Full Automatic Wide Range Fire Extinguish System for Residential Use

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Abstract

We have continued to improve on previous studies. It is an improvement of the system which detects the fire automatically and performs the initial extinguishment. This system operates attached to the digestive device of existing products. In this system, the nozzle is automatically aimed at the fire position, and when it is determined to be a fire, the fire is extinguished automatically. An infrared camera is used to determine the fire, and a fire is determined by image processing. After extinguishing the fire, the fire information is transmitted to the smartphone through the user. In this paper, we improved this system. As a result, compared to previous research, it was possible to detect a fire in the wider range of rooms and to perform initial fire extinguishment.

Keywords: Raspberry Pi; Image Processing; Fire Extinguish

1. Introduction

According to the United States of National Fire Protection Association reports “Full Loss in the United States During 2014”⁽¹⁾, 84% of all fire deaths occur in home fires. Figure 1 shows the breakdown of the fire in the United States⁽¹⁾. 38 % of the fire in the United States is a structure fire. In addition, the number of structure fires has remained relatively constant in the past 15 years. The most effective and efficient means to prevent damage by the home fire, the initial firefighting. The advantage of the initial extinguishing in order to maximize detects the fire at

Fig. 1. Fires in the United States, 2014.

Fig. 2. Presence of firefighting and fire damage⁽³⁾.

an early stage, there must be a system for applying a properly extinguish. Initial firefighting is that of firefighting carried out in up to two minutes before and after the fire. By applying the fire before the fire becomes large fire, it is possible to greatly reduce the damage to the fire place. Further firefighting performed by the fire also can be minimized. Therefore, it can be said to be a very efficient

firefighting. Currently, a fire detection fire detector is used. Fire detector, there is a heat detector and a smoke detector⁽²⁾. Heat detector is operating temperature has been set, if the temperature in a short period of time to jump, to detect a fire in that the cable is destroyed by heat. Therefore, it is impossible to carry out initial fire extinguishing be performed extinguishing from the detection of the fire. If the initial fire extinguishing is performed, in the case where not performed, human, leaving a large difference in size of the material damage. The numerical value as the reference is shown in Fig. 2. Based on the above, the importance of the initial fire is seen. However, the initial firefighting is not performed in most cases even happening fire. As the factors, if you do not notice the fire, or if that aware of the fire calm also would give priority to flee to not be able to deal with can be considered. Factors that do not notice the fire's different, but, for example, such as a fire in the fire, or without people place during sleep can be considered. In the case of such a situation, it is very difficult to perform the initial firefighting. In addition, in the home of the elderly, it is difficult to carry out the initial firefighting even if a fire occurs. In fact, in Japan is about 60% of the dead in house fire is the elderly⁽⁴⁾. Even in situations that allows an initial fire extinguishing elderly, it is not easy to perform properly extinguish. Because, or did not know the appropriate firefighting method, because the body may or may not move freely. Smoke detector incorporates a sample of air in the pipe, and analyzed for the presence of smoke, it is determined that a fire when it detects smoke. The heat detector and the smoke detector are both unable to detect the fire until the fire is increased. Development of universal design fire extinguisher⁽⁵⁾ it has also been carried out. However, it is difficult for fire-fighters while ensuring safety.

Currently, the system subjected to a fire is present a large number. For example, if the sprinkler, fire extinguishing capability is high. However, do not start a fire until the sprinkler body is heated to 70 degree Celsius. It cannot be said that the order is carried out the initial firefighting. In addition, it carries out the fire if it is sprayed with a large amount of water. Therefore, the room together even if successful subsidence will be wetted with water. Thus, it would put a lot of damage to electronic equipment and precision equipment. Besides, the development of firefighting robots has been widely. Tokyo Fire Department of Japan is also like to have a remote control firefighting equipment georgette Fighter and intelligent ownership^(6, 7). However, not for general household. The advantage of the

Fig. 3. Operation overview of relation.

Fig. 4. Structure of the system.

initial extinguishing in order to maximize detects the fire at an early stage, there must be a system for applying a properly extinguish fire source.

Therefore we will aim to construct a system for performing initial fire extinguishing for general household. As a result of previous study⁽⁸⁾, when a fire at home occurs on the go, the development of fire extinguishing system which can perform the initial fire extinguishing by remote control. Moreover, the improvement of extinguishing accuracy, improving the added fire detection systems have been successfully developed a better system. However, in previous studies, extinguishing range of fire extinguishers vertical 90 degrees, is limited to a range of left and right 90 degrees. So, up and down 90 degrees extinguishing the extent possible, by extending to the left and right 180 degrees, has succeeded in improving the initial fire extinguishing system.

