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스마트 홈에서 연소에 따른 화재감지기 원격 IoT 작동 시간에 관한 연구

A Study on Remote IoT operating time for Fire Detector of Smart Home

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요약 스마트홈 시대에 화재안전은 인명 및 시설안전에 매우 중요한 사항이다. 화재로 인한 사상자 및 재산상 피해는 국가적으로 큰 손실일 것이다. 본 논문에서는 스마트홈에서 화재에 따라 화재감지기 작동시간을 판단하여 위험성을 예측할 수 있도록 제안하고자 한다. IoT 화재감지기인 열감지기와 연기감지기 중에서 화재에 따라 작동하는 시간의 차이로 인하여 위험성을 예측할 수 있다. 본 실험결과를 바탕으로 이온식 연기감지기가 매우 빠른 특성을 보여 추후 화재예방 시설시에 본 결과물이 잘 활용되면 좋을 것이다.

Abstract In the smart home era, fire safety is very important for human life and facility safety. Casualties and property damage from the fire would be a huge national loss. In this paper, we propose to predict the risk by determining the operating time of the fire detector according to the fire in the smart home. Among IoT fire detectors, heat detectors and smoke detectors, the risk can be predicted due to the difference in the operating time depending on the fire. Based on the results of this experiment, the ion-type smoke detector shows very fast characteristics, so it would be good to use the results in future fire prevention facility.

Key Words : Fire, Smart Home, Fire Detector

1. Introduction

A fire detector is a device that early detects combustion products generated from a fire, such as heat, smoke and flames, and detects a fire,

then informs officials in the building the fire and helps them evacuate quickly.

Currently, fire detectors used in South Korea include heat detectors, smoke detectors and flame detectors, but the most frequently installed

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ones are heat detectors and smoke detectors. These fire detectors are installed in accordance with National Fire Safety Council (NFSC 203)[1] to detect fires early.

Heat detectors are divided into fixed temperature types and rate rise of temperature types, while smoke detectors are divided into photo-electric types and ionization types[2]-[4].

In this study, heat detectors and smoke detectors, which are currently installed the most in the country, were installed on a certain scale of test room ceilings and burned the liquid combustibles(n-heptane). In addition, the operating time was measured and compared and analyzed to compare which detector was more advantageous in terms of early fire detection of heat detectors and smoke detectors.

II. Fire Detector

Fire detectors are divided into heat detectors and smoke detectors and so on. Heat detectors are divided into fixed temperature types and rate rise of temperature types.

The fixed temperature type fire detector is a fire detector that operates when the temperature is above a certain level, and has bimetal type and detection line type. Bimetal type is sent by moving the contacts using heat deformation of the bimetal, and detection line type is sent by touching the piano wire when the two piano lines are bounded by plastic and the plastic melts in the event of a fire[5].

The rate rise of temperature type fire detector is a type of fire detector that operates when the temperature rises faster than the limit. Combining the two temperature detectors to increase the thermal time constant on one side, decrease the thermal time constant on the other side, detect the rate of temperature rise from the temperature difference, make a small hole in the end of the metal tubule, and if the temperature

slowly rises, the internal pressure does not rise, but when the temperature rises rapidly, the internal pressure is supposed to surge and close the electrical contacts. The former is a spot type detector, and the latter is used as a distributed type detector[6].

Photoelectric fire detectors are fire detectors operated when smoke from a fire scatters infrared rays from light-emitting diodes and changes the amount of light in the photoelectric device[7].

Ionization fire detectors are fire-fighting term, with two ion chambers inside and outside the detector, and the air inside the cation chamber is ionized by radium radiation by a constant voltage. If the combustion product enters the outer ion chamber in the event of a fire and reduces the ion current, the voltage acting on the external ion chamber increases, activating the lever and sending an alarm because the pressure ratio of the ion chamber in and out changes. It is used in highly sensitive electronic and telecommunication rooms[5].

III. Experiment Subjects and Methods

1. Experiment Subjects

The subjects of the experiment were automated fire detection facilities used as national fire safety standards and heat detectors and smoke detectors, which are commonly used in Korea, according to visual warning device.

