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Anna Dmochowska, Ph.D
Faculty of Safety Engineering and Civil Protection
The Main School of Fire Service

Threat Prevention at the Airports Using Detection Systems

Abstract

An airport is a place where there is a possibility of many threats. Not without reason it is included in the critical infrastructure. The quite large area which the airports occupy makes it difficult to control all people in order to eliminate the smuggling of prohibited goods or bringing dangerous tools to the aircraft. This is an area where there is often a local, high density of people, which promotes theft or the possibility of hide an explosive charge. In addition, deliberate or accidental fire hazards are often associated with breakdowns.

The article presents the characteristics of detection systems installed and used at the airports in terms of increasing the level of security of both passengers and their property.

Keywords: airport security, detection systems

Zapobieganie zagrożeniom na terenie portów lotniczych

Abstrakt

Port lotniczy jest miejscem, gdzie istnieje możliwość wystąpienia wielu zagrożeń.

Nie bez powodów zaliczany jest do budowli infrastruktury krytycznej. Dość duży obszar jaki zajmuje, utrudnia szczegółową kontrolę wszystkich osób, celem eliminacji przemytu towarów zakazanych czy wnoszeniu do samolotu niebezpiecznych narzędzi. To teren, na którym występuje często miejscowe, duże zagęszczenie ludzi, co sprzyja kradzieżom czy możliwości podrzucenia ładunku wybuchowego. Dodatkowo zagrożenia pożarowe spowodowane celowo bądź przypadkowe, często związane są z awariami.

W artykule przedstawiono charakterystykę instalowanych i wykorzystywanych na terenie portów lotniczych systemów detekcyjnych pod kątem zwiększenia poziomu bezpieczeństwa zarówno pasażerów, jak i ich mienia.

Słowa kluczowe: bezpieczeństwo portów lotniczych, systemy detekcyjne

Introduction

The process related to threat detection is associated with the use of appropriate detection technology [6,8]. Nevertheless, installing the most advanced detection systems involves training the appropriate personnel to operate it. Unfortunately, it is the human being who is the weakest link in the process of identifying the potential threats [14, 19].

The basic condition for the effective protection of facilities is the harmonization of systems and support for their operation through the use of mobile devices and appropriate procedures [16].

Characteristics of detection systems

The perimeter protection system concerns the identification of events in connection with crossing the boundaries of protected areas, e.g. boundaries delimited by fences. They work by detecting changes such as ground vibrations or magnetic field disturbances [10]. These systems are combined with the monitoring systems so they can automatically direct any selected camera to the place where the signal occurred and cause its verification. EU recommendations indicate that the airport security should be differentiated depending on the zone, which includes the public, restricted and sterile areas. There are also objects of special importance, such as an airport apron or control tower [9]. Detection of a restricted zone should occur when the intruder passes through the fence barrier. Cameras, on the other hand, allow observation of the area in front of and behind the fence [12, 18].

Fig. 1. An image from the perimeter protection system combined with the monitoring, showing the detection of an intruder

Source: own source based on [21]

The airport perimeter security systems are very extensive. They include radars, video and thermal cameras, mutually coupled with ranges of several hundred meters. The diagram of the critical infrastructure facility protection system is presented in Fig. 2.

