Improvement on structure of fire alarm systems alarm bell stop switch

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Abstract. Fire alarm systems are essentially installed in specific firefighting equipment and serve as one of important alarm equipments which senses fire early. The main goal of the study is to find methods for improving the structure of fire alarm needs. This study is about false alarms of fire indicating equipment in fire alarm systems. It is found that false alarms by fire alarm systems are constantly occurring and fire safety manager is neglecting his duty of work by turning alarm bell stop switch on even during usual times. To prevent this, the alarm bell stop switch should be changed into an automatically resetable manual operation type so that it can automatically reset to its original state even though fire safety manager turns the switch on. As a result, aid in correcting fire safety managers' wrongful practices by making the alarm bell ring whenever an actual fire occurs, and ultimately reduce false alarms by eliminating fundamental causes when false alarms occur.

KEYWORDS: fire indicating equipment, automatically resetable manual operation type, meta-analysis, fluorescence attenuation, false alarms.

1. Introduction

In any country or any building, the fire continues to occur, so a fire alarm system that warns of fire early is necessary. However, the fire alarm system has two problems when a fire occurs. They are 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 a fire. The fire alarm system is a complex mechanism, including special sensors, control panels, warning systems for people, which works during an ignition [1].

In addition to identifying the factors of ignition and the transmission of alarm signals, the alarm should also provide: remote control of fire extinguishing and smoke removal systems; control access control system for the purpose of rapid evacuation of people from premises in

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which a fire is detected; transmit alarm signals to the mobile phones of the owners of the protected facility.

Fire alarm, warning and evacuation control systems for people in a fire must be installed at facilities where exposure to hazardous fire factors can lead 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 or 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 recent 5 years, out of annual average of 1877 cases, there were 1745 cases of false alarms and 132 cases of No Operation, which states that only 7.56% are the cases of No Operation compared to false alarms of fire alarm systems. Therefore, this study will discuss false alarms which are common problems.

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There are various fire alarm systems that differ in structure, functions. The various functionality of the sensors allow detecting the ignition at the very initial stage, which contributes to reacting in a timely manner and preventing a fire.

2. Literature review

For studies related to fire alarm systems, in a study on "Photoacoustic Compound Fire Alarm System for Detecting Particles and Carbon Monoxide in Smoke" of Jiang, Y.L., Li, G., and Wang, J.J. (2016), a complex fire alarm system was designed using the principle of photoacoustic spectroscopy. The complex fire alarm system was used to detect particles and carbon monoxide in smoke. The experiment was carried out 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 does not cause system alarm to go off, so unnecessary alarm caused by the existing fire detector could be avoided [5].

Festag, S. (2016) found in his study on "False Alarm Ratio of Fire Detection and Fire Alarm Systems in Germany" 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, general understanding of false alarms and proper use of detection and fire alarm systems were required [6].

In the study on "Development of a Traceable Fire Alarm System Based on the Conventional Fire Alarm System," Jee, Seung-Wook, Lee, Chun-Ha, Kim, Si-Kuk, Lee, Jae-Jin and Kim, Phil-Young (2014) analyzed various problems of fire alarm systems. To solve these problems, they develop an addressable fire alarm system. One of the features of the addressable fire alarm system is that it is possible to upgrade existing fire alarm systems only by replacing the existing detectors with addressable detectors without changing the wiring [7].

Sun, T, Zhang, Z.Y. and Grattan, K.T.V. (2001) determined the potential for fire or high-temperature alarm applications based on the use of fluorescence attenuation in the frequency domain in their study on "Frequency-domain Fluorescence Based Fiber optic Fire Alarm System." As a result of the study, the initial results show that temperature excursions of 125 degrees C within 10 cm along a length of a 1.2 m sensing loop can be determined within a period of some tens of seconds, which is adequate for the sensor purpose, and work is continuing to increase the system's sensitivity [8].
For studies related to false alarms by fire indicating equipment of fire alarm systems, Choi, G.C. et al. (2015) published "A Research Report for Technical Suggestion to Reduce False Alarms of Fire Alarm Systems." They suggested ways to reduce false alarms of fire alarm system components through statistical data of Korea National Security Agency and existing research data [9].

Hwang, C.H. (2013) made "A Study on the Functional Improvement of P-type Fire Control Panel" and 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 [10].

