Perimeter Protection: Security and Surveillance of the Sensitive Zones

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The present research article investigates the past and modern state in the zone of outdoor security. In the first part of the article, the sensory systems, which have been used for numerous years are described. Consideration is paid to the sensors using predictable ideologies of the recognition of the entities. New recent sensory systems together with their principles used for the defense of the outdoor environment are also described. Other problem is that older sensory systems of spatial protection were focused on the security of properties and buildings without expecting any change position in the time. The article analyzes also new possibilities of protecting of the outdoor perimeter even in the situations when the borders of the areas of interest are only temporary or mobile. As the Unmanned Aerial Vehicles (UAVs) systems have been used hugely and frequently involve modern multisensory systems, the last part of the article describes current sensors, which have been currently used to detect the UAVs systems and to guard the range of attention.

Automated defense of the area of curiosity has a significant meaning, and we enhance consideration in that technique. A significant hazard from the side of security is extensive changes of options to try attacks from intruders. Now-a-days technologies provide better conditions for attempts of stealing, terroristic attacks, sabotages, or other attacks, the goal of which is destroying or damaging protected objects or people in that objects. The last few years, companies started using UAVs (Unmanned Aerial Vehicles), which have technological possibilities for the simple realization of many kinds of illegal activities like terroristic attacks, assassination, carrying contraband, or trespassing and others. Based on the above mentioned facts and entirely various commercial disponibility of the UAVs, we had to implement adequate actions. These actions forced to increase the standard requirements for the outdoor perimeter protection. The main goal of the outdoor protection is to catch an intruder in a secured place with technical resources to prevent illegal activity. When we reveal intruders before trespassing into the area of interest, the security service has more time to react to eliminating the threat. Solutions and installations of the systems of outdoor protection are very specific problems because creating adequate protection is impacted by the various conditions. These conditions are, for example, forecast, false alarm and other situations. We have to combine and integrate many different elements and methods, as in the case of the indoor environment. We expect from devices and the systems for outdoor

protection that they will work without a problem as the main priority. They have to be weatherproof. Sometimes, we can predict some weather conditions and eliminate their consequences. Often, we have to place them within easy reach of people and animals. Because it can cause many unexpected complications. Quality sensorial and software equipment provides correct detection of disturbance of space without false alarm and failures. However, proper installation of outdoor protection has to be well designed and implemented to fulfill its purpose. Technological progress enables new ways to disrupt the protected target place. New systems and equipment could easily eliminate security systems. It is essential to stay current in researching and developing new security systems and sensors for outdoor protection. It is necessary to focus on this domain.

SAFETY SENSOR IDEOLOGIES FOR THE OUT-OF-DOORS LOCATION: Various intrusion detection systems are used to secure a defined area of interest. According to the principle used to detect intrusion into the protected area, electronic perimeter protection devices are divided into two broad groups. These are overhead and underground systems. Overhead systems use passive infrared detectors, microwave detectors, dual detectors, infrared barriers, microwave barriers, microphone cable, and fence-crossing detection systems. Fence-crossing detection systems use multiple principles, or methods, of intrusion detection. For example, electromechanical evaluation of mechanical wire tension, shock detectors placed on the fence mesh or a wall, evaluation of changes in the primary parameters of the detection cable, and others are used. The second group of outdoor protection is underground systems. These uses capacitive cable, microwave cable, unique cable systems, pressure hose and slotted cable to detect intrusions. Of the above detection systems, systems using infrared detectors, microwave detectors, microwave barriers and infrared barriers are still widely used today. The others are less and less widely used. The main factor is the complexity of the application and hence the cost per deployment. Also, in case of a failure, the repair is complicated, expensive and time-consuming. New systems are available on the market today. These perimeter protection systems will be introduced in the second part of the article. PIR (Passive Infra-Red) detectors are still very attractive despite many years of use. Their advantage is their low price, ease of installation and reliability. PIR detectors evaluate changes in radiation in the infrared band of the electromagnetic wave spectrum. The sensing element is a gradient transducer (so called pyro-electric element). It means that, in principle, it cannot detect a constant level of radiation, but only changes in the radiation incident on the sensor. If in the field of view PIR detector moves a body with a temperature different from the ambient temperature, and the sensing element evaluates the changes and the connected electronics report that motion is occurring in the area of interest. PIR detectors offer a different range of sensing characteristics with different ranges. The quality of PIR detectors has significantly increased (sensitivity, range, detection characteristics and others). Therefore, they are still very attractive and in demand in the market. An example of the use of PIR detectors with sensing characteristics is shown in Figure 1.