The heat detector was tested in two types: a fixed temperature type spot(70 °C) and a rate rise of temperature type spot, while the smoke detector was tested in two types; a photoelectric spot and an ionization spot.

2. Experiment Methods

The combustion space used for the experiment consisted of a test room with a size of living room in the house and a size of 10m wide, 6m long and 3m high, assuming a small office. Each

detector was installed on the ceiling of the test room, including two types of heat detector, a fixed temperature type spot and a rate rise of temperature type spot, and two types of smoke detector, a photoelectric spot and an ionization spot.

The fire was decided to create an artificial fire for a fair experiment as the characteristics of the fire and the operating time of the fire detector could change depending on the location of the item, the material of the object, and the material of the fire, by installing furniture such as sofa, decoration room, bookshelf, etc. and the office desk and chairs in the house.

To create an artificial fire, we insert 2.5 liters of n-heptane (99% purity) into a square combustible pan (43.5 cm × 43.5 cm) on the floor, then burn the n-heptane using an igniter, and measure the time the detector operates by heat or smoke generated from the combustible.

IV. Experiment Results and Analysis

In this experiment, N-heptane was burned using a square fuel pan(43.5 cm × 43.5 cm) to determine the time the detector operates according to smoke and temperature from the fire.

As a result of checking the operating time of the fire detector, the operating order was as followings: the two types of smoke detector ionization spot → the two types of heat detector a rate rise of temperature type spot → the two types of smoke detector photoelectric spot → a heat detector fixed temperature type spot

Experiments have shown that smoke detectors are more capable than heat detectors, especially two types of ionization type spot.

This experiment can be classified into the characteristics of the fuel combustible n-heptane, compared to the case where it takes a considerable amount of time to slowly ignite and burn, such as the sofa, decoration, desk, bookcase, chair, etc., which is a general combustible.

The results of this experiment show that the fuel combustible n-heptane showed a response characteristic that is limited to the characteristics of very rapid temperature rise and instantaneous combustion compared to the general combustor. If a large amount of smoke occurs during a fire of general combustibles, such as sofa and bookcase, the response characteristics, such as the operating time of the fire detection site, may vary.

표 1. 감지기 작동시간

Table 1. Detector Operating Time

Unit: seconds

a fixed temperature type	a rate rise of temperature type	a photoelectric	an ionization
107	38	53	21



그림 1. N-heptane 연소 모습

Fig. 1. N-heptane Combustion Figure

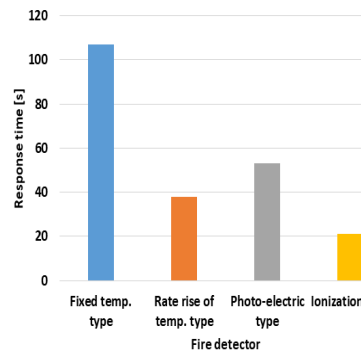


그림 2. 감지기별 작동시간 비교

Fig. 2. Comparison of Operating Time by Detector

V. Conclusion

Based on this experiment, it showed five times the detection time characteristics depending on the type of fire detector.

The characteristic of a fire is that it can cause a very dangerous situation due to the spread of flames in a short time, so it is a very important factor to choose fire detector for reducing the risk.

Through this experiment, the operating time of the heat detectors, a fixed temperature type and a rate rise of temperature type, were analyzed, and the rate rise of temperature type showed faster response characteristics with 38 seconds while the fixed temperature type showed 107 seconds. This shows that the rate rise of temperature type detectors among heat detectors have better response characteristics in terms of early fire detection.

According to the analysis of the operating time of the smoke detector photoelectric and ionization, the ionization showed faster response characteristics with 21 seconds while photoelectric showed 53 seconds. This shows that ionization detectors among smoke detectors have better response characteristics in terms of early fire detection.

Based on the results of this experiment, smoke detection and heat detection will be very effective when ionizing smoke detector and a rate rise of temperature type heat detector are installed simultaneously.

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