

## A Design of Smart Home Security System

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**Abstract:** In this paper, we propose a Smart home security system. Proposed smart home security system consists of arduino which is inexpensive main processor, ultrasonic sensor and human body detection sensor to detect whether someone breaks into home. Data from ultrasonic and human body detection sensor are transmitted to web server via ethernet shield connected to arduino. Web server checks whether someone breaks into home by using stored data from ultrasonic sensor and human body detection sensor. Snapshot is photographed via webcam connected, user can monitor in web or smart device environment. When examining efficiency of proposed smart home security system, it was found that proposed system is easier to be made than existing home security system, is cost effective by using arduino and is efficient and convenient and stable as it enables a user to handle an error in person and it uses reliable data.

**Keywords—**Home Security, Ultrasonic sensor, Arduino, Motion sensor

### 1. Introduction

Recently Smart Home becomes commonplace which ensures the comfort of residents, minimizes the crime in the residential space and prevents it in our living. But the interest in home security which prevents illegal intrusion and protects the privacy of the residents, is soaring due to a variety of intelligent crimes. As interest in the smart home security increases worldwide, the studies on the various units, such as CCTV surveillance systems, home monitoring system, access detection system and off-house safety system have been carried out. [1-3]

As the existing security equipment such as CCTV or DVR is expensive and requires complex installation procedure, private use of it can give you some burden in installation fee and maintenance fee and also has the disadvantage of difficult installation.[4]

In this paper, a home security system is proposed in order to resolve the problem. Since the home security system suggested has been designed using Arduino of open source-based single board micro controller, anyone can install it just through drawing easily and can operate it on PC by connecting it to general interface using excellent USB web camera.

### 2. Smart Home Security System

#### 2.1 Configuration of Smart Home Security System

The proposed home security system is composed largely of processor unit, storage unit and, input and output unit. Processor consists of sensor unit and process unit as sensor

unit passes data to process unit using ultrasonic sensor and human body detecting sensor while process unit can tell attacker from residents by handling sensor data and transfer the processed data to storage unit through ethernet shield. Storage unit consists of web server and database and saves the data delivered from process unit and can operate the webcam. Input and Output unit is equipped with webcam and smart devices of users and the snapshots taken by webcam can be monitored through smart device of user. Figure 1 shows the configuration diagram of the home security system proposed in this paper.

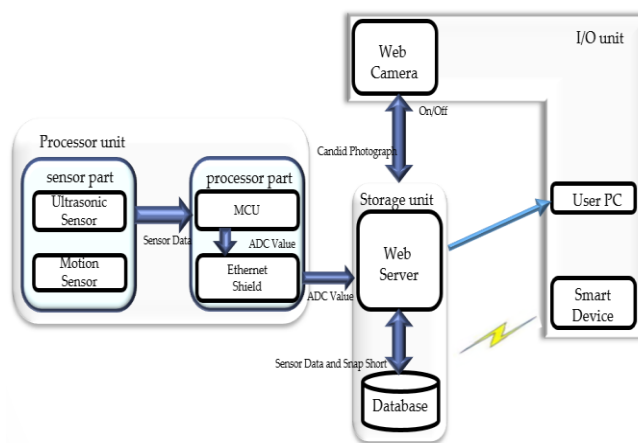


Figure 1. System Configuration

The sensor used to determine whether intrusion was made in home security system basically consists of ultrasonic sensor and the human body detection sensor and variety of sensor can easily attached to the main processor in process part, which handles sensor data and Arduino UNO R3 which is open source-based single board micro controller was used. Processor unit and storage unit has been designed to deliver data to web server through Ethernet shielder compatible with micro controller. Storage unit configured web server so that it can take snapshots and used Mysql database to store snapshots and sensor data delivered and transfer the snapshot. The input and output unit uses webcam ()to take a snapshot, and the snapshot can be verified in the user's smart device.

#### 2.2 Proposed Smart home security system algorithm

The proposed home security system algorithm can be divided into main processor and control algorithm of web server. Each of the main processor processes the sensor data and an algorithm to deliver it to a web server was designed. The algorithm that in the Web server, also, snapshots are taken and storage and output is performed. Figure 2 shows the algorithm of the home security system proposed in this paper.

### 3. Smart Home Security Implementation

In order to verify the efficiency of the Smart home security system proposed in this paper, the experiment environment was composed like Figure 3 (a) and its installation position was restricted so that it can extract and confirm the ultrasonic sensor data in various distance and the data from human body sensor correctly in accordance with situation.