FIGURE 1: SPECIMEN OF APPLICATION OF PASSIVE INFRA-RED (PIR) DETECTORS WITH SENSING FEATURES.

Microwave motion detectors (MW), designed for the outdoor environment, emit a high-frequency signal (typically 10.525 GHz - the so-called X band) and evaluate changes in the signal reflected from the environment. The principle of operation uses the Doppler phenomenon, in which the frequency of the signal reflected from moving objects changes. The disadvantage of microwave detectors in general is the sensitivity to any movements in the field of view of the detector. In the outdoor environment, objects belonging to the protected area moving due to adverse weather conditions (wind, rain, snow) can cause false alarms. Therefore, MW detectors designed for the outdoor environment are usually equipped with additional circuits to protect against false alarms. These include close-up signal suppression circuits that limit the effects of rain, vibration, and wind-borne objects. Some detectors use a dual design to increase durability. Dual MW detectors use two receives channels. In order for an alarm to be triggered, the evaluation circuits monitoring both channels must detect a movement on the track of at least 20 cm. In addition, a signal processing mechanism is used. This mechanism eliminates weak signals, movement outside the set speed range and signals indicating bidirectional movement, which triggers false alarms caused by the movement of vegetation or small animals. An example of the introduction of microwave detectors is shown in Figure 2.

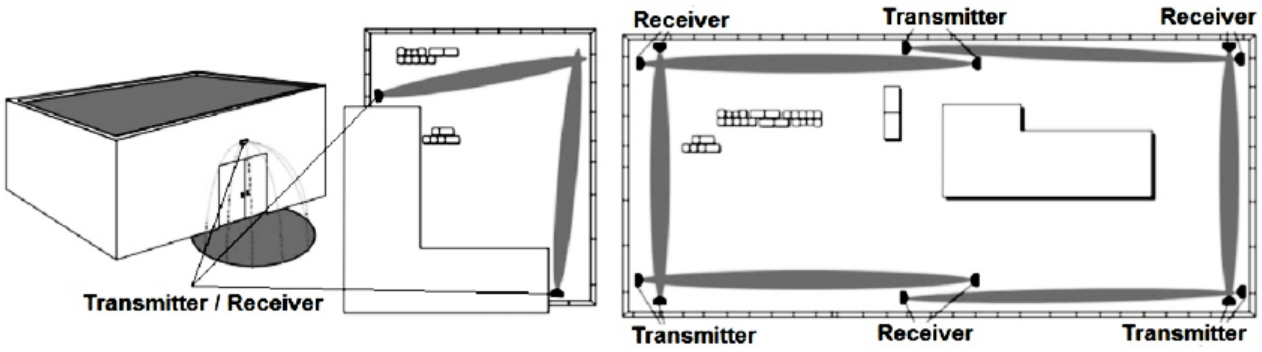

FIGURE 2: APPLICATION OF MW DETECTORS AND MW BARRIERS.

If we need to guard the perimeter of a larger perimeter, it is advisable to use microwave barriers. Microwave barriers do not use the Doppler Effect in their operation. The MW barrier uses the principle of evaluating the change in the signal received by the receiver. The change in amplitude of the received signal is directly proportional to the size and density of the target. Newer types of barriers operate in the 27 GHz frequency band (so-called T band); older ones use a frequency in the 24.125 GHz band (K band). Due to the fact that several barriers are used to protect the perimeter, it is necessary to ensure the resistance of the barriers to mutual influence. In practice, this is realized by modulating the transmitted frequency. For example, modulation frequencies of 3 kHz, 4.5 kHz, 7.5 kHz and 10.5 kHz are used. Figure 2 shows an example of the installation of MW barriers and Figure 3 shows a 3D visualization of the detection characteristic around the perimeter of the protected space. For such protection, it is necessary to use 4 MW barriers, which contain 4 MW receivers and 4 MW transmitters.

FIGURE 3: 3D PICTURING OF MW BARRIER FEATURES.

An infrared (IR) barrier is a detection device that triggers an alarm condition in response to an interruption of the infrared beam between the transmitter and receiver. The infrared barrier is created by applying an optical sensor. Optical sensors generally respond to light, or to the difference in brightness of the light beam that strikes the optical sensor. An example of the use of the infrared barrier is shown in Figure 4, where there is also a detailed view of the optoelectronic sensor and the IR barrier transmitter, respectively.

