Using Big data and artificial intelligence to solve the fire safety problem of potentially dangerous objects

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Abstract. In this paper, we consider a hardware-software system for evaluating the level of fire safety in real-time, which allows us to proactively monitor the dynamics of changes in the level of fire safety and provide the supervision authorities with remote access to the information about the level of fire safety

1. Introduction
Currently, the evaluation of the fire safety level is carried out based on a periodic inspection by the fire inspectors, issuing them instructions on the elimination of the revealed violations [1]. The inspections rate to evaluate the level of fire safety depends on the risk category of an object:
- For the high-risk category - once every 3 years;
- For the significant risk category - once every 4 years;
- For the medium risk category - no more than once every 5 years;
- For the moderate risk category - no more than once every 10 years;

The disadvantage of this approach is the significant time interval between inspections, during which a huge fire may occur causing the death of a significant number of people and great economic damage, which is unacceptable for the objects of the national economy.

2. Problem statement
To solve this problem, it is proposed to develop and implement a hardware-software system for evaluating the level of fire safety in real-time (HSS ELFS) at capital construction facilities, primarily with a massive presence of people, the block diagram of such system (HSS ELFS) is presented in Fig.1.

Figure 1. The block diagram of HSS ELFS.
Consider the main blocks in the presented block diagram (Fig. 1).

The sensor unit includes:

Video cameras monitoring the presence/absence of emergency exits and evacuation routes for people at the facility, the absence of obstacles on the access roads to the facility, recording the presence of people indoors, monitoring the presence and other factors affecting fire safety;

Sensors that detect the presence of locks on the exit doors;

Sensors that monitor the performance of alarm and fire extinguishing systems, the state of insulation of conductive networks, other parameters of various equipment of the facility that affect fire safety [2-3].

The text and other information unit includes instructions of the fire supervision authorities, measures aimed at eliminating the identified comments and other information related to the issue of ensuring fire safety. Essentially the data from the test and information unit together with the data from the output of the sensor unit can be considered as big data due to the large amount of data from video observation cameras in real-time and the need for high-speed processing, as well as data various types of information (continuous video data as binary codes, text and information). Processing of this information in real-time is carried out in the processing and analysis of information unit and based on the use of artificial intelligence systems [4-6].

The output information block contains an automated workstation of an operator of the facility operation service, the computer screen displays the output information of the processing and analysis unit, for example, in the form of simple semaphore signals: green – high level of fire safety, yellow – medium fire safety, red – low fire safety.

3. Solving the construction problem of HSS ELFS

Information from the sensor unit and the text and information unit is fed to the information processing and analysis unit, which is used as a computer program that implements artificial intelligence technology. The operation of the processing and analysis of information is as follows:

Three types of data are processed: video information from cameras, sensors data and the data from the text and information unit.

The first input of the artificial intelligence system receives video information from cameras. Based on the analysis of video information it generates a signal whose amplitude is proportional to the number of people indoors, unfavorable factors that impede the evacuation of people through emergency exits, unfavorable factors that impede access of fire equipment to the facility and other adverse factors reducing the level of fire safety [5-7].

The second input receives information in the form of binary codes (0, 1) on the status of the output doors (locked/unlocked), on the status of individual elements of the alarm and fire extinguishing systems (operational/inoperative), on the insulation status of the electrical wiring (meets accepted standards/does not correspond to accepted standards) and other information affecting the level of fire safety.

The third input receives textual and information, including the instructions of the fire control authorities, information on measures taken to ensure fire safety adopted and scheduled by the administration of the facility.

For a predefined sliding time interval (ex. 30 days), the artificial intelligence system analyzes all gathered data and generates a signal depends on a combination of various factors affecting the level of fire safety. For example, during the predefined time interval there is a day/night accumulation of the large number of people indoors of the facility, the presence of packing emergency exits and evacuation routes at the facility, the presence of obstacles on the access roads to the facility, the presence of locks on the exit doors, the inoperative individual elements of alarm systems and fire. In this case, the system generates a signal which has a low level of fire safety at the facility. Other combinations of output data from the sensor unit are possible, on the basis of which all possible combinations are divided into three groups [6-8].
1. The combination of output data from the sensor unit for a specified time interval, recording a high level of fire safety.
2. The combination of output data from the sensor unit for a specified time interval, recording a medium level of fire safety.
3. The combination of output data from the sensor unit for a specified time interval, recording a low level of fire safety.

The output information unit contains a 3-D model of the object. In case of a medium and low level of fire safety, the 3-D model of the object displays conventional signs (ex. flashing) showing that there are factors that reduce the level of fire safety and these conventional signs will act as long as these factors are not eliminated.

Information about the level of fire safety of an object can be remotely represented in a single system of operational and Supervisory control and has a central authority - the unified duty dispatch service of the city. This will allow to rank all potentially flammable objects by the level of their fire safety and to take preventive measures to improve the level of fire safety at those facilities which revealed low to medium level of fire safety.

4. Conclusions

Thus, we can conclude that the HSS ELFS allows us to proactively monitor the dynamics of changes in the level of fire safety and provide the supervision authorities with remote access to the information about the level of fire safety.

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