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Review Article

# IoT Security and Home Automation Management System

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## Abstract

The smart home and management system in this study are powered by D.C. batteries. It can operate for two to three days on a fully charged battery before running low. The project title and the maximum temperature are shown on the LCD when the system is powered on. It will also demonstrate to you that the house is empty. The quantity of persons you choose to enter the house is up to you. When the maximum is set to 12, the door won't open again until someone hits the escape button and leaves the house before someone else can enter. There is a fan in the house that is used to cool the temperature of the house if it is hot, and you can choose when you want the fan to turn on automatically by selecting the maximum temperature. If you choose the maximum temperature to be 30 °C, the fan will not operate until that temperature is reached. And if everyone leaves the house, both the fan and light will automatically switch off since no one is inside the house. There is a light in front of the house for security reasons. If it is dark at night, it will automatically turn on. This light is controlled by the second light-dependent resistor outside the house. If the LDR senses the presence of light, the bulb outside the house will switch off during the day, and if it senses the presence of darkness, that is, at night, it will turn on itself for security purposes. The first LDR is inside the house. If any person enters the house, it will turn on the light in the house. The light will not go off until everyone leaves the house. There is a smoke detector sensor to sense the presence of fire in the house; if there is a fire outbreak, the GSM Module and ESP32 that are used in the research will help send a message to the houseowner. These messages will both be sent as SMS and through a smart phone using a Wi-Fi connection. Most of the research done nowadays doesn't have both an IoT connection and a GSM module. Also, a motion detection sensor is used to detect an intrusion. If an intruder tries to enter the house or approach the house by the time everyone is asleep, it will send an SMS to the houseowner that they are motion-detected.

**Keywords:** ESP32, Passive Infrared sensor, LDRs, LCD, Smart House, Arduino Microcontroller, Motor, Lights.

## I. INTRODUCTION

The idea of the Internet of Things (IOT) is that every device has an IP address, which anyone may use to identify that item on the internet. Unique identifiers (UIDs) and network data transmission capabilities are offered to mechanical and digital machines, eliminating the need for human-to-human or human-to-computer interaction. It was essentially founded as the "Internet of Computers." Studies have predicted that the number of "things" or gadgets connected to the Internet will increase dramatically. The "Internet of Things" (IoT) is the name of the resulting network. The recent developments in technology that permit the use of wireless controlling environments like Bluetooth and Wi-Fi have enabled different devices to have the capability of connecting with each other. Using a Wi-Fi shield to act as a micro-web server for the Arduino eliminates the need for wired connections between the Arduino board and computer, which reduces cost and enables it to work as a standalone device. The Wi-Fi shield needs a connection to the internet from a wireless router or wireless hotspot, and this would act as the gateway for the Arduino to communicate with the internet. With this in mind, an internet-based home automation system for remote control and observing the status of home appliances is designed. Due to the advancement of wireless technology, several different types of connections have been introduced, such as GSM, WIFI, and BT. Each of the connections has its own unique specifications and applications. Among the four popular wireless connections that are often implemented in HAS projects, Wi-Fi is being chosen for its suitable capability. The capabilities of Wi-Fi are more than enough to be implemented in the design. Also, most current laptops, notebooks, and smartphones come with built-in Wi-Fi adapters. It will indirectly reduce the cost of this system. The concept of "home automation" has been in existence for several years. "Smart Home" and "Intelligent Home" are terms that have been used to introduce the concept of networking appliances within the house. Home automation systems (HASs) include centralized control and distance status monitoring of lighting, security systems, and other appliances and systems within a house. HASs enables energy efficiency, improves security systems, and certainly increases the comfort and ease of users. In the present emerging market, HASs is gaining popularity and has attracted the interests of many users. Hass comes with its own challenges. Mainly, in the present day, end users, especially the elderly and disabled, even though they have huge benefits, aren't seen to accept the system due to the complexity and cost factors.

## II. LITERATURE REVIEW

Satyendra et al. (2020) developed a smart energy-efficient home automation system using IOT. It uses IOT to convert home appliances into smart and intelligent devices with the help of design control. An energy-efficient system is designed that accesses the smart home remotely using IOT connectivity. The proposed system mainly requires Node MCU as the microcontroller unit, IFTTT to interpret voice commands, Adafruit, a library that supports MQTT, to act as an MQTT broker, and Arduino IDE to code the microcontroller. This multimodal system uses Google Assistant along with a web-based application to control the smart home. The smart home is implemented with a main controller unit that is connected to a 24-hour Wi-Fi network. To ensure that the Wi-Fi connection does not turn off, the main controller is programmed to establish an automatic connection with the available network and connected to the auto-power backup.

