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Smart Camping Safety System Based on IoT

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Abstract

There has recently been an increase in the number of people going out to camp, and in proportion to this increase, there has been a growth in safety accidents. Therefore, this study aims to combine camping and IoT technologies so that consumers can enjoy camping more conveniently and safely. It uses the Arduino module fire sensor, a carbon monoxide sensor, a relay module, etc. to prevent fires, carbon monoxide poisoning, etc. that can occur inside camping tents. By doing so, this study designed and configured a camping safety assistance system so that consumers can enjoy safe camping.Therefore, this study implemented a smart camping safety system based on IoT(Internet of Things).

Keywords; *IoT, Arduino, Sensor, Camping, Tent, Accident prevention, Safety accidents, Technology, Carbon monoxide sensor.*

I.INTRODUCTION

Due to the recent economic growth, the national income per capita has exceeded 31,000 USD. The five-day work and school week has contributed to advancements in leisure cultures, thus leading to an increase in the camping population [1]. According to Statistics Korea, the camping population has grown from 600,000 in 2011 to about 5 million as of2016, thus showing an approximately 700% increase [2]. Furthermore, the scope of the camping market has also grown from about 20 billion KRW in 2008 to about 1.5 trillion KRW in 2016 [3].

As such, the increased camping population and market has led to a higher likelihood of safety accidents at camping sites. According to the camping site safety accidents and other leisure (everyday sports) accidents in the Ministry of Public Safety and Security's disaster yearbook in 2017, there were a total of 1,465 safety accidents [4]. According to the Ministry of Culture, Sports and Tourism's campsite business safety training, the major danger factors in camping sites included electric fires, gas poisoning in closed spaces, and suffocation [5]. Accordingly, this study proposes a 'smart camping safety helper using arduino' for safe camping.Arduino refers to an open source computing platform and software development environment based on a simple microcontroller board. It receives input values from various switches and sensors and controls output with electronic devices such as LEDs and motors to create objects that can interact with the environment [6-9].Therefore, this study designed and implemented a smart camping safety system based on IoT(Internet of Things).

II. RELATED WORKS

A. IoT (Internet of Things)

IoT refers to smart technologies and services that connect all things based on the internet for mutual communication of information between people and things and between things and things. It is similar to ubiquitous or M2M (Machine to Machine) in the past; however, it expands the concept of M2M that

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mainly focuses on communication between communication devices and people to the internet to be an evolved stage that includes interaction with all information of the virtual world with that of the real world as well as things [10].

B.Arduino

Arduino refers to the open source computing platform and software development platform that equips a microcontroller that can activate programs. The Arduino integrated development environment allows writing and editing source codes, and compiles codes into commands that the Arduino hardware can understand and uploads them [11].

C.WiFi and Server

As the abbreviation of wireless facility, WiFi is a technology referring to the short-distance communication network that provides wireless internet using electronic waves within a certain distance where AP (access point) is installed [12]. WiFi uses 2.4GHz and 5GHz bandwidth frequencies, which are designated as the ISM bandwidth (Industrial Scientific and Medical Band) [13]. Limitations like this are described in IEEE 802.11 [14].In general, server refers to the computer hardware in which the server program is being executed and also refers to computer programs that offer services to other programs as well. The server can monitor and control the entire network, connect the mainframe or public networks with other networks, or help share software resources such as program files and hardware resources including fax machines, printers, and other equipment [15-18].

III. SYSTEM DESIGN AND IMPLEMENTATION

A.System Design

This study uses the relatively inexpensive Arduino as the board. The status in the tent was measured using a carbon monoxide sensor, a temperature sensor, and a spark detection sensor. A relay module was used to control ventilation and heating devices. In addition, a WiFi communication module was used for communication to send the information of fires occurring in tents to the server [19-21]. Also, a Bluetooth module was used to control the LED in the tent. Fig. 1 shows the blueprint of this configuration.

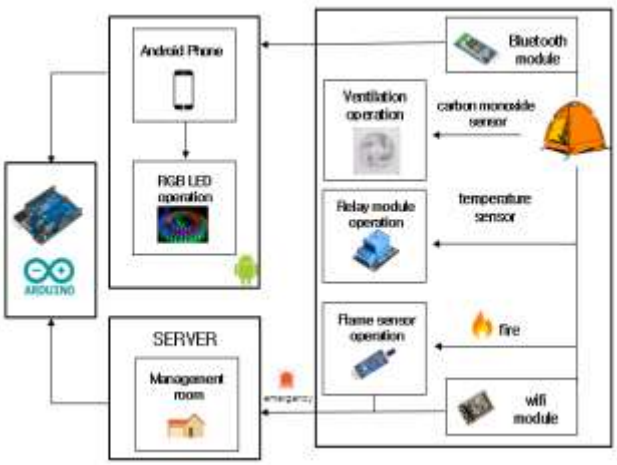

Fig. 1. System Architecture

In this design, when carbon monoxide is found to be in excess of a certain amount by the carbon monoxide sensor, the vent is set to activate and the spark detection sensor detect fires in the tent to send an emergency notification to the management office via WiFi. Furthermore, in order to prevent fires that may occur in the tent due to the use of heating devices, when the temperature sensor detect that the temperature in the tent exceeds a certain temperature, a relay module is used to block the power of the heating devices. By doing so, it can prevent and respond to safety accidents that can occur while camping.In addition to preventing safety accidents that occur while camping, a Bluetooth module is used to control the RGB LED through an Android application so that the user may enjoy camping.

