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A Development of the Safety Accident Prevention Fence System Based on Internet of Things

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Abstract

Children's home accidents are less common than in the past. However, safety accidents continue to occur due to carelessness of the parents. To solve the problem, there are fall prevention screens that can withstand the weight of children, and safety railings that can be adjusted directly to solve the problem. However, these have disadvantages such as stability, convenience, and damage to the landscape. In this paper, we developed an automatic safety accident prevention fence system that can be installed on a window using Arduino, eliminating the disadvantages of previous safety accident prevention products. This system measures the height of a person standing in front of the fence and the distance between the person and the fence with two infrared sensors and moves automatically using a motor. In addition, in accordance with the U-Healthcare society, users can check the temperature, humidity, and fine dust concentration of the external environment through mobile. Each information can be obtained through DHT 11 sensor, fine dust concentration sensor, and Bluetooth connected to Arduino. These can help the user's health care.

Keywords: Children, Safety, Automatic System, Application

Major Classification s: Internet of Things, U-Healthcare

1. Introduction[6]

Modern society has a higher interest in education, play, health and safety for children(0-14 years old) than in the past. Accordingly, parents are using the house as hobby space, garden, and playroom. However, the reason that children's safety accidents occur is that facilities and equipment are organized around adults (Kim & Kim, 2017).

According to the safety accident results of "Korean Social Trends 2019" of the Statistics Research Institute, children are likely to fall through the window, so parents need to pay attention. Falling accidents by children have decreased significantly since 2014, but they are still occurring today. In 2018, the most number of child safety accidents occurred in housing (16,343 cases, 67.9%). As for the proportion of child fatal accidents by type, intentional accidents such as suicide and murder accounted for 35.6%, and unintentional accidents such as transport, fall, drowning, suffocation, fire, and poisoning accounted for 64.4%. There were 163 children who died in unintentional accidents, of which 28 children (17.2%) died in a fall, with the third highest death rate. Compared to major OECD countries, the

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death rate of children in the fall of children in the OECE is 0.2, but in Korea it is higher a 0.3 (Ryu, 2019).

2. Literature Review

There are previous studies to prevent safety accidents. First, safety screens are most often used as a method to prevent fall accidents. This is because general insect screens are torn or fall out easily even by the weak force of children, and there is a risk of accident. However, since there is no separate standard, it is difficult to guarantee the quality and safety, and the performance is not consistent for each product (Ok, et al., 2009). Second, safety railings can be installed on the window of apartment verandas, villas, and townhouses (Jung et al., 2007). It can also be installed by adjusting the height according to the height of the window (O, 2000).

However, these have disadvantages such as safety, convenience, and damage to the landscape. Therefore, IoT not only collects information, but also connects to add meaning (Lee, 2016), so this study implements a system that solves problems and automatically prevents accidents using Arduino.

According to “Design a Portable Biomedical Signal Measuring System for U-Health”, people are demanding the improvement of medical services in health care due to the development of information and communication (Lee et al., 2008). And according to the “Elderly Care System in the U-Health Environment”, information and communication technology enables people to cope with all the actions that occur in the home in real time because they provide various conveniences and stable lives (Jang et al., 2013). Therefore, we developed a system that combines information and communication technology and U-Health in the health care field in accordance with the social atmosphere in this paper. Through the DHT11 sensor, information on temperature and humidity can be obtained, as well as information on the concentration of fine dust that causes various diseases (Shin et al., 2018) can be transmitted via Bluetooth to check with the application.

3. System Development

3.1. System Configuration

The block diagram of the system proposed in this paper is shown in Figure 1. The System is divided int o a fence drive unit, which is hardware system, and a n environmental measurement unit, which is a U-Healt hcare system.

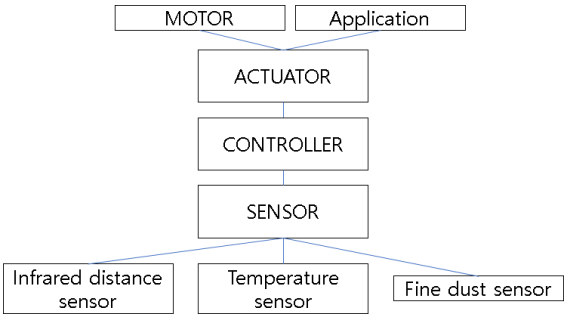

Figure 1: The Block Diagram of System

The safety fence was developed using an Arduino board. This is because it makes it possible to develop devices that control and interact with components such as LEDs and motors through I/O ports (Kim, 2020). An infrared sensor and a motor were used for the driving part of the fence. The infrared sensor GP2Y0A21YK is structurally uncomplicated and has a signal processing function, making it easy to measure close distances. The motor moves the fence according to the measured distance.