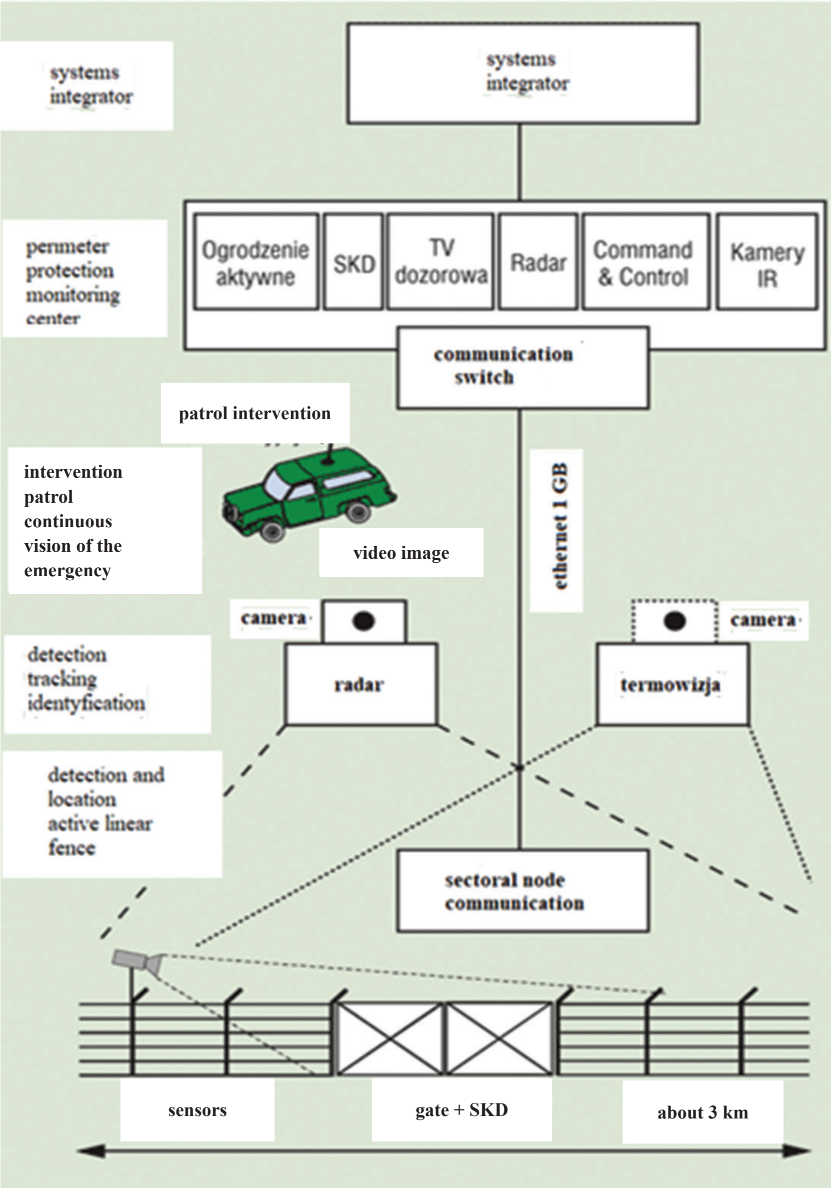


Fig. 2. Restricted area protection system

Source: own source based on [21]

An example of a special development of the teletransmission technology is the use of digital intelligent vision systems Fig. 3 and 4.

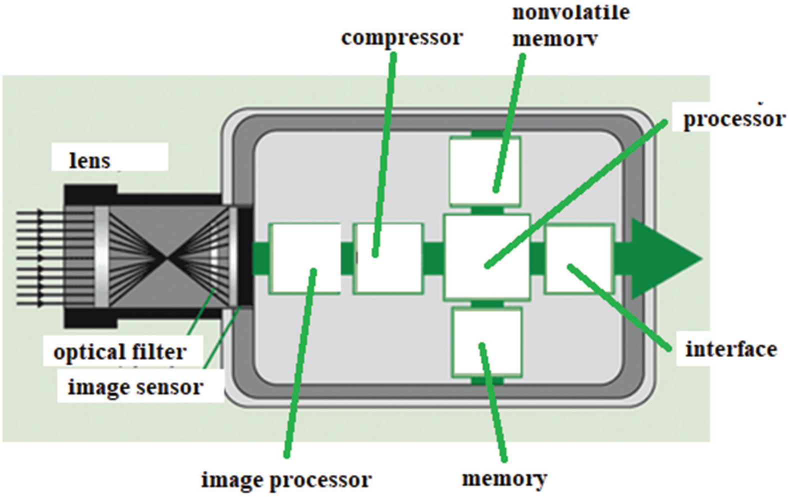


Fig. 3. Intelligent Network Camera

Source: own source based on [21]