Tui-Yi et al. (2019) proposed an energy management algorithm for a home sensor network for a home automation system. Their work proposes an optimization of home power consumption based on PLC (Power Line Communication) for easy access to home energy consumption. This also proposes a Zigbee and PLC-based renewable energy gateway to monitor the energy generation of renewable energies. The ACS and DDEM algorithms are proposed for the design of an intelligent distribution of power management systems to ensure the ongoing power supply of home networks. To provide efficient power management, the power supply models of the home sensor network are classified into four groups: main supply only, main supply and backup battery, rechargeable battery power, and non-rechargeable battery power. Devices with particular features are assigned to these groups. It targets establishing a real-time processing scheme to address variable sensor network topologies.

Tushar Churasia and Prashant Kumar Jain. (2019) developed a model to reduce the computation overhead in existing smart home solutions that uses various encryption technologies like AES, ECHD, hybrid, etc. These solutions use an intermediate gateway for connecting various sensor devices. The proposed model provides a method for automation with sensor-based learning. The system uses a temperature sensor for development, but other sensors can also be used as per requirement. These smart home devices with sensors can configure themselves autonomously and operate without human intervention. This work minimizes encryption and decryption and focuses on authentication and automation of smart home devices with learning. The system bypasses the local gateway mentioned in the existing system to provide better security for smart home devices and sensor data and save computation overhead. The real-time broker cloud is directly connected to Smart Home and manages all incoming and outgoing requests between users and devices. The main purpose of using the real-time broker cloud is to save time on cryptographic operations.

Suraj et al. (2020) designed a visual machine intelligence system for home automation. The proposed method of sensing the state of appliances results in a novel home automation system. The accessibility of the suite of devices in the home over a remote network is facilitated by the IP-addressing methods in the IOT. This project uses two boards, viz., the Raspberry Pi and the Intel Galileo Gen 2. The communication between the user devices, the Raspberry Pi, and the Intel Galileo boards happens over a wireless network. The UDP protocol is deployed to facilitate the wireless communication of the nodes present in the home automation network. A Pi Cam and a USB Logitech camera attached to the rotating shaft of two different servo motors capture snapshots that are passed as inputs to the machine learning-based models trained using dlib-C++ to detect the state of the operation of the appliances. The proposed method uses visual modality to automate the appliances, as privacy concerns may emerge while using the images from some specific places. As a counter to this issue, an SPDT switch is added to the Raspberry Pi, which, when turned off, ensures that even if the images are taken from the webcams, they are just passed as inputs to the machine learning models and are not displayed on the website when the users access the website on the server address obtained from the Raspberry Pi.

Paul et al. (2021) developed a voice-controlled home automation system using natural language processing and the Internet of Things. A fully functional voice-based home automation system that uses the Internet of Things, artificial intelligence, and natural language processing (NLP) to provide a cost-effective, efficient way to work together with home appliances using various technologies such as GSM, NFC, etc. was designed. It implements a seamless integration of all the appliances into a central console, i.e., the mobile device. The prototype uses an Arduino MK1000, known as the Genuino MK1000. The NLP in this project gives the user the freedom to interact with the home appliances with his or her own voice and normal language rather than complicated computer commands. The appliances are connected to the mobile device through an Arduino board that establishes the concept of the Internet of Things. The Arduino boards are interfaced with the appliances and programmed in such a way that they respond to mobile inputs.

## III. MATERIAL AND METHODS

Table I: Below are the materials used in this research

| S/N | Names of components | Number used |
|---|---|---|
| 1 | LDRs | 2 |
| 2 | Lights | 2 |
| 3 | Liquid crystal display | 1 |
| 4 | Arduino Uno | 1 |
| 5 | Buzzer | 1 |
| 6 | IR Sensor | 1 |
| 7 | Switch Button | 1 |
| 8 | Light Emitting Diode | 1 |
| 9 | Battery | 3 |
| 10 | Connections | 39 |
| 11 | Fan | 1 |
| 12 | Smoke Detector | 1 |
| 13 | ESP32 | 1 |
| 14 | Motion Sensor | 1 |
| 15 | DC Motor | 1 |
| 16 | Gas Sensor | 1 |

### 3.1. DESIGN OF POWER SUPPLY UNIT

A DC source is necessary for the majority of electronic circuits and devices to function. The most affordable and practical power source is an AC supply. Converting this alternating voltage, which is often 240 volts, to DC voltage, which is typically less in value, is helpful. An AC to DC converter, a charger battery, and a regulator circuit enable this process of converting AC voltage to DC. The total maximum current rating of the parts in our circuit dictates which transformer we should use.

