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## Wi-Fi and GSM Based Motion Detection in Smart Home Security System

To cite this article: Munawir *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **536** 012143

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# Wi-Fi and GSM Based Motion Detection in Smart Home Security System

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**Abstract.** WiFi and Global System for Mobile Communication (GSM) based the smart home security system is a system that designed to improve security in most private housing. The main devices in this research are sensor for motion detection using Passive Infrared Sensor (PIR), Arduino Mega2560 as microcontroller board, NodeMCU V3 ESP8266 as WiFi development board that helps to prototype IoT product with few Lua script lines, or through Arduino IDE and then SIM800L as GSM module that also features GPRS support. The detection of motion is based on the principle of infrared radiation produced by human body heat which triggers a Passive Infrared Sensor (PIR). When the microcontroller received and processed the signal from human motion, then the trigger the buzzes the alarm, the microcontroller also activates the GSM module and sends SMS message to the user's mobile phone device. This system enables to control the home by using android device, such as door, garage, and lamp in the rooms.

## 1. Introduction

Home is one of basic needs in human life. It is a place protecting us from all weather, as well as a place for growth and family gathering. Every families have rights to feel secure and comfortable in their homes. Burglary usually happens when the householders sleep at night. Everyone agrees that it is important to feel secure and safe from the burglar. However, considering the limitation of human's power it seems impossible to create. On the previous research, home security system was made only by using one kind of sensor or singular sensor. It was placed at the door or the window house [1] So, when someone broke into the home through the door or the window, the alarm would produce sound. In other researches is using Bluetooth technology [4] and using raspberry pi [5] This home security system still has a weakness. The weakness is that not all burglars break house through the door or the window. They still can get to the house from the ceiling, ventilation or other opened spaces in the house. Therefore, in order to cover the weakness of home security system on the previous research, the researcher made a new model using multi sensors.

This home security system was based on microcontroller which was used as alarm control or buzzer. The microcontroller used was Arduino, the electronic components used in this model were magnetic sensor applied to the door or window and a motion sensor placed in some opened spaces in the house or important room or a place to store valuable stuffs. Also, SMS facility applied in the



system was used to notify the homeowner if someone tried to enter the house [2]. In addition, other components were also used as supporting series.

PIR sensor is an infrared based sensor which used to detect the presence of an infrared beam. This sensor is passive. It means that the sensor is only able to receive infrared radiation, it cannot emit infrared light [3]. Arduino Mega 2560 is an Arduino-based microcontroller development board using the ATmega2560 chip. Arduino Mega 2560 is equipped with a 16 MHz oscillator, an USB port, DC power jack, ICSP header, and a reset button. This board is very complete, it has everything needed for a microcontroller. With a fairly simple usage, just connect the power from USB to PC or via the AC / DC adapter to the DC jack. ESP8266 is a WiFi module functioned as an additional microcontroller like Arduino. So that, it can directly have connected to WiFi and create a TCP / IP connection. This module needs about 3.3v power with three WiFi modes, namely Station, Access Point and Both.

SIM800L is GSM/ GPRS Module which allows for GPRS transmission, sending and receiving SMS, making and receiving voice calls.

## 2. Methodology

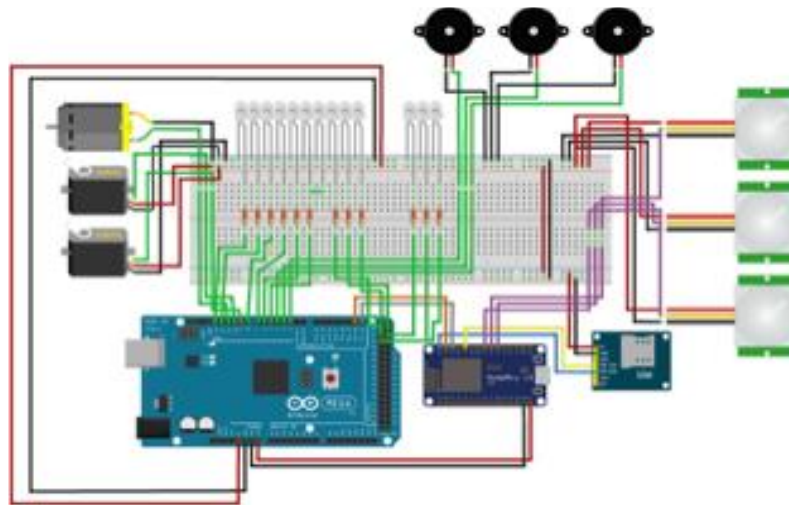
### 2.1. Hardware Requirements

Hardware requirements for this system:

