AUTOMATED VIDEO SURVEILLANCE SYSTEM USING NEURAL NETWORKS FOR OBJECT RECOGNITION

Pribytko P.D., Shvedova O.A.
Belarusian State University of Informatics and Radioelectronics
Department of Information Systems and Technologies
E-mail: shvedova@bsuir.by

Annotation. *The uniqueness of the developed automated system lies in the use of technologies based on neural networks, which allows the equipment to use the "Deep Learning" effect. Considering the unfavorable epidemiological situation, thermal equipment is integrated into the automated system which enables to carry out thermometric measuring when visiting the enterprise. The advantages of this system are such as the following: monitoring the integrity of the protected perimeter, organization of time tracking and organization of preventive measures (COVID).*

An automated video surveillance system using neural networks for object recognition is a full-fledged high-tech complex that solves the problems of ensuring the security of an enterprise in the internal and external territories along the perimeter of the protected object.

The system is controlled by the Operator from the control point located in the administrative building on the territory of the enterprise. The perimeter video surveillance consists of 14 IP cameras with intelligent object recognition capability (the IP cameras' name is Hikvision DS-2CD2647G2) and 3-speed robotic PTZ IP cameras with the ability to recognize objects and bind to them throughout the entire travel route (the IP cameras' name is Hikvision DS-2DE4425IW-DE).

Structurally, the access control and management system integrated into this automated system are divided into two main blocks: a block for managing the entry / exit of vehicles, a block for managing the passage of employees through a checkpoint (hereinafter referred to as the checkpoint) of a protected enterprise. The vehicle entry/exit management unit consists of 2 IP video cameras (the IP video cameras' name is Hikvision iDS-2CD7A26G0/P-IZHSY), 2 entry/exit controllers (the controllers' name is Hikvision DS-TME402-TPC), the control terminal (the terminal name is Hikvision DS-TPE104) and the final executive device which is an automatic barrier. The block for managing the passage of employees through the checkpoint consists of 1 IP video camera with the ability to measure temperature and detect fires (the name of the IP video camera is Hikvision DS-2TD1217-3 / PA), 2 access terminals for entry and exit (the name of the terminals access is Hikvision DS-K1T341) and the swing turnstile (the turnstile name is Hikvision DS-K3Y501).

An automated video surveillance system using neural networks for object recognition solves the problems of implementing the security of the perimeter of a protected area. The integrity of the perimeter is monitored by security radars in the amount of 3 pieces (the radar's name is Hikvision DS-PR-1-60), which allows you to simultaneously conduct digital surveillance of 32 targets in the "Online" mode, as well as design the intended route of movement of the object of observation. The security radar operates using electronic beamforming technology which is coupled with intelligent deep signal processing algorithms. This information is sufficient to determine the location and movement of monitored targets with high accuracy. İn case of an unauthorized access attempt detection, an alarm signal from the security radar is transmitted to the PTZ camera (the IP video camera's name is Hikvision DS-2DE4425IW-DE) as well as to the control center. This configuration allows you to activate instantaneous video recording and thereby carry out the identification and visualization of the object of observation by the operator of the control center. The method of functioning of the security radar (the radar name is Hikvision DS-PR-1-60) is shown in Figure 1.

Figure 1 – The method of functioning of the security radar

The automated video surveillance system is controlled by using a digital IP video recorder (the name of the IP video recorder is Hikvision DeepinMind Ids-7732NXI-I4/X (B)). The general management of the complex security system of the protected enterprise is carried out through the use of a workstation (the name of the workstation is HikCentral-Workstation/64).

The functional component of the automated video surveillance system provides for the organization of long-term storage of information that is archiving in the system. The archiving function is performed by the data storage server (the name of the data storage server is Hikvision DS-AT1000S/288). The required storage size of the video surveillance system is 158.445 TB.