FIGURE 4: AN IR BARRIER WITH A COMPREHENSIVE VIEW OF AN OPTOELECTRONIC SENSOR / TRANSMITTER.

MODERN WAYS TO PROTECT THE OUTDOOR SPACE: A camera system is a part of almost every security in the areas of interest. The above-mentioned older detection systems were in most cases supplemented by a camera system. However, they did not serve to detect the intruder. They performed the task of continuous surveillance of the protected area for the security service. In the event of a breach, the above systems have notified the security service. They could immediately look at the place of violation through the camera system and, based on that, adequately intervene or evaluate a false alarm. CCTV systems are still widely used a direct visual surveillance of the protected area, where continuous monitoring is required. Today we know cameras that are at a higher technological level and some of them have the possibility of various functions. Today, camera systems are commonly used as a stand-alone intrusion detection system. They can detect space distortion from the captured image and highlight it on the display unit. Some smart camera systems can alert suspects. Some camera systems can even detect any movement, mark movement points on the display unit and analyze the object (human, animal, car, vegetation, objects carried by the wind, birds, unmanned aircraft, etc.). They are camera systems with a certain level of artificial intelligence. There are camera systems with the ability to learn. These are not yet used in practice for spatial protection. The quality of the cameras has increased many times in recent years. Due to the competitive struggle, the price of the cameras is falling despite the growing quality. Nowadays, ordinary people can afford quality camera systems. The big disadvantage of intelligent space protection camera systems is that they cannot work reliably in poorer visible conditions. Another problem is when the intruder merges with the background. Thermal cameras or other systems working on a different physical principle are used to protect areas where visual conditions are worse. Due to the high price, thermal imagers have long been used only in the military and in special applications in industry. Today, their quality is high at a relatively low price. Therefore, the use of thermal imagers in the commercial sphere is constantly growing. Thermal imagers are of great importance in protecting areas of

interest with poorer visual conditions. They make it possible to reliably monitor the area of interest at night, in a smoky area, in dusty conditions and in worse meteorological conditions. It can be seen that the use of a thermal imager multiplies the possibility of detecting a potential intruder in poor visual conditions. The thermal imager consists of infrared radiation sensors or radiant thermal energy sensors. These sensors are not sensitive to visible light, which makes us see very well in poor lighting conditions. This is because they sense infrared radiation emitted by the observed objects. The energy captured by the sensors is converted into an image that shows the energy differences between the scanned objects. Infrared light reveals characteristics that are not recognizable under visible light. For this reason, even in complete darkness, it is possible to observe the outline of humans, animals, mobile devices and the like. In critical areas of industry, it is possible to monitor heat leaks or high voltage lines, where it is possible to identify the extent of damage or detect an impending fault with the help of a thermal imager. Subsequently, it is possible to take all measures in time to prevent huge damage. We currently have the Sun-view system on the market. This system can automatically identify and alert people to high temperatures. The Sun-view system integrates a thermal temperature camera and a standard camera in one device. This system works reliably in public places as a preventive measure against the rapid spread of infectious diseases, the symptoms of which are fever. A typical place for installation can be spaces through which an increased number of people pass. This system can be easily applied to airports, bus and train stations, shopping centers, schools, kindergartens, banks, hotels, restaurants and more. It is clear from this view that it is a system with a certain level of intelligence. The system can recognize faces and assign a measured temperature value to a given face. In the case of a measured elevated temperature, it notifies the authorized person and distinguishes this person in color on the display unit with the corresponding measured temperature value. There are currently a number of radars on the market with various parameters such as the size of the monitored perimeter, detection characteristics, the number of monitored objects and others. Radars have been used in the past mainly to protect the perimeter of larger ranges. Today, manufacturers also offer radars with a small protective perimeter, such as the Spotter RF SP-CK2 radar. This radar offers a protective perimeter in the horizontal plane (125 x 40) m. Such radar is an ideal solution for securing space around small companies, lands of small farmers, used cars and the like. A very interesting detection method that has been used to protect the perimeter is with LiDAR (Light Detection and Ranging). LiDAR measures distances based on the calculation of the pulse propagation time of the laser beam reflected from the scanned object, which is evaluated in the photo-detector. The distance of the LiDAR object is calculated as half the time that elapses between the transmission and the laser pulse. The result of the mapping of the terrain or space by LiDAR is a so-called point cloud, which is processed using algorithms and interpolated to create a 3D digital model of the surface of objects in the field of view. By further processing and filtering, a digital terrain or space model can be created from the points. Instruments working with this technology are used in both ground and aeronautical applications. The advantage of Lidar in the monitored area of interest is that it works the same in complete darkness. Quality LiDARs work reliably even in worse meteorological conditions. LiDAR makes it possible to