1. Arduino
2. PIR (Passive Infrared Sensor)
3. NodeMCU V3 ESP8266 ESP12 CH340 IOT wireless Arduino
4. GSM Module SIM800L
5. Breadboard
6. Jumper Cable
7. Buzzer
8. Motor DC
9. Motor servo
10. Lamps
11. Handphone
12. Miniature Home

### 2.2. System Design

The system design GSM and WiFi based motion detection in smart home system as shown in Figure 1. The system design consists of a mega Arduino, using 3 PIR sensors: PIR 1, PIR 2 and PIR 3. These PIR sensors responsible to give signal if they find any movement approaches the microcontroller. Then, the microcontroller instructs the buzzer module, lights and GSM modules to provide information through SMS if the PIR sensor detects any movement in the working area of each PIR sensor. This system is simulated in a house miniature. Beside the functions mentioned, this system also has other utilities, such as turns off the lights, opens an automatic door, opens the garage and turns on the fan.

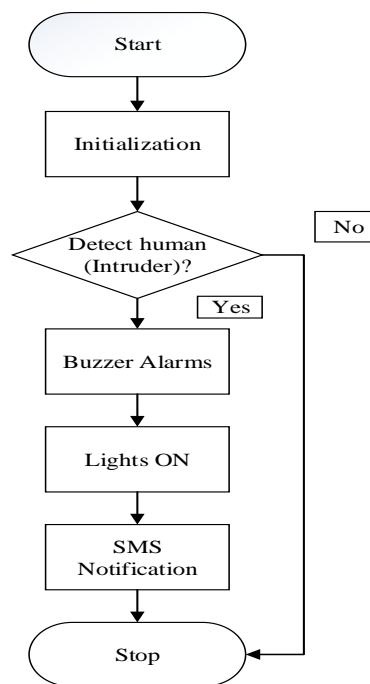


**Figure 1.** System Design

### 2.2.1. GSM Based Security System Design

The design of GSM-based security system is as shown in the Figure 2. The SMS checking process is starting from initialization. Then, check SMS, if it is "TURN ON" then the process will proceed to the "System = 1" check phase. If the "System = 1" process transmitted to the PIR 1 sensor, if the PIR 1 sensor catches human movement the SMS will be sent to the mobile phone by this message "Motion Detected", if it does not find any movement then the process will continue checking the PIR 2 sensor, it also happens to other PIR sensors. If there is getting human movement, the PIR sensor will be forwarded to the Arduino system, then the buzzer or bell in the room or where the sensor is located produces sound, and at the same time the system sends the SMS said "Motion Detected" as what has been determined.

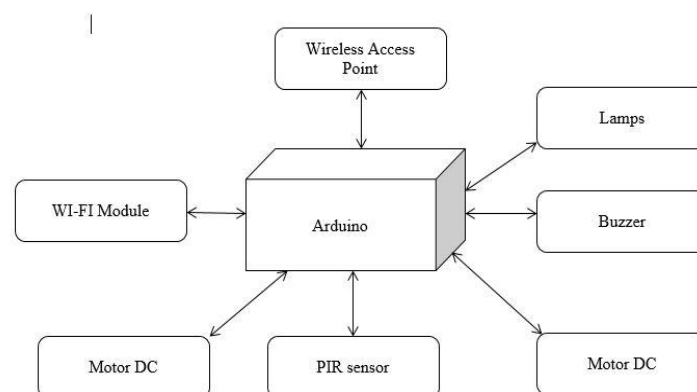
If the system receives an SMS with "TURN OFF" format then the system is zero "0", then it will continue to check the buzzer whether it gets an SMS from the user with the "BUZZER OFF" format or not. If it's a "YES" then the buzzer will turn off. If it isn't off the buzzer will keep producing sounds or the user can do reset as he wanted.



**Figure 2** GSM-Based Security System Design

### 2.2.2. Wi-Fi Based System Design

Figure 3 shows WiFi based system design to control the home and detect movement that occur at the home when homeowners are not at home. The Figure 4 shows an android application using a WiFi network connected to a system. So that, the house can be controlled from a distance or wherever we are as long as we have access to the internet connection.