2. Configuration

The system sends images of the room from the two infrared cameras to computer. Then, each image processing is performed. When a fire is detected, the user can see the

real-time video in the room from the video camera. Based on the image, check whether a fire is occurring. If a fire is confirmed, extinguish the fire. When extinguishing fire, control each motor by Raspberry Pi. The motor uses one for moving the hose of the fire extinguisher up and down and the other two for moving it to the left and right. By doing this, it manipulates the direction and trigger of the hose of the fire extinguisher. This system can be roughly divided into two parts.

One is a fire detection unit and the other is a fire extinguishing unit. The configuration of the system is shown in Figs. 3 and 4. The fire detector consists of two infrared cameras as shown in Fig. 5 and Raspberry Pi. The infrared camera is used to detect a fire. Since the flame is emitting infrared light, you can know the size of the flame by looking at the infrared shape with an infrared camera. Image processing is applied to the infrared image with Raspberry Pi, and the presence or absence of a fire is detected by discriminating the size of the flame. Image processing uses OpenCV. The language used is Python.

The method of fire detection is shown below. First, the image from the infrared camera is imported into Raspberry Pi. The image of the infrared camera shows the infrared ray emitted from the flame. The image is processed by Open CV. The processing flow is shown below. The image of the infrared camera is stored in each pixel 0 convert to a grayscale with a value of 0 ~ 255. The converted image is compared with a threshold set in advance in the program. By comparing, infrared other than flame is removed. In other words, pixels below the threshold value are represented as black, pixels above the threshold value as white. This is called binarization. Binarization makes it easier to distinguish the shape of the flame. By the processing so far, only the flame shape is extracted from the image from the infrared camera. This makes it possible to judge whether or not a fire has occurred. In this system, binarized images are divided into 10×10 regions. In the area divided into 10×10 , the user designates the area in which something that generates strong infrared rays such as a stove or a gas stove is generated on a daily basis. By doing so, it is possible to prevent the malfunction by mistaking the infrared ray from the stove or gas stove as a fire. When a fire is detected, a notification is sent to the mail address registered in advance in the system. The user accesses the website described in the e-mail. This website is a site for remotely controlling the fire extinguishing system and it is possible to confirm with real time the fact that a fire is occurring on this website before extinguishing fire.

Table 1. Used equipment.

Equipment	Maker	Model Number
Raspberry Pi	Raspberry Pi	MODEL B
Camera	ELECOM	UCAM-DLE300T
IR Camera	iBUFFALLO	BSW20KM11BK
DC Motor	TAMIYA	ITEM72008
Servo Motor	GWS	GWS777FCG/6BB
IR Filter	FUJIFILM	IR 96

Fig. 5. Dual-video camera.

When extinguishing a fire, firefighting can be done using a command to move the hose of a fire extinguisher on the website up and down or left and right or a command to fire extinguishing agent.

3. Experiments and Results

Experiments were carried out to confirm that the part that improved was operating properly. In this system, we used equipment as shown in Table 1.

3.1 Operation Experiment of IR camera

In this research, the number of infrared cameras used has been increased to two. If this infrared camera is not working properly, fire detection and location of the fire cannot be specified. Therefore, experiments were conducted as to whether the two cameras are operating normally. Fig. 6 shows an image obtained by photographing the state of Fig. 7 with an infrared camera. Camera 1 is on the left side toward the fire extinguisher. Camera 2 is on the right side facing the fire extinguisher. There is a flame in the part projected white. From this experiment, it was confirmed that the two cameras operate separately. By using two cameras, image processing takes time. However, this experiment is effective in that the detection angle of the fire source has expanded, and that different processing can be

carried out.

3.2 Operation Experiment of System

This fire extinguisher automatically performs the initial extinguishment. In order to do this, the angle of the hose corresponding to all extinguishing area in Fig. 6 must be known. Therefore, the angle of the hose of the fire extinguisher corresponding to each extinguishing area was measured. The contents of the experiment are shown below. In this experiment, a candle was set as a fire source at each of the 200 extinguishing area at a position 1 m away from the infrared camera, and the angle when the hose was directed to the candle was recorded. Based on this record, we performed experiments as to whether Raspberry Pi memorized the angle corresponding to each squirrel, and whether this system can really aim the fire base. As a result, we confirmed that this system can aim at the origin of the fire.

4. Conclusions

In this study, we succeeded in developing an automatic initial fire extinguishing system that does not require users, by improving the automatic initial fire extinguishing system developed up to the previous research. In addition, fire detection and fire extinguishing activities in a wider range were made possible by rotating the hose of a fire extinguisher by 180 degrees on the horizontal axis and increasing the number of infrared cameras. As mentioned in Chapter 3, many problems still remain to commercialize this system. For example, processing time of image processing caused by using two cameras is long. Improvement can be expected by using processors with multiple cores or by image processing in terms of hardware. We would like to further improve it in future research.

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Fig. 6. Images of IR cameras.

Fig. 7. Image of fire.

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