CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF ELECTRICAL ENGINEERING

Department of Microelectronics

Master Thesis

IoT based Smart Home

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Prague, 2020

MASTER'S THESIS ASSIGNMENT

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Specialisation: **Electronics**

II. Master's thesis details

Master's thesis title in English:

IoT based Smart Home

Master's thesis title in Czech:

IoT based Smart Home

Guidelines:

1. Discuss the possibilities of using ESP32 and ESP8266 using Wi-Fi to provide basic control applications of smart house and security system.
2. Design a simple Home Automition system to provide the following functions: Turn light on / off, Turn air condisonor / Air Cooler / Fan on / off, Open / close curtains (blinds) for windows, Lock / un-lock main gate, Turn on / off sprinklers for garden water (grass) and design a simple Security System to provide a folowing functions: Security of Main gate, Fire alarm system, Vehicle theft security, Activation / de-activation of security system. The built in Wifi will allow remote access to system. For this purpose use MQTT protocol and a free MQTT server.
3. Evaluate the parameters of the proposed system and compare it with commercial systems.

Bibliography / sources:

1. Bhatnagar, H. et al, Implementation model of Wi-Fi based Smart Home System. 2018 ICACCE.
2. Khan, A. et al, Design of an IoT smart home system. 2018 L&T.
3. Xiao, Z. et al, Design of Home Appliance Control System in Smart Home based on WiFi IoT. 2018 IAEAC.

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Date of master's thesis assignment: **18.02.2020** Deadline for master's thesis submission: **22.05.2020**

Assignment valid until: **19.02.2022**

prof. Ing. Miroslav Husák, CSc.	prof. Ing. Pavel Hazdra, CSc.	prof. Mgr. Petr Páta, Ph.D.
Supervisor's signature	Head of department's signature	Dean's signature

III. Assignment receipt

The student acknowledges that the master's thesis is an individual work. The student must produce his thesis without the assistance of others, with the exception of provided consultations. Within the master's thesis, the author must state the names of consultants and include a list of references.

.	
Date of assignment receipt	Student's signature

Declaration:

I hereby declare that I have completed this thesis independently and that I have used only the sources (literature and webpages) listed in the enclosed bibliography.

Date Signature

Acknowledgment:

I want to thank my supervisor, prof. Ing. Husák Miroslav, CSc for helping me for making my thesis successful. He was always available whenever I stuck in some problem. I would also like to thank my parents, family members, and friends for their moral support.

Abstract:

With the advancement of Internet of Things, Smart Home automation system is in high demand. People are so busy in their life, so everyone wants to do their work in a smarter and less time-consuming way. This Master Thesis deals with the designing of the IoT based Smart Home System. In the theoretical part of the thesis basics of IoT, Smart Home and the research is done on the IoT based Smart Some System. After that comparison between few commercial products is done. In the practical part of the thesis, an IoT based Smart Home model is designed using ESP8266 and ESP32. An IoT platform Ubidots is used for the control and monitoring of sensors and home appliances. Data transfer between sensor and IoT platform is done using MQTT protocol. Home security system is also included in the practical part. If intrusion occurs, owner will receive the email notification about intrusion.

Keyword: Smart Home, IoT, ESP32, ESP8266, MQTT, Ubidots

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Abbreviations

IoT: Internet of Things

MQTT: Message Queue Telemetry Transport

QoS: Quality of Service

PIR: Passive Infrared Sensor

LED: Light Emitting Diode

IDE: Integrated Development Environment

GPIO: General Purpose Input Output

1 Introduction

In this extremely fast life, everyone is so busy, and it is very difficult and hard to manage everything together. Most of the people are working now a days and they have to manage their office work and home together, with the advancement of IoT technology the developers start focusing on using this technology and make the home which work likes a robot and have secure security system. Every then can me operated and controlled by just a single touch keeping yourself stable at one place.

The Smart home provide better quality living by combining technology and services through a network. The smart home is where all the household functions are automatic which give ease in daily household activities. Smart home technology tends to make every home appliance and devices to act smart and in future era every electronic device and home appliances will be connected to Internet of Things (IoT). IoT is an add-on features of Internet and other network connection connected to different sensors and devices. IoT has potential to collect and share data from its devices to other connected devices [1]. Smart home technology has ability to reduces the workload and it is started being implement in entire house. The main benefits for this technology in a house are security system, ease in lifestyle and power management. As per the data [2] the estimate is shown that the number of smart homes worldwide in 2020 is 174.98 million and expected to reach 375.30 million till 2024. The data of the revenue from the smart home in 2020 is 9096.8 million and the assumption is to reach 158,875.9 million till 2024 [3].

In this thesis the IoT based Smart home prototype is constructed, it has home automation and security features such as: Lock/Unlock Garage shutter, Turn On/Off room lights, Fire alarm system etc. The technology which is used to send and receive data is Wireless Fidelity (Wi-Fi). Wi-Fi allows a user or a device to get connected to a network through radio waves, without taking help of wires [4]. The constructed IoT based Smart home is a demonstration of practical implementation of this technology where the sensor and devices are placed in different parts of the house and connected to the low powered ESP 8266 and ESP 32 which are IoT based microcontrollers. An IoT based platform “Ubidots” is used to control the devices and sensors. The communication between the devices take place through MQTT protocol. MQTT is machine to machine “IoT” connectivity protocol, it is designed as extremely light weight publish/subscribe messaging transport [5].

2 Literature Review

For the construction of the IoT based smart home, many researches took place to find which technologies are used and which is more suitable for constructing the model.

As the need of the smart home is increasing and is on peak the stability is becoming the main factor to focus on. Below are some research work done to build IoT based Smart Home.

Urvi Singh et al. [6] proposed a home automation and security system using ESP 8266 which is controlling home appliances and sensors. It includes interface of hardware and software, in the hardware interface wi-fi technology is used with the blynk application as a software interface. The application used for controlling the devices and sensors can be used on mobile phones, PC's, laptops etc. They used temperature sensor and humidity sensor, flame sensor, ESP 8266 etc. There system was working satisfactory with ESP8266 Wi-Fi module and also their system can also be used for monitoring purpose.

M. Rajasekhar Reddy et al. [7] proposed Voice Controlled Home Automation Using Blynk, IFTTT with Live Feedback. They made a very cost-effective system in which they used Blynk application, blink cloud, IFTTT and google assistance. The data is taken from google assistance and send to the blink application through blink cloud the data is shared with ESP board to perform various functions. The system can be connected with various appliances like Fan, Lights, refrigerator, etc.

Shaam Garg et al. [8] proposed a IoT based home automation system. They used nodemcu board, blynk application, cloud computing, temperature and humidity sensor. They compared Arduino, nodemcu and Raspberry pi and according to them the nodemcu is much better due to its less cost and built in wifi module. Blynk application shows real time data of temperature and humidity and they also added toggle switch to turn on/off room lights and fan. They can control their system from anywhere at any time. Cloud computing is used to save the data and information from sensors to the cloud instead of saving to the hard drive. They added home security feature in their system.

Robert Susany et al. [9] proposed a IoT and remote controlled android based home automation system implemented with Arduino mega 2560, ESP 32 RFID, LED, Fan, PIR sensor, Light sensor, temperature sensor and Flame sensor. They used ESP32 to decide the speed of the fan to maintain the desired temperature in the room.

Md. Sadad Mahamud et al. [10], the authors proposed an IoT based system for smart home automation and power consumption monitoring with ESP 32. They developed a custom-made private home web server based on OSI model of network architecture from which they can monitor and control home appliances according to their needs. Their system can be upgraded furthermore and, more than one house can be connected to one server.

Vivek Raj et al. [11] proposed a IoT based smart home working with multiple language (English and Malayalam) voice commands via google assistance and a smart door locking/unlocking system. They used ESP 32, Arduino Cam, Blynk application and IFTTT application. In their system they also added

features like controlling home appliances and smart door locking/unlocking system. When somebody arrives in front of door, the Ardu cam mini send the photograph of the person to the user, then user gives command whether to open the door or keep closed. Their system is beneficial for the elderly and physically challenged people who can speak in their own language to get the work done being at one place.

Akram Khan Abdullah et al. [12] proposed an unique IoT based smart home system which can be operated by an application and with IR technology (remote) at the same time very needful system which can allow the people who don't know how to use smartphones or tablets.. They interfaced the system with the power distribution box, and connected relays with the home appliances to connect or disconnect the device from the main. If their system fails to work even, then the appliances will still able to work with manual switches installed on the walls. The HTML web page is created to controlling and monitoring the devices.

Harsh Vardhan et al. [13] proposed a smart home system using ESP 8266, temperature sensor , Air quality sensor, LPG gas detection sensor and motion. The mobile application is used to monitor the data from the sensor. Their system regulates the temperature of the room by turning ON/OFF air conditioner automatically as per the data captured by the temperature sensor. User will receive a warning notification on mobile if gas sensor detects the leakage of gas.

3 Description and Specifications of devices and components used in the designed model.

3.1 ESP-32S, 2.4GHz Dual-Mode, Wi-Fi + Bluetooth

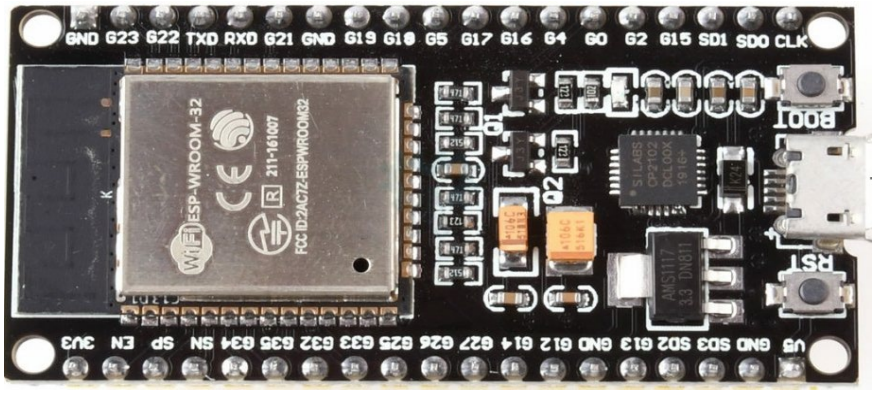

Figure 1: ESP-32S

- Processor
    - The main processor is Tensilica Xtensa 32-bit LX6 microprocessor which is a dual-core

The clock frequency is up to 240MHz

        - Performance is up to 600 DMIPS
    - Ultra-low-power co-processor allows to do ADC conversions, computation, and level thresholds while in deep sleep mode.
- Wireless connectivity:
    - Wi-Fi**:** 802.11 b/g/n
    - Bluetooth**:** v4.2 BR/EDR and Bluetooth Low Energy (BLE)
- Memory
    - Internal memory:
        - ROM: 448 KB used for booting and core functions.
        - SRAM: 520 KB used for data and instruction.
        - RTC fast SRAM: 8 KB used for data storage and main CPU during RTC Boot from the deep-sleep mode.
        - RTC slow SRAM: 8 KB used for co-processor accessing during the deep-sleep mode.
    - Embedded flash: Flash connected internally via IO16, IO17, SD_CMD, SD_CLK, SD_DATA_0, and SD_DATA_1
- Peripheral input/output: Rich peripheral interface with DMA that includes capacitive touch, ADCs, DACs, I²C, UART, CAN 2.0, SPI, I²S, RMII, PWM, and more.

- Security:
    - IEEE 802.11 standard security features all supported, including WFA, WPA/WPA2, and WAPI
    - Secure boot
    - Flash encryption
    - 1024-bit OTP, up to 768-bit for customers
    - Cryptographic hardware acceleration: AES, SHA-2, RSA, elliptic curve cryptography (ECC), random number generator (RNG)

3.2 NodeMcu ESP8266 Lua WIFI V3, CH340

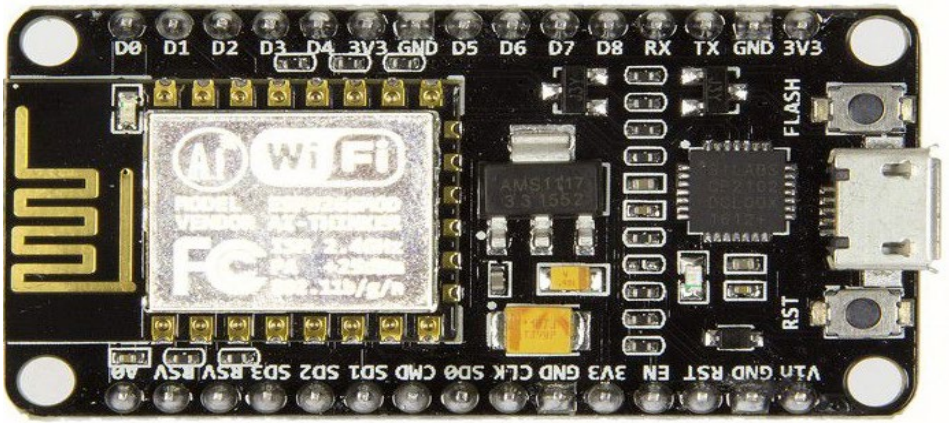

Figure 2: NodeMcu ESP 8266 Lua WIFI V3

- Processor
    - The main processor L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro is a single core.
        - The clock frequency is up to 80 MHz
- Wireless connectivity:
    - Wi-Fi: 802.11 b/g/n
- Memory
    - 32 KiB instruction RAM
    - 32 KiB instruction cache RAM
    - 80 KiB user-data RAM
    - 16 KiB ETS system-data RAM
    - External QSPI flash: up to 16 MB is supported (512 KiB to 4 MB typically included)
- Peripheral input/output: ADCs, I²C, UART, SPI, I²S.

