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Improvement in the structure of fire alarm systems' alarm bell stop switch

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Meta-analysis;
Fluorescence attenuation;
False alarms.

Abstract. Fire alarm systems are essentially installed on specific firefighting equipment and serve as one of the important alarm equipment that senses fire quickly and earlier than human beings. The main goal of this study is to find methods for improving the structure of fire alarm systems. This study is concerned with false alarms of fire-indicating equipment in fire alarm systems. During the course of analysis, it was found that false alarms by fire alarm systems frequently occur and, also, fire safety managers neglect their duty of work by turning the alarm bell stop switch on, even during normal times. To prevent this, the alarm bell stop switch should be changed into an automatically resettable manual operation type so that it can automatically be reset to its original state, even though fire safety manager turns the switch on. As a result, this study provides aid for correcting fire safety managers' wrongful practices by making the alarm bell ring whenever an actual fire occurs; ultimately, false alarms are reduced by eliminating fundamental causes when false alarms occur.

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1. Introduction

In any country or any building, fire continues to occur and, thus, it is necessary to install a fire alarm system that warns of fire quickly and early. However, the fire alarm system has two problems when fire occurs: the false alarm problem and the No Operation problem.

Fire alarm is necessary for timely transmission of information to certain structures to prevent fire. The less time is spent transferring information, the faster it is possible to prevent fire. The fire alarm system is a complex mechanism, composed of special sensors, control panels, and warning systems for people, which works during ignition [1].

In addition to identifying the factors of ignition and the transmission of alarm signals, the alarm should (a) provide remote control of the fire extinguisher and smoke removal systems, (b) manage the access control system for the purpose of rapid evacuation of people from premises in which a fire is detected, and (c) transmit alarm signals to the mobile phones of the owners of the protected facility.

Fire alarm, warning, and evacuation control systems must be installed at facilities, especially where exposure to hazardous fire factors leads to injury or loss of life [2].

The speed of detection and elimination of fire depends on the smooth operation of the sensors.

The sensor is a device that reacts to smoke and excess temperature in the room, or reacts to the excess of carbon monoxide in the air of the room where it is installed.

From 2010 to 2014, as a result of analyzing the cases of false alarms and No Operation of fire alarm systems during the recent 5 years, out of annual average of 1877 cases, there were 1745 cases of false alarms and 132 cases of No Operation; accordingly,

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it can be stated that only 7.56% were the cases of No Operation, compared to false alarms of fire alarm systems. Therefore, this study discusses false alarms, which are common problems.

There are various fire alarm systems that differ in structure and functions. Various functionalities of the sensors allow detecting the ignition in the very initial stage, which is conducive to a timely reaction and fire prevention.

2. Literature review

Concerning fire alarm systems, Jian et al. (2016) [5] designed a complex fire alarm system using the principle of photoacoustic spectroscopy. They used the complex fire alarm system to detect particles and carbon monoxide in smoke. The experiment was carried out along with three small experiments using cotton puff smoke, polyurethane foam fire, and wood smoke fire. Experimental results showed that the CO gas of the smoke particles generated by the experiment did not cause system alarm to go off; therefore, the unnecessary alarm caused by the existing fire detector could be avoided.

Festag (2016) [6] found that, as a result of meta-analysis, the false alarm ratio of fire detection and fire alarm systems in Germany was high. He claimed that in order to reduce the false alarm ratio, a general understanding of false alarms and proper use of detection and fire alarm systems were required.

Jee et al. (2014) [7] analyzed various problems of fire alarm systems. To solve these problems, they developed an addressable fire alarm system. One of the features of the addressable fire alarm system is the possibility of upgrading existing fire alarm systems only by replacing the existing detectors with addressable detectors without changing the wiring.

Sun et al. (2001) [8] determined the potential for fire or high temperature alarm applications based on the use of fluorescence attenuation in the frequency domain in their study. The initial results showed that temperature excursions of 125°C within 10 cm along with a length of a 1.2 m sensing loop could be determined within a period of some tens of seconds, adequate for the sensor purpose; in addition, much work needs to be done to increase the system's sensitivity.

Concerning false alarms by fire-indicating equipment of fire alarm systems, Choiet al. (2015) [9] suggested ways to reduce false alarms of fire alarm system components through statistical data of Korea National Security Agency and existing research data.

Hwang (2013) [10] improved the fire control panel so that the status of the fire control panel could be received in real time through smart phones' text messages in remote places.

Lee et al. (2012) [11] developed a system that transmits various information of a receiver to a remote control monitor in real time. As a result of the analysis, it was found that the system had excellent operation performance, small size, light weight, and high accuracy, which is economically advantageous as well as easy to install.

Lee et al. (2015) in [12] paid attention to the efficiency of an addressable fire alarm control panel with voice guidance. They developed an addressable fire alarm control panel with voice guidance, and confirmed that it was possible to shorten the evacuation time by minimizing evacuation errors through emergency public address providing voice guidance based on fire location in case of fire.