precisely determine the distance of the intruder, or to ensure its tracking. Space protection can be provided by 2D or 3D LiDARs. 2D LiDAR, compared to 3D LiDAR, provides a simpler and cheaper alternative to protect the area of interest. In this case, LiDAR alerts you to the location of the disturbance without 3D visualization of the space. There are many LiDAR manufacturers on the market today that offers a variety of design solutions.

SPECIAL MODERN WAYS TO ENSURE THE OUTDOOR PERIMETER: Many authors focus on securing the stationary perimeter when protecting the outer perimeter. However, it is a common practice today to secure also a moving perimeter. It is mainly used in the automotive industry. Today's modern cars create a certain protective perimeter in their surroundings. They use ultrasonic sensors, radars, LiDAR, cameras and others to do this. Based on the data captured from the sensors used, cars can warn or react to pedestrians, animals and other obstacles. It is a view of the perimeter in front of the car while driving in the city at night. An ordinary camera and human eye are not able to detect a potential threat such as a person standing on the side of the road. This person is clearly visible on the LiDAR record. We can also notice that LiDAR also scans the lines on the road, which testifies to its high sensitivity and accuracy.

CONCLUSION: Increasing attention is being paid to the protection of areas of interest. In the past, security systems for spatial protection were concentrated mainly on the boundaries or the perimeter of the area of interest. These were fencing breach systems or underground systems located around the perimeter of the secured or protected area. Today, such security and protection systems are insufficient. The nature of the attacks is increasingly complex in terms of detection, so the demands on the spatial security have been increasing. Based on these facts, better perimeter security systems have been developed. Some of them are replacing older detection systems. Advances in sensors, electronics and artificial intelligence also make a significant contribution to the development of new and better detection systems. Today's systems focus not only on borders, but also on the entire interior space. They even provide the ability to monitor the area beyond the protective perimeter. This makes it possible to detect a potential threat before it enters the protected perimeter. Furthermore, it should be noted that the protective perimeter can be stationary, temporary or mobile. Temporary and mobile perimeter security and/or protection have been known in the military for several years. In particular, mobile perimeter protection is used more frequently in the military on ships, submarines, tanks and special military vehicles. In the civilian sphere, the interest in the security and protection of the mobile and temporary perimeter has only begun to show significantly in recent years. Today, mobile perimeter protection is used mainly in modern cars. Every car that is capable of perimeter protection must have sensory equipment for this purpose. Today, ultrasonic sensors, radars, LiDar and camera systems are used. Modern intelligent cars create a safe perimeter in their surroundings, which is constantly monitored. In the event of danger, the system can warn or decide and react on its own, thus increasing the safety of the car traffic. Today, there is a trend to produce multisensor modular systems that the user can easily assemble according to their own needs.

Multisensor systems are used to prevent false alarms in harsh conditions and to increase detection capabilities. Also, in case of a failure of some sensors, the security system is able to continue working and to provide a certain degree of reliable detection. Manufacturers are introducing the ability to connect with smartphones. In this way, it is possible to ensure the immediate submission of information about the violation, even with the visualization of the violation. The system can notify security components in parallel. This supports a timely response and consequent rapid and effective disposal of the intruder. In conclusion, it can be stated that the number of incidents of disruption of areas of interest is increasing from year to year. As well as the nature of the attack, as intruders have better access to today's technical gains. For this reason, the development of external perimeter security and protection systems will have to constantly develop and improve.

ACKNOWLEDGEMENTS: The authors thank the Sushil Ansal Foundation, 115 Ansal Bhawan, 16, Kasturba Gandhi Marg, New Delhi-110001 for financial assistance under the Project Scheme: R&D Grant-in-Aid Scheme bearing the **Project ID: SAF/AITM-LKO/2016/MRP-06.**

REFERENCES:

[1]. Veľas, A. Elektrické zabezpečovacie systémy. Žilina: University of Žilina. 2010. 104 p.

[2]. Mikrovlnné bariéry a detektory. Sup companies. 2012. Available at: http://www.supkn.sk/specialne-sluzby/