Design of Smart Shoe Box Based on IOT

Dae-Jea Cho
Dept. Of Multimedia Engineering
Andong National University
Andong City, Rep. of KOREA
djcho@andong.ac.kr

Ye-Rin Jeong
Dept. Of Multimedia Engineering
Andong National University
Andong City, Rep. of KOREA
difls8137@daum.net

***Abstract*— Footwear is closely related to foot care and certainly necessary when going out. Footwear care is essential for foot care since footwear provides the optimum condition for microorganism to inhibit due to sweat, dead skin cells, dust out of secretion of feet. The smart IOT shoe box is designed in order for busy people in everyday lives to minimize inconvenience of shoe care and make it more efficient. Conditions inside the shoe box is automatically judged and controlled based on an embedded system, and it is also possible to be controlled by a smart phone. The shoe box is designed to save the conditions inside the shoe box as sensor data and automatically operate each device through ultrasonic sensor and temperature sensor. Also it can be controlled by a smart phone using bluetooth sensor.**

Keywords—smart system; embedded system; IOT; arduino; intelligent shoe box

I. INTRODUCTION

Feet are very important parts which support weight and hold the center of gravity, so that they make us be able to walk and move in a balanced way. The importance of managing feet has been emphasized enough to call feet the second heart. However, it is difficult to manage them because the secretion of sweat is three times more than other parts of a body and there are few sebaceous glands, which makes it easily dry and rough. It is very important to manage footwear for foot care in respect of foot care. Nevertheless it is neglected by many. Footwear should be worn to be out and is the optimum space for microorganisms due to sweat, dead skin cells, dust secreted from feet. Therefore, it is essential to manage footwear for foot care. Yet, it is not easy for people who live busy daily lives to invest their time in shoe care.

In this paper, we design the IOT(Internet of Things) shoe box which can be managed without investing time and effort. It is made to be able to keep footwear clean by judging temperature, humidity and the status of opening/closing of the door and operating UV lamp, halogen lamp and a cooling fan depending on the conditions through temperature/humidity sensor and ultrasonic sensor. Moreover, using the bluetooth sensor, the conditions inside the shoe box can be checked and the devices can be controlled.

II. RELATED WORKS

A. Relevant Technologies

IOT refers to a technology or an environment to exchange data in real time by attaching sensors. In 1999, it began to be used after Kevin Ashton, a former P&G brand manager, firstly said: "Internet of things will be built by installing RFID and other sensors on things in everyday life"[1]. According to a study conducted by Korea Institute of Industrial Economics and Trade(KIET), the domestic market of IOT in Korea is expected to reach 4.9 trillion won in 2016 and increase by 22.9 trillion won in 2022, which is 5 times bigger[2].

Literally, an embedded system is configurated as part of the whole system, which is specifically intended to function as a brain for the system requiring control[3]. An embedded system, capable of reducing weight and providing lower power consumption, is in the limelight as, recently, the price of microprocessor has been lowered and the miniaturization and high performance of systems have made progress[4]. In addition, the technology of IOT in which sensor control is essential has been developed, and accordingly an embedded system has been grown, which can be optimally designed to meet specific sensors[5, 6].

B. Existing Devices for Footwear Management

Figure 1 shows shoes manager 'i-Foot'. 'i-Foot', a sterilizer and dryer on the market, is ergonomically designed with the motif of joints. It can be used for various shapes and sizes of shoes and provides functions such as sterilization, drying and deodorization[1]. On one hand, it has a strong point where one touch and automatic timer function can be easily operated. On the other hand, it is available for only a pair of shoes.

Fig. 1. Shoes manager: i-Foot.

WiZELL, a sterilizer and dryer which is most similar to the shoe box in this study is for sterilizing, deodorizing and drying footwear. However, this dryer also requires user's control and it seems inconvenient in respect of storage and management.

Fig. 2. Shoes manager: WiZELL.

In this study, the functions have been developed to be stored and managed simultaneously by supplementing the disadvantages of the shoe sterilizer and dryer on the market. The shoe box has been designed and implemented to provide an easier environment for users through the automatic control system. Furthermore, IOT function is added to check the conditions inside the shoe box outside a house, which can be controlled by a smart phone.

III. Design and Implementation

In this study, as shown in Figure 3, the shoe box is designed, which can judge the conditions and automatically operate the devices through temperature-humidity sensor and ultrasonic sensor based on an embedded system[7, 8].

The left part of the Figure 3 analyzes the given data from various sensors, sends the processing result to the smartphone, and controls the sensors using the smartphone. The right part of the Figure 3 is the part that determines whether to operate the fan according to the result of the sensor.

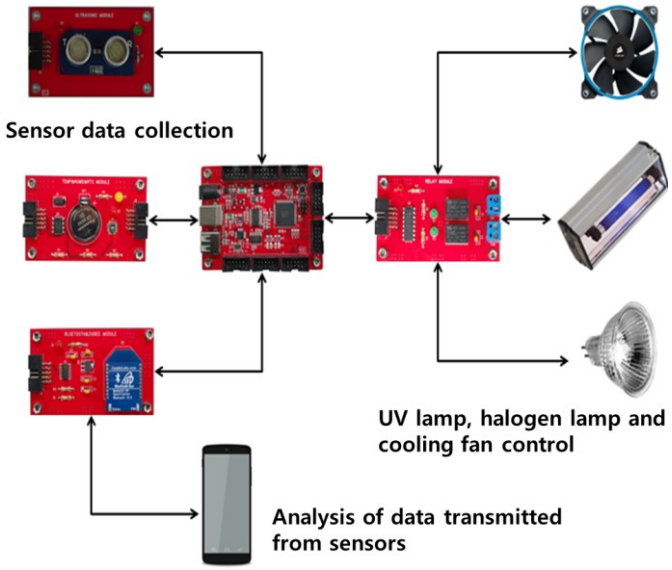

Fig. 3. Configuration diagram of smart IOT shoe box.