### 3.1.1. POWER SUPPLY ENERGY SYSTEM

Charging Regulator: 2-amps, low voltage cut-off, AC to DC charge an adaptor was used to draw out or squeeze more charge out of the adaptor and protect the system from over or under voltage. The diagram below shows the overall diagram of the power supply unit.

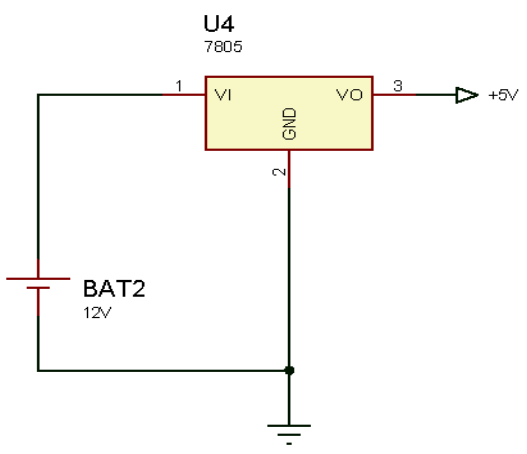


**Figure 3.1: Power supply energy unit**

## 3.2. FLAME SENSOR

A flame sensor is a device that can detect the presence of fire or other light sources within a specific wavelength range, typically from 760 nm to 1100 nm.

### 3.2.1. FIRE DETECTION SYSTEM USING FLAME SENSOR & ARDUINO

Now let us interface the flame sensor with the ESP32 board and make our own fire detection system.

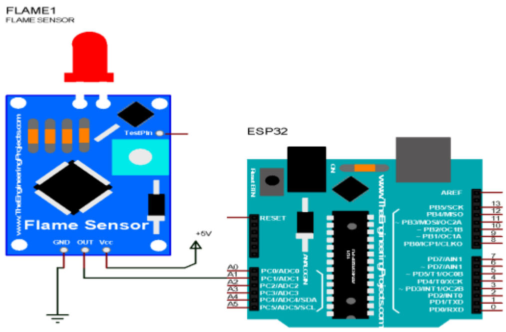


**Figure 3.2: Connect the flame sensor's VCC to Arduino's 5V and GND to Arduino's GND, and its digital output pin to Arduino's pin 4.**

## 3.3. MQ3 GAS SENSOR

The most popular analog gas sensor used is the MQ3 gas sensor. The MQ3 smoke sensor detects the presence of various types of smoke, such as carbon. The sensor interacts with smoke to measure its concentration, ranging from 100 ppm to 3,000 ppm.

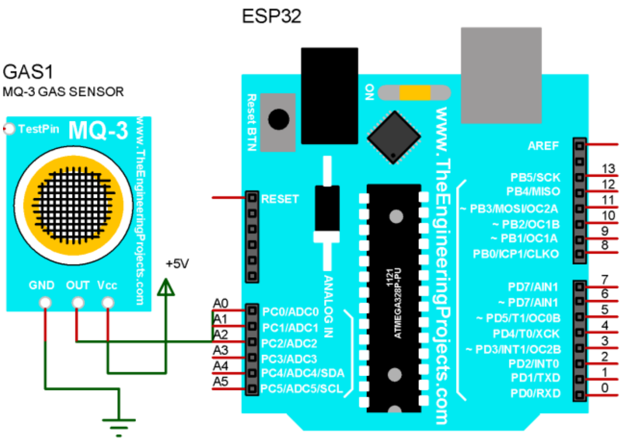


**Figure 3.3: Interfacing the Arduino with the MQ3 Gas Sensor**

When a gas interacts with this sensor, it is first ionized into its constituents and is then absorbed by the sensing element. This absorption creates a potential difference in the element, which is conveyed to the controller unit through an output analog pin in the form of current. Thus, we are measuring the analog current as an output that increases with increasing gas level.

The sensor works on 3V–5V and has both analog and digital outputs. It has 4 pins: VCC, GND, D0, and A0.

## 3.4. MOTION SENSING UNIT

This unit senses the presence of motion using a passive infrared sensor interfaced with the ESP32. The sensor works between 3V and 5V. So, connect its VCC pin to 5V/3.3V of the ESP32. Connect the GND to the GND and its output pin to any of the digital pins of the Arduino. Digital pin 2 of the Arduino is used to connect the sensor.