DHT 11, fine dust concentration measurement sensor, and Bluetooth were used for the environment measurement unit. DHT 11 measures temperature and humidity. The fine dust sensor uses the optical dust detection sensor GP2Y1014AU, which measures the amount of fine dust according to the scattered light by emitting LED light into the external air introduced through the hole of the sensor (Nam, 2019). The value measured by the sensor is transmitted to the application through the HC-06 module connected to the Arduino.

3.2. System Principle

3.2.1. Hardware System

Figure 2 is a flow chart for a hardware system. First, the system reads the initial values of the two infrared distance sensors. The system recognizes that the window is closed when the value of one infrared sensor is 10cm. If the measured value is more than 10cm, the system recognizes that the window is open and performs the following process. Two infrared sensors measure height using the change in distance between the fence and the person and determine whether they are children. If children work, system operate the motor of the fence. After three minutes, the infrared sensors check for a person in front of the window. If there are no people, system operate the motor to close the fence.

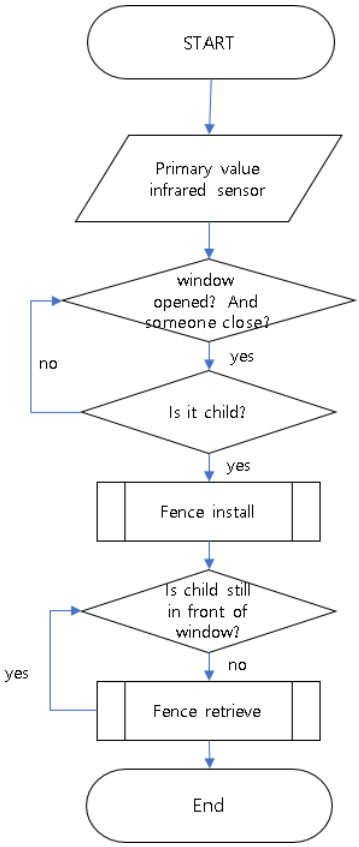

Figure 2: Hardware System Flow Chart

3.2.2. U-Healthcare System

Figure 3 is a flow chart for the U-Healthcare system. The control unit reads the value measured by the DHT 11 and the fine dust sensor. And they are passed on to the user's mobile application via Bluetooth, and the application displays them on the screen. Depending on the fine dust concentration value, the application changes the fine dust image. In this paper, an application environment was built using 'MIT App Inventor' provided by MIT, which is capable of linking Arduino with Bluetooth. The application was run on a Galaxy Note 8 that supports Android 8.0 version of Bluetooth 5.0.

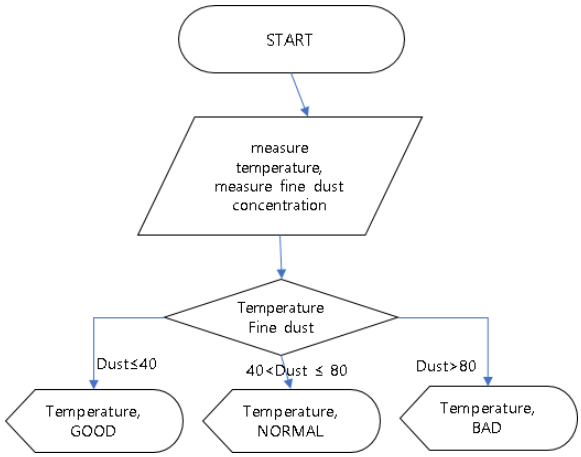

Figure 3: U-Healthcare System Flow Chart

3.3. Pseudo Code

```
# Main System
DC_motor = motor
infrared_ray_distance_sensor 1 = distance 1
infrared_ray_distance_sensor 2 = distance 2

input : motor, distance 1, distance 2

if distance 2 <= 5
        motor off

if 5<distance 2<30 && distance 1 <= 130 ==child
if 5<distance 2<30 && distance 1 > 130 == adult

if child
        motor start
        check child after 3 min
        if there is child
                motor on
        if there is not child
                motor start
                motor off

if adult
        motor off


# Temperature, Humidity, Fine Dust System
dht11
fine_dust_sensor = dust
bluetooth
phone

input : dht 11, dust
connect : bluetooth, phone <- input
output from phone : temperature, humidity, fine dust density
```

4. Results and Discussion

The result of developing the system in this paper is shown in Figure 4.