It determines whether to operate UV lamp, halogen lamp, and a cooling fan in the shoe box after judging the status of opening/closing of the door through ultrasonic sensor, which generates ultrasonic wave to measure the distance. When the value of the ultrasonic sensor becomes larger than the set value, the shoe box considers its door open, and then ceases to operate the whole device. It helps to minimizes unnecessary consumption of power. When it judges the door is closed according to the value of ultrasonic sensor, it operates UV lamp to sterilize inside of the shoe box.

When the temperature value accepted through the temperature-humidity sensor is higher than the set value, the shoe box is designed to cool down the inside temperature by operating a cooling fan. When the humidity value is higher, it can keep the humidity value by operating a cooling fan and halogen lamp. Figure 4 shows the algorithm for the automatic control system that judges the conditions inside the shoe box and controls each device through ultrasonic sensor and temperature-humidity sensor.

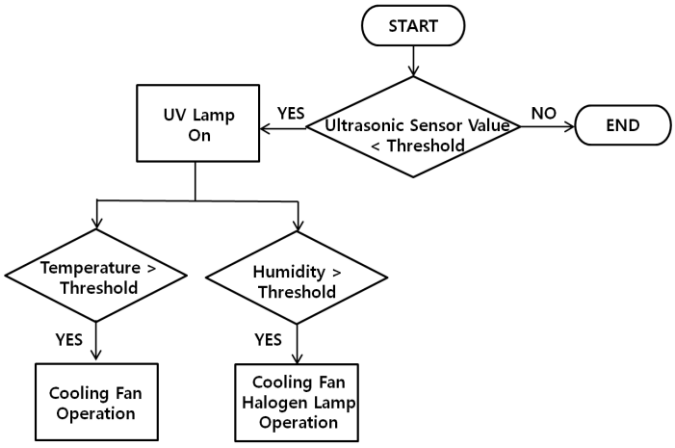

Fig. 4. Flowchart of automatic control system for smart IOT shoe box.

All of the values accepted via ultrasonic sensor and temperature-humidity sensor can be checked on a smart phone through the bluetooth sensor. It is possible to check whether or not each device is operating. What is more, the devices inside the shoe box can be controlled by a smart phone. By using the application on a smart phone, the conditions inside the shoe box can be checked according to the value of each sensor in real time and the devices can be controlled. Figure 5 is the conceptual diagram of IOT shoe box network.

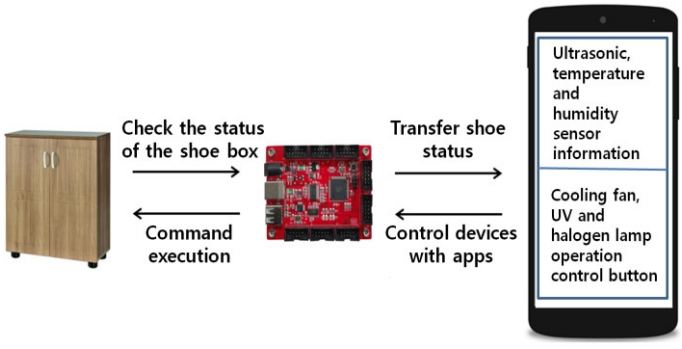

Fig. 5. Conceptual diagram of network for IOT shoe box.

In this study, programming is conducted with Arduino program to implement an embedded system and Auduino

Mega 2560 or Mega ADK is a microcontroller. It is programmed to make each device automatically controlled according to values of ultrasonic sensor and temperature-humidity sensor. Figure 6 shows part of the program.

```
if(Distance < 150){
 if(temp_c>= 28)
  digitalWrite(relayPin2, HIGH);
 else
  digitalWrite(relayPin2, LOW);

if(humidity>=70){
 digitalWrite(relayPin2, HIGH);
 digitalWrite(relayPin3, HIGH);
} else {
 digitalWrite(relayPin3, LOW);
 if(temp_c < 28)
  digitalWrite(relayPin2, LOW);
}
  digitalWrite(relayPin1, HIGH);
}
else
{
 digitalWrite(relayPin1, LOW);
 digitalWrite(relayPin2, LOW);
 digitalWrite(relayPin3, LOW);
}
```

Fig. 6. Program of shoe box automatic control system.

Fig. 7. Inside view of smart IOT shoe box.

The main board, bluetooth, ultrasonic sensor and switch are separately located at the bottom of the shoe box so as to reduce inconvenience in storing shoes. Temperature-humidity sensor is located on the wall of the middle compartment where shoes are stored in order for the shoe box to judge the conditions inside the shoe box more accurately. Figure 7 shows part of the compartment for storing shoes and how a cooling fan and UV lamp are attached.

IV. Conclusion

The products based on IOT technology enable more convenient lives with intelligent systems and their configurations come to be diverse depending on different situations and user's environment. In this study, the IOT shoe box has been implemented, which automatically judges and controls the conditions inside the shoe box based on an embedded system, including smartphone control. Using ultrasonic sensor and temperature-humidity sensor, the conditions inside the shoe box are judged and each device is automatically controlled. Furthermore, it can be controlled through a smartphone based on the bluetooth sensor. By developing this study, furniture, such as wardrobes and drawers, is to be designed and studied as the next smart products with IOT technology.

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