**Figure 3.** Wi-fi Based System Design



**Figure 4.** Application control menu using Wi-Fi based system

### 3. Results and Discussion

#### 3.1. How Motion Detection Works

The system designed in this study is a smart home security system which detects motion, buzzer, SMS notification, turn on the lights, open the garage automatically and open the door house. The working system is based on the motion detection carried out by PIR, then Arduino forwarded to other components such as Buzzer, Module lights and GSM to be forwarded to the homeowner's handphone.

**Table 1.** PIR Sensor Testing's

Condition	PIR sensors	Buzzer and Lamp	
		On	Off
1	Motion Undetected	No	Yes
2	Motion Detected	Yes	No
3	After Motion Completed	No	No

To activate SMS notification function on this security system prototype, the first thing to do is to connect the prototype with the mobile phone containing the notification maker application. Connections between these devices can be established by using a Wifi connection between security system and mobile phone. The condition is explained on the following table.

The following table illustrates the conditions when the device is connected to wifi.

**Table 2.** Wi-Fi Testing

Condition	PIR Sensors	SMS Message	
		Succeed	Failed
1	Motion Undetected	-	Yes
2	Motion Detected	Yes	-
3	After Motion Completed	Waiting for Next Motion Detection	

The system requires IP address setting on Wifi. Therefore, controlling home security system can be done through an Android mobile device.

### 3.2. GSM Systems Testing

The first step is testing the system using GSM. Arduino connected to GSM Module and PIR Sensor which is programmed to SMS notification and it is connected to the destination number. The Figure 5. shows SMS notification message sent by the system to the destination cell phone. The message informed that a movement found in the house or room which was paired with a security system.



**Figure 5.** SMS Notification

### 3.3. Wi-Fi Testing

The Figure 6. shows the testing was conducted to detect motion on the PIR sensor through a programmed Android application. Besides that, other tests were also carried out such as automatic garage door, automatic door and turning on the light.



**Figure 6.** Testing Through an Android Application

### 3.4. Objects and Distance Testing

When a human movement or an object with infrared radiation found, the system will sound the buzzer and send an SMS, at the same time the lamp will turn on automatically where the PIR sensor is located.

PIR sensor testing aimed to find out whether the sensor able to detect human's body heat radiation or not, also to measure the minimum and maximum distance that the sensor can detect generated heat radiation. Basically, the components that produce heat also produce infrared radiation including the human body and animal body. The research was tested on human objects, cats and inanimate objects which generally moved very often like cloth, chairs and ropes. The reason is because the things are easily found inside people's home.

**Table 3.** Object Tested Result

Objects	Sensor Status	Detected	PIR Sensor Accuracy
Human	Active	Yes	100%
Cat	Non-active	No	0%
Cloth	Non-active	No	0%
Chair	Non-active	No	0%
Rope	Non-active	No	0%

Based on table 3. above it can be seen that PIR sensors are suitable for detecting human movements or detecting human presence due to heat temperatures that produce infrared radiation in the human body.



**Table 4.** PIR Sensor of Distance Detection Test Result

Distance Detection Test	Detection Position Range			Explanation	Time range of SMS notifications
	Right (90°)	Left	Straight (90°)		
30 cm	Yes	Yes	Yes	Detected	3 seconds
50 cm	Yes	Yes	Yes	Detected	4 seconds
100 cm	Yes	Yes	Yes	Detected	4 seconds
150 cm	Yes	Yes	Yes	Detected	4 seconds
200 cm	Yes	Yes	Yes	Detected	5 seconds
250 cm	Yes	Yes	Yes	Detected	4 seconds
300 cm	Yes	Yes	Yes	Detected	4 seconds
350 cm	Yes	Yes	Yes	Detected	4 seconds
400 cm	Yes	Yes	Yes	Detected	5 seconds
450 cm	Yes	Yes	Yes	Detected	4 seconds
480 cm	Yes	Yes	Yes	Detected	5 seconds
500 cm	No	No	No	Not detected	-
550 cm	No	No	No	Not detected	-
600 cm	No	No	No	Not detected	-
650 cm	No	No	No	Not detected	-
700 cm	No	No	No	Not detected	-

#### 4. Conclusion

The testing results of carrying out motion detection using PIR is suitable and effective to be applied at home. So that, it will be very helpful to improve the security system and to supervise the home from the distance because the user will get an SMS notification every time an unknown movement found in the home, the system also can to control the home in everywhere that connected to internet by using android application.

#### 5. Acknowledgement

The authors would like to express the highest gratitude to Kemenristekdikti for funding this research through the “*Penelitian Dosen Pemula* (PDP) 2018” scheme.

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