3.3 PIR Sensor Features

Figure 3: PIR Sensor

- Input voltage: Varying from 4V to 12V (+5V recommended)
- The output voltage is High/Low (3.3V TTL)
- It can easily find a difference between Human motion and Object motion
- Has two operating modes
  - Repeatable(H)
  - Non- Repeatable(H)
- Cover the distance of 7 meters and the angle of 120°
- Power consumption: 65mA
- Operating temperature: -20° - +80° Celsius

3.4 HC-SR04 Ultrasonic Sensor

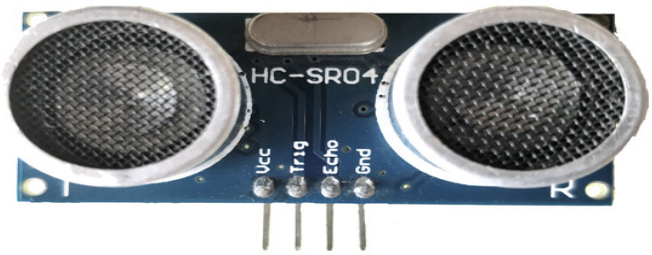

Figure 4: Ultrasonic Sensor HC-SR04

- Operates on 5V
- The theoretical Measuring Distance range is from 2cm to 450cm
- The practical Measuring Distance range is from 2cm to 80cm
- Accuracy is 3mm

- Measuring angle covered: <15°
- Operating Current should not exceed from 15mA
- Operating Frequency is 40Hz

3.5 8-Channel 5V Relay Module

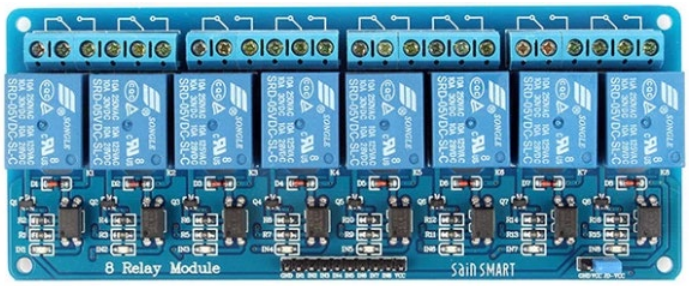

Figure 5: 8-Channel 5V Relay Module

- Operates at 5V known as 8-Channel Relay interface board and each relay needs 15-20mA Driver Current
- High-current relay, AC250V 10A: DC30V 10A each.
- Standard interface that can be controlled directly by microcontroller
- LED's are placed to indicate which Relay is ON

3.6 Magnetic switch LS-311-B38

Figure 6: Magnetic switch LS-311-B38

- Maximum current: 300(mA)
- Maximum Voltage: 20V
- Operating will start when the distance is more than 14mm and not less than 20mm
- Maximum Power: 3W
- Weight (kgs): 0.03KG
- Anti-fire ABS shield

3.7 Water level switch ZP7510

Figure 7: Water level switch ZP7510

- Compact, vertically structured float switch which can be placed on top or bottom of the tank and used to sense the water level in a tank.
- Float diameter: 24mm
- Sensor length: 75mm
- Maximum load: 50 W
- Maximum Switching Voltage: 100V DC
- Maximum Switching Current: 0.5 A
- Operating temperatures: -20 ~ + 80 ° C
- Material: Polymer Plastic

3.8 Water Pump mini ultra-quiet DC 3-6V 120 L/H

Figure 8: Water Pump

- DC voltage: 3-6V
- The maximum lift: 40-110 cm
- Flow rate: 80-120 L / H
- The outer diameter of the runoff: 7.5 mm
- The inner diameter of the water outlet: 4.7 mm
- Diameter: 24 mm
- Length: 45 mm
- Height: 33 mm
- Life of 500 hours

3.9 Buzzer

Figure 9: Buzzer

- Maximum Voltage: 12V
- Beep: Constant tone
- Sound: 95dB
- Frequency: 3.8kHz
- Connector: Wire Terminals
- Dimensions: 23x18mm

3.10 LED

Figure 10: LED

- LED 5mm, Red, 125mcd, 24 ° HLMP-3750

- Diameter: 5 mm
- Light color: Red
- Peak wavelength: 635 nm
- Case transparency: Clear
- Luminous intensity Iv at I: 20 mA
- Housing: T-1 3/4
- Operating Voltage (typical): 1.9 V
- Typical luminance lv: 125 mcd
- Case color: Clear
- Dominant wavelength: 626 nm
- Beam angle:24°
- Max If: 25 mA

- LED 5mm Green, 265mcd, 24 ° HLMP-3950
  - Diameter: 5 mm
  - Light color: Green
  - Peak wavelength: 565 nm
  - Case transparency: Clear
  - Luminous intensity Iv at I: 20 mA
  - Housing: T-1 ¾
  - Operating Voltage (typical): 2,2 V
  - Typical luminance lv: 265 mcd
  - Case color: Clear
  - Dominant wavelength: 569 nm
  - Beam angle: 24°
  - Max If: 25 mA

- LED 5mm, Blue, 3000mcd, 20 ° 520LB7C
  - Diameter: 5 mm
  - Light Colour: Blue
  - Case Transparency: Clear
  - Luminous Intensity Iv at I: 20 mA
  - Housing: T-1 3/4
  - Operating Voltage (typical): 3.3 V
  - Typical Luminance lv: 3000 mcd
  - Case Colour: Clear
  - Dominant Wavelength: 470 nm

- Beam Angle: 20°
- Max If: 30 mA

- LED 5mm, White, 4000mcd, 15 ° SUW50020
  - Diameter: 5 mm
  - Light color: White
  - Case transparency: Clear
  - Luminous intensity Iv at I: 20 mA
  - Housing: T-1 3/4
  - Operating Voltage (typical): 3.5 V
  - Typical luminance lv: 4000 mcd
  - Light temperature: 7500 K
  - Case color: Clear
  - Beam angle: 15°
  - Max If: 25 mA

3.11 Slide Switch

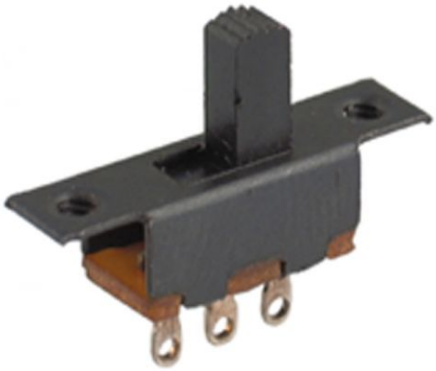

Figure 11: Slide Switch

- Weight; 0.00098 Kg
- Orientation: Direct
- Rated voltage: 125 V
- Contacts: 2
- Rated current: 0.5 A
- Switch positions: IS IS
- Number of poles: 1

4 Construction

4.1 Demonstrated model description:

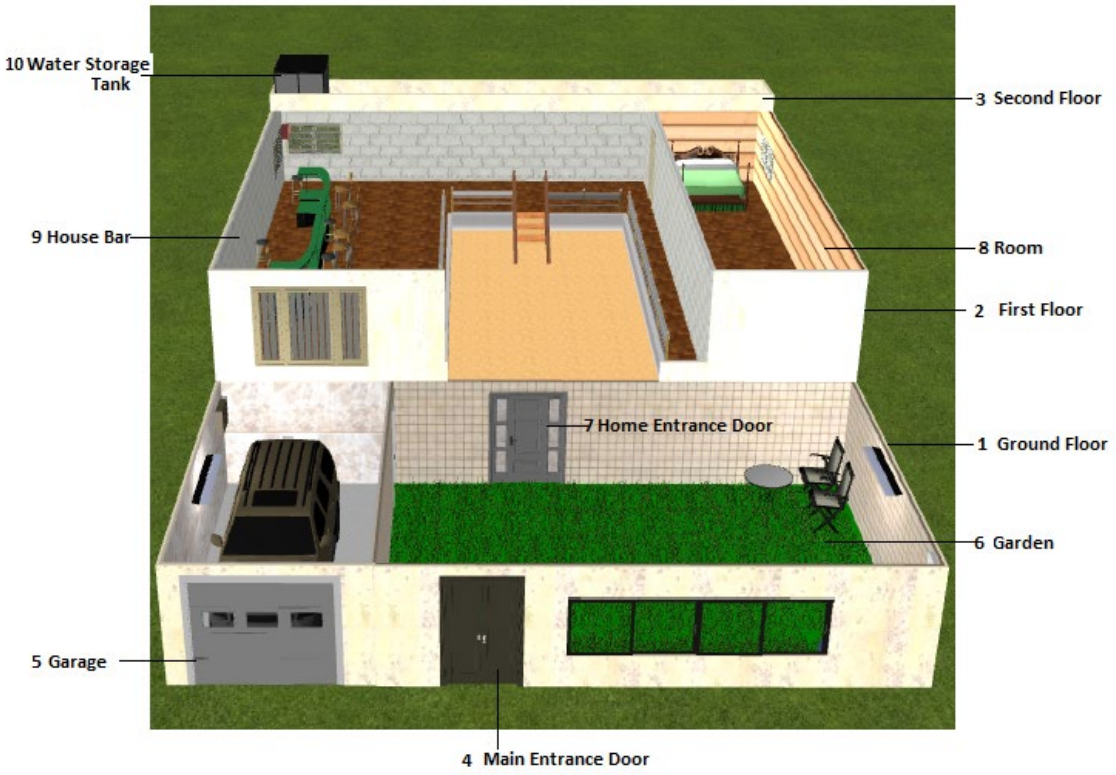

Figure 12: Overview of the model

Figure 12 is the front top tilted view of the model which is been made for a demonstration of the home automation application and this model is a live working example of my thesis topic "IoT based Smart Home"

- For the ease for the explanation of the IoT based Smart Home, the demo of 2 story house is constructed. The house is divided into several parts and in each part automation or security feature takes place. Below is the brief description given of this model: as follows

1. Ground Floor: It contains
    - Main Entrance Door (4): This door is used by people to enter the house area.
    - Garden (6): After entering the house are there is a small house garden.
    - Garage (5): The garage shutter is just next to the 4 Main Entrance Door and there is a door at the end of the garage which joins garage with the house garden area.
    - Home Entrance Door (7): After the garden, there is a door through which entry to the inner house is possible.

2. First Floor: It contains
    - Room (8)
    - House Bar (9)
3. Second Floor:
- Water Storage Tank (10)

4.2 Placement and Connection of the Sensors, Buzzer, and the ESPs Boards:

A. Ground Floor

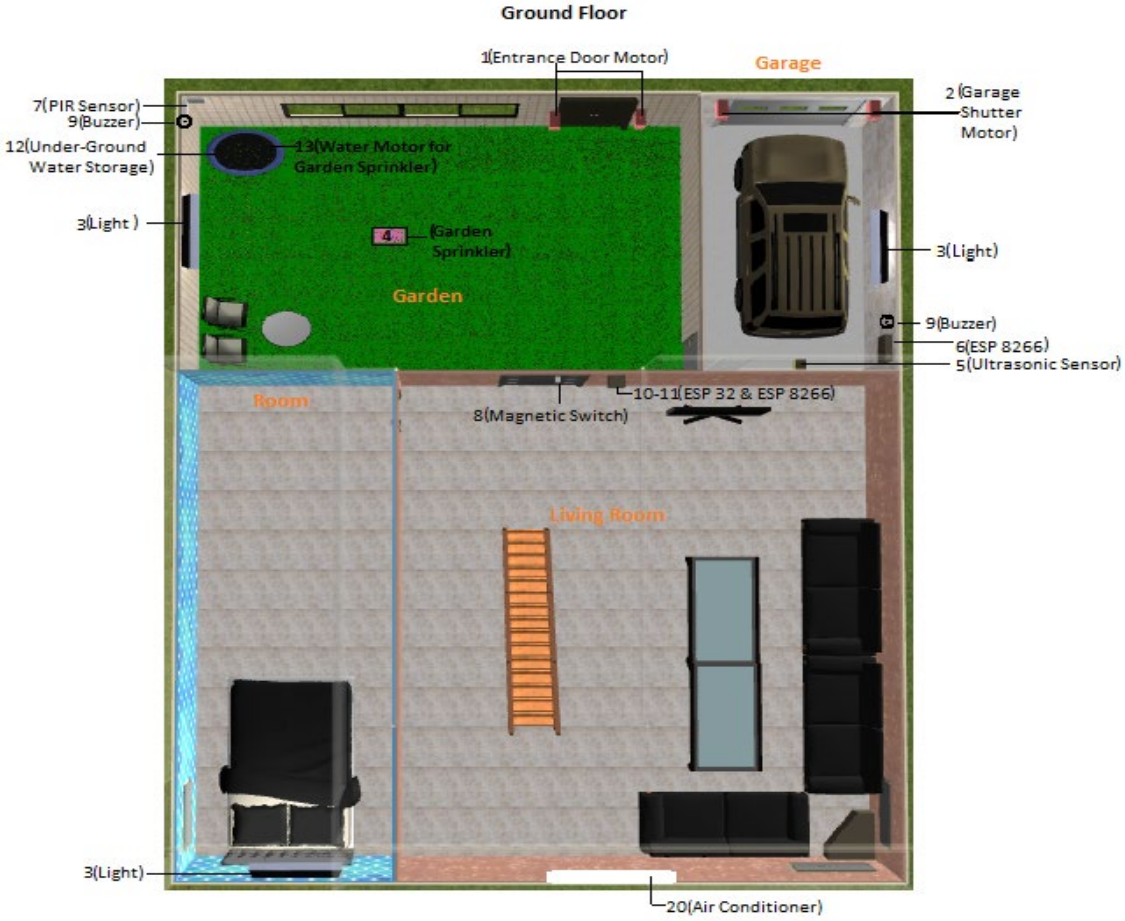

Figure 13: Placement of the electronics devices on Ground Floor

I. Placement of Sensors, Alarm buzzers, and ESP Boards:

This floor is divided into 4 parts

i. Garage

ii. Garden

iii. Living Room

iv. Room

i. Garage: It contains both features of automation as well as security.

The garage shutter door is connected with a Motor labeled as 2 (Garage shutter motor), the motor will act either to lock the garage stutter or to unlock. There is a light labeled as 3 (Light) which turns ON/OFF automatically with the help of the PIR sensor.

The security feature is also installed in the garage, the device used here is an ultrasonic sensor labeled as 5 (Ultrasonic sensor) and for alert buzzer is installed labeled as 9 (Buzzer). The board used for the garage security system is ESP 8266 board labeled as 6 (ESP 8266) which is installed next to the buzzer.

ii. Garden: It also contains both features of automation as well as security.

The entrance door is connected with a Motor labeled as 1 (Entrance door motor), the motor will act either to lock the entrance door or to unlock. There is a light labeled as 3 (Light) which turns ON/OFF automatically with the help of the PIR sensor. There is an underground water storage tank labelled as 12 (Under-Ground Water Storage) in which 2 water motors (water pumps) are placed, one water pump motor is used for lifting the water to the top floor where another water tank is placed to supply water in the house and the second water pump motor is used in watering the grass through water sprinkler labelled as 4 (Garden Sprinkler). The garden pump motors are labeled as 13 (Water Motor for Garden Sprinkler)

The security feature is also installed which secure the garden are as well as the main house door, the device used here is a PIR sensor labeled as 7 (PIR sensor) and for alert, a buzzer is installed labeled as 9 (Buzzer) which is installed next to the PIR sensor.

iii. Living Room: The Home entrance door (living room door) has a security feature.

The Magnetic switch labeled as 8 (Magnetic Switch) is installed on the door, the wired side of the magnetic switch is installed on the fixed side of the door and the wireless part of magnetic switch is installed on the moving part of the door but it should be installed in that way that when the door is close then both the parts of the magnetic switch should connect properly so that it can work efficiently.

There are 2 ESP boards which are ESP 32 and ESP 8266 are placed on the same wall of the door it is labeled as 10-11 (ESP 32 & ESP 8266).

The lights of the living room are automatic which works with the help of the PIR sensor.

There is an air conditioner labeled as 20 (Air Conditioner) which can turn ON/OFF wirelessly

iv. Room: This place just has lights automatic feature which works with the help of the PIR sensor. Light is labeled as 3 (Light).