B.System Implementation

The system used in this study was configured using the Windows 10 64 bit operating system. The Android Minimum Required SDK was configured with API 14 : Android 4.0 (Ice Cream Sandwich) and Target SDK was configured with API 23 : Android 6.0 (Marshmallow).

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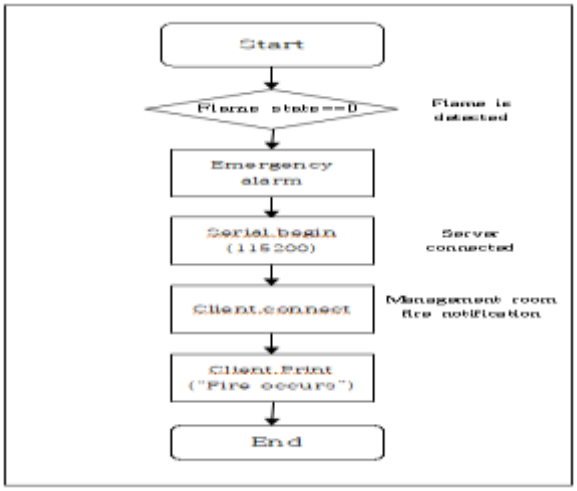

Fig. 2. Arduino Web-Server Connection

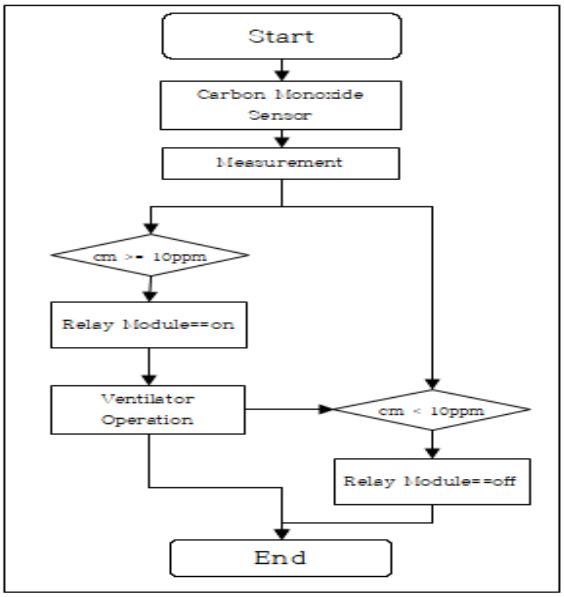

Fig. 3. Carbon Monoxide Control Algorithm

The above Fig. 2 shows the web server fire communication algorithm that displays fire information with the web server by using serial communication via Arduino and the WiFi communication module.When flame state==00 is determined by the spark detection sensor, the fire is detected. When a fire is detected, the fire alarm goes off and the web server is connected through the Arduino ESP8266 module. After the server is connected, the information of the fire is sent to the management server.The above Fig. 3 shows the algorithm that controls carbon monoxide concentration according to the carbon monoxide concentration.The carbon monoxide concentration is measured in real-time using the carbon monoxide sensor. The standard was set at 10ppm, which is the maintenance standard of carbon monoxide in public-use facilities [22]. When carbon monoxide is measured to be higher than 10ppm, the relay module is activated and the vent activates. If the indoor carbon monoxide concentration drops below 10ppm by using the vent, the relay module stops operation.

C.Implementation Results

The system was operated with Intel Core (TM) i5-8250U CPU, Android 6.0 (Marshmallow). The system configuration results are as shown in Fig. 4 to 7.

Fig. 4. System Implementation Results 1

In Fig. 4, when a fire is detected through the WiFi module and the spark detection sensor, a fire notification is sent through the web server to help the camping site management office to be aware of the fire promptly.

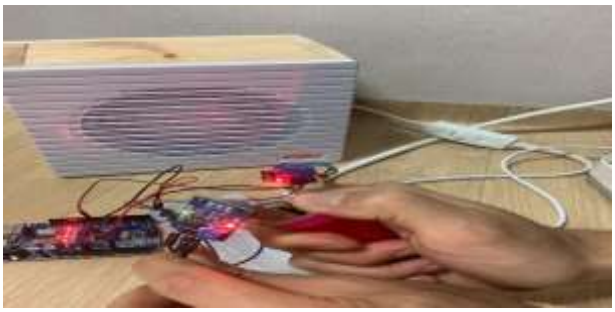

Fig. 5. System Implementation Results 2

Fig. 5 shows carbon monoxide concentration being measured in real time using the carbon monoxide sensor. When carbon monoxide is measured to be in excess of the standard amount (10ppm), the relay module is activated to activate the vent.