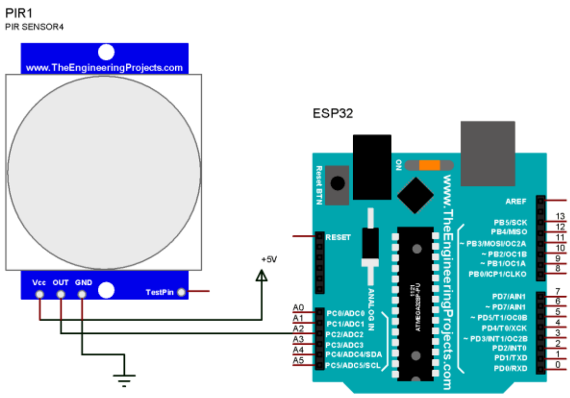


**Figure 3.4: Interfacing the Arduino with a motion sensor detector**

## 3.5. DESIGN OF ESP32 MICROCONTROLLER

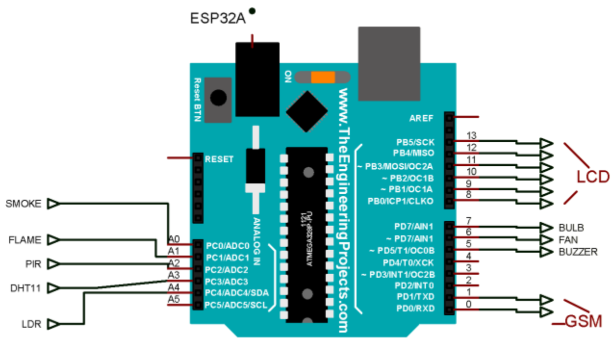


**Figure 3.5: Interfacing the whole system with the Arduino Uno**

## 3.6. INTERFACING LCD TO ESP32

Depending on how many lines are used for connecting an LCD to the microcontroller, there are 8-bit and 4-bit LCD modes. The appropriate mode is selected at the beginning of the operation in the process called "initialization." The main purpose of the 4-bit LCD mode is to save valuable I/O pins on the microcontroller. Only four higher bits (D4–D7) are used for communication, while others may be left unconnected. Each piece of data is sent to the LCD in two steps—four higher bits are sent first (normally through the lines D4-D7). Initialization enables the LCD to link and interpret received bits correctly.

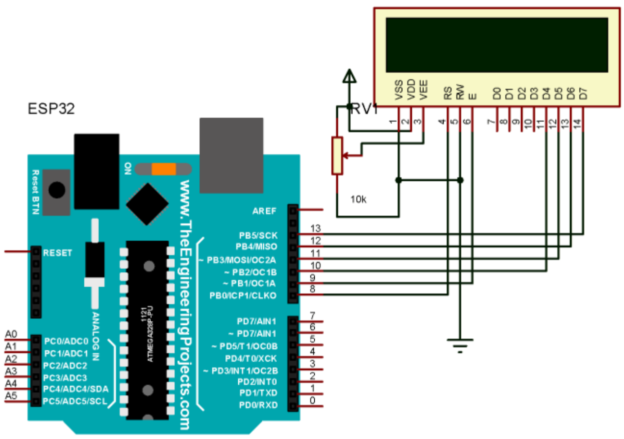


**Figure 3.6: LCD interfaced to ESP32**

## 3.7. DHT11 TEMPERATURE/HUMIDTY SENSOR UNIT

The DHT11 acts as a temperature and humidity sensor. It gives an output of 10 mV/C and is capable of producing a voltage from 10 mV to 1.5 mV that corresponds to temperatures from 0 °C to 50 °C and 0-80%.