Figure 3 (b) shows in detail the configuration connecting the Arduino ultrasonic sensor which is the main processor in the experiment and the human body detection sensor for the main processor in the test environment.

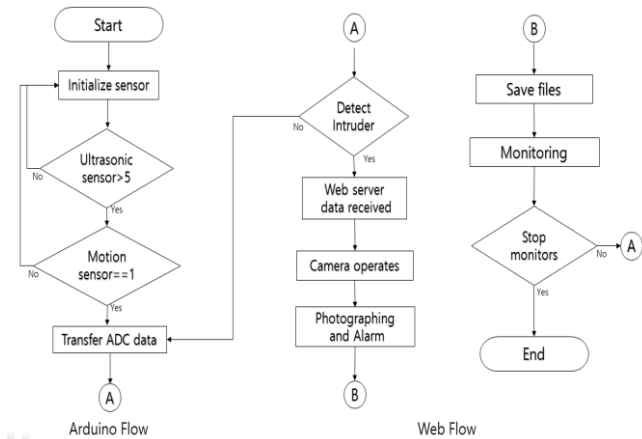


Figure 2. Smart Home Security System Algorithm

Arduino control algorithm starts its work by initializing each sensor. Next, it measures the distance to an object by using a difference of time for the ultrasonic sensor to slam the object and return. Because the data transferred is generated at the speed of sound, series of equation are used to determine whether an intrusion was made. Time to take until the signal returns can be expressed as equation (1) in order to measure the distance of the ultrasonic sensor.

$$t = \frac{2 * L}{V_s} \quad (1)$$

Where, t: time for signal to return (s),  $V_s$ : sound velocity, L : distance(m) to the objec.

Thus the time it takes for the round trip for 1cm is about  $58 \mu s$ , and the arrival time to the object can be inferred to be about  $29 \mu s$  by dividing the time t for signal to return by 2 and generally you can calculate the distance to object using the formula (2).

$$L = \frac{t * V_s}{2} \quad (2)$$

Where, L: distance to the object (m), t: time(s) for signal to return,  $V_s$ : sound speed (m/s).

It determines that the door is opened for more than 5 cm based on the calculated data and it determines one again whether any intrusion was made. As the human body temperature is within the range of infrared as  $36.5 \text{ }^\circ\text{C}$ , it is indicated as IR and if there is any movement, sensor detects it and send 1 or 0 to main processor. It processes the sensor data and transmits the data to the web server if any intrusion happens while web server stores sensor data in data base and takes snapshots by operating webcam. The snapshot taken is stored as an image file on a Web server and the user can determine whether the intrusion was made by using a smart device from any remote location where Internet is available. Users can temporarily shut down the home security system and can monitor continuously any intrusion if it is not shut down.

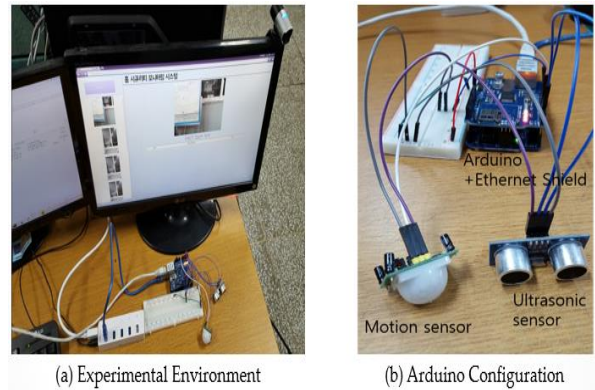


Figure 3. All experimental environment

The criteria for the decision of intrusion by ultrasonic sensor was 5 cm in Smart home security system and the experiment was conducted for 3 cases. Table 1 show the cases according to the ultrasonic sensor and the human body detection sensor data.

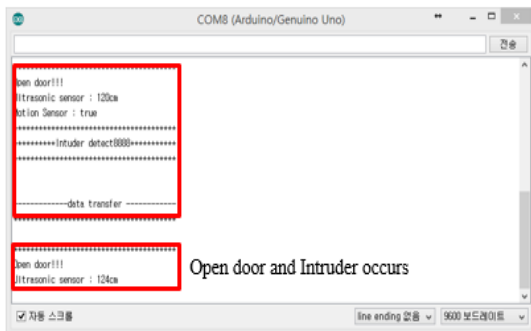
Table 1. Case of a experiment

Case.	Ultrasonic Sensor	Motion Sensor	Circumstance
Case1.	5cm under	false	Clear
Case2.	5cm exceed	false	Open door
Case3.	5cm exceed	true	Attacker occurred

Figure 4 (a) and (b) shows the data from the ultrasonic sensor and the human body detection sensor about any intrusion. And based on the values of 5cm from the ultrasonic sensors, it was tested to determine the door opening and closing. Figure 4 (a) represents the sensor data in case of the absence of an intruder. Since the ultrasonic sensor measures the distance of less than 5cm, human body sensor didn't work and generated a value of False. In Figure 4 (b), the data value from ultrasonic sensors was higher than 4 cm and it determined the door was open and it decided whether it is just simple opening or opening by intruder using human body sensor.