Oh (2011) in [13] developed a monitoring program and an automatic fire-detecting system used in remote control that allows monitoring of the data transmitted from the fire-indicating equipment through monitors at 119 control rooms or the disaster prevention center.

Lee et al. (2011) [14] analyzed statistical data of Korea Fire Insurance Association for 5 years to investigate the measures to reduce false alarms of automatic fire detection systems. They analyzed the steps of the operation mechanism that could cause false alarms to generate and construct the data on the main causes and frequent locations of false alarms. In addition, based on the comparative analysis, they reviewed technical considerations for installation, economic maintenance method, and fire safety consciousness review and introduced an evaluation system for improving hands-on workers' practical ability. Finally, they suggested measures to reduce false alarms from various perspectives for the maintenance of optimum conditions for fire detection.

Lee (2011) developed a system that transmits information, such as the location and the type of the detector, to the fire control panel in case of fire.

Kim (2010) [15], regarding the analysis of the inter-control panel network efficiency, constructed an inter-control panel network between fire control panels to understand the statuses, advantages, and disadvantages of the operating inter-control panel network in residential facilities, sales facilities, and educational research facilities. As a result of the survey, the operation of the inter-control panel network at residential facilities was quick to initially respond in case of fire. However, there was crosstalk of the fire interlocking priority, and the processing speed of the fire signals was slow. In addition, it was not easy to remove the causes of false alarms due to privacy issues. The operation of the inter-control panel network at sales facilities might have confusion due to a large number of floating population in case of fire; however, they enabled integrated monitoring and control through the inter-control panel network. The operation of the inter-control panel network at educational research facilities did not have

a problem within 1 km; however, crosstalk occurred when the inter-control panel network exceeded 1 km.

Lee (2008) in [16] investigated the problems in operation and facilities of existing fire-indicating equipment and proposed a fire protection system using touch screen fire-indicating equipment, which applied RS485 communication program. In this system, the RS485 communication method is adopted to analyze input values of the fire detector status monitoring that are transmitted and received through the internal repeater of the fire-indicating equipment by means of an industrial computer. The computer analysis result, such as fire event status of fire detector malfunction, is represented by texts. This fire protection system applies R-type integrated fire-indicating equipment using a touch screen controlled by a user-centered program using a touch screen.

Kim et al. (2006) [17] developed a new fire alarm system. It was verified through experiments that this system reduced not only the number of circuits in comparison to the existing P-type and R-type systems, but also the construction period and labor cost, because it was easy even for an unskilled person to make a connection and that it could be operated without additional devices such as a receiver or a repeater.

Despite these studies, false alarms by fire alarm systems are continuously occurring and fire safety managers neglect the duty of such a work by turning the alarm bell stop switch on, even during normal times. Therefore, this study aims to prevent this and reset the alarm in case of fire breakout by converting the alarm bell stop switch to an automatically resettable manual operation type to make the alarm bell stop switch automatically reset to the original state in case that it is manually controlled, even if the fire safety manager turns the alarm bell stop switch on.

3. Structure of the existing alarm bell stop switch

When a fire alarm system generates fire alarms, fire alarms are immediately issued to the site without the fire determination procedure of the fire safety manager. Therefore, the fire safety manager shows a tendency to solve it by stopping the alarm first rather than trying to find the cause of the failure. More specifically, there is a problem in a push-type switch, the structure of which is a manually resettable manual operation type. In order to turn the warning sound of the alarm bell off and reset it to the normal fire monitoring operation state, a switch of this type is manually operated and, then, manually reset in the event of a false alarm.

In case of frequent false alarm occurrences, the fire safety manager keeps the alarm bell stop switch of the fire-indicating equipment on, even during normal times when the fire safety manager does not usually check the alarm bell stop switch. In this case, no alarm sound of the alarm bell is set to go off even when the actual fire occurs [10,14]. The operation mechanism of the existing alarm bell stop switch is shown in Figure 1.

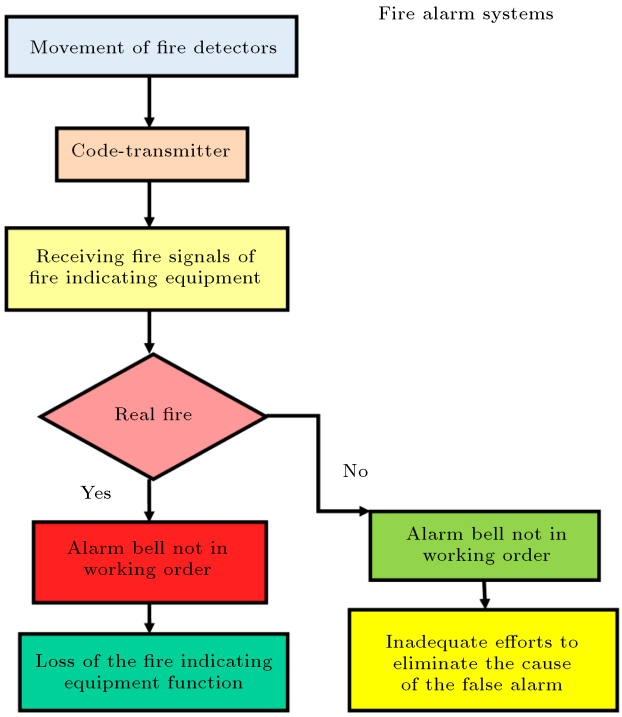

Figure 1. Operating mechanism of the existing fire-indicating equipment's alarm bell stop switch.