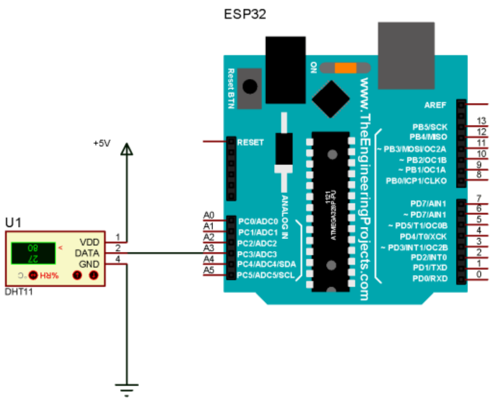


**Fig. 3.7: Connection of DHT11 to microcontroller**

## 3.8. LDR DESIGN

The internal ADC of the microcontroller is used to convert the analog output of the sensor into its equivalent digital value. The internal ADC of the microcontroller has eight channels of analog input and gives a 10-bit digital output. In this research, the ANO is used for monitoring analog voltage from the LM35, ranging from 0 to 1501 = 1500 mV. The internal ADC of the microcontroller is used to convert the analog output of the sensor into its equivalent digital value. The internal ADC of the microcontroller has eight channels of analog input and gives a 10-bit digital output. In this research, the ANO is used for monitoring analog voltage from the LDR, ranging from 0 to 1501 = 1500 mV. The internal ADC of the microcontroller is used to convert the analog output of the sensor into its equivalent digital value. The internal ADC of the microcontroller has eight channels of analog input and gives a 10-bit digital output. In this research, the ANO is used for monitoring analog voltage from the LDR, ranging from 0 to 1501 = 1500 mV.

The resolution of the ADC can be calculated as follows

$$\text{Resolution} = \frac{Vref}{(1024-1)}$$

$$= \frac{5}{1023}$$

$$= 4.88 \text{ mV}$$

It means that for every 4.88 mV change in the analog input, the ADC input voltage will change. The analog output of the sensor at its pin 2 is connected to Port A at A4 for conversion into a digital equivalent value.

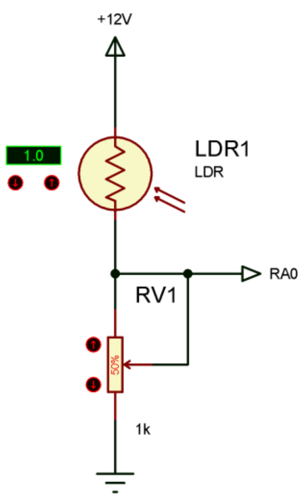


**Figure 3.8: Infrared Sensing Unit**

## 3.9. DC FAN/LIGHT CONTROL UNIT

The unit serves to control the DC fan and light system using a BD139 transistor. The circuit of this unit is shown in the figure below.

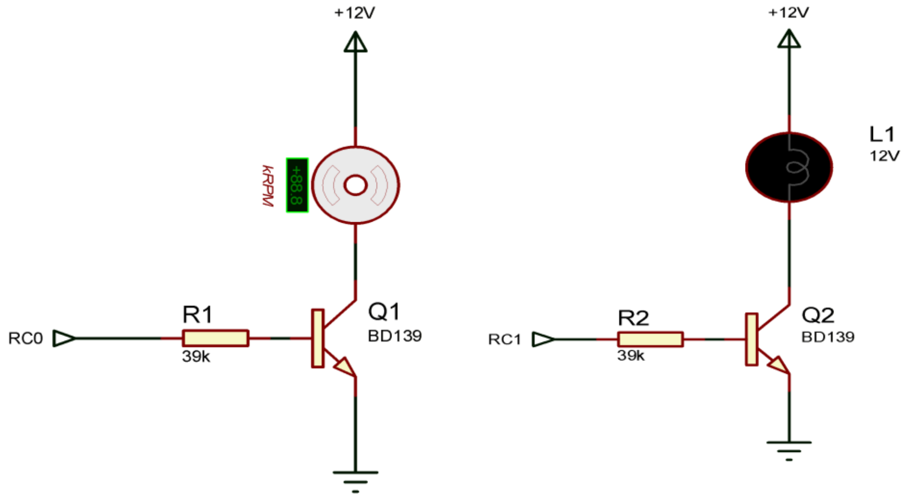


**Figure: 3.9: DC Fan transistor**

$\beta = {}^{1_C}/_{1_B}$

$1_B = {}^{1_C}/_{\beta}$

$1_c$ = 10mA, $\beta$ = 90

$I_B R_B = Vcc - V_{BE} - V_{CE}$

At saturation point

$V_{CE} = 0$

$V_{BE} = 0$

$R_B = \frac{VCC - VBE}{I_B}$

$1_B = \frac{10 \text{ x } 10^{-3}}{90} = 111.1\text{A}$

$R_B = \frac{5 - 0.7}{0.000111} = 38703.8\Omega$

$R_B$ =39KΩ was selected due to availability in the market.

### 3.10. DOOR CONTROL UNIT

The arrangement of the circuit as below is the actuator part, which uses the BC547 transistors to enable the actual door control to open and close due to the movement of the motor clockwise and anticlockwise when a visitor arrives.