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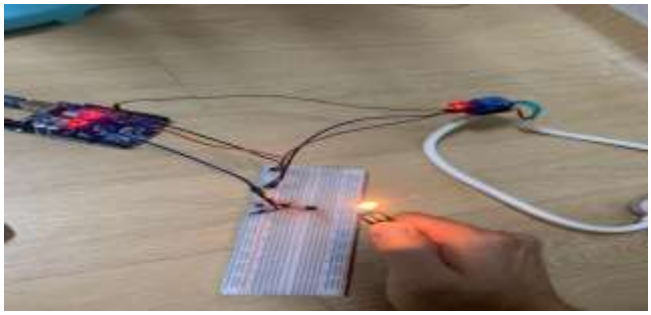

Fig. 6. System Implementation Results 3

Fig. 6 shows the temperatures in the tent, which were measured in real-time using the TMP36 temperature sensor to control the temperature in the tent. When the temperature is measured to be higher than the standard level (27℃), the relay module is activated to stop the operation of the heating devices [23].

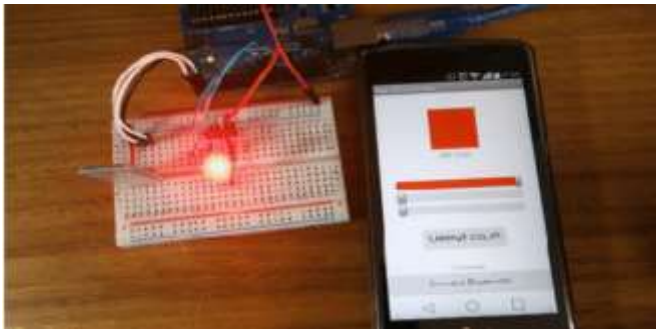

Fig. 7. System Implementation Results 4

Fig. 7 shows the configuration in which the user directly controlling the lighting in the tent using a bluetooth module.

Fig. 8. System Implementation Final Results

Fig. 8 shows the combination of all configured results of the web server's fire notification function through the spark detection sensor, the indoor ventilation system through real-time carbon monoxide concentration measurement, the indoor temperature control system using electric power control, and the indoor lighting control system through Bluetooth.

IV.PERFORMANCE EVALUATION

Performance evaluation was performed on fire detection accuracy per distance of the spark detection sensor using the Arduino board, carbon monoxide sensor measurement, and temperature sensor measurement accuracy. The performance evaluation results were shown in Tables 1 to 3. The below Table 1 shows the performance evaluation results according to the distance of the spark detection sensor. The results of measuring 50 times per distance were shown. As shown in Table 1, it showed high accuracy at relatively close distances of 5cm to 10cm. However, the margin of error gradually increased from about 15cm. At over 20cm, the number of times that it did not activate increased. As shown in the above Table 1, the measurement limit of the spark detection sensor was found to be about 15cm.

Table 1. Flame Detection Sensor Operating Result 1

Operating / CM(within)	Operating	Non operating
5cm(within)	50	0
10cm(within)	48	2
15cm(within)	36	14
20cm(within)	15	35
25cm(within)	2	48

The below Table 2 presents the evaluation result on how much carbon monoxide concentration was decreased in the tent through the operation of vents. The carbon monoxide concentration in the tent was set at 50ppm to evaluate the performance. It was measured a total of 30 times to determine the average value of the carbon monoxide concentration in the tent.Up until the first five minutes, the carbon monoxide concentration in the tent was measured to be three times higher than the CO maintenance standard of 10ppm for facilities used by the public [11]. After about 10 minutes, it dropped to about 18ppm and then from 15 minutes, it dropped to below 10ppm.

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Table 2. Ventilation System Based on Carbon EvaluationMonoxide Evaluation Result 2

Temperature / Minutes	Temperature(℃)
5minutes	38.4
10minutes	35.2
15minutes	31.7
20minutes	26.8
25minutes	24.3

The below Table 3 shows the indoor temperature control evaluation through the power control of the heater to control the temperature in the tent. The environment in the tent was set at a temperature of 40℃ to perform evaluations [12]. It was measured a total of 30 times and the temperature in the tent was shown as average values. The initial indoor tent temperature was recorded to be higher than 30℃ from 5 minutes to 15 minutes. After about 20 minutes, it was found that the temperature dropped to below 27℃, which is the appropriate room temperature.

Table 3. Temperature Control via Power Control Evaluation Result 3

Operating / Minutes	Operating
5minutes	36.2
10minutes	18.2
15minutes	7.8
20minutes	4.6
25minutes	2.6

V.CONCLUSIONS

This study designed and configured the camping safety helper using the arduino board, a carbon monoxide sensor, a spark detection sensor, a WiFi communication module, a relay module, and a bluetooth module. The camping safety helper using arduino configured the system to effectively reduce camping site safety accidents that have been increasing with the growth of the camping population and market. The system was configured with the focus on preventing carbon monoxide poisoning and fires in the tent, and furthermore, designed to allow for users to more safely and comfortably enjoy camping through temperature control and lighting control in the tent.Therefore, this study designed and implemented a smart camping safety system based on IoT(Internet of Things)

The system for sending fire notifications via the web server has been configured in this study. It will be supplemented so that automatic notifications are sent to the manager's smartphone in the future.

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