Lee, B.S., Kwak, D.K., Jung, D.Y. and Cheon, D.J. (2012) carried out "A Study on Design and Operation Performance of Automatic Fire Detection Equipment (P-type One-class Receiver) by Bidirectional Communication" and 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 has excellent operation performance, small size, light weight and high accuracy, which is economically advantageous as well as easy to install [11].

Lee, M.Y., Lee, Y.S., Lee, C.H. and Lee, G.H., Kim, P.Y. and Kim, S.K. (2015) conducted "A Study on the Development of Addressable Fire Alarm Control Panel with Voice Guidance Based on Fire Location" in regard to the efficiency of 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 [12].

Oh, S.J. (2011) made "A Study on Monitoring Program for Automatic Fire Detecting System Used in Remote Control" and developed a monitoring program and an automatic fire detecting system used in remote control which enables monitoring of the data transmitted from the fire indicating equipment through monitors at 119 control rooms or the disaster prevention center [13].

Lee, J.H., Lee, C.H., Kim, S.G. and Kong, H.S. (2011) carried out "A Study about False Alarm of Automatic Fire Detection System" and 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 be generated and constructed 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 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 [14].

Lee, H.J. (2010) conducted "A Study on the Implementation of the Integrated Fire Automation System on based P-Type Fire Control Panel" and developed a system that transmits information such as the location and the type of the detector transmitted to the fire control panel in case of fire.

Kim, E.S. (2010) conducted "A Study on Analysis of the Performance Advancement of the Intercontrol Panel Network" in regard to the analysis of the inter-control panel network efficiency and constructed an inter-control panel network between fire control panels to understand the status, the advantages and the 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 in 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 the privacy issue. The operation of the inter-control panel network in sales facilities might have confusion due to the large number of floating population in case of fire but they enabled integrated monitoring and control through the inter-control panel network. The operation of the inter-control panel network in educational research facilities did not have a problem within 1 km but crosstalk occurred when the inter-control panel network exceeded 1 km [15].

Lee, J.H., Kong, H.S. and Cho, Y.T. (2008) made their "Study on the Design of Touch Screen Fire Indicating Equipment Which Is Simple to Use and Applied RS485 Communication Program." They investigated the problems in operation and facilities of existing fire indicating equipment and suggested 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 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 [16].

Kim, Y.D., Oh, G.K. and Kang, W.C. (2006) carried out their "Study on Fire Indicating Equipment Based on CAN Communication" and developed a new fire alarm system. It was verified through experiments that this system did not only reduce the number of circuits compared to the existing P-type and R-type systems but also reduced the construction period
and labor cost because it was easy even for an unskilled person to connect and that it could be operated without additional devices such as a receiver or a repeater [17].

Despite these studies, false alarms by fire alarm systems are continuously occurring and fire safety manager is neglecting the duty of work by turning alarm bell stop switch on even during usual time. It is the purpose of this study to prevent this and reset the alarm in any case when fire really occurs 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 fire safety manager turns the alarm bell stop switch on.

3. Structure of 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 speaking, 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 warming 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 manually reset in the event of a false alarm.

Figure 1.

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.

4. Improvement of structure of alarm bell stop switch

It is necessary to improve the structure of the existing manually resettable manual operation type alarm bell stop switch attached to the fire indicating equipment to the ON/OFF switch structure with the semiautomatic function of the automatically resettable manual operation type. The existing structure of the switch used for stopping the alarm bell is a push type. Therefore, if there is a malfunction of the alarm bell, 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.
Figure 2.

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 malfunction such as false alarms [14]. Operating mechanism of improved alarm bell stop switch is as Figure 2.

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's alarm bell stop switch.

Table 1.

5. Conclusion

Fire alarm systems are essentially installed in particular firefighting objects and serve a role of important alarm equipment by sensing fire early. However, problems of decreasing the 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 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 a push type. Author suggests to change 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 in 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.

Conflict of interest
The author confirms that this article content has no conflict of interest.

References


Figure 3. Operating mechanism of existing fire indicating equipment's alarm bell stop switch
Figure 4. Operating mechanism of improved fire indicating equipment's alarm bell stop switch

Table 2. Comparative analysis of the fire indicating equipment's alarm bell stop switch

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Biographies

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