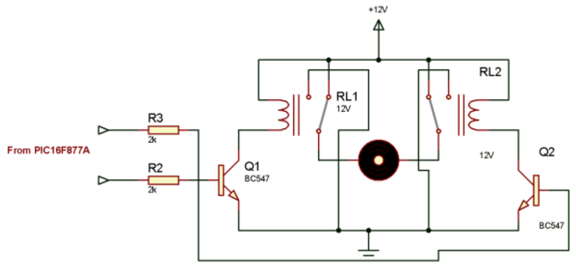


**Figure 3.10: Door control circuit**

## 3.11. ALARMING UNIT

This unit is employed for alarming. When the limit is exceeded, it will sound an alarm. As shown in the figure below.

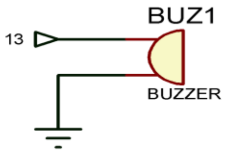


**Figure 3.11. Alarming unit**

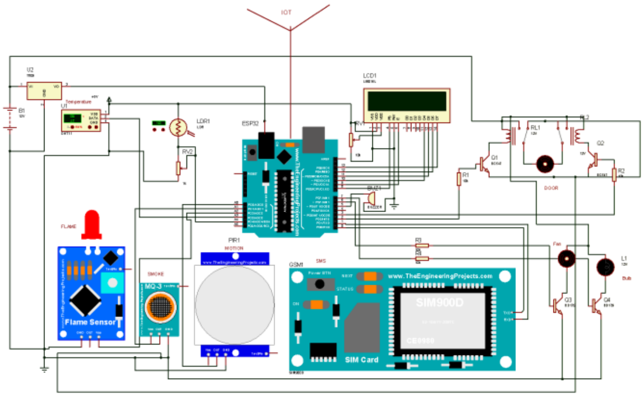


**Figure: 3.12: Complete interfacing of the whole system**

## IV. RESULTS OBTAINED

The images below show the results obtained from the implemented circuit.

Figure 4.1: Implementation of the Circuit


Figure 4.2: The display of project title on the LCD


Figure 4.3: The display of the system status


Figure 4.4: The Passive Infrared Sensor that is used to detect motion, if there is an intrusion labeled D.