In case of a power outage on the territory of the protected facility, a backup power supply is provided through the use of uninterruptible power supplies (hereinafter referred to as UPS). The automated system uses 11 UPSs. The battery life in accordance with the technical specifications is: UPS No. 1 - 1.32 hours, UPS No. 2 - 1.19 hours, UPS No. 3 - 1.7 hours, UPS No. 4 - 0.8 hours, UPS No. 5-7 - 4.7 hours, UPS No. 8 - 0.21 hours, UPS No. 9 - 1.02 hours, UPS No. 10 - 0.8 hours, UPS No. 11 - 1.7 hours.

The protected object is an open flat area with an administrative building, outbuildings and several parking lots. The layout is shown in Figure 2.

Regarding the organization of network interaction (network interface), the equipment is connected via the network data transfer protocol "TCP". The organization of packet transmission at the transport layer is implemented through using the network data transfer protocol "TCP". The application layer is organized using the following protocols: RTSP, SNMP, HTTP, HTTPS, UPnP, EHome 5.0 (protocol developed by Hikvision).

The designed automated video surveillance using neural networks for object recognition operates on the basis of the software (hereinafter referred to as the software) HikCentral professional ver. 2.0.1. This software allows you to integrate the components of the access control and management system together with the elements of the video surveillance system into a single whole, which significantly optimizes the work of the Control Center Operator. In this project, the following features are implemented: measuring the temperature of the human body, monitoring the presence of a respiratory mask on the face, binding and tracking the object of observation in the control zone, detecting objects left (unattended), face recognition, recognition of registration plates of motor vehicles, recognition and classification objects of observation by categories, organization of patrols by levels in three planes (PTZ), biometric access to the territory of the enterprise. All implemented technical components are built on the basis of technologies that operate on the principle of deep learning algorithms. This project uses technologies with applying neural networks such as ColorVu, AcuSense, DarkFighter, DeepLearning.

ColorVu is a technology for additional warm lighting, which enables to transmit a color image even in the dark. Video cameras, incorporating ColorVu technology, effectively cope with such tasks as deep recognition of the object's details in conditions of insufficient visibility. Camcorders are equipped with LED-backlight, which quarantees high-quality color shooting 24 hours a day in high resolution. An important feature of ColorVu technology is the use of "deep learning algorithms" for accurate classification of targets (person /vehicle), as well as for the

maximum elimination of various false alarms caused by non-target objects (animals, precipitation, natural phenomena, etc.).
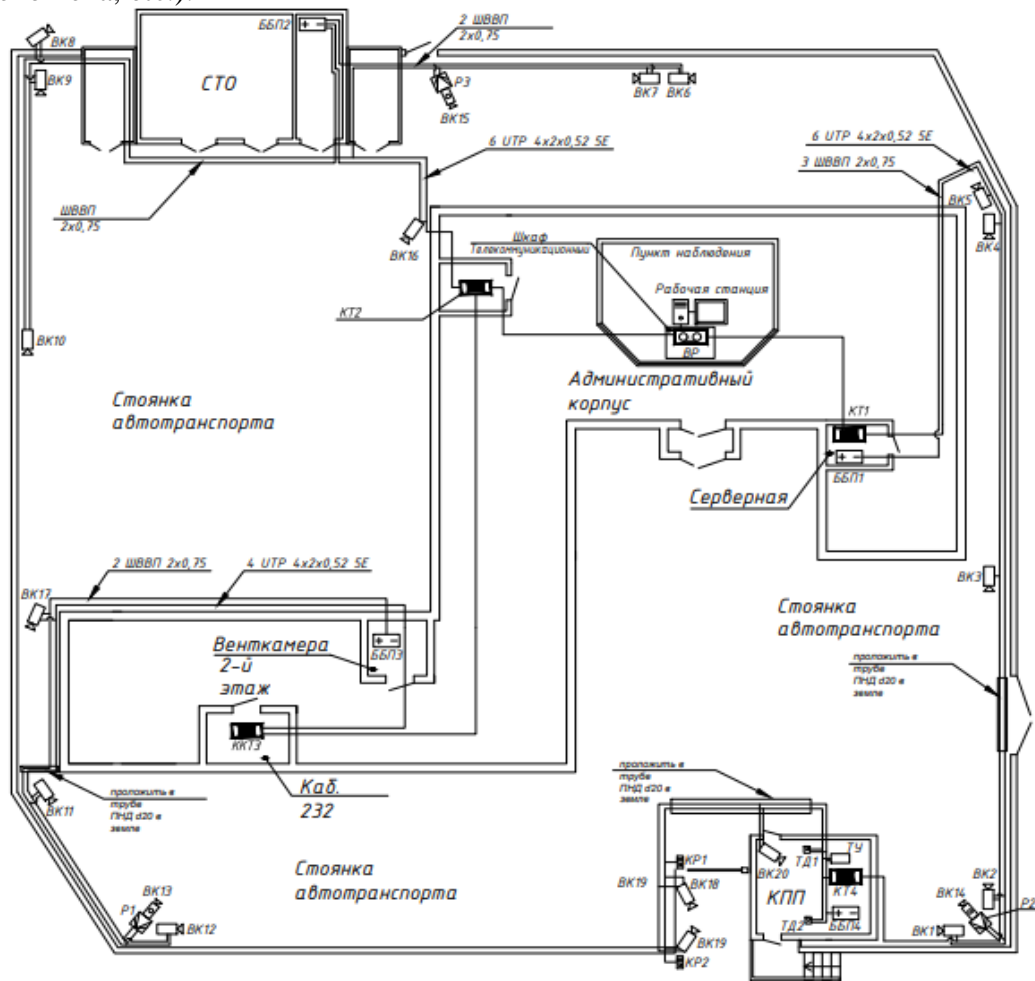

