00 02 40 00 AF 45
2	FF 08 00 00 00 00 08	A0 08 00 00 00 00 AF 07

The determination of technical possibilities of observation for specified detailed areas by individual cameras is an important element associated with the analysis process for individual capabilities of the system and with the creation of control procedures (generation of control instructions). Therefore, it is necessary to build an individual table of relationships for each object. The table of relationships for presets of PTZ cameras settings making it possible to achieve the observation goals for detailed surveillance zones (Fig. 8) has been presented in Tab. 4. This table illustrates

the relations between presets defined in the system for individual rotary PTZ cameras and detailed surveillance areas.

Table 4. Dome cameras PTZ presets in CCTV system – table of relationships

Survellance areas	1	2	3	4	5	6	7	8	9	10	11
Camera PTZ 1	1	2	3	4	5	6	7	8	-	-	-
Camera PTZ 2	-	-	-	1	2	3	4	5	6	7	8
Camera PTZ 3	1	2	3	4	-	-	-	-	5	6	7

The example of a message (chain of commands) in Pelco-P protocol standard (hexagonal code) generated and sent to the control system (RS-485) by an application aiding the cameras settings management in CCTV system, enabling the setting of all available cameras to the detailed surveillance area No 4, has the following form:
A0 01 00 07 00 04 AF 0D;
A0 02 00 07 00 01 AF 0B;
A0 03 00 07 00 04 AF 0F.

CONCLUSIONS

The correct operation of CCTV video monitoring system is based upon the cooperation between the operator and the system as well as the correct use of available equipment by the system operator. Therefore, the most reasonable solution consists in the best equipment enabling the video data recording and archiving as well as in auxiliary equipment of the system in the form of elements releasing the operator from the execution of unnecessary, complicated or time consuming procedures. In the opinion of authors, such a solution consists in the application of a dedicated program platform matched to object characteristics and making it possible to call assumed procedures and functions directly from the application window. The operator's role is limited to the choice of a function without any analysis of the manner of its performing. In such a case, the operator can engage himself in the object's observation instead of tasks associated with correct execution of control process.

Due to the equipment of conventional CCTV system with the system aiding PTZ, rotary cameras settings management and control in CCTV system, it is possible to achieve a quick and simultaneous preview of a selected sensitive zone in the protected object for all cameras available in the system. The task of the operator is to choose an area of interest in the synoptic map of the object. The change of current settings of cameras to the settings associated with the preview of an area determined in specified preset of camera is carried out in a smooth and unattended manner. Therefore, the time associated with change of system settings is significantly reduced in comparison with manual operation of control devices.

Further integration of PTZ rotary cameras settings control system with other protective systems (Intrusion and Hold-up *Alarm Systems* (*I&HAS*)), access control systems and fire alarm systems, enables automatic change of cameras settings in order to enable the preview to selected zone at the time of hazard occurrence or for the time associated with the performance of assumed procedure.

The use of PTZ rotary cameras in CCTV systems makes it possible to reduce the costs associated with the system installation and video data archiving. In contrast to stationary cameras, the preview of many sensitive zones (obviously not at the same time) is possible by means of single rotary camera. The correct determination of cameras presets makes it possible to achieve the multiplication of rotary cameras capabilities in comparison to stationary cameras.

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PLATFORMA PROGRAMOWA WSPOMAGAJĄCA PRACĘ OPERATORA KAMER PTZ SYSTEMU CCTV – ASPEKT POPRAWY FUNKCJONALONOŚCI I ERGONOMII UŻYTKOWANIA SYSTEMU

Streszczenie: Funkcjonalność systemu sterowania oraz ergonomia i intuicyjność jego użytkowania to obok doświadczenia operatora systemu główne czynniki mające wpływ na proces zarządzania systemem monitoringu wizyjnego CCTV. Optymalne powiązanie funkcjonalności systemu jego ergonomii użytkowania i doświadczenia operatora umożliwia szybkie przystosowanie parametrów rejestrowanego obrazu do potrzeb aktualnie realizowanych zadań związanych z obserwacją zadanego obszaru. Zarządzanie systemem CCTV to w dużej mierze kontrola ustawień kamer oraz dopasowanie parametrów kamer PTZ do aktualnych potrzeb obserwacyjnych. W artykule przedstawiono rolę ergonomii stanowisk pracy oraz technicznych możliwości platform programowych wspomagających pracę operatora kamer PTZ systemu CCTV. Przedstawiona platforma programowa to aplikacja zbudowana na bazie środowiska LabView. Platforma programowa oprócz realizacji funkcji sterowania dostępnych w standardowych, sprzętowych manipulatorów ustawień kamer PTZ umożliwia wizualizację stanu obiektu ma monitorze oraz proceduralne wykonywanie zadanych funkcji sterowania. W artykule szczególny nacisk został położony na praktyczne możliwości takich systemów, na wspomaganie pracy operatorów, zmniejszenie czasów obsługi przy realizacji zadań związanych ze zmianą ustawień kamer PTZ.
Słowa kluczowe: systemy sterowania i nadzoru, monitoring wizyjny, systemy CCTV, kamery PTZ, protokoły komunikacyjne, ergonomia procesów zarządzania.