4. Improvement of the structure of alarm bell stop switch

It is necessary to transform the structure of the existing manually resettable operation type of the alarm bell stop switch attached to the fire-indicating equipment to the ON/OFF switch structure with the semi-automatic function of the automatically resettable manual operation type. The existing structure of the switch used for stopping the alarm bell is of a push type. Therefore, if the alarm bell malfunctions, it is necessary to perform the two-step operation in which the alarm switch should be pressed first and, then, reset to its original state.

However, it is improved into the structure that is operational with only one step where the switch turns into ON status when lifting up and automatically recovers to OFF status when setting it free. Through this improvement, it is expected to be used for the appropriate management purpose of alarm bell stop switch of fire alarm systems correcting fire safety managers' wrongful practices, which occur in the event of a malfunction such as false alarms [14]. The operating mechanism of the improved alarm bell stop switch is shown in Figure 2.

Table 1. Comparative analysis of the fire-indicating equipment's alarm bell stop switch.

	Existing alarm bell stop switch	Improved alarm bell stop switch
Switching method	Push type	Toggle type
Operating method	Manually resettable manual operation type	Automatically resettable manual operation type
Circuit type	Priority circuit for stopping the alarm bell	Priority circuit for operating the alarm bell
Fire safety manager	Neglecting work	Working normally

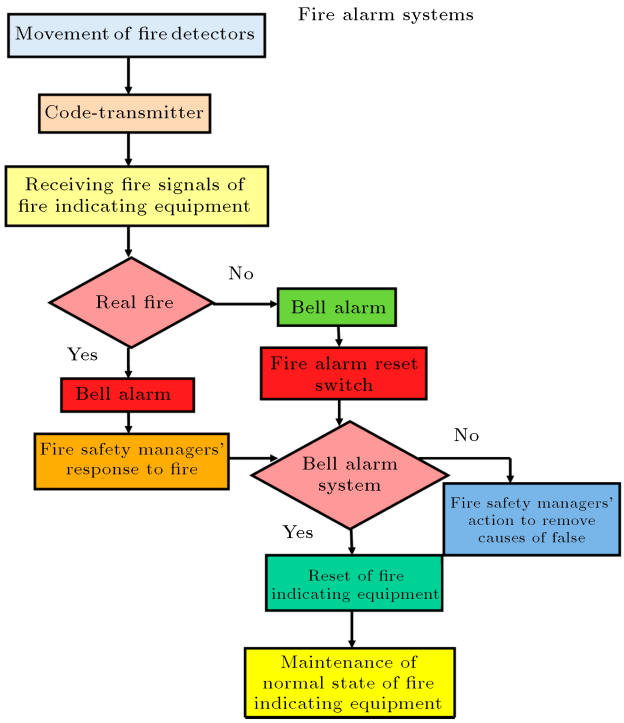

Figure 2. Operating mechanism of the improved fire-indicating equipment's alarm bell stop switch.

Table 1 shows the comparative analysis of the switch type, the operating method, the circuit type, and the fire safety manager's working status based on the operating mechanism of the alarm bell stop switch of the existing fire-indicating equipment.

5. Conclusion

Fire alarm systems are essentially installed on particular firefighting objects and serve a role of important alarm equipment by sensing fire early. However, problems of decreasing reliability due to false alarms have been constantly brought up.

The false alarm problem in the latest scientific works was studied. In the process of analysis, a problem with a push type switch, the structure of which is a manually resettable manual operation type, was found. The operating mechanism of the existing fire-indicating equipment's alarm bell stop switch was described, and the structure of the improved operating mechanism was suggested. The existing structure of the switch used for stopping the alarm bell is of a push type. This study suggests changing it to the two-step operation in which the alarm switch should be pressed first and, then, reset to its original state.

Thereby, this study aids correcting fire safety managers' wrongful practices by changing the existing alarm bell stop switch from a manually resettable manual operation type to an automatically resettable manual operation type and tries to ultimately reduce false alarms by eliminating fundamental causes when false alarms occur. The fire safety is secured as the circuit becomes the priority circuit for operating the alarm bell by changing the existing push type alarm bell switch into the toggle-type alarm bell switch. It is also expected to help the alarm bell function normally as it prevents the negligence of the fire safety manager in advance.

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Biography

Ha-Sung Kong majored in disaster science in the Graduate School of University of Seoul. His main interests include firefighting facilities, safety policies, disaster management, and firefighting qualification systems, among others. He currently works at the Department of Fire Safety of Kyungil University as an Associate Professor.