



# An-Najah National University

Faculty of Engineering & Information Technology

Presented in partial fulfillment of the requirements for Bachelor degree in (Computer Engineering).

Graduation Project 2

## Smart Home Automation System



**Introduced By:**

Suzan Banifadel

Shua'a Abdoh

**Supervisor:**

Miss. Asma'a Afeefi

Date: 8/12/2020

## **Acknowledgment**

we have already spent much efforts to make this project, although it wasn't possible to do it without the support of many people. We are taking this opportunity to express our thanks and gratitude to our families in the first place, our parents, brothers and sisters for their greatest support specially at hard times through all of our university life not just through this project development, greatest thanks to you, to your understanding, contain and endless love. Also, thanks to our lecturers and professors for sharing their knowledge with us through the 5 years, and special thanks to Miss.Asmaa' Affefi for her support and help to finish this project.

We are so thankful to all of you, and we appreciate every single moment and effort you spent with and on us. We are not going to forget our amazing friends and mates, thanks for beautiful, fun and even hard moments we went through together. We do really appreciate your encouragements and support.

## **DISCLAIMER**

This report was written by Suzan Banifadel and Shuaa' Abdoh students at the Computer Engineering Department, Faculty of Engineering, An-Najah National University. It has not been altered or corrected, other than editorial corrections, as a result of assessment and it may contain language as well as content errors. The views expressed in it together with any outcomes and recommendations are solely those of the students. An-Najah National University accepts no responsibility or liability for the consequences of this report being used for a purpose other than the purpose for which it was commissioned.

## Table of Contents (TOC):

<b>Abstract.....</b>	<b>5</b>
<b>Main Body.....</b>	<b>6</b>
<b>Chapter 1 introduction.....</b>	<b>6</b>
<b>Chapter 2 Constraints and Earlier course .....</b>	<b>7</b>
2.1 Constraints.....	7
2.2 Earlier course.....	7
<b>Chapter 3 Methodology and requirements.....</b>	<b>8</b>
3.1 Hardware Requirements.....	8
3.2 Software Requirements.....	16
3.3 Project Systems and their Functionalities.....	17
<b>Chapter 4 Results and Discussion.....</b>	<b>22</b>
4.1 Software Application.....	22
4.2 Hardware Code.....	32
4.3 Final Connection of home.....	33
4.4 Pros of Smart Home Automation.....	38
<b>Chapter 5 Conclusion.....</b>	<b>40</b>
<b>References.....</b>	<b>41</b>

## **Abstract:**

Internet of Things (IoT) is growing every day since it has allowed the interconnection of different devices existent in smart environments e.g., home environment, and because it has allowed improving or supporting different services such as physical security, energy consumption management, entertainment among others. A great application on (IoT) is Smart Home Automation System (SHAS), this system that spread out fast through world and solved the domestic needs of families in different ways with its different features.

In our second graduation project we created a model for this system with the following features:

- we have sensors and an application that runs electrical devices in the house like fan, lamps and so on, also we provide security for the house by putting a protection system on the main door that depend on entering password thus if any one enters a wrong password or try to enter the house by not using the main door an alarm will start. The application can control house devices from anywhere, even using different network.
- A smart fire detection system that will detect if any fire occurred then it will start emergency alarm. Also connected to mobile app.
- An irrigation system for house garden, this system will work according to humidity of ground also we can control it using mobile phone
- Garage system can be controlled from mobile phone.

## **MAIN BODY**

### **Chapter 1: Introduction:**

Smart Home could be any place containing electronic devices that can be connected in a network and controlled remotely through smartphone or computer interface.

Smart Home systems come with great unrestricted benefits for homeowners. In general, we could say whatever benefits the smart home come with, those benefits could be joined together to represent the great main benefit which is to comfort homeowner and to make his life much easier and effective. As an example of comforting home owner, we in our smart home connected home lights, devices and even doors with smart application, thus the owner can control all of them using his mobile phone wherever he is, and according to effectiveness its simply achieved with sensors we used, for example the irrigation system works automatically once the ground is dry and once it becomes wet enough it will be turned off automatically too, so user doesn't need to watch the pump as manual system where if he forgot the pump water will be wasted and it might also destroy plants, so automation system prevents such problems.

In the next pages we will talk in more details about our Smart Home automation system, give the implementation and the design and we will be describing the results and give suggestion for more ideas that can be added in the future.

## Chapter 2: Constraints and Earlier course work

### 2.1 Constraints:

While doing this project, we face many constraints that restrict us, the main one that we developed this project through COVID 19 pandemic and this affected us, I and my team mate were not able to meet normally, we have to separate the work, so each one of us has to work hard at home with keeping online contact, then meet once time a week for about 7 hours a day. to gather our work together.

Other constraints were the bad internet connection which causes delay in the project work, and also the software we used which is Arduino IDE also used to take a lot of time each time we try to upload our code to the controller, these things cost us much times than needed.

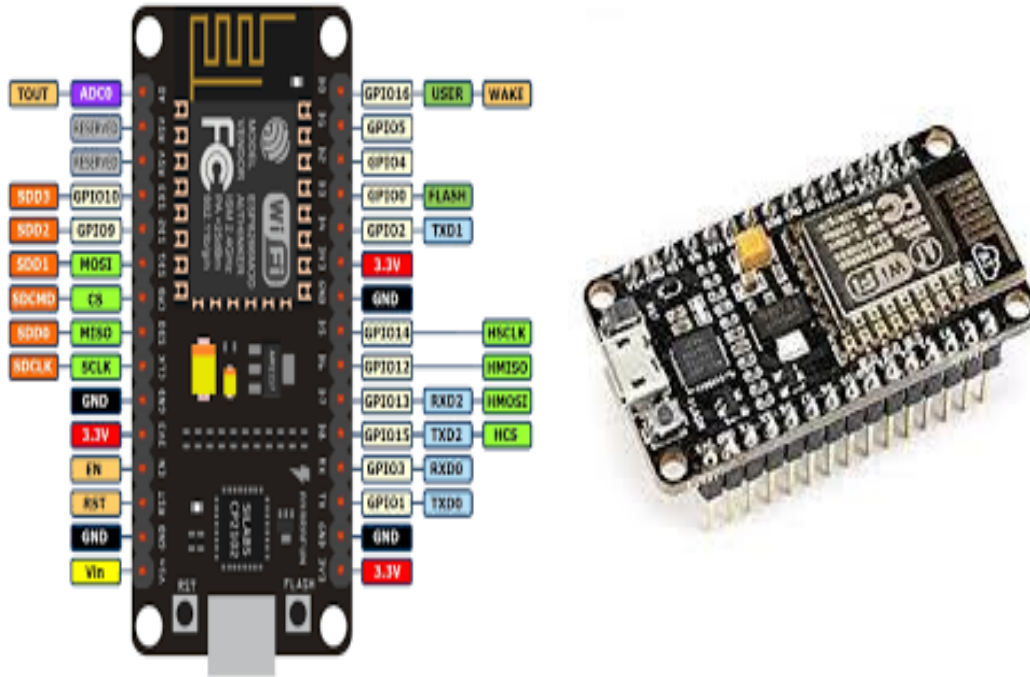
In a better situation without these obstacles, we could achieve much better results, although we are satisfied with our result.

### 2.2 Earlier course work:

Using different technologies requires reading it docs and watching different courses about it. For our project we read a course on how to develop React Native application using Expo, and read many related documentations on that field. Also, we read a course on firebase database to learn how to deal with it as we connect our application to it.

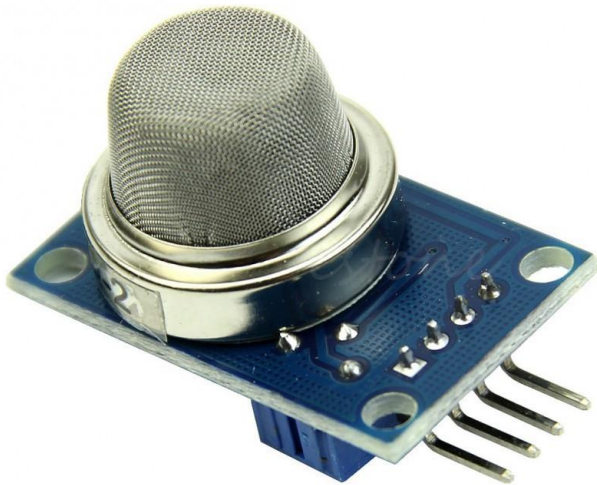


- ESP8266MOD (node mcu) : this controller is also used in addition to the main one to connect door keypad.

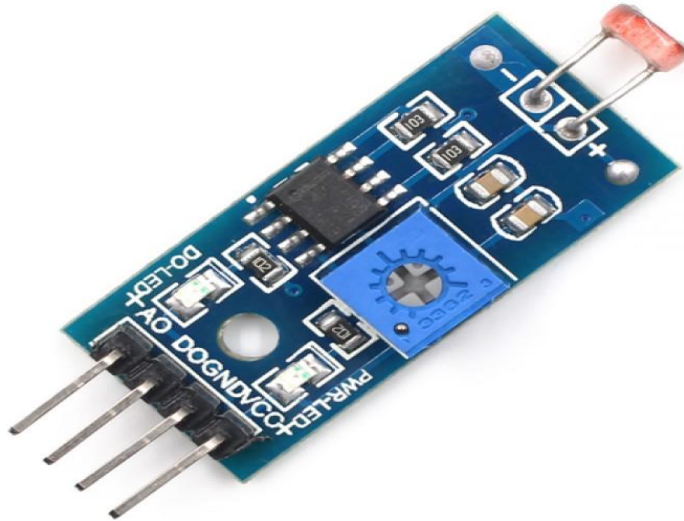


Sensors:

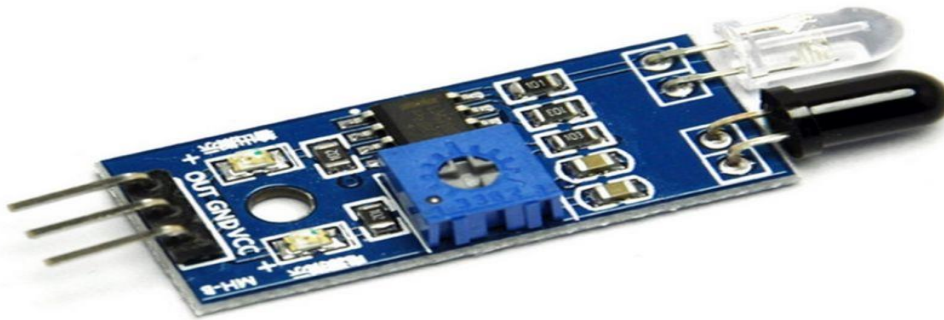
- (Smoke and gas) Sensor: this sensor is used for house fire detection system as it will give input to main controller if it detects gas or smoke signal.



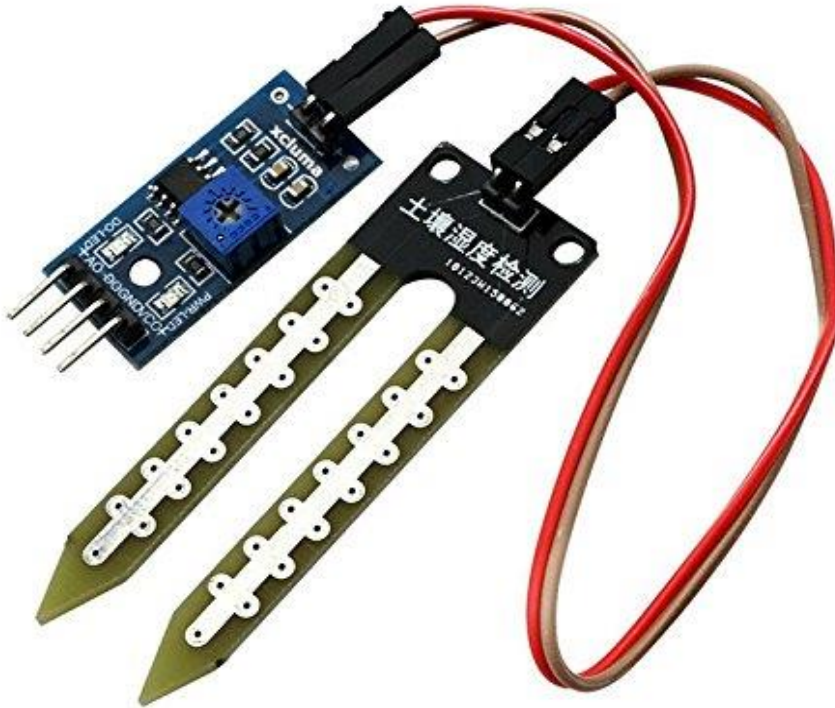
- Light Sensor: this sensor is connected externally above the outdoor to check light status, if the time is morning there is no need to turn outer light so it will give input to controller that light is detected to turn off outer light, but if its dark the input would be low so turn on outer light.



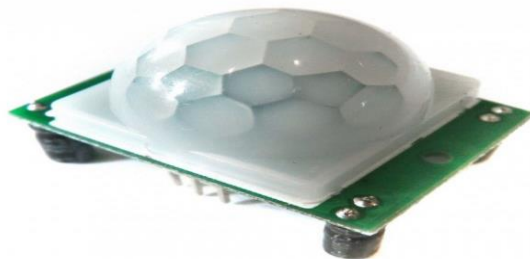
- Infrared sensor: this sensor is used in garage control system to detect if there is a car entering the garage or not and sends suitable input to main controller to do its work.



- Humidity Sensor (for irrigation system): it checks ground humidity and sends a suitable signal to main controller to run the pump if its dry or stop it if its wet enough.



- Motion Sensor: we buy it as we aimed at the beginning to make a smart lightning system that checks if there is anyone in the room to keep light on and if the room is empty to turn it off, but we don't use it as our home is small and this sensor was too sensitive for every single motion, so we weren't able to achieve what we want using it.



Motors and Drivers:

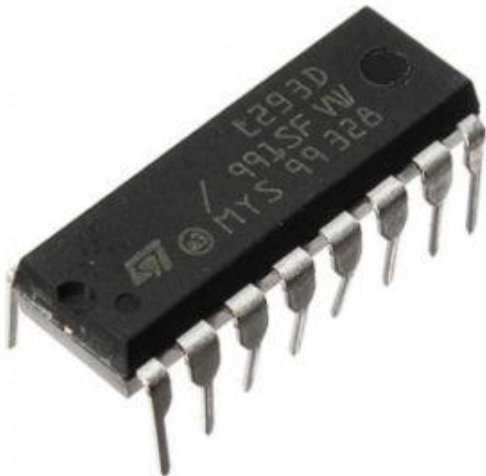
- 2 Servo motors: these motors are used for garage control system and for main door control system, its job is to open or close door according to the signal which get from controllers.



- Water pump (for irrigation system): runs to water the plants according output signal which get from dc driver controller.

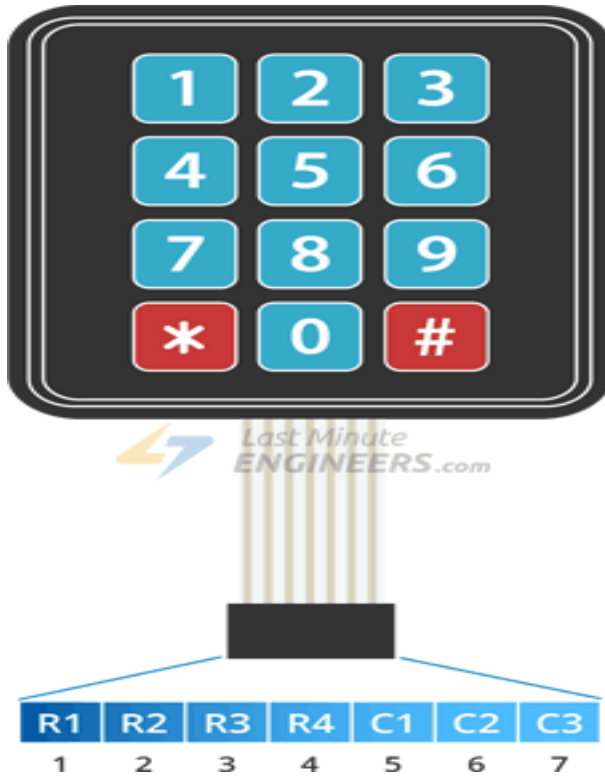


- L293D MOTOR DRIVER: we need this dc motor driver to run the water pump dc motor in irrigation system, it gives output to the pump according to signals which get from controller.



Others:

- Keypad: it's part of main door system to get password the user entered for the main door, our keypad has 4 rows and 3 columns.



- Buzzer: it will alarm if fire detected in the house.



- Leds: used for lightening house, inner and outer lights.



- Wires:



### 3.2 Software Requirements:

we used these software to program our controllers and to create our React Native app.

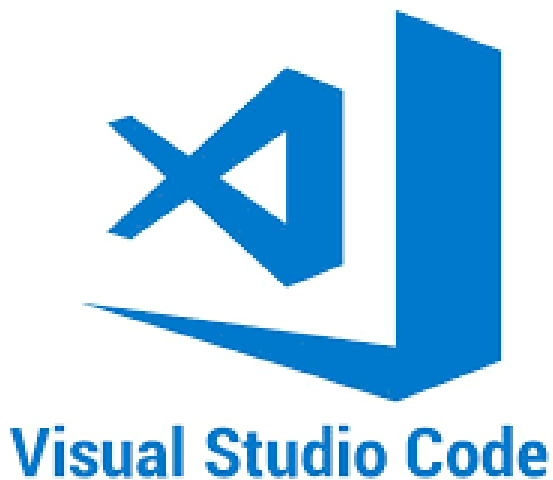
➤ **Arduino Software (IDE):**

We used this IDE to upload our C# code to the controllers



➤ **Visual Studio Code:**

We used it as the editor in developing our react native home app.



## Project Systems and their Functionalities:

### ❖ Main Door Secure System

#### System Functionality:

This system is responsible for keeping house safe and secure, as if anyone want to enter the home, he must insert the correct password for house door using door keypad or using home application from anywhere, the house owner can also update the password that is saved on firebase using the application.



#### How it Works:

- ❖ If user is in front of home door and enters the password using keypad, then the inputted keys user enter will be sent to ESP8266 controller to be processed, the controller will read current password saved in database and compare it with the entered one, if they are equal it will update the status of door which is saved in the database to “open”. Then the main controller that keeps reading the door status in a loop will find that the status change to “open” then send output signal to servo motor to rotate to open door. If the password entered is wrong the door status stay “closed”.
- ❖ If user uses the application, the entered password will be compared within the application with the old saved password, if it corrects directly change door status to “open” and alert user that door will be open, then the process will continue as before. If the password is wrong also nothing changed, but the application alert that the password is wrong.

## ❖ Fire Detection System:

### System Functionality:

This system aims to keep home safe from fire dangers, as it will run an alarm if any smoke detected in the house, also it will notify the user on his mobile phone that there is a fire in your house call the emergency, and the application provides list of numbers for emergency for different regions.



### How it Works:

- ❖ The smoke and gas sensor that is attached in the house is connected to the main controller, if it detects enough amount of smoke it will send a signal to the controller to change fire status of the home that is stored in the database from “no fire” to “fire”.
- ❖ once the status changed to “fire”, the buzzer that is attached in the house will run to alarm anyone inside or around the house.
- ❖ The application will receive push notifications alarming home owner that his/her house is in danger.
- ❖ If no smoke detected, the status will stay “no fire”.

## ❖ Garage Control System

### System Functionality:

- ❖ This system allows user to control his/her garage using mobile phone. Thus, he didn't need to step out of his/her car to open the garage door, as he can open it from anywhere.



### How it Works:

- ❖ If user click on his mobile phone on open button, the application will edit garage door status on database to be “open”, then the main controller that is connected to this database and keep checking door status will read the status value “open” then send output signal to servo motor connected to garage door to open the garage.
- ❖ If the garage door is open and the user want to close it, the system first of all make sure that there is no car still entering the door by reading the status of infrared sensor that is connected near door, if the infrared sensor detect a car near door it will send back to the controller to edit car sensor status on database to be “there is a car” and keep door status “open” to not close the door, once the car totally entered or leave the garage the sensor will stop detecting any car and the controller will change sensor status in database to be “no car”, then change door status to “close”.
- ❖ Then the controller sends output to servo motor to close the garage.

## ❖ Irrigation Control System

### System Functionality:

This system help owner to irrigate garden using his/her mobile phone, the user can run or stop water pump by clicking on his/her mobile, or he could set it to be automatically working according to plant ground if it is wet the pump is off and if it is dry the pump will automatically work.



### How it Works:

- ❖ If user choose “AUTO” mode then the pump will work automatically as we said, so the controller will keep getting input from humidity sensor which is buried on ground, if the sensor sends signal that ground is wet the controller will set irrigation status on database to “off”, and when the signal from sensor shows that ground is dry the controller will edit irrigation status to “on” and then sends output to dc motor driver, then the motor driver will drive the signal to pump dc motor to run it.
- ❖ If user set mode to “OFF” the application will edit irrigation status directly to be “off”, then the controller will read the state and send appropriate output to motor driver to keep the pump motor off.
- ❖ if user set mode to “ON”, then as before the application will edit irrigation status directly to be “on”, then the controller will read the state and send appropriate output to motor driver to run the pump motor.

## ❖ *Lightening System:*

### System Functionality:

- ❖ This system aims to make house lightning more effective and easier to owner, for example the user will control his home lights from anywhere even if he is out of his home using his application and the application give him the status of every room light on or off.
- ❖ Also, out light of the house can be set automatically, so if it is morning out light will be off and if it is dark the light will be on, and the user also can control it manually from his/her mobile.



### How it Works:

- ❖ There is a status value saved on database for every light in the house.
- ❖ Using mobile phone, the user can control these statuses individually to be “on” or “off”.
- ❖ The controller keeps tracking these values, for example if kitchen light sets to “on” it will sends output “HIGH” signal to kitchen led to turn it on, and if it is “off” it will send “LOW” signal to it to turn it off.
- ❖ According to outer light, it has in addition to above mode the “Auto” mode which means that it can be set to be automatically controlled according to light sensor that is attached on the outdoor, if the sensor detect light it will sends the right signal to controller to turn off light, and no light detected and it is evening or dark it will send the right signal to controller to turn light on.

And those were the main systems we implement in our project; next chapter we will be describing in more details how we design this project.

## Chapter 4: Results and Discussion:

The development of our project passed through those phases:

1- Software application

1- Hardware code

3- Final Connection of home