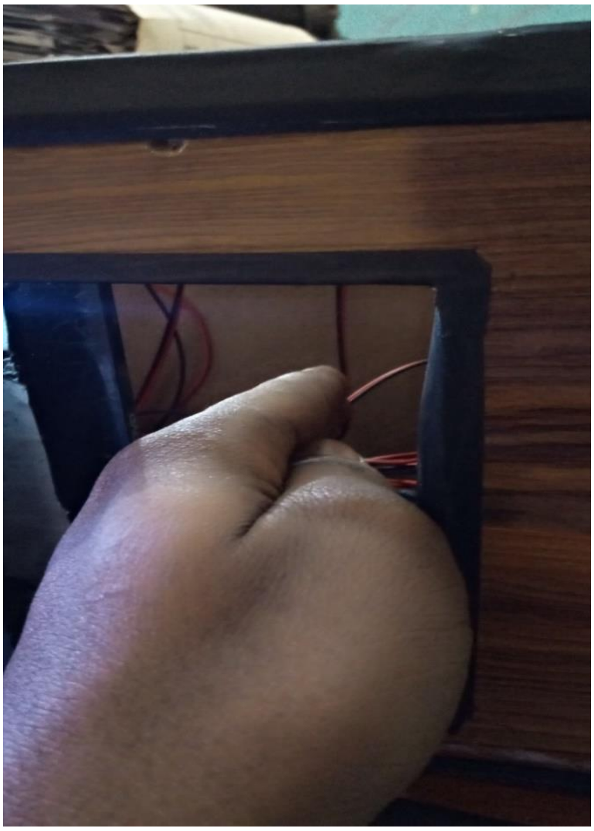

Figure 4.5: The Process of entering the door

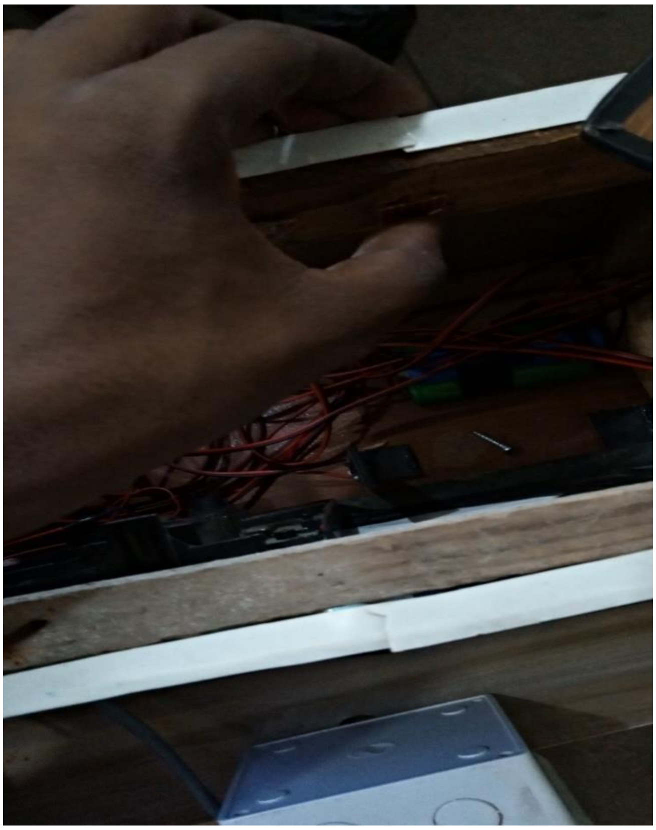

Figure 4.6(a): The process of pressing exit button from the house

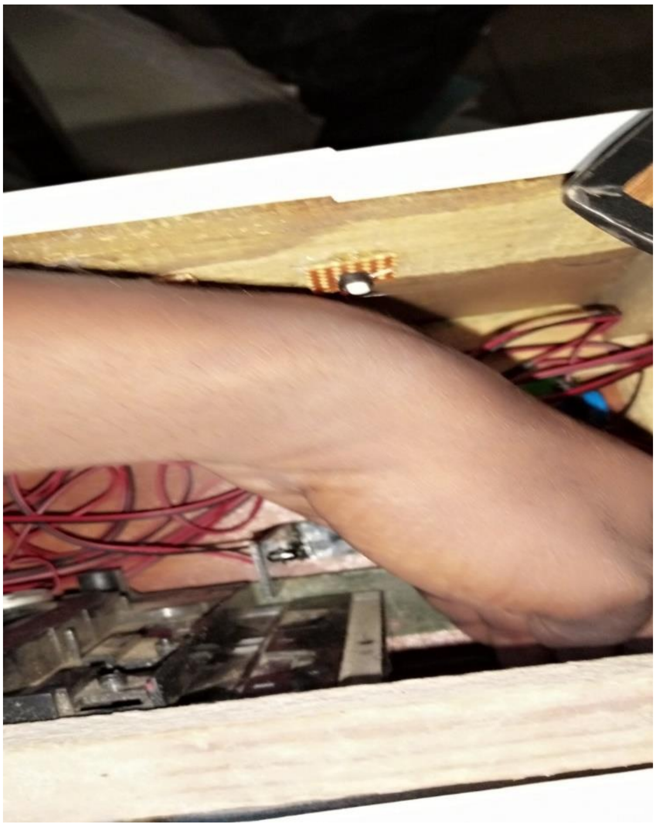

Figure 4.6(b): The process of leaving the house through the door

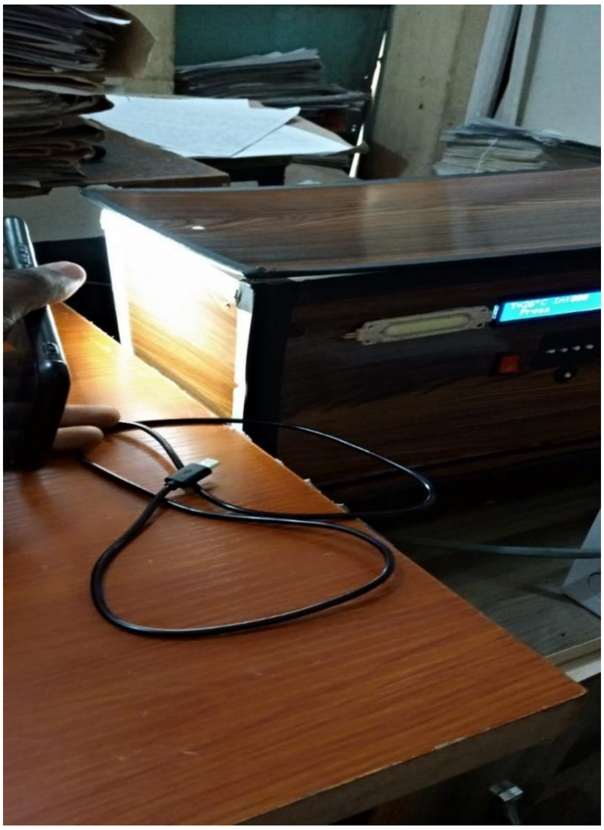

Figure 4.7: The outside LDR that is used to control the front light of the house

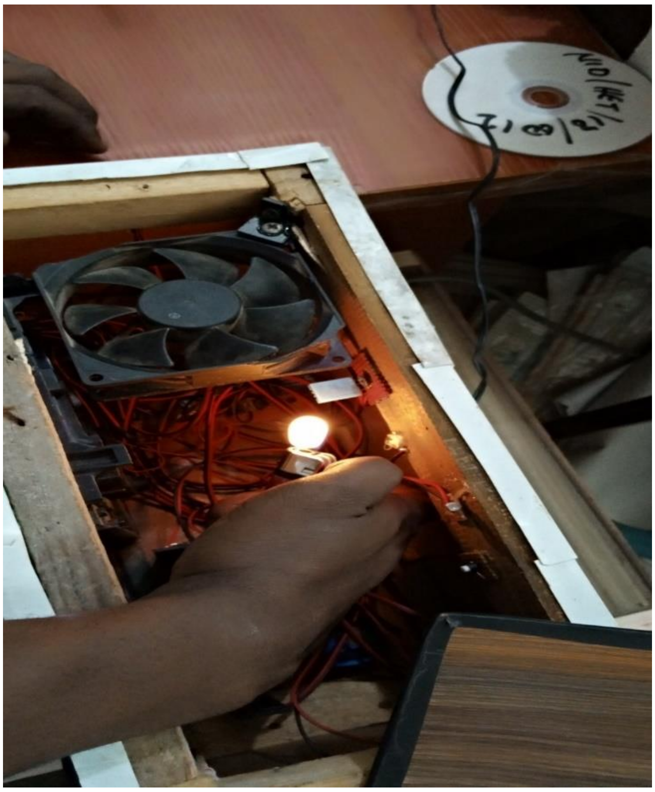

Figure 4.8: The DHT-11 sensor that is used to monitor the temperature/humidity of the house


Figure 4.9(a): The system sending message as a SMS and IoT