Figure 2 – Layout plan

AcuSense is a deep video analysis technology based on the use of "deep learning algorithms" which is used to detect targets and classify them into the categories such as: "A Person", "A vehicle" or "Others". The technology helps to reduce the number of false alarms. When using technology with algorithms of "deep learning algorithms", the original signal passes through several layers of information processing. Consequently, the algorithm transforms a partial understanding (surface level) into a general pattern (deep level). The perception of the object analyzed is based on this general pattern (deep level).

DeepLearning is a technology based on the application of "deep learning algorithms". The peculiarity of this technology is that it does not require the participation of the operator since it relies on artificial intelligence for the purpose of self-extraction of functions, that is, self-learning. DarkFighter is a technology that enables to provide clear color images both in the daytime and at night. DarkFighter technology cameras use special ½-inch sensors with the best light sensitivity, high signal-to-noise ratio and increased wide dynamic range. The area of one pixel of this matrix is almost twice as large as that of a standard type matrix, which is one of the most important conditions for issuing a high-quality image in poor visibility conditions. Camcorders with DarkFighter technology use aspherical lens to reduce image aberrations. The main feature of aspherical lenses from standard types of spherical or flat lenses is the presence of a free-form surface. This feature helps focus light more precisely to further improve image quality. DarkFighter solves the problem of image aberrations and improves the light transmittance, resulting in significantly improved image quality under poor visibility conditions.

The effectiveness of the functioning of an automated video surveillance system in the field of ensuring the security of a protected enterprise is directly proportional to the reliability of the functioning of all nodes and mechanisms used in the system as a whole. Based on the principles of reliability, all aspects of the application of reliability indicators are considered, on the basis of which the probability of failure-free operation of the applied units and mechanisms $P(t) = 0.72$ is obtained.

The designed automated system makes it possible to increase the security level of the protected enterprise using neural network equipment, carry out round-the-clock monitoring of internal and external territories, keep track of the working hours of the enterprise employees and organize unhindered passage of official vehicles.

In addition, it is worth noting that the integration of the applied technical systems with the implemented solutions in the field of enterprise security makes it possible to obtain a high level of protection of the facility and organize a unified security system with the solution of urgent tasks, for instance, ensuring the integrity of the protected area, eliminating the possibility of unauthorized access, increasing the level of security of the employees of the enterprise, exclusion of illegal actions against the property of a legal entity, exclusion of violations of public order, organization of registration of the time of arriving personnel, organization of registration of the time of incoming vehicles, organization of preventive measures against COVID, collection and storage of data for further analysis.

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