(a) Case an intruder is not



(b) Case an intruder has occurred

Figure 4. Sensor data according to the situation

Figure 5 shows the measured sensor data, Arduino program source code for transmitting to a web server. In order to convert the distance of the ultrasonic sensor by using the formula (2) was defined as a separate function. And it sends the parameters to the POST manner to the web page to store the sensor data to the Web server.

```

void loop() {
  long duration, cm;
  int sensor = digitalRead(8);
  digitalWrite(2,HIGH);
  delayMicroseconds(10);
  digitalWrite(2,LOW);
  duration = pulseIn(3,HIGH);
  cm = Centimeters(duration);

  if(cm > 5){
    if(sensor == HIGH){
      if (client.connect("hrlab.co.kr",80)) {
        client.println("POST
          /home_security/arduinosubmit.php
          HTTP/1.1");
        client.println("Host: hrlab.co.kr");
        client.println("Content-Type:
          application/x-www-form-urlencoded");
        client.print("Content-Length: ");
        client.println(data.length());
        client.println();
        client.print(data);
      }
    }
  }

  long Centimeters(long micro)
  {
    return micro / 29 / 2;
  }
}

```

Figure 5. Arduino Source code

Data in each of the ultrasonic sensor and the human body detection sensor is transmitted to the web server through an Ethernet shield connected to Arduino while the web server operates webcam on the basis of the relevant data when any intrusion was made. The webcam take snapshot every 3 seconds until it is finished and save the images in web server while user can determine whether the intrusion was made through PC or smart device.

Figure 6 represents the state that you can determine whether the intrusion was made from the smart device. In Smart home security system proposed in this paper, you can find the results using HTML5 and CSS, Canvus, JQuery in smart devices from any remote places without installing extra applications.

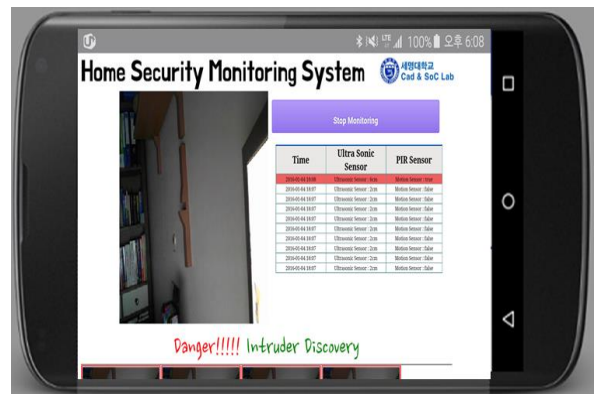


Figure 6. The Monitoring screen of the Smart Device

In addition, it displays the most recent snapshot at the top left of the screen. And the right to display the data of each of the sensors was possible to compare in time, At the bottom of the screen is a comparison of the screen over time it was possible to display a previous snapshot in order to compensate the disadvantage of the snapshot.

Table 2 shows the results of comparing and analyzing the performance of smart home security proposed in this part and the existing home security.

Table 2. Capabilities Comparison

Item	Existing Home Security	In this paper Home Security
Data Reliability	Low	High
Complexity	High	Low
Adaptation	Low	High
Readableness	Low	High

## 4. Conclusion

In this paper, a smart home security system was designed and anybody could produce it just through drawing without need of installation of complex equipment such as existing smart home security system was required by implementing Arduino which is the actual micro processor, its compatible

ultrasonic sensors and human body sensor and also immediate response was possible when a malfunction was discovered due to relatively easy configuration. Also, ultrasonic sensors and human body sensor used to determine whether any intrusion was made enabled stable system operation through more reliable data compared to existing home security system which used just single sensor. However it could be obtained easily without using equipment like CCTV or DVR and installation from personal use was improved in aspect of burden of installation and maintenance fee by using webcam which is excellent in cost-effectiveness.

As the future task, use of more reliable data to determine whether any intrusion was made through various sensors and addition of face-recognizing algorithm which recognize the intruder, delivery of correct information about intruder, access control using door lock system and automatic start and end of operation should be studied.

## References

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