II. Connection of sensor, devices, and boards:

a. Garage Security:

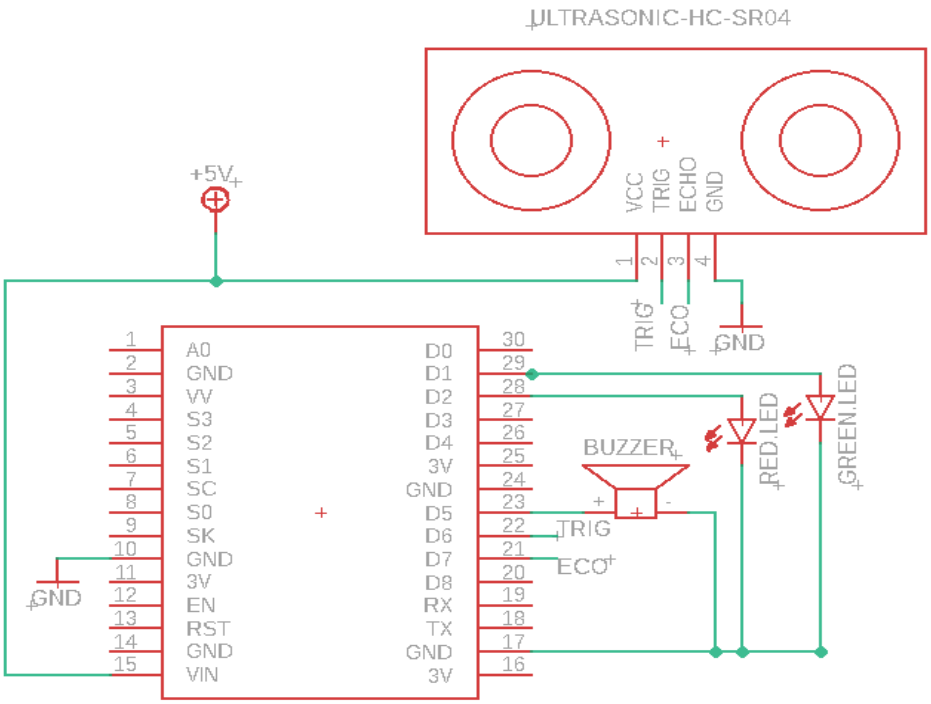

Figure 14: Schematic of ESP 8266 with Ultrasonic Sensor, Buzzer and Indication LED's

Following are the connections with the pin number:

- 5 (Ultrasonic sensor): In Table 1 the connection is shown between Ultrasonic Sensor and ESP 8266

Table 1: Connection of Ultrasonic Sensor with ESP 8266

Ultrasonic sensor	ESP 8266
Pin (1): VCC	Pin (15): VIN
Pin (2): TRIG	Pin (22): D6
Pin (3): ECHO	Pin (21): D7
Pin (4): GND	Pin (10): GND

- 9 (Buzzer): In Table 2 the connection is shown between Buzzer and ESP 8266

Table 2: Connection of Buzzer with ESP 8266

Buzzer	ESP 8266
Wire 1 (+ ve)	Pin (23): D5
Wire 2 (- ve)	Pin (17): GND

- Indication LED's: In Table 3 the connection is shown between Indication LED's and ESP 8266

Table 3: Connection of Indication LED's with ESP 8266

LED (RED)	ESP 8266 (RED)	LED (GREEN)	ESP 8266 (GREEN)
Anode (+)	Pin (28): D2	Anode (+)	Pin (29): D1
Cathode (-)	Pin (17): GND	Cathode (-)	Pin (17): GND

b. Home Entrance Door Security:

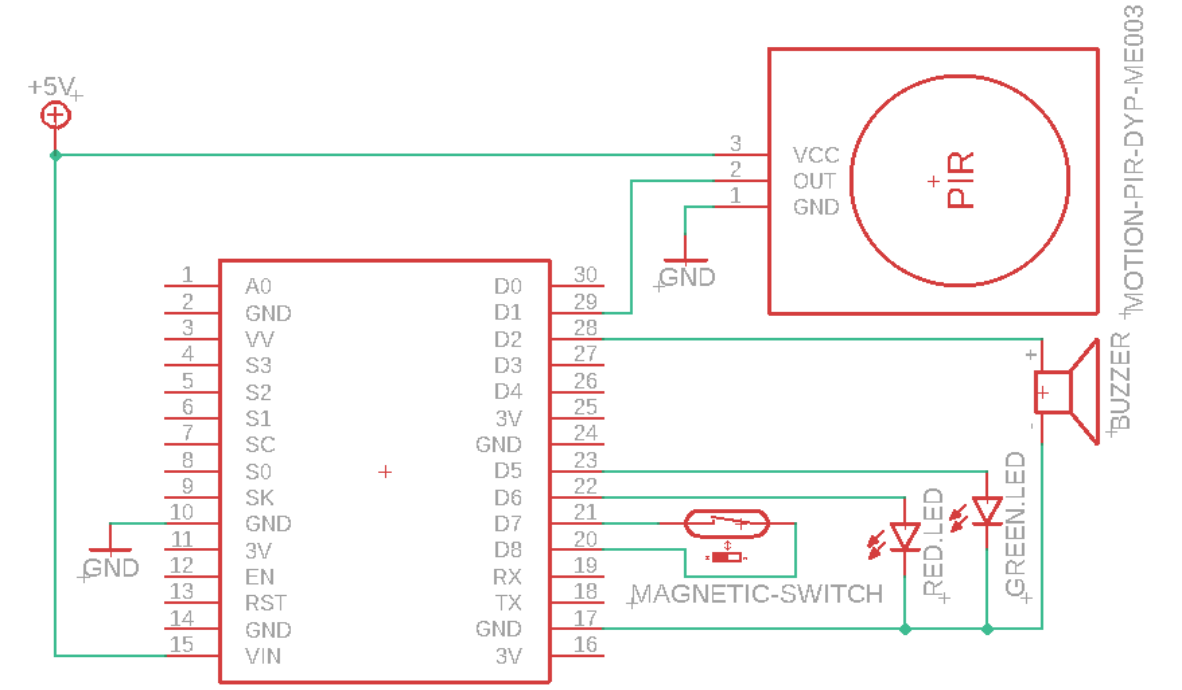

Figure 15: Schematic of ESP 8266 with PIR Sensor, Magnetic Switch, Buzzer and LEDs

Following are the connections with the pin number:

- 7 (PIR Sensor): In Table 4 the connection is shown between PIR Sensor and ESP 8266

Table 4: Connection of PIR Sensor with ESP 8266

PIR Sensor	ESP 8266
Pin (1): GND	Pin (10): GND
Pin (2): OUT	Pin (29): D1
Pin (3): VCC	Pin (15): VIN

- 9 (Buzzer): In Table 5 the connection is shown between Buzzer and ESP 8266

Table 5: Connection of Buzzer with ESP 8266

Buzzer	ESP 8266
Wire 1 (+ ve)	Pin (28): D2
Wire 2 (- ve)	Pin (17): GND

- Indication LED's: In Table 6 the connection is shown between Indication LED's and ESP 8266

Table 6: Connection of Indication LED's with ESP 8266

LED (RED)	ESP 8266 (RED)	LED (GREEN)	ESP 8266 (GREEN)
Anode (+)	Pin (22): D6	Anode (+)	Pin (23): D5
Cathode (-)	Pin (17): GND	Cathode (-)	Pin (17): GND

- 8 (Magnetic Switch): In Table 7 the connection is shown between Magnetic Switch and ESP 8266

Table 7: Connection of Magnetic Switch with ESP 8266

Magnetic Switch	ESP 8266
Wire 1	Pin (21): D7
Wire 2	Pin (20): D8

c. Home Automation applications:

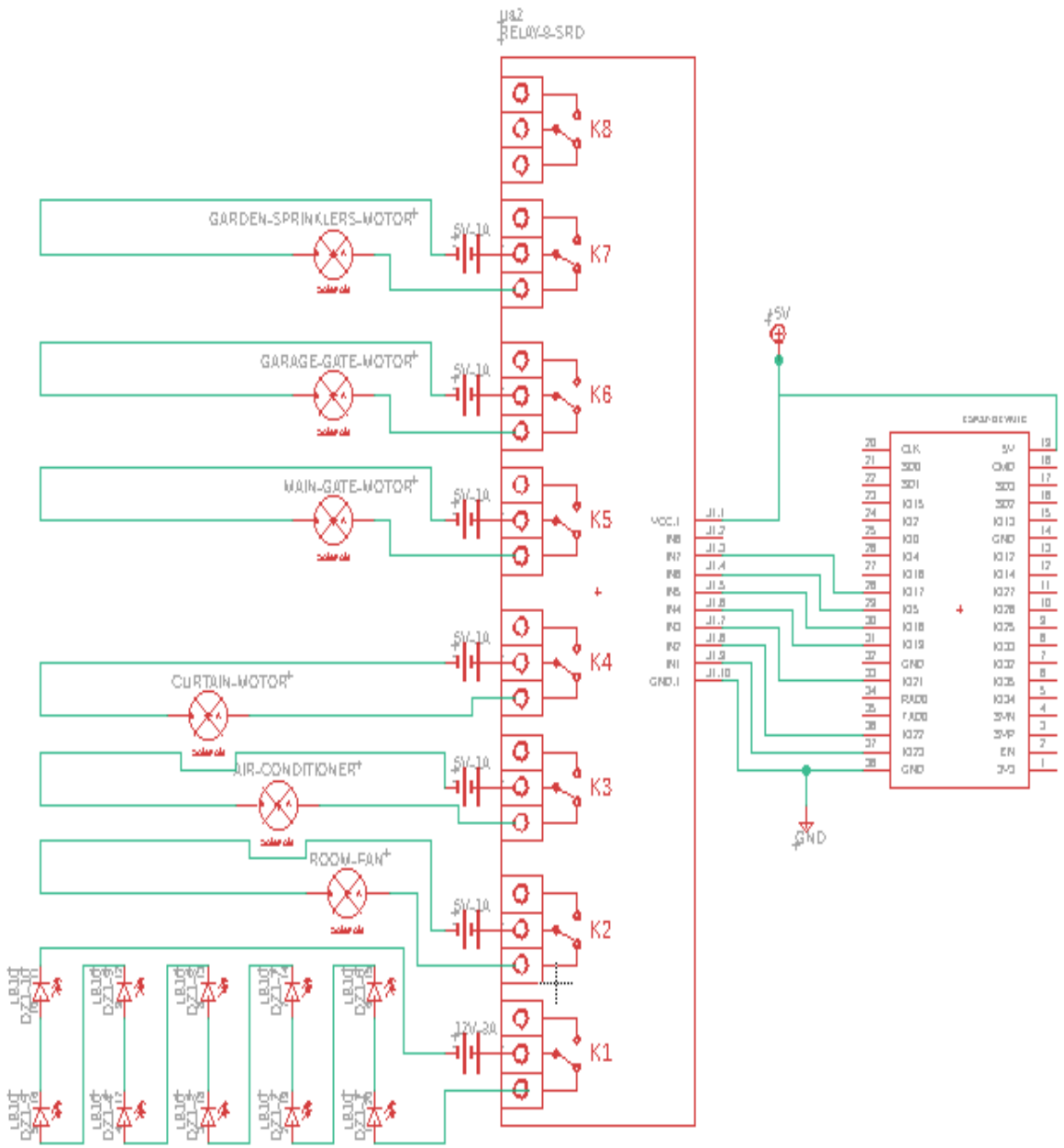

Figure 16: Schematic of ESP 32 with Relay bank, Motor and LED's

a. Garage Shutter (Ground Floor):

The 2 (Garage Shutter Motor) is connected to the 6th channel "K6" of the relay bank, the normal AC motor can be used but at present for the demonstration, DC motor is used connected with 5V battery. This function will work with respect to the operation of ESP 32.

b. Main Entrance Door (Ground Floor):

- The 1 (Main Entrance Door Motor) is connected to the 5th channel "K5" of the relay bank, the normal AC motor can be used but at present for the demonstration, DC motor is used connected with 5V battery. This function will work with respect to the operation of ESP 32.

c. Garden Sprinkle (Ground Floor):

- The 4 (Garden Sprinkle Motor) is connected to the 7th channel "K7" of the relay bank, the normal AC motor can be used but at present for the demonstration, DC motor is used connected with 5V battery. This function will work with respect to the operation of ESP 32.

d. Air Conditioner (Ground Floor):

- The 20 (Air Conditioner) is connected to the 3rd channel "K3" of the relay bank, the normal AC air conditioner can be used but at present for the demonstration, DC motor is used connected with 5V battery. This function will work with respect to the operation of ESP 32.

e. Room Fan (First Floor):

- The 21 (Room Fan) is connected to the 2nd channel "K2" of the relay bank, the normal room fan can be used but at present for the demonstration, DC motor is used connected with 5V battery. This function will work with respect to the operation of ESP 32.

f. Window Blinds (First Floor):

- The 14 (Window Blinds Motor) is connected to the 4th channel "K4" of the relay bank, the normal room fan can be used but at present for the demonstration, DC motor is used connected with 5V battery. This function will work with respect to the operation of ESP 32.

g. Lights (Complete Premises):

- All the lights of the house 3 (Lights) are connected to the 1st channel "K1" of the relay bank, the normal AC light can be used but at present for the demonstration LED's bulbs are used connected with 5V battery. This function will work with respect to the operation of ESP 32.

Following are the connections of devices and equipment:

Table 8: Connection of electronics devices with the relay bank and ESP 32

Function	Channel	Relay Input	ESP 32 Pin-out
VCC	-	VCC.1	Pin (19): 5V
Garage Shutter	K6	IN1	Pin (29): IO5
Main Entrance Door	K5	IN5	Pin (30): IO18
Garden Sprinkle	K7	IN7	Pin (28): IO17
Air Conditioner	K3	IN3	Pin (33): IO21
Room Fan	K2	IN2	Pin (36): IO22
Window Blinds	K4	IN4	Pin (31): IO19
Lights	K1	IN1	Pin (37): IO23
GND	-	GND.1	Pin (38): GND

B. First Floor

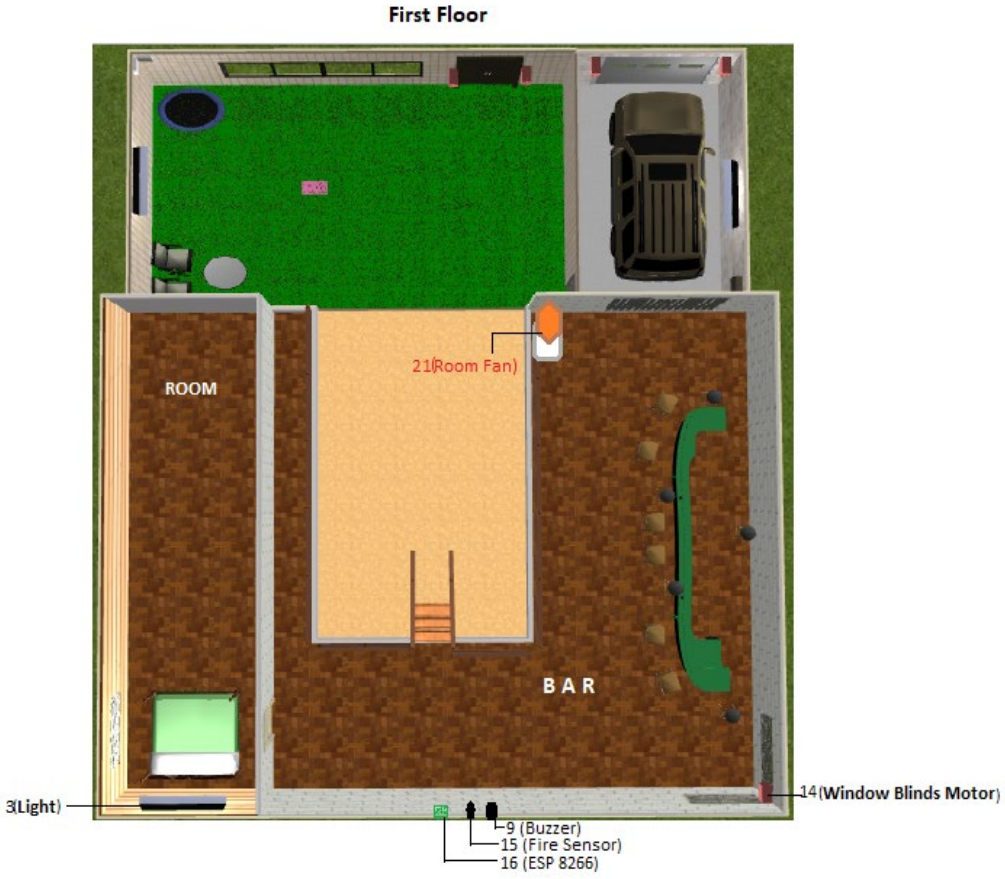

Figure 17: Placement of the electronics devices on First Floor

I. Placement of Sensors, Alarm buzzers, and ESP Boards:

This floor has in total of 3 features of automation and home safety.

i. ROOM: The lights are automatic which works with the help of the PIR sensor the light of the room is labeled as 3 (Light).

ii. BAR:

a. There is a fire detect sensor is installed for the safety labeled as 15 (Fire Sensor), for alert buzzer is installed next to the fire detect sensor labeled as 9 (Buzzer) and the ESP 8266 bord is also installed next to the fire detect sensor labeled as 16 (ESP 8266).

b. The blinds in the bar are automatic, the blinds are connecter to a motor labeled as 14 (Window Blinds Motor). The motor will work to act either to open the blinds or close.

c. The light in the BAR is also automatic which works with the help of the PIR sensor.

II. Connection of sensor, devices, and boards:

a. Fire Alarm System

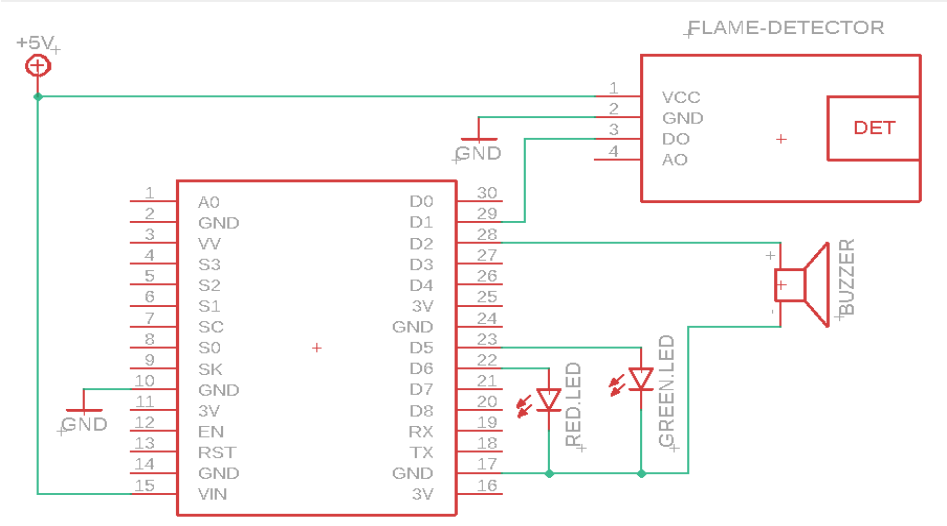

Figure 18: Schematic of ESP 8266 with Flame sensor, Buzzer and Indication LED's

Following are the connections with the pin number:

- 15 (Fire Sensor): In Table 9 the connection is shown between Fire Sensor and ESP 8266

Table 9: Connection of Fire Sensor with ESP 8266

Fire Sensor	ESP 8266
Pin (1): VCC	Pin (15): VIN
Pin (2): GND	Pin (10): GND
Pin (3): DO	Pin (29): DO
Pin (4): AO	NOT CONNECTED

- 9 (Buzzer): In Table 10 the connection is shown between Buzzer and ESP 8266

Table 10: Connection of Buzzer with ESP 8266

Buzzer	ESP 8266
Wire 1 (+ ve)	Pin (28): D2
Wire 2 (- ve)	Pin (17): GND

- Indication LED's: In Table 11 the connection is shown between Indication LED's and ESP 8266

Table 11: Connection of Indication LED's with ESP 8266

LED (RED)	ESP 8266 (RED)	LED (GREEN)	ESP 8266 (GREEN)
Anode (+)	Pin (22): D6	Anode (+)	Pin (23): D5
Cathode (-)	Pin (17): GND	Cathode (-)	Pin (17): GND

C. Second Floor

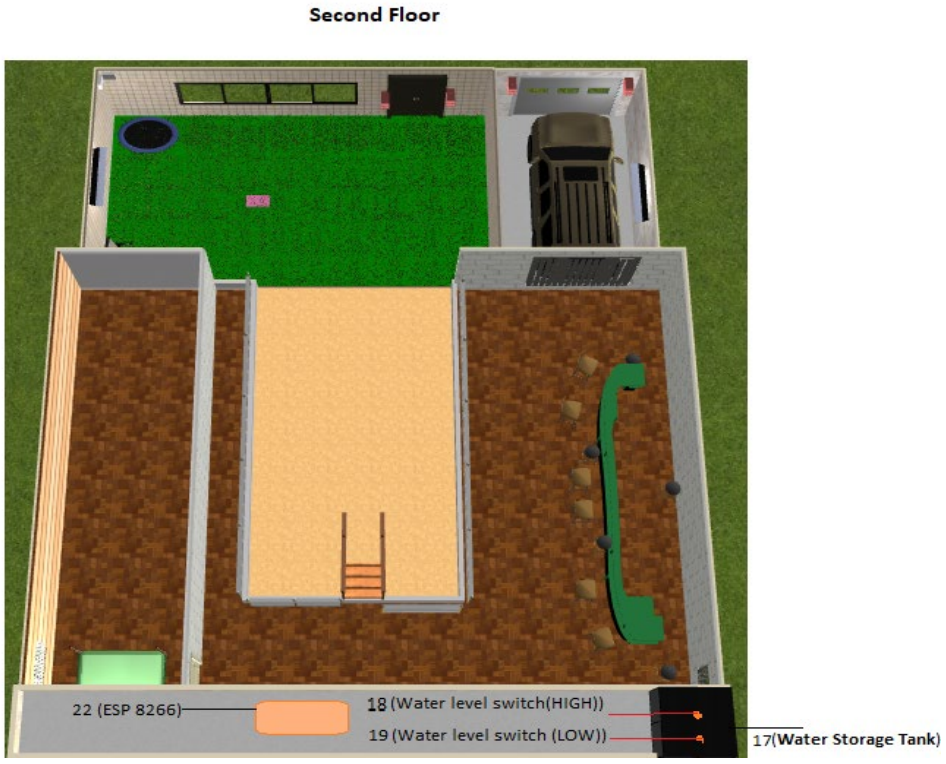

Figure 19: Placement of the electronics devices on Second Floor

I. Placement of Sensors and ESP Boards

There is just a water storage tank on a top of the roof which is filled by a motor labeled as 13 (water motor) placed inside of underground water storage tank labeled as 12 (Under–Ground Water Storage) on the ground floor.

In the 17 (Water Storage Tank) there are water level sensors installed in it labeled as 18 (Water level switch (HIGH)) and 19 (Water level switch (LOW)). There is ESP 8266 installed labeled as 22 (ESP 8266) near to 17 (Water Storage Tank) to control the automatic system of water refilling system.

II. Connection of sensor, devices, and boards:

i. Automatic Water Filling System:

The 4 (Water Motor) is connected to the 8th channel "K8" of the relay bank, the normal AC motor can be used but at present for the demonstration, DC motor is used connected with 5V battery. This function will work with respect to the operation of ESP 8266.

There are two water level switches 18 (Water level switch (HIGH)) & 19 (Water level switch (LOW)) are installed in 17 (Water Storage Tank) which are connected to ESP.

In Figure 20: Schematic of ESP 8266

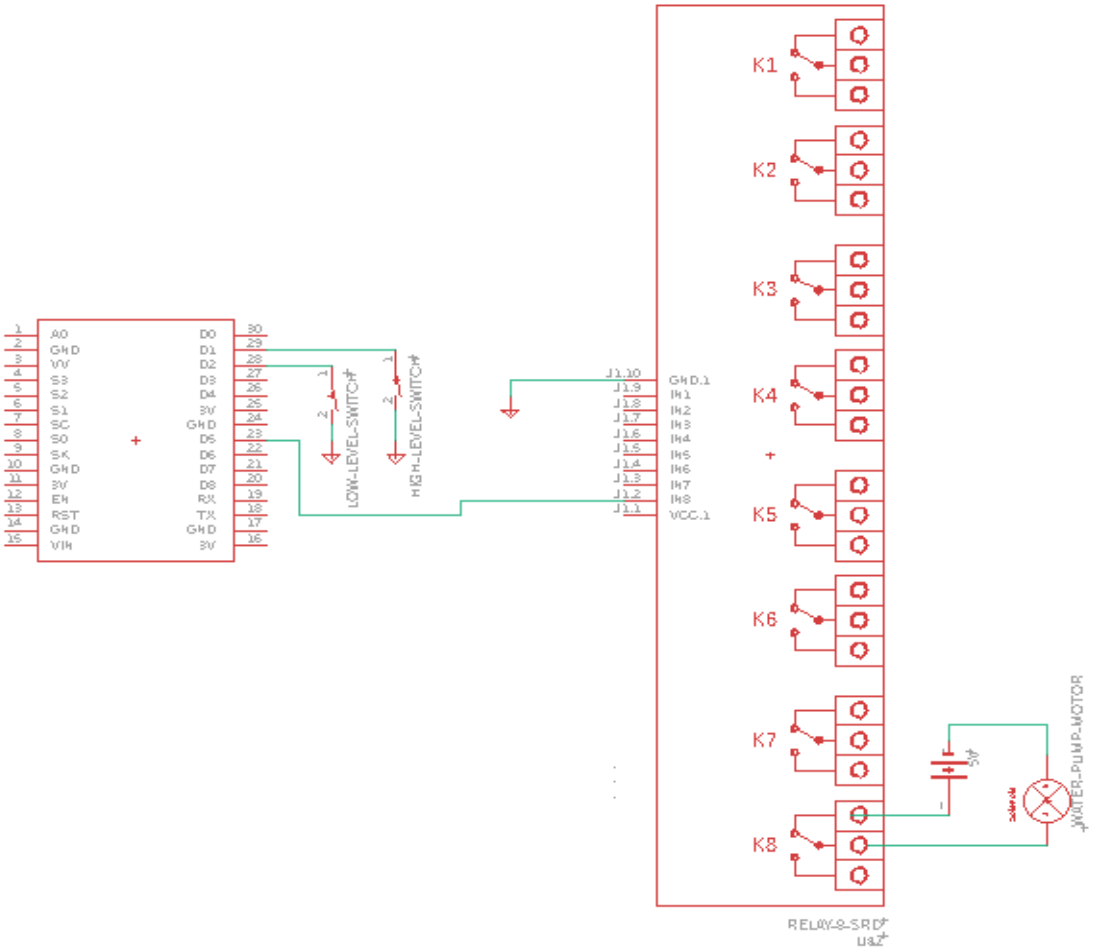

Figure 20: Schematic of ESP 8266 with Water Pump Motor

Following are the connections with the PINs number:

Table 12: Connections of water level switches, relay and ESP 8266

Sensors	Channel	Relay Input	ESP 8266 Pin-out
Water level switch (HIGH) +ve			Pin (29): D1
Water level switch (HIGH) -ve			Pin (17): GND
Water level switch (LOW) +ve			Pin (28): D2
Water level switch (LOW) -ve			Pin (17): GND
Water Motor +ve	K8	IN8	Pin (23): D5

5 Woking

ESP 32 is used to perform all the function of the home automation system and 3 ESP 8266 is used for the home security system and 1 ESP 8266 is used for automatic water tank filling system Ubidots is the platform which is used here to control all the devices, electronic equipment, and home appliances which functions wirelessly sitting anywhere in the globe, it can easily be used from the web or on a mobile phone application. There are many features, so it is divided into two main parts. The working will be described in the parts as follows:

5.1 Home Automation System

```
19:17:06.211 -> Wait for WiFi....
19:17:06.726 -> WiFi Connected
19:17:06.726 -> IP address:
19:17:06.726 -> 192.168.43.173
19:17:06.726 -> Attempting MQTT connection...
19:17:07.352 -> Connected
19:17:07.558 -> Message arrived on topic: /v1.6/devices/general-control-system/room-lights/lv. Message: 0
19:17:07.558 -> Turning room lights off
19:17:07.793 -> Message arrived on topic: /v1.6/devices/general-control-system/room-lights-auto/lv. Message: 0
19:17:07.793 -> Turning room lights auto off
19:17:07.793 -> Message arrived on topic: /v1.6/devices/general-control-system/room-fan/lv. Message: 0
19:17:07.793 -> Turning room fan off
19:17:07.793 -> Message arrived on topic: /v1.6/devices/general-control-system/room-air-con/lv. Message: 0
19:17:07.793 -> Turning room air con off
19:17:07.793 -> Message arrived on topic: /v1.6/devices/general-control-system/room-curtains/lv. Message: 0
19:17:07.793 -> Room curtains close
19:17:07.793 -> Message arrived on topic: /v1.6/devices/general-control-system/main-gate/lv. Message: 0
19:17:07.793 -> Main gate unlock
19:17:09.218 -> Message arrived on topic: /v1.6/devices/general-control-system/garage-shutter/lv. Message: 0
19:17:09.218 -> Garage Shutter close
19:17:09.218 -> Message arrived on topic: /v1.6/devices/general-control-system/garden-sprinkler-system/lv. Message: 0
19:17:09.218 -> Turning garden sprinkler system off
19:17:09.218 -> Message arrived on topic: /v1.6/devices/home-safety-systems/motion-detected/lv. Message: 0
19:17:09.218 -> motion detected no
```

Figure 21: Serial monitor of ESP 32 when system is turned ON

For the demonstrated model, Figure 22 dashboard is created in Ubidots to access all the functions of the home automation system as well as the home security system.

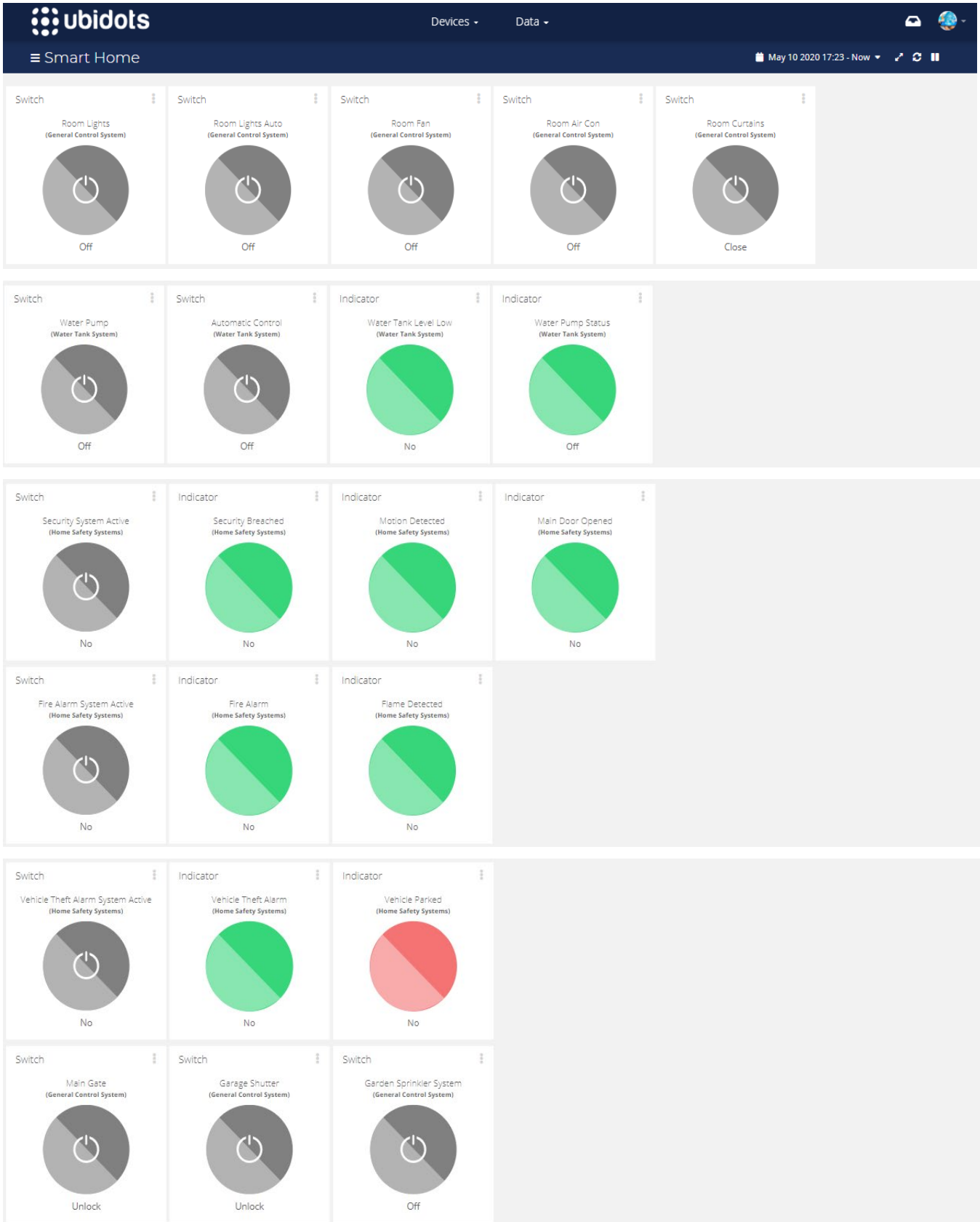

Figure 22: Dashboard "Ubidots"

A. Turning ON/OFF Room lights:

i. There are 2 switches installed in Ubidots Dashboard as shown in **Figure** 23. The first switch name “Room Lights” has a function as a manual ON/OFF switch at present both the switches are in the OFF state. The Room Lights switch is turned ON for turning on the lights Figure 24.

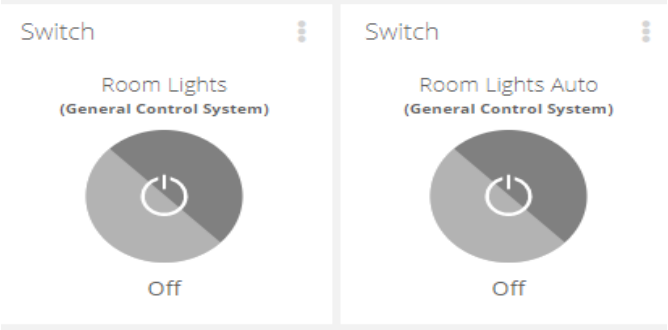

Figure 23: Room light and Room light auto control switches

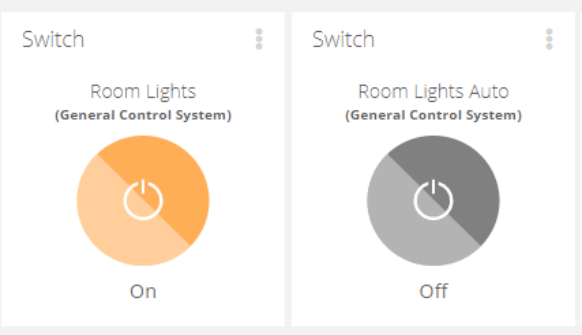

Figure 24: Room light switch is in ON state and Room light auto switch is in OFF state

Below is the flow diagram to explain the working clearly:

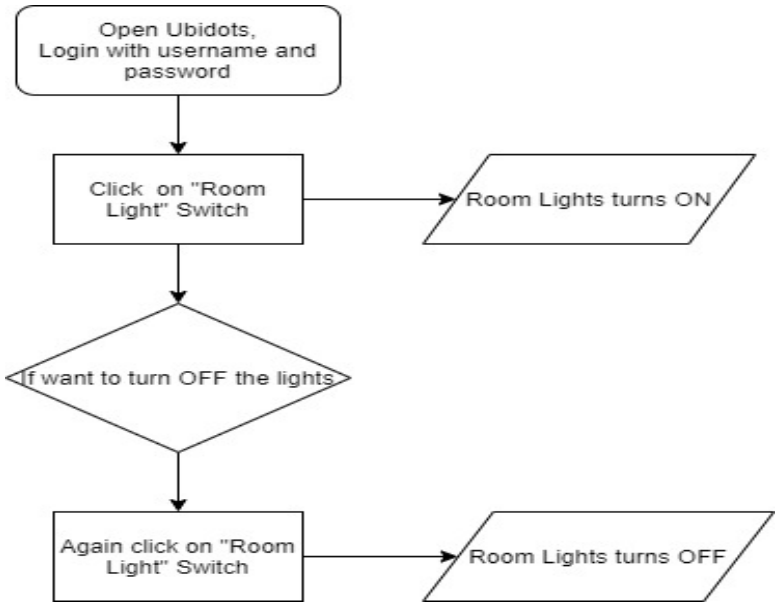

Figure 25: Working of room lights manually

ii. The second switch name “Room Lights Auto” has the function to turn ON/OFF lights automatically with the help of the PIR sensor. For demonstration, all the lights in the house are kept common when the PIR sensor sense some movement it turns on the relay results it turns on the lights. It will work only in one condition when the switch named “Room Lights” is in the OFF state as shown in Figure 26.

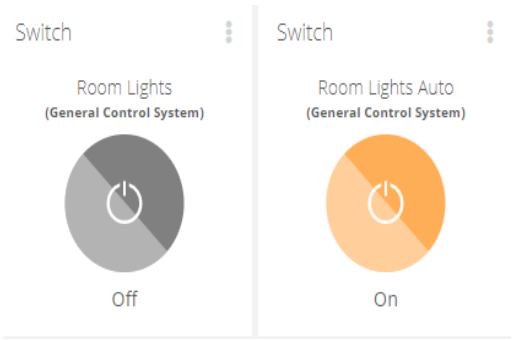

Figure 26: Room light switch is in OFF state and Room light auto switch is in ON state

Below is the flow diagram to explain the working clearly:

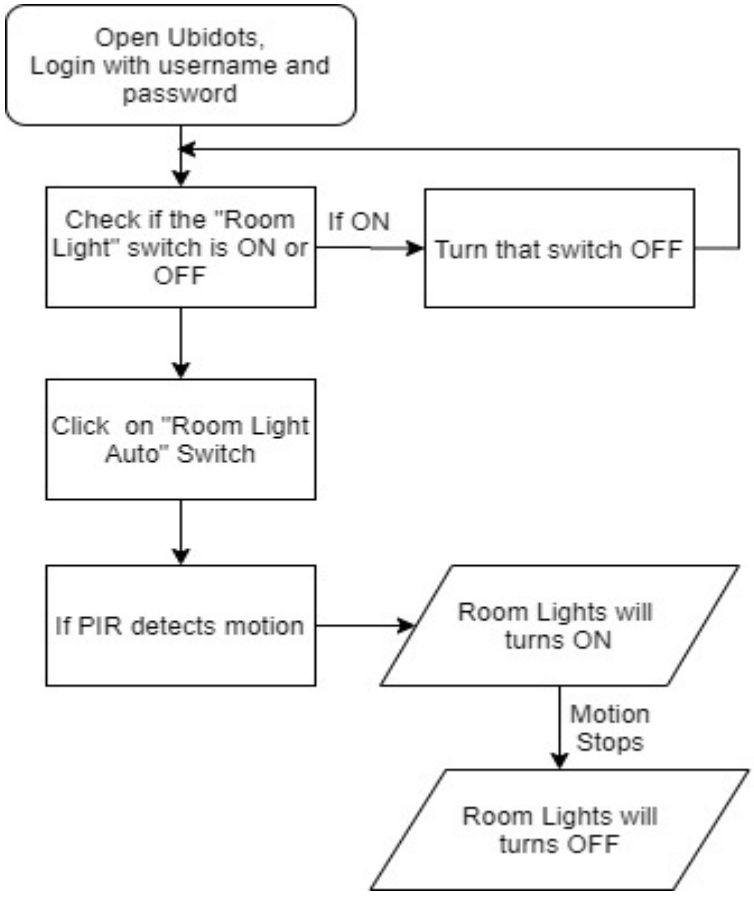

Figure 27: Working of room lights automatic system

B. Turning ON/OFF room fan:

i. This feature provides the control (ON/OFF) of room fan wirelessly below in Figure 28 is the switch installed in the ubidots dashboard.

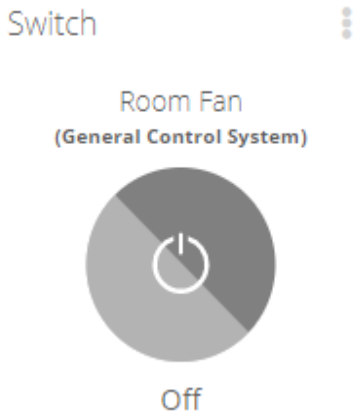

Figure 28: Room Fan control switch

Below is the flow diagram to explain the working clearly:

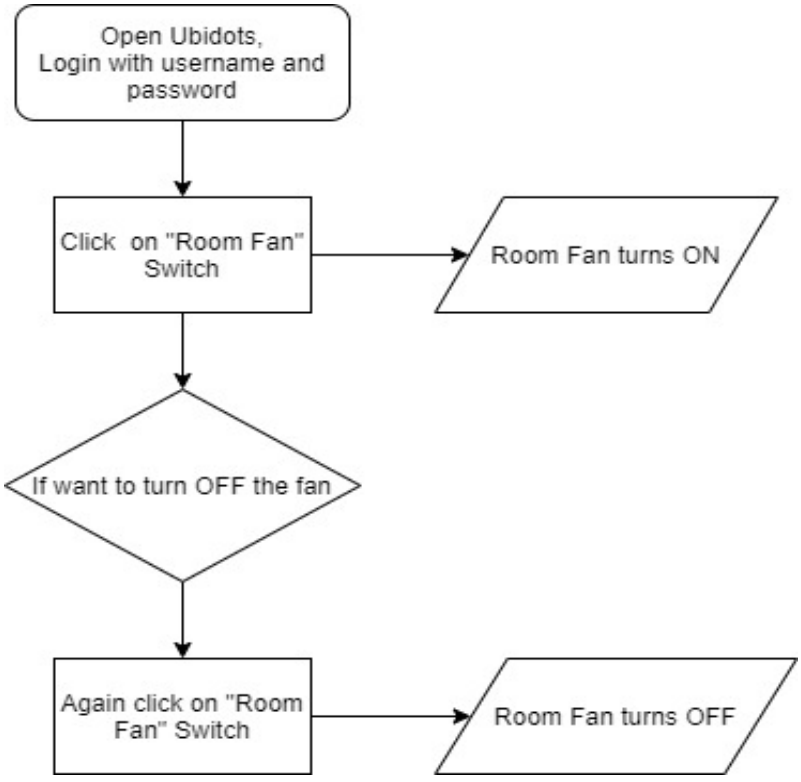

Figure 29: Working of turning ON/OFF room fan automition system

C. Turning ON/OFF Room Air-conditioner:

i. This feature provides to turn ON/OFF room air-conditioner wirelessly, below in Figure 30 is the switch installed in ubidots dashboard.

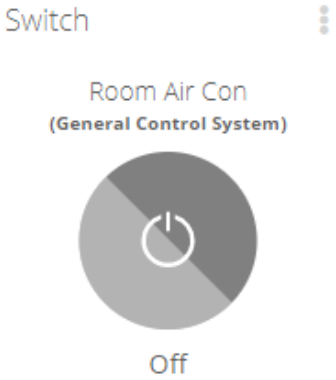

Figure 30: Room Air-conditiner control switch

Below is the flow diagram to explain the working clearly:

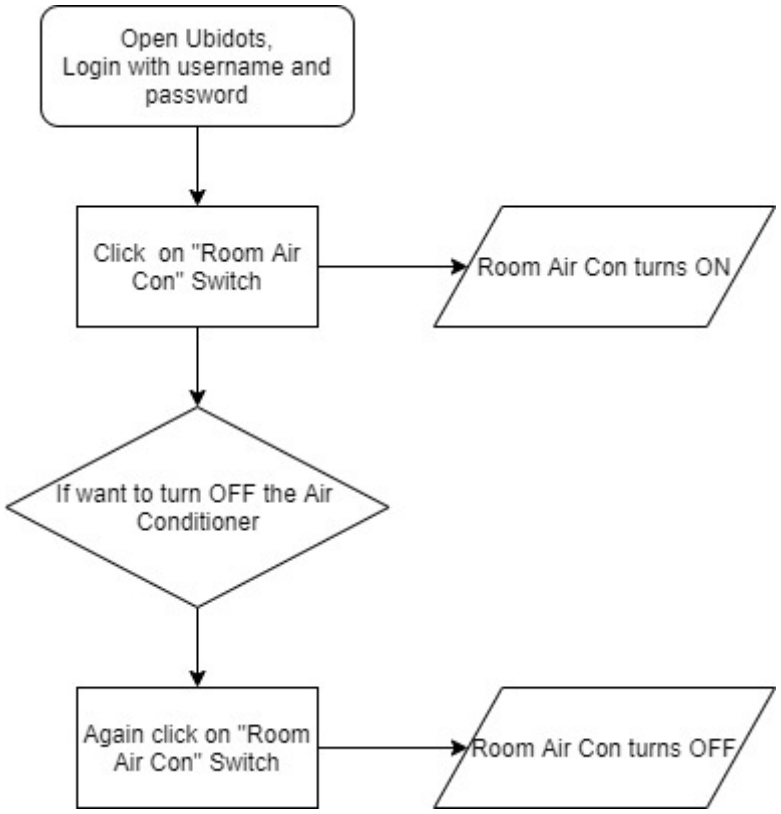

Figure 31: Working of turning Air-conditioner ON/OFF automation system

D. Open/Close Room Curtains:

i. This feature provides to Open/Close room curtains wirelessly, below in Figure 32 is the switch installed in ubidots dashboard.

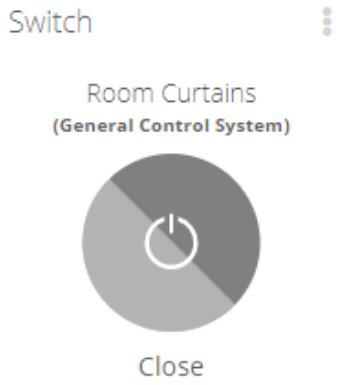

Figure 32: Room Curtains control switch

Below is the flow diagram to explain the working clearly:

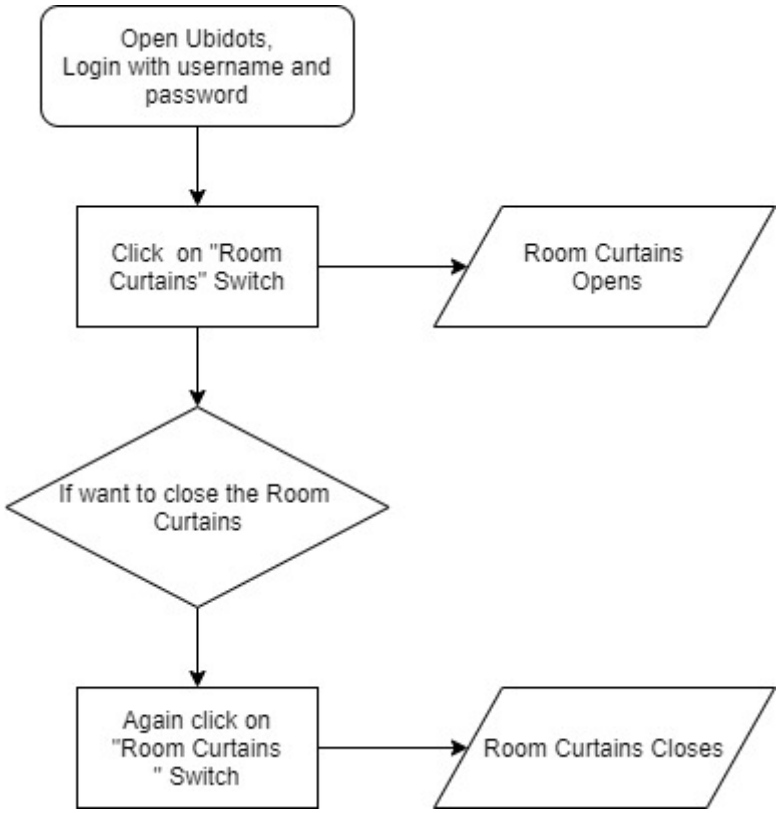

Figure 33: Working of room curtains open/close automation system

E. Lock/Unlock Main Gate:

i. This feature provides to Lock/Unlock Main Gate wirelessly, below in Figure 34 is the switch installed in ubidots dashboard.

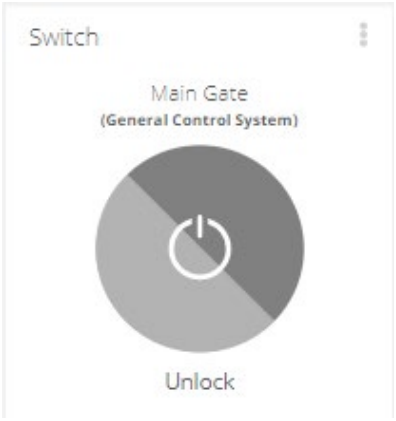

Figure 34: Main Gate control switch

Below is the flow diagram to explain the working clearly:

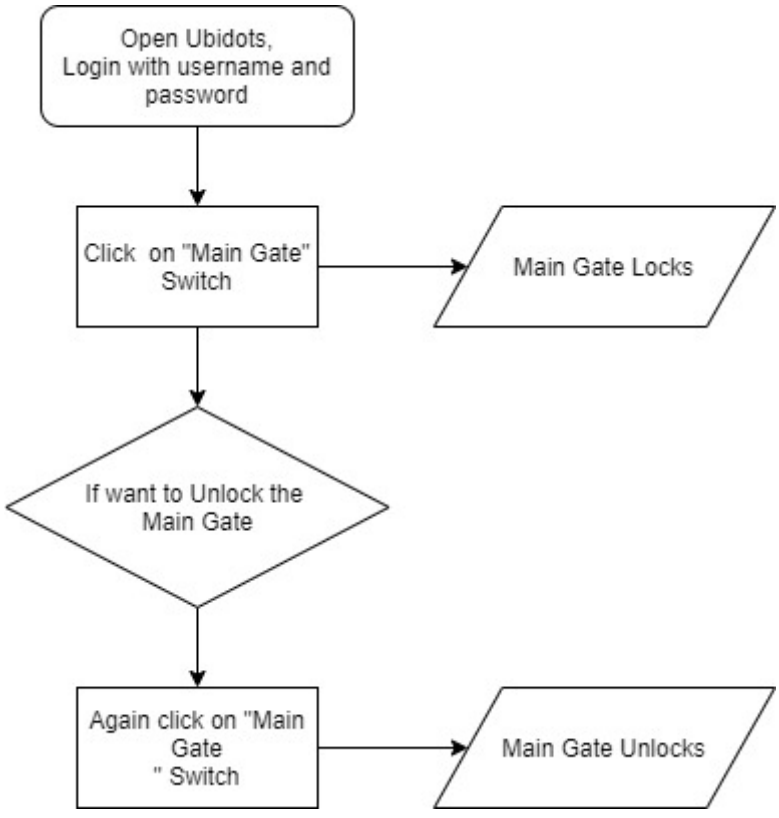

Figure 35: Working of main gate lock/unlock automation system

F. Lock/Close Garage Shutter:

i. This feature provides to Lock/Close Garage Shutter wirelessly, below in Figure 36 is the switch installed in Ubidots dashboard.

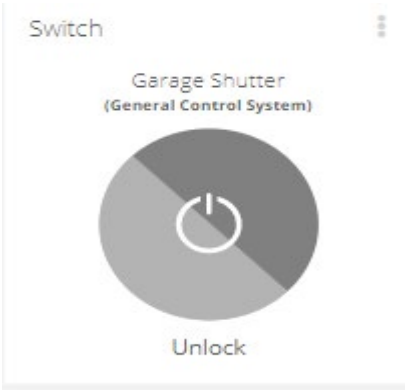

Figure 36: Garage Shutter control switch

Below is the flow diagram to explain the working clearly:

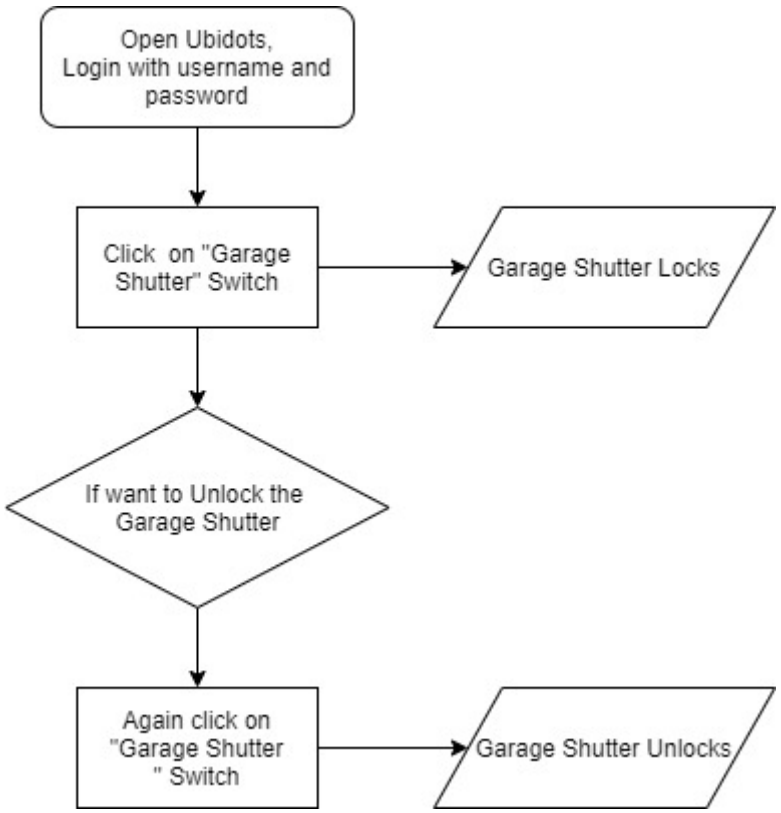

Figure 37: Working of garage shutter lock/unlock automation system

G. Turning ON/OFF Garden Sprinkler System:

i. This feature provides to turn ON/OFF garden sprinkler system wirelessly, below in Figure 38 is the switch installed in ubidots dashboard.

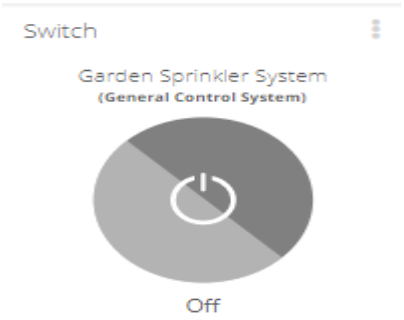

Figure 38: Garden Sprinkler control switch

Below is the flow diagram to explain the working clearly:

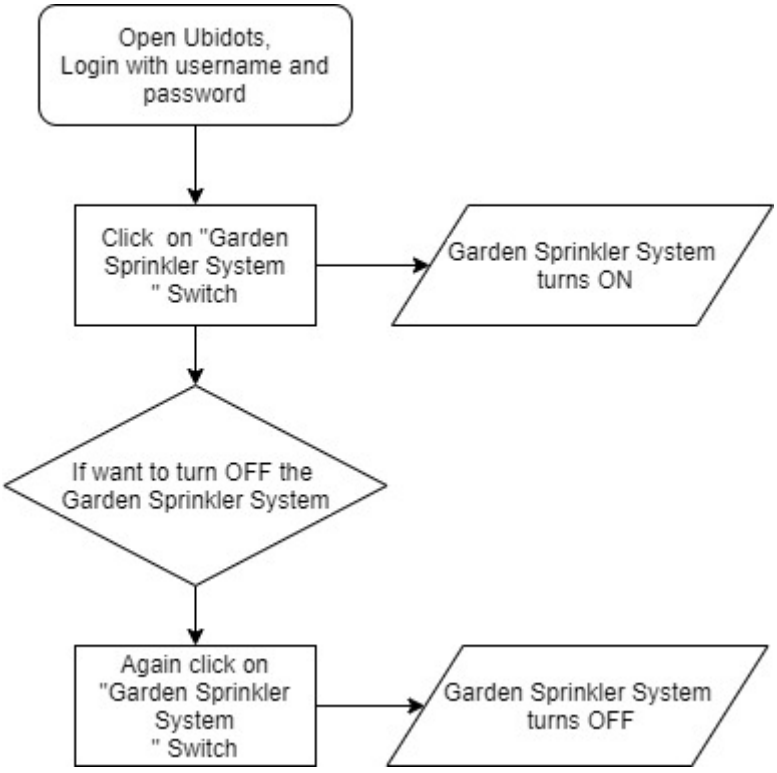

Figure 39: Working of turning ON/OFF garden sprinkler automation system

H. Turning ON/OFF Water Pump:

i. This feature helps to lift water from the underground tank to fill water in the tank which is placed on the top of the house which is used to supply the water inside the house.

- There are two switches to control the water filling feature, the first switch is for the manual control if a person wants to turn ON/OFF the motor according to himself/herself.

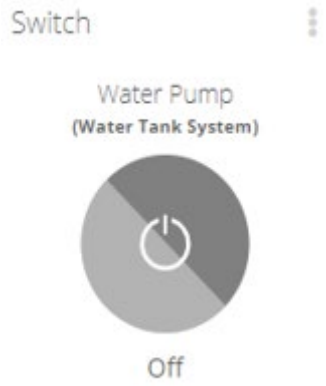

Figure 40: Water Pump control switch (manual)

Below is the flow diagram to explain the working clearly:

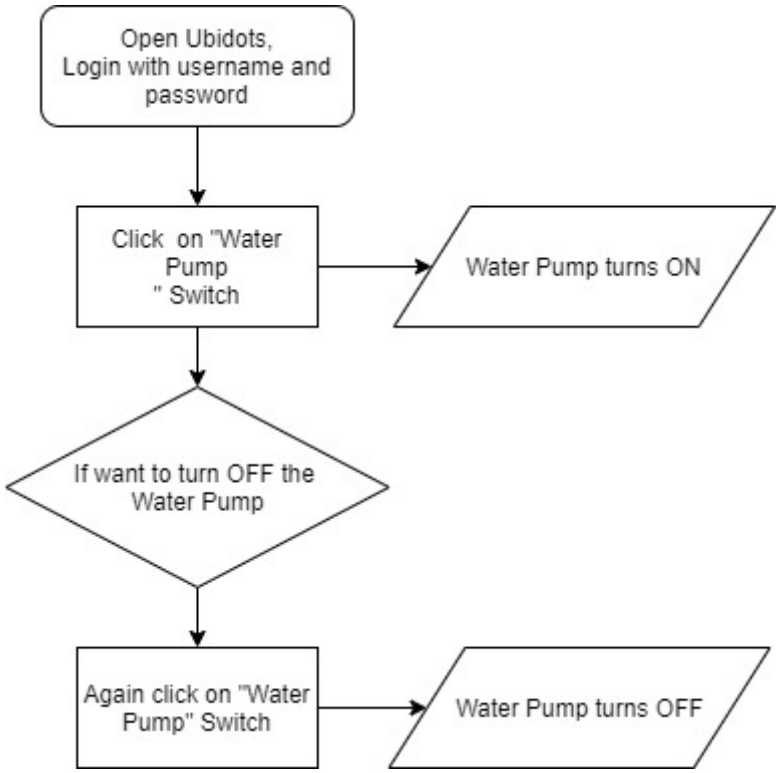

Figure 41: Working of turning ON/OFF Water Pump (manual) system

- The second switch provides automatic control to the water pump motor to turn ON/OFF with the help of a water level switch placed inside the main tank. There are two indicators present in ubidots which gives a live update of water level status and water pump status regardless of Automatic Control Switch is ON or OFF.
- The two water level switches are placed on the different levels, one switch is installed near to the bottom surface of the tank and the second water level switch is installed at the highest required level of the water in the tank as shown in the figure. When both the water level

switches are low, the ESP 8266 will get informed and it turns on the water pump motor to start lifting water from underground tank till the high-level switch inform the water level high to ESP 8266. When the water is been used in the house, the water level starts going down the water pump motor will not start until both the water level switches will give information to ESP8266 that the water level is low.

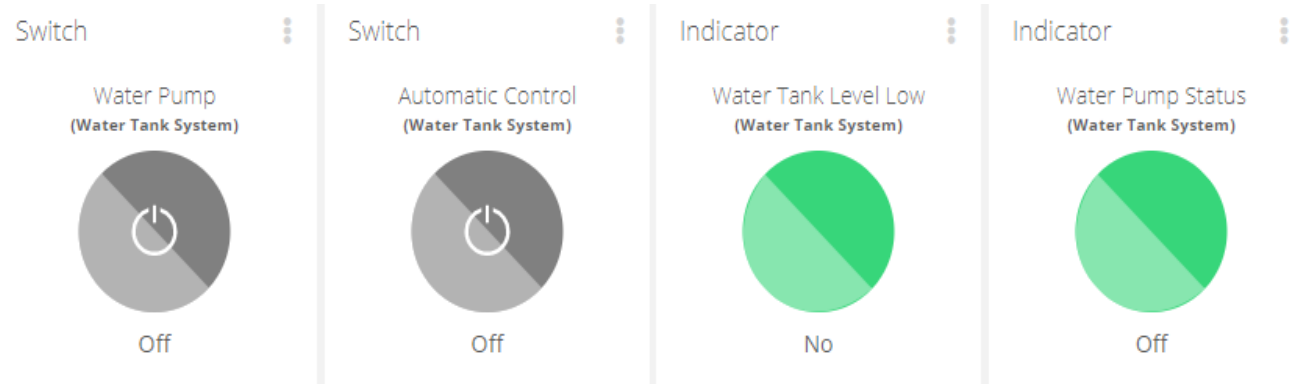

Figure 42: Automatic control water pump switch and indicators

Below is the flow diagram to explain the working clearly:

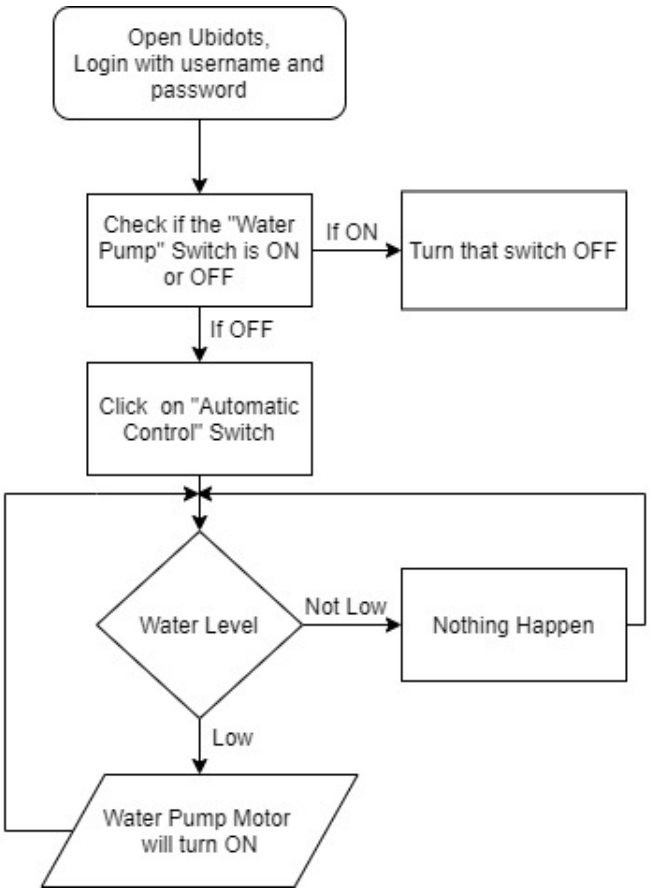

Figure 43: Working of Automatic water pump system

5.2 Home Security System:

A. Home Door Security:

It is high-level security which includes two layers of protection. There are two sensors which are been used for this part of security.

1. PIR sensor
2. Magnetic Switch

In reference to the Figure 13,

The PIR sensor is placed on the edge of the garden wall so that if it someone tries to enter the main door the PIR will detect the intrusion and will trigger the alarm as well as on the other side the email will be sent automatically to the owner.

The second layer is the magnetic switch, which is placed at the home entrance door, if the intrusion get succeed in passing from the range of PIR sensor and tries to enter the house and as soon as the magnetic switch will detect some intrusion it will trigger alarm as well as on the other side the email will be sent automatically to the owner.

Below is the practical working of this system:

In Figure 44 the serial monitor of ESP 8266 “Main Door Security System” is shown.

```
20:16:20.358 -> Wait for WiFi.........
20:16:23.844 -> WiFi Connected
20:16:23.844 -> IP address:
20:16:23.844 -> 192.168.43.151
20:16:23.844 -> Attempting MQTT connection...
20:16:24.187 -> Connected
20:16:24.325 -> Message arrived on topic: /v1.6/devices/home-safety-systems/security-system-active/lv. Message: 0
20:16:24.325 -> Changing Security Alarm State to Inactive
20:20:03.301 -> Message arrived on topic: /v1.6/devices/home-safety-systems/security-system-active/lv. Message: 1
20:20:03.301 -> Changing Security Alarm State to Active
```

Figure 44: Serial Monitor of ESP 8266 “Main Door Security System”

Figure 45 is the Ubidots dashboard which shows that PIR detect the motion and triggers the alarm.

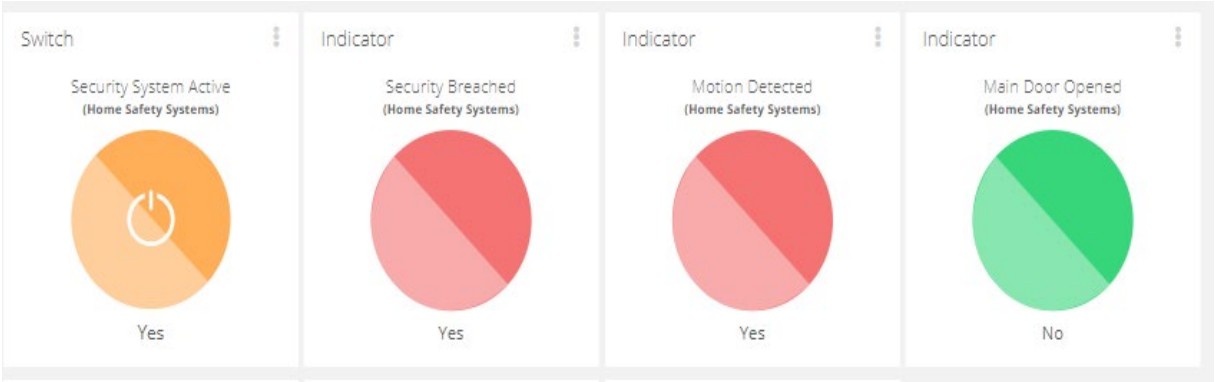

Figure 45: Security System Dashboard” Ubidots”

In Figure 46 serial monitor shows the exact time (8:35 pm) when the motion got detected by PIR sensor

.

```
20:35:26.645 -> Message arrived on topic: /v1.6/devices/home-safety-systems/security-system-active/lv. Message: 0
20:35:26.645 -> Changing Security Alarm State to Inactive
20:35:37.378 -> Message arrived on topic: /v1.6/devices/home-safety-systems/security-system-active/lv. Message: 1
20:35:37.412 -> Changing Security Alarm State to Active
20:35:58.640 -> Motion detected!
20:36:01.050 -> Message arrived on topic: /v1.6/devices/home-safety-systems/security-system-active/lv. Message: 0
20:36:01.050 -> Changing Security Alarm State to Inactive
```

Figure 46: Serial Monitor of Main Door Security System after motion detection

In Figure 47 it is shown that when PIR sensor detected the motion at the same time (8:35 pm) the email was received to the owner.

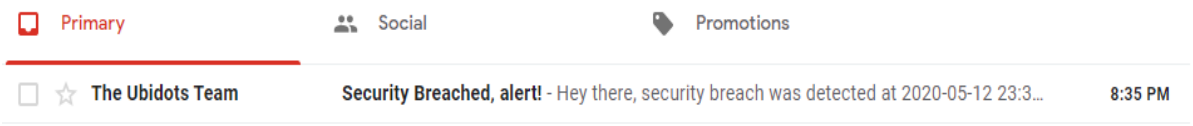

Figure 47: Email regarding house door security alert

Now let us assume that PIR sensor doesn't work or if the intrusion gets succeed in passing from the range of PIR sensor and tries to enter the house.

In Figure 48 it is shown that if PIR did not detected anything but due to an extra layer of security the intrusion when tries to open the main house door the magnetic switch which is installed at the door will detect the intrusion and will triggers the alarm.

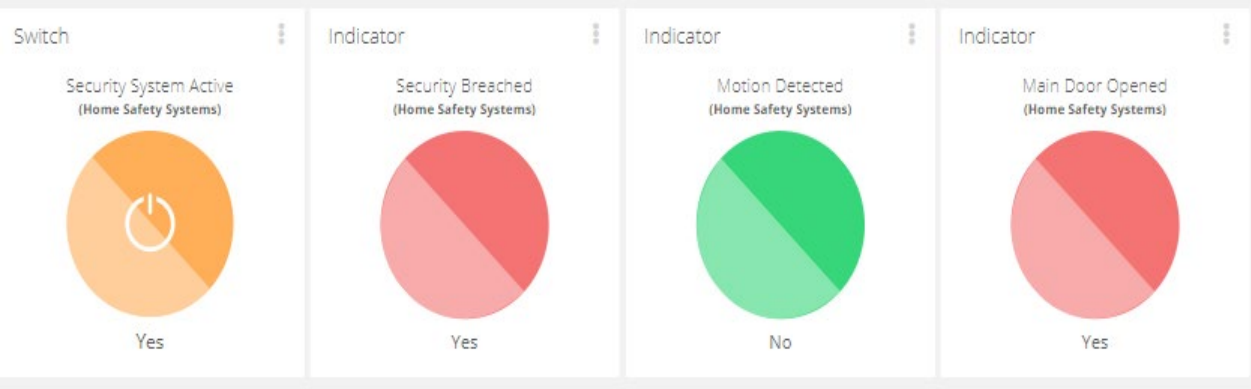

Figure 48: Security System Dashboard" Ubidots"

In Figure 49 serial monitor shows the exact time (8:42 pm) when the magnetic switch detects the door is opened.

```
20:42:24.540 -> Message arrived on topic: /v1.6/devices/home-safety-systems/security-system-active/lv. Message: 1
20:42:24.540 -> Changing Security Alarm State to Active
20:42:28.963 -> Door Opened!
20:42:34.054 -> Message arrived on topic: /v1.6/devices/home-safety-systems/security-system-active/lv. Message: 0
20:42:34.054 -> Changing Security Alarm State to Inactive
20:42:35.855 -> Door Closed!
```

Figure 49: Serial Monitor of Main Door Security System after main door opened

In Figure 50 it is shown that the time when magnetic switch detects the door is opened at the same time (8:42 pm) the email was received to the owner.

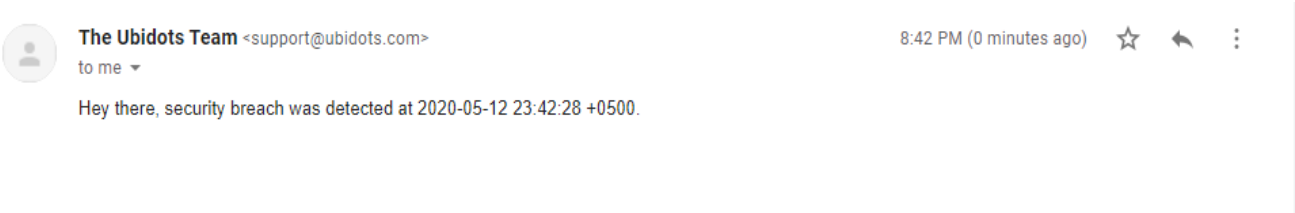

Figure 50: Email regarding house door security alert

Below is the flow diagram to explain the working clearly:

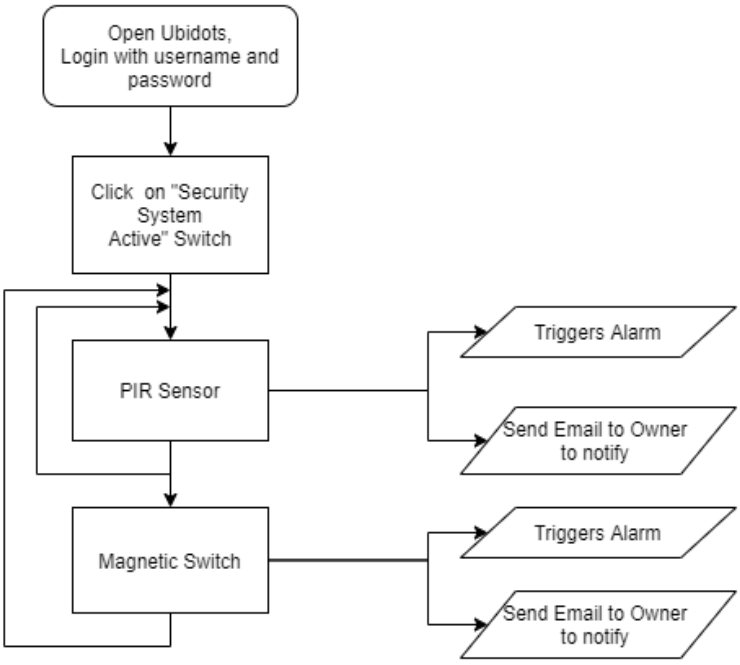

Figure 51: Working of Main door security system

B. Vehicle Theft Security:

This is a very important part of the security system, as we know the cars as so expensive now a days and usually when someone comes at home after work or from somewhere, they park their car in garage and directly go inside their homes. Today's life is so busy and fast many people leave their important documents, keys, laptop etc in the car. So, in that case garage security is one of the main security features.

As in demonstrated model Figure 13 there is a garage next to the main entrance door. The sensor which is used for garage security is Ultrasonic Sensor, as it is used most commonly in garages because it works with respect to the distance.

Below is the practical working of this system:

Figure 52 is Dashboard of Vehicle theft security system in Ubidots, the system is currently active and the two indicators (in green colour) are showing that

1. Vehicle Theft Alarm is not triggered yet.
2. Vehicle is Parked

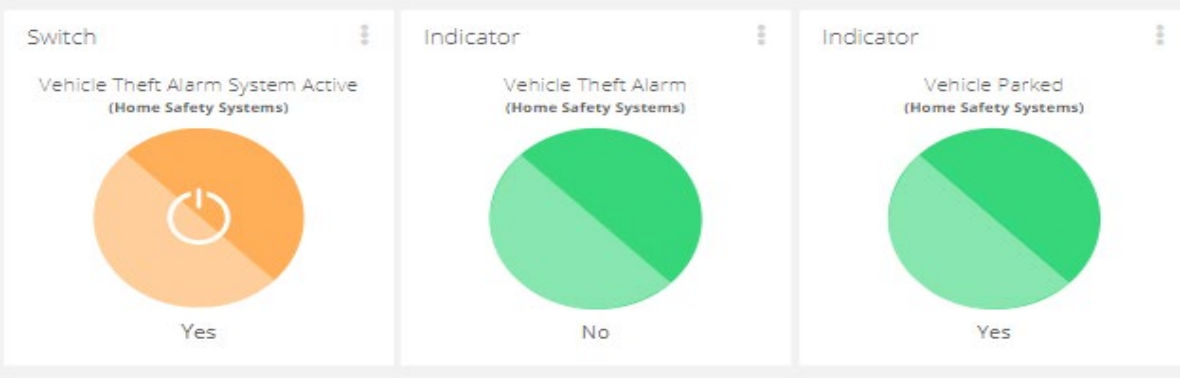

Figure 52: Vehicle Theft Security Ubidots Dashboard when vehicle is parked

Figure 53 is Dashboard of Vehicle theft security system in Ubidots, the system is currently active and the two indicators (in red colour) are showing that

1. Vehicle Theft Alarm is triggered.
2. Vehicle is not parked or moved from the security range

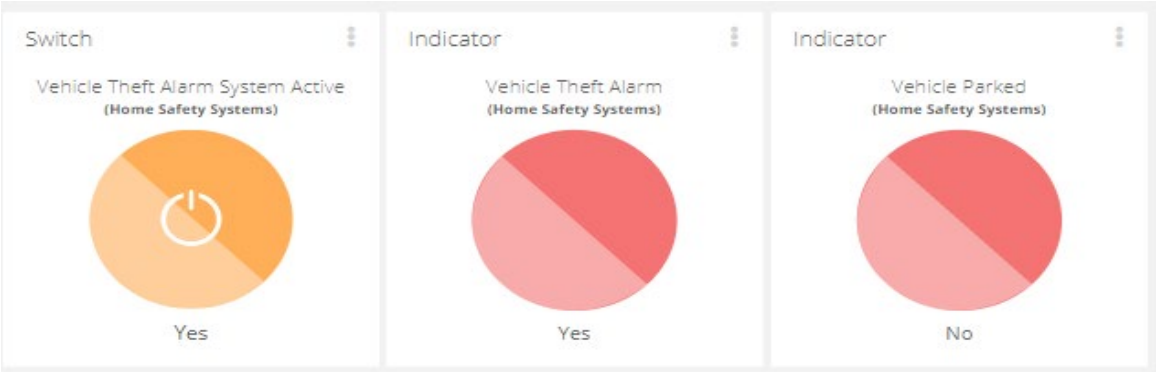

Figure 53: Vehicle Theft Security Ubidots Dashboard when vehicle is not parked

In Figure 54 serial monitor of Vehicle Theft Security shows the time (10:23 pm) when the ultrasonic sensor detects the vehicle is not parked or moved from its place.

```
22:23:00.336 -> Vehicle Not Parked!
22:23:15.071 -> Message arrived on topic: /v1.6/devices/home-safety-systems/vehicle-theft-alarm-system-active/lv. Message: 0
22:23:15.071 -> Changing output to off
22:23:17.389 -> Vehicle Parked!
22:23:17.728 -> Vehicle Not Parked!
22:23:17.864 -> Vehicle Parked!
```

Figure 54: Serial Monitor of Garage Security System" after vehicle movement

In Figure 55 it is shown that the time when ultrasonic sensor detects the vehicle is not parked at the given distance at the same time (10:23 pm) the email was received to the owner.

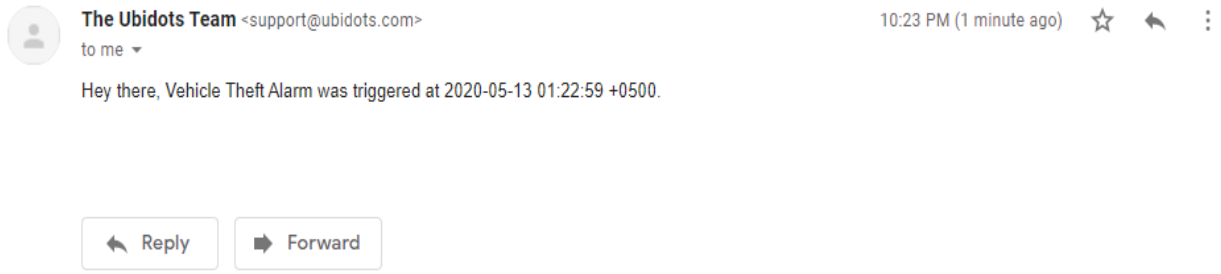

Figure 55: Email regarding Vehicle theft security alert

Below is the flow diagram to explain the working clearly:

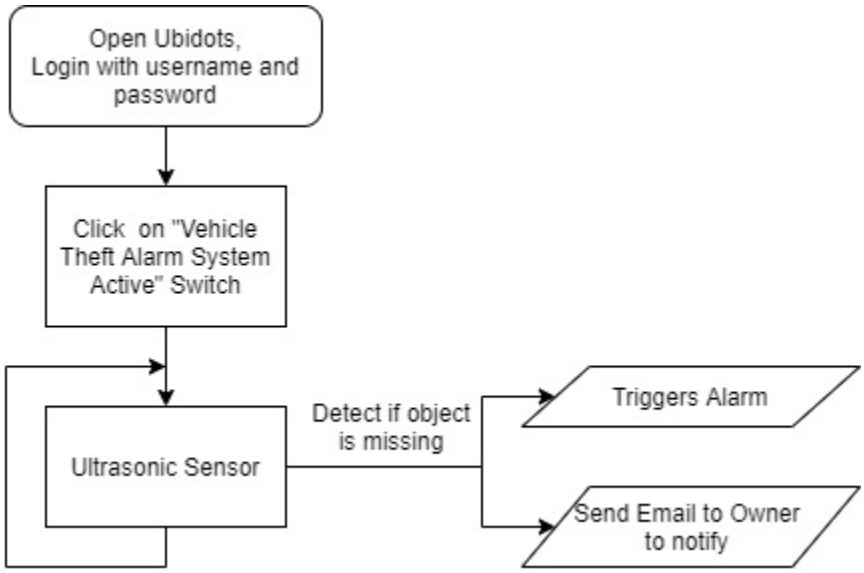

Figure 56: Working of Vehicle theft security system

C. Fire Alarm:

This is a basic need of the security system, most of the things we use in houses are electronic or electrical and a small spark or intense heat can break down into fire. So, it is very commonly used now a days, it is not so expensive so, it's better to be safe and stay secure.

As in demonstrated model Figure 17 the Fire sensor is installed in the common area, Buzzer and ESP 8266 is installed next to it. The sensitivity of the fire sensor can be adjusted according to the area

Below is the practical working of the demonstrated model:

Figure 57 is Dashboard of Fire Alarm System in Ubidots, the system is currently active and the two indicators (in green colour) are showing that

1. Fire Alarm is not triggered.
2. No fire detected

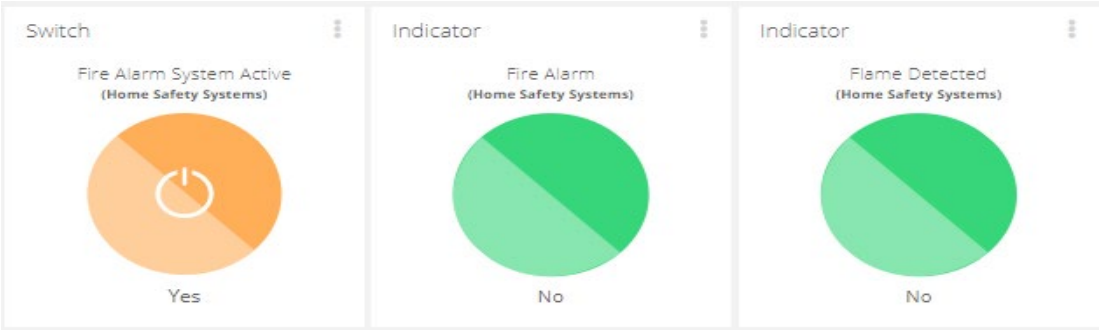

Figure 57: Fire Alarm System Dashboard" Ubidots" in safe condition

Figure 58 is Dashboard of Vehicle theft security system in Ubidots, the system is currently active and the two indicators (in red colour) are showing that

1. Fire Alarm is triggered.
2. Fire is detected.

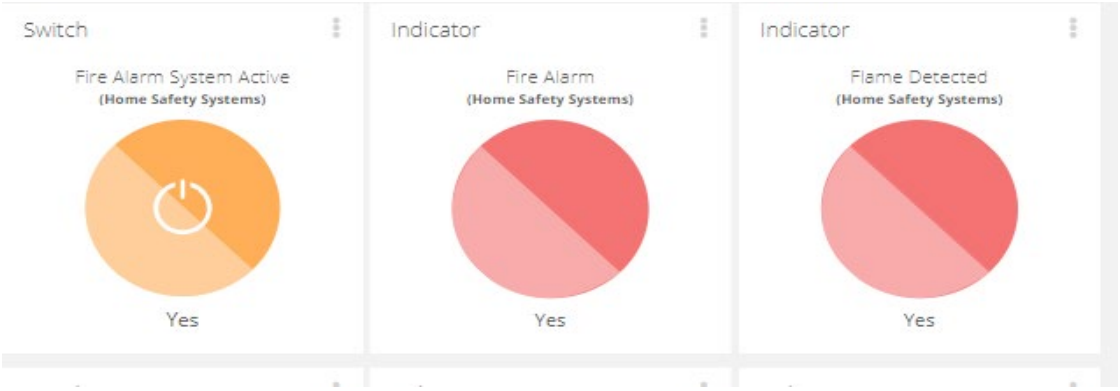

Figure 58: Fire Alarm System Dashboard" Ubidots" in un-safe condition

In Figure 59 serial monitor of ESP 8266 "Fire Alarm System" shows the time (11:14 pm) when the fire sensor detects the fire.

```
23:14:26.431 -> Wait for WiFi.........
23:14:29.936 -> WiFi Connected
23:14:29.936 -> IP address:
23:14:29.936 -> 192.168.43.169
23:14:29.936 -> Attempting MQTT connection...
23:14:30.277 -> Connected
23:14:30.445 -> Message arrived on topic: /v1.6/devices/home-safety-systems/fire-alarm-system-active/lv. Message: 0
23:14:30.445 -> Changing Fire Alarm System State to Inactive
23:14:35.589 -> Message arrived on topic: /v1.6/devices/home-safety-systems/fire-alarm-system-active/lv. Message: 1
23:14:35.622 -> Changing Fire Alarm System State to Active
23:14:48.497 -> Flame detected!
23:14:48.497 -> Flame extinguished!
```

Figure 59: Serial Monitor of Fire Alarm System after detection of fire

In Figure 60 it is shown that the time when fire sensor detects fire, at the same time (11:14 pm) the email was received to the owner.

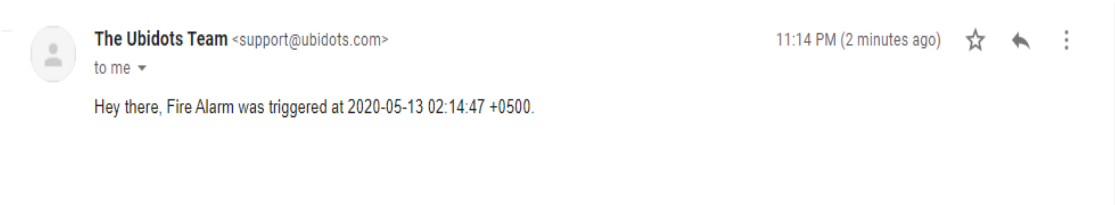

Figure 60: Email regarding fire security alert

Below is the flow diagram to explain the working clearly:

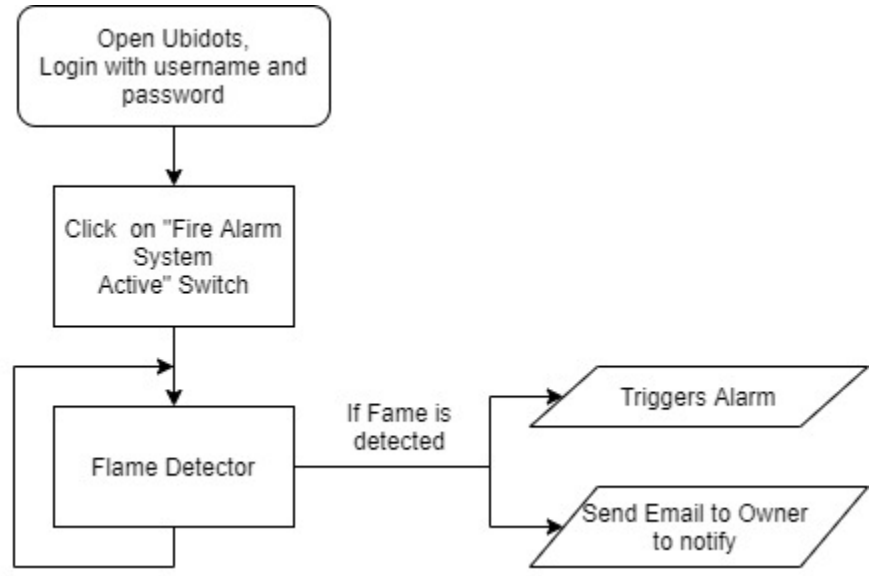

Figure 61: Working of Fire security system

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