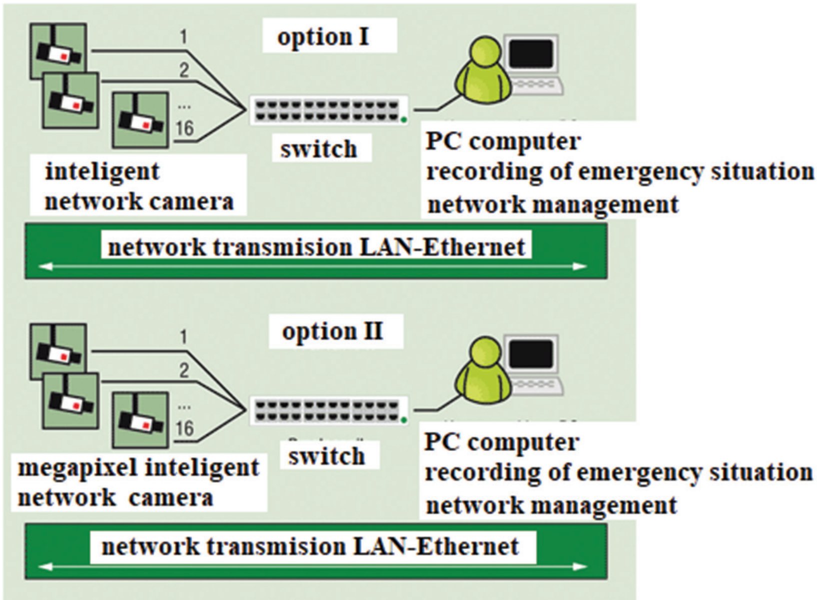


Fig. 4. Diagram of a video system with intelligent network cameras

Source: own source based on [21]

The vision camera systems are not adapted to wide angle vision. However, by adapting the field of view to the resolution of the matrix they become useful to identify a potential suspect. Unlike a vision camera, a thermal imaging camera records the thermal contrast between an object and the environment because every object in motion generates energy higher than the environment. Both technologies complement each other in security systems [9, 15].

Fig. 5 a and b show a camera and camera-radar system.

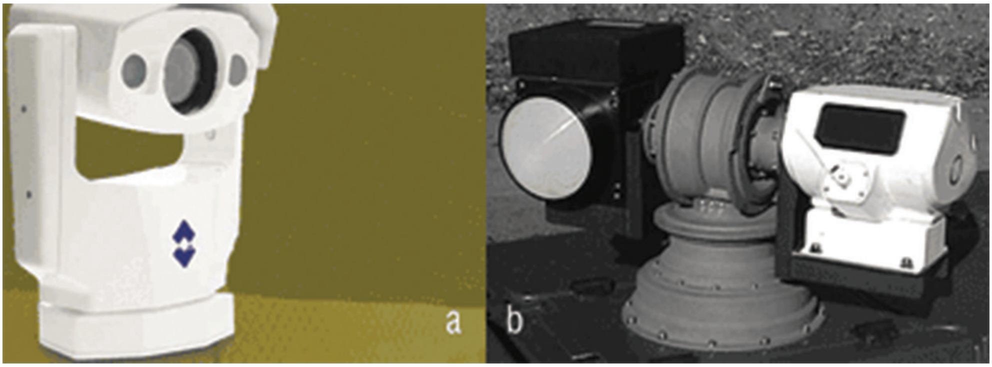


Fig. 5 Camera system, camera and radar system

Source: own source based on [21]

Despite the different principle of an object detection, the sensitivity of both cameras to weather conditions is similar [2, 11]. This applies to rainfall or snowfall as well as air transparency in fog. The port is also protected by the radar, which has the ability to penetrate microwaves through the smoke, fog or rain, detecting the flying objects along with the ability to track them. The radars operating on 3–30 GHz waves, having a range at the upper and lower frequency limits respectively: 2–5 km, 5–10 km and radars operating on the waves in the 30–300 GHz frequency range, having a range are used 1–3 km. The radars, unlike the cameras, are less dependent on the atmospheric conditions, they do not give a visual image of the object but project a point symbolizing it on the screen [3, 5]. A characteristic feature of the ground-based radars is the ability to search the space in a given second in a given sector quickly. Thanks to the appropriate software, the radars have been adapted to work in the security systems as the intruder detection sensors that can work with the sensors on the border of the fence. They can guide the cameras to the detected object in order to facilitate its recognition and identification. In intelligent camera systems, the appropriate software analyzes the image according to the criteria entered by the system operator, so the camera signals the alarm when it appears in the field of view of the programmed image sequence: a human, a car or an object. Another technology is the imposition of the images from a video and thermal imaging camera, which improves image quality and, above all, the effectiveness of computer analysis [4, 13].

The airport security also uses a two-phase system for monitoring suspicious people, recognizing the face of Fig. 6 and performing the tracking function of Fig. 7.

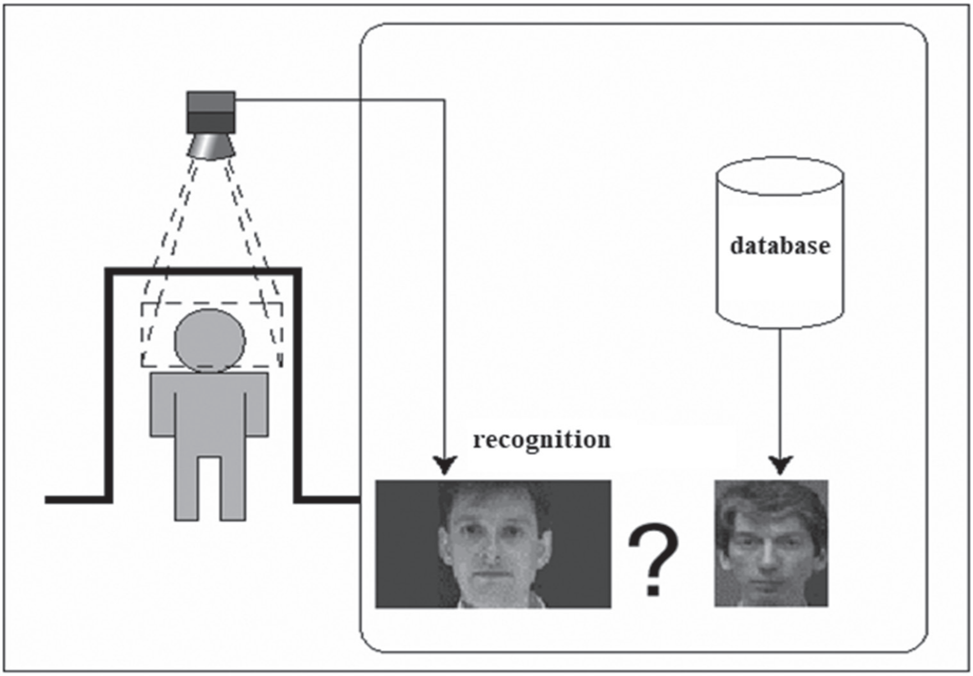


Fig. 6. Operation diagram of the subsystem used to mark the person being tracked at the entrance to the monitored object
Source: own source based on [21]

The camera at the entrance to the object sends an image of a person walking to the processing system where the face is extracted and compared with the database of people who have committed a crime in the past. After a positive result, the person is marked for tracking. The first technology in the field of software to assist the operator in the analysis of video image was the analysis of motion in the field of view of the cameras and radars. The program compares the current image of the camera field of view with the previous one and in case of detected changes, it starts an alarm. Interference is e.g. insects, leaves and tree branches that generate false alarms so that is why this program is used in closed rooms [1, 17].

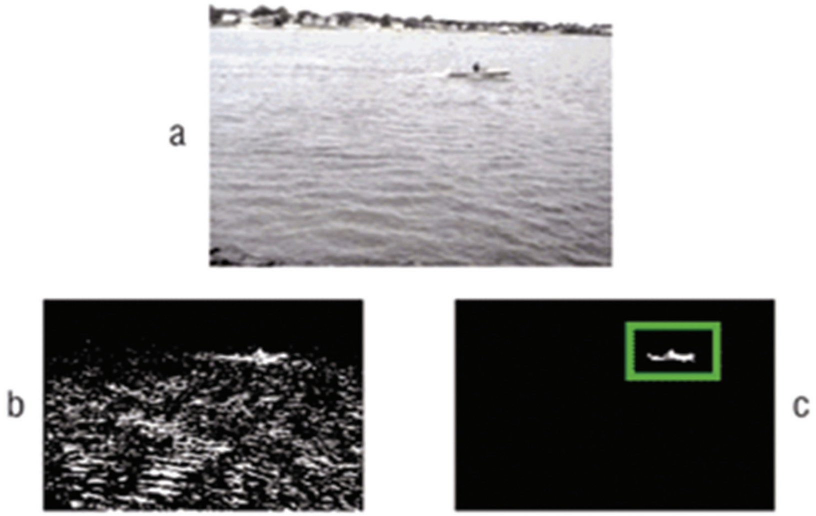


Fig. 7. Comparison of traffic analysis systems a) source image; b) VMD – hardly detects a floating object when moving around; c) IVS – clear object detection

Source: own source based on [21]

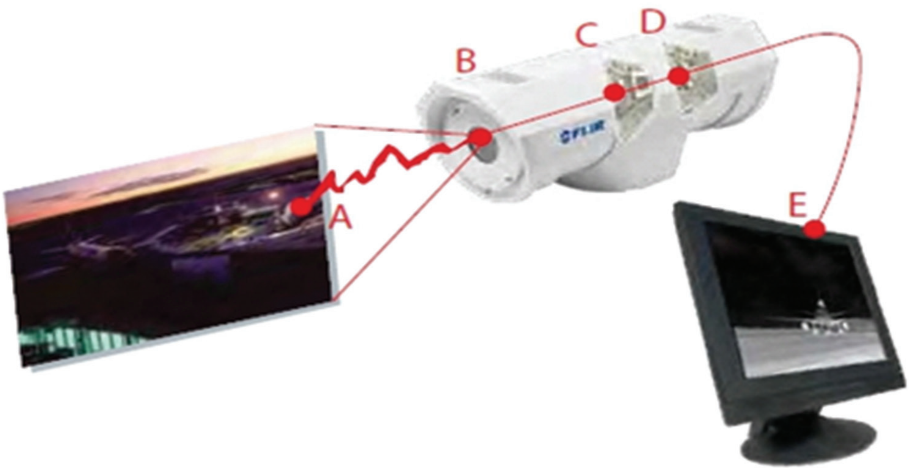


Fig. 8. Principle of operation of a thermal imaging camera

Source: own source based on [21]

Infrared radiation (A) from this area is focused by the lens (B) on the infrared detector (C). The detector sends information to the processor (D) for further electronic processing. Then the detector data is converted to image (E). The generated image can be displayed on an LCD monitor. Commonly defined criteria in the camera systems are crowd monitoring if it occupies 5% of the screen, the person detection if it occupies 20% of the screen, the person recognition if it occupies 50% of the screen and the person identification if it occupies 120% of the screen [7].

However, the criteria and concepts of detection, recognition and identification are defined differently in the IVS intelligent-automatic image analysis systems. There is a criterion that assumes that the critical human dimension is 0.75 m, and defines the criterion of 50% probability: detection when the length of 0.75 m reproduces 1.5 pixels, which means 1.5/0.75 = 2 pixels per meter; recognition when 0.75 m maps 6 pixels, which means 6/0.75 = 8 pixels per meter, and identification when 0.75 m maps 12 pixels, which means 12/0.75 = 16 pixels per meter. It also assumes that a standing man has a height of 1.8 m and 0.5 m in width. After converting the human surface to the number of mapping pixels, we get the detection criterion 1.8 × 2 = 3.6 vertical pixels and 0.5 × 2 = 1 horizontal pixel. And as above the criterion is defined: recognition: 14.4 by 4 pixels on the screen and identification: 28.8 by 8 pixels on the screen [14, 20].

This is shown in Fig. 10 where, for contrast, the criteria for observation television and television computer vision have been compared. In case of the automatic image analysis, the recognition criteria were defined as: detection – it means detection of the presence of an object in the field of view (with or without); recognition – it means determining the type of an object in the sense of animal, human, car; identification – here it has military significance: own or foreign, in civil practice it means the possibility of determining e.g. possession of items, luggage [22].

However, the analysis of the parameters of a particular camera, usually given for optimal conditions, should be related to the expected parameters in the extreme conditions. The optimal vision is ensured by the overlay of images from the cameras of various technologies: vision and thermo vision, day and night or in various weather conditions [7].

The imposition of images from the cameras of various technologies fusion and presentation of the resulting image on one screen, improves image quality, eliminates the weaknesses of individual technologies, and increases the operator efficiency and comfort Fig. 10 a, b, c.

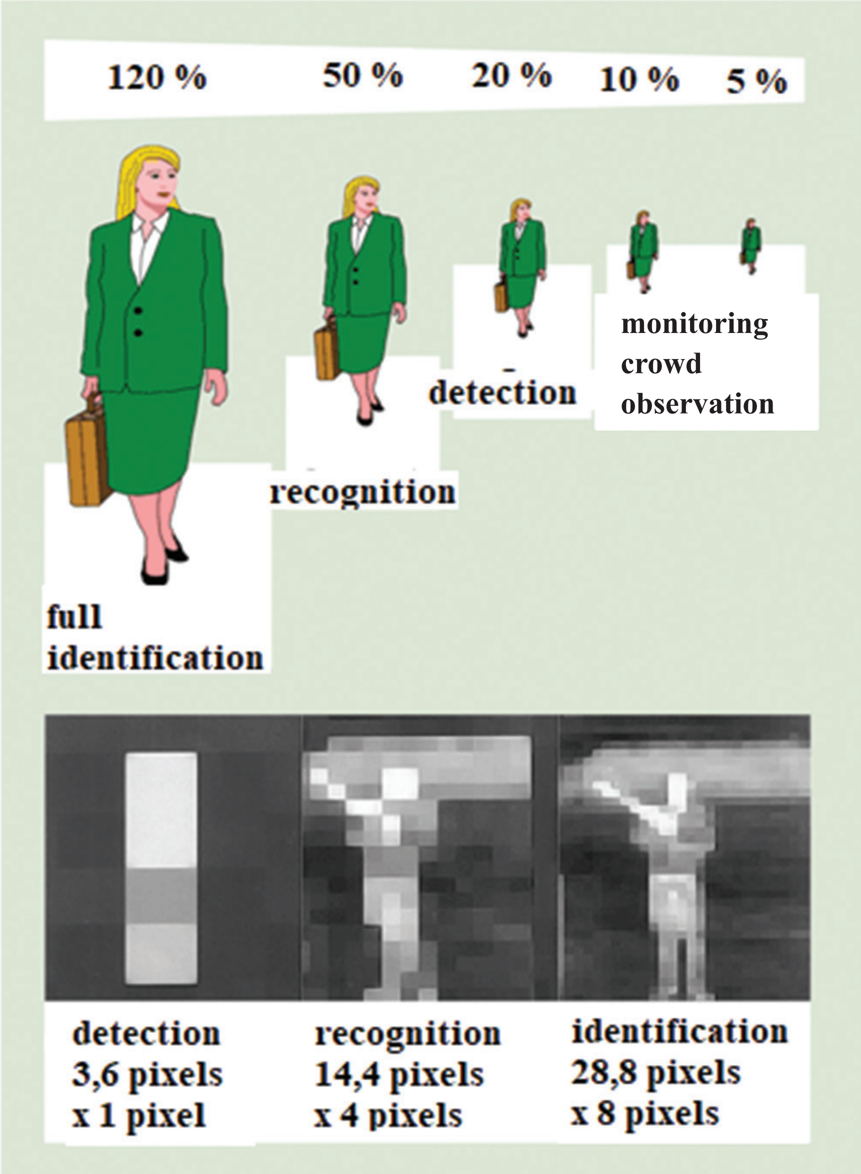


Fig. 9. Detection, recognition and identification criteria in human image analysis (top) and automatic computer analysis (bottom) – automatic analysis based on the example of a thermal imaging camera

Source: own source based on [21]

a

b

c

Fig. 10 a) image from a video camera, b) image from a thermal camera, c) merger

Source: own source based on [21]

Scanners are important elements of the airport equipment. The gate metal detector is equipped with a self-diagnosis program and a system for setting control parameters [21, 22]. The side panels have the LED indicators that precisely indicate the position of the prohibited object Fig. 11.

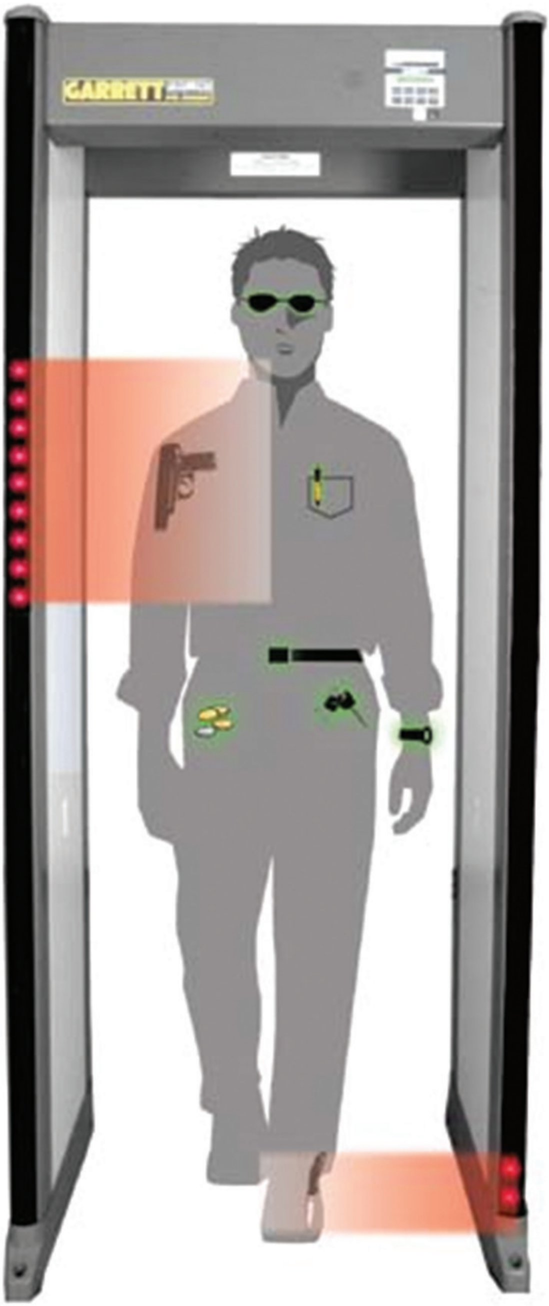


Fig. 11. Gate metal detector

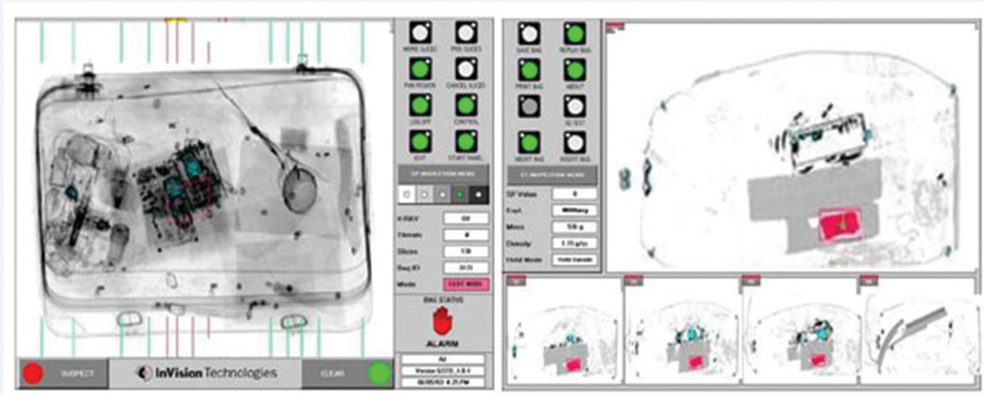
Source: own source based on [21]

Automated baggage scanning systems are based on the computed tomography technology. These scanners are much more effective than those based on X-rays. The baggage moves along the conveyor belt where the X-ray projection image is created first. In the next stage, the computer algorithms embedded in the system analyze the images and compare the properties detected by the CT scanner with the parameters of known explosives. When the data match, the alarm system is activated [5].

Fig. 12. Baggage scanning system
Source: own source based on [21]

The detailed control of the hand luggage is carried out at the control gate, which uses the advanced systems to analyze the flow of air around the human body [22].

The transition gate is fully automatic, which itself gives the voice and visual instructions to the passengers. The gate emits gusts of air that move the particles on clothing or skin. The gate sensors capture and analyze the air samples for the traces of explosives [5]. Differently, but equally thoroughly all baggage is checked which takes place in the inner part of the airport, out of sight of the passengers Fig. 13.



CTX 9000 DSi X-ray Image CTX 9000 DSi CAT Scan Image

Fig. 13. Picture from the baggage scanner
Source: own source based on [21]

Detectors used at the airports also include detectors in the fire alarm systems. These include smoke detectors: ionization, optical and linear detectors: heat, flame and gas.

Summary

The organization, structure and effectiveness of the security systems depend on the technical ones and the IT capabilities of the technologies used. In the protection of large airports, it becomes necessary to use mixed technologies: the detection (e.g. fence sensors and ground radars), the day/night imaging (e.g. vision and thermal imaging cameras), the guidance and the tracking (e.g. radar and a set of video cameras and additionally a thermal imaging camera) and the technology of automatic recognition, the identification during tracking of an intruder, including intelligent recognition and fusion of the images from several sensors.

The development of information technologies and their penetration into the security systems revolutionize the structures of security systems and, above all, significantly improves the airport security.

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