Figure 4.9(b): Motion detected with the help of PIR sensor used


Figure 4.9(c): Results of the detection detected

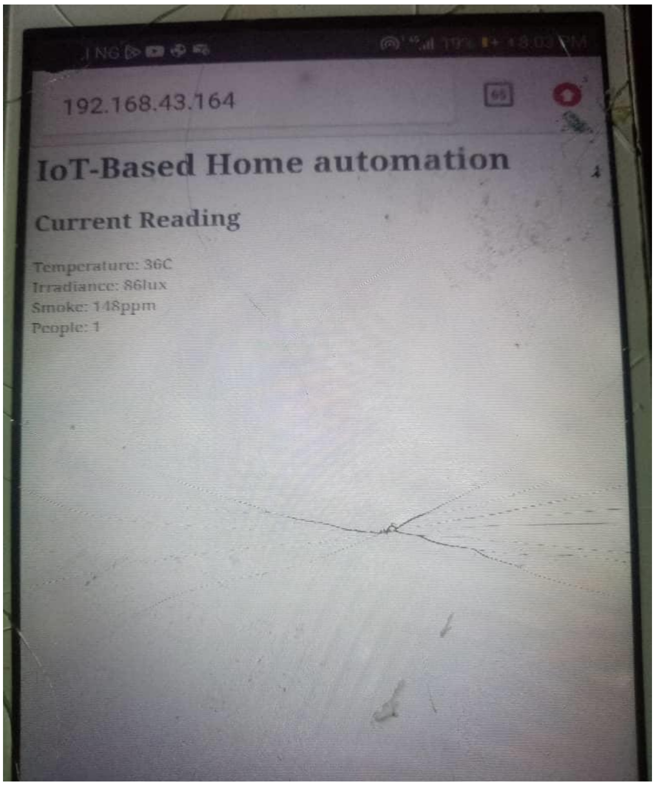


Figure 4.9(d): Results of the IoT from the Smart Phone

## V. CONCLUSION

A smart home's primary goals are to increase security, decrease energy consumption, and provide greater comfort for its residents. The goal of this project was to develop a framework for low-cost smart home automation. A smart gate door controller's two main functions are to provide security and control who is allowed entry into the home.

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