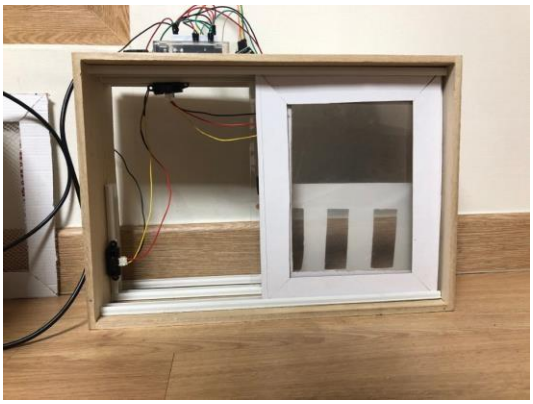

Figure 4: The Safety Accident Prevention Fence

In the fence driver, two infrared distance sensors measure the distance and height between the fence and the person, respectively. The motor moves the fence according to the value of the infrared sensor. If the value of the infrared sensor below is less than the reference value of 10cm, the sensor determines that window is closed.

```
loop
ifrared_down : 7
window close
```

Figure 5: Close Statement

If the value of the under infrared sensor is larger than the reference value of 10cm, the sensor determines that the window is open, and when a change value occurs, it determines that a person is approaching, and receives the change value for height estimation. When the system receives changes from both sensors, it uses them to estimate the height.

```
loop
window open
1_irsU : 22
1_irsD : 15
first_Step start after 5 sec, detact human
2_irsU : 13
2_irsD : 13
=======================
D_irsU : 9
D_irsD : 2
=======================
TALL = 9
CHILD
```

Figure 6: Open Statement

If the estimated height is less than the set height, it is judged as a child, and if it is taller, it is considered as an adult. After 3 minutes, the system uses the value of the distance sensor to check if there is anyone, and if not, it moves the motor to close the fence.

The main screen of the application is shown in Figure 7. When the Arduino's Bluetooth and the application are connected, the message "Bluetooth connection has been established." is displayed on the application, otherwise the message "Bluetooth connection cannot be established." is displayed.

Figure 7: The Application Main Screen

When the Arduino and the application run normally, the sensors measure temperature, humidity, and fine dust concentration in real time, and the application outputs the measured values and images.

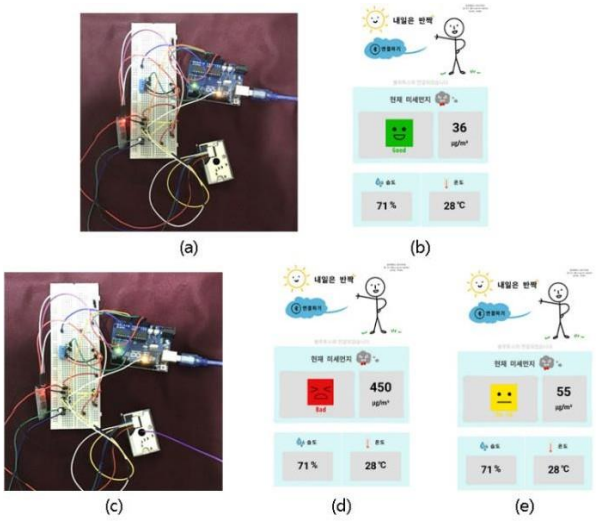

Figure 8: Image Change

When the fine dust concentration value exceeds 80μg/m³, a red image, when it exceeds 40μg/m³, a yellow image, and under 40μg/m³, a green image is displayed.

5. Conclusions

The implemented safety accident prevention fence system reduces the burden on children care. Also, unlike conventional methods, this system is efficient because it uses a motor to move. Users can check the values of the temperature and humidity sensors and fine dust sensor installed in the fence with the application and manage their seasonal illness and health.

However, because this system uses inexpensive sensors, the measured values can change drastically. Also, application created using App Inventor is Android-based, so IOS users cannot use them. This needs to be resolved after further study on the application development environment that supports both operating systems.

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