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Development of a system for locating of persons by triangulation

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Abstract. Systems that monitor movement of persons are closely linked to ensuring the security of the entire monitored complex. The security of the buildings is mediated via different types of systems such as I&HAS, CCTV, EFS, and others. These systems are combined with each other in order to achieve more optimal security of the guarded building. Patrol, attendance and other surveillance systems that do not provide the exact location of a person via coordinates are also used to monitor specific groups of people. For this reason, our goal is to design a system that is able to locate the monitored person (employee) in the building with minimal deviation.

Key words: triangulation, security, employees, monitoring.

INTRODUCTION

The basic elements designed to detect the movement of employees are access and attendance systems, which primarily detect the presence of employees at the worksite (Lukáš, 2011). There are many of these simple systems on the market today and many more are being added. Their differences are usually very small, and they frequently vary in terms cost and reliability.

When designing a security system and systems for monitoring people, it is necessary to realize that monitoring the movement of employees in the area is mainly associated with the Act on the Protection of Personal Data, which has reservations about the constant surveillance of persons in a building. For this reason, only the presence of persons in the worksite from the perspective of their arrival and departure is addressed. These systems are fully utilized in many companies where there is no need to ascertain the movement of people in all areas of the worksite (Heřman, 2008; Lukáš, 2011).

The system design for the localization of persons on the basis of triangulation is based on determining the position of employees in real time. It is intended primarily for use in companies where it is necessary to track the location of a particular employee at a particular moment. This is not an intrusion detection system.

MEASUREMENT AND METHODS

Monitoring people is associated with a number of aspects. Among the most important is the actual method of monitoring an area, where it is a matter of monitoring access to the building by an intruder, monitoring entry to the building by an authorized person and the passage through the building (Valeš, 2006). All of these options are associated with the security of the buildings.

Access control systems are also widely used to monitor the entry of authorized persons to the worksite. Persons entering the building are classified as employees, visitors and intruders (Rak, 2008). Persons who have access to the building, typically employees, have a security feature in the form of an identification card or chip. This feature allows the authorized person to enter the building. The validity of the security feature is addressed in terms of time, i.e. the validity of the pass for an indefinite period of time, or more often for a fixed period, such as 1 year or 1 month. Another alternative is one-time access, usually used for one-time visitors (Damjanovski, 2005; Cieszynski, 2007).

Walkthroughs through the guarded area apply to an area with increased security requirements for employees, or for visitors to this area. These are most often areas with valuable information, data or materials. This method of monitoring people is divided into walkthroughs according to:

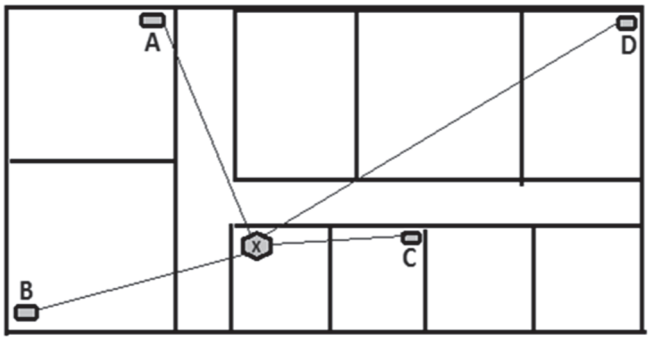
a time perspective – after applying a particular media serving for opening, the opening of the passage for a certain time period with regard to the length of the section; this is a short time interval and a small area (1 door, hall, etc.) (Damjanovski, 2005; Valeš, 2006).

a sectional perspective – after applying a particular media serving for opening, a certain section of a given area is opened (Damjanovski, 2005; Valeš, 2006).

an area-based perspective – after applying a particular media serving for opening, a relevant section is opened, e.g. and entire floor (Damjanovski, 2005; Valeš, 2006).

All of these types of monitoring of persons are associated with many systems for individual monitoring of people, the most important of which are security systems, access control systems and CCTV systems. Other systems providing access to a building include, for example, attendance or patrol systems, etc. (Cieszynski, 2007; Nilsson, 2008).

At present, the Czech University of Life Sciences in Prague is conducting research that seeks to build on the existing transmitters a system that will be able to monitor the movement of persons with accuracy almost to the centimetre. The monitoring functions on the basis of triangulation of a person using four receivers that determine the distance and spatial location of the monitored person – see Fig. 1.



A, B, C, D – receiver
X – transmitter

Figure 1. Principle of monitoring persons in a guarded area.

The principle of this equipment is that at a certain point the transmitter sends a signal to all receivers within range. These receivers, which are time-synchronized, will send information to the central unit about the time of the message was received (from the transmitter). After entering times into the algorithm, the system is able to give the coordinates where the transmitter is situated. On the basis of this information, using three such receivers, on which will be ascertained the response time of the transmission, it will be possible to determine the distance of the detected chip, and, through their combination and using triangulation, the precise location of the chip in the plane. At least four receivers will be required if it will be necessary to measure in the range of multiple floors.

All of the testing was conducted on wireless communications in the 868MHz band. A space was determined that was to simulate the actual building in which it is necessary to monitor the position of an employee (see Fig. 1). The figurant, who was to simulate the employee, had a miniaturized transmitter attached to his belt, which was compatible with receivers from the Teco a.s. Foxtrot series – see Fig. 2. The current method of detection only allows for precise localization in an open area, or in an area that is separated by plasterboard walls. Thus far, it has been ascertained that the attenuation of a broadcast that arises in the event of passage through solid obstacles (brick or concrete wall), affects the accuracy of localizing a person. At present, an algorithm is being developed that should remedy these deficiencies.

Once this system is fully functional, during practical use it will not be necessary to limit to the use of four receivers, but it will be possible to freely expand it according to the requirements of the end customer. Logically, the larger the area that must be guarded, the more receivers will be needed.

Figure 2. Miniaturized transmitter.

RESULTS AND DISCUSSION

After the tests were carried out, it was necessary to compare the system with the existing technology. The Orthos system was selected for this comparison, which is designed to monitor the movement of persons, focused on departure from the allocated space (room). The average response time of both systems in relation to the distance was compared, see Fig. 3.

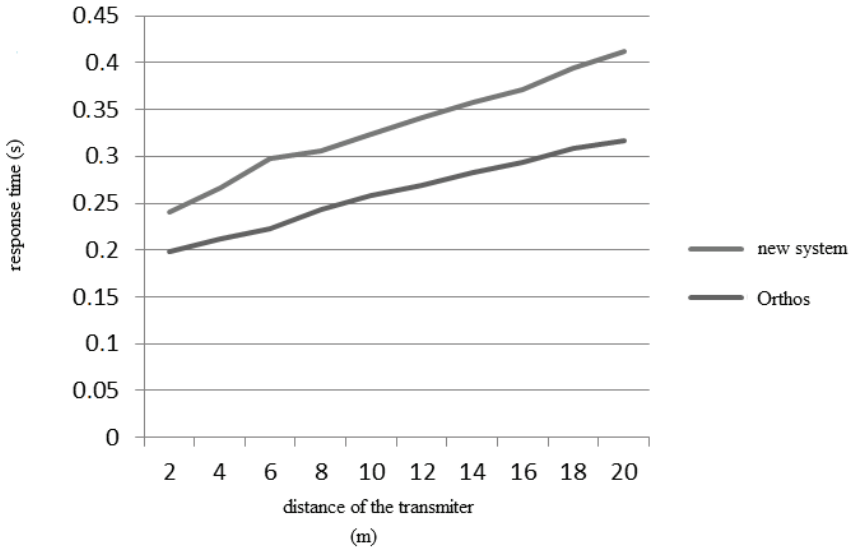


Figure 3. Comparison of the response time of both systems.

The measured data showed that the relationship of distance dependence on the response time in the new system based on triangulation corresponds to the response time of the existing technologies. The resulting values of the new system were slightly higher.

The ability of the existing Orthos system is only based on ascertaining a presence in an allotted space. Adversely, the new system is able to identify the specific position of the monitored person with a similar response time.

We are constantly working on accurate and reliable detection of people. Many of the technologies used to it. Tassos Dimitriou wrote in the article 'Key evolving RFID systems: Forward / backward privacy and ownership transfer of RFID tags' use RFID readers to monitor people (Dimitriou, 2016). The authors of the article 'Fusion of Different Height pyroelectric Infrared Sensors for Person Identification' trying to monitor people using PIR detectors (Xiong, 2016). Both methods are functional but not provide precise positioning, as it allows our system.

CONCLUSIONS

The monitoring of persons system serves as an automated control system that provides instantaneous monitoring of the movement of employees in all guarded risk areas, and at any time. This is a feature that streamlines the monitoring of the movement of these employees. The advantage of this control is primarily the monitoring of the movement of employees in terms of the safety of the employer and the employees. This system would be suitable for monitoring employees at airports, medical facilities, premises, warehouses, halls and other specific areas.

The basic function of the system is the ability to monitor the location of a particular employee in real time with a response time in milliseconds, according to the distance of the monitored people from different receivers. The speed of the system's response is therefore dependent on the response time of the farthest receiver. The test area is currently focused on areas with plasterboard partitions, where the monitored location of the employees is focused on ascertaining an occurrence in a plane where system deviations in the order of a few centimetres were found.

The overall solution of this system is advantageous for several reasons. In addition to the attendance control and partial departures, it is mainly used to determine the movement of employees in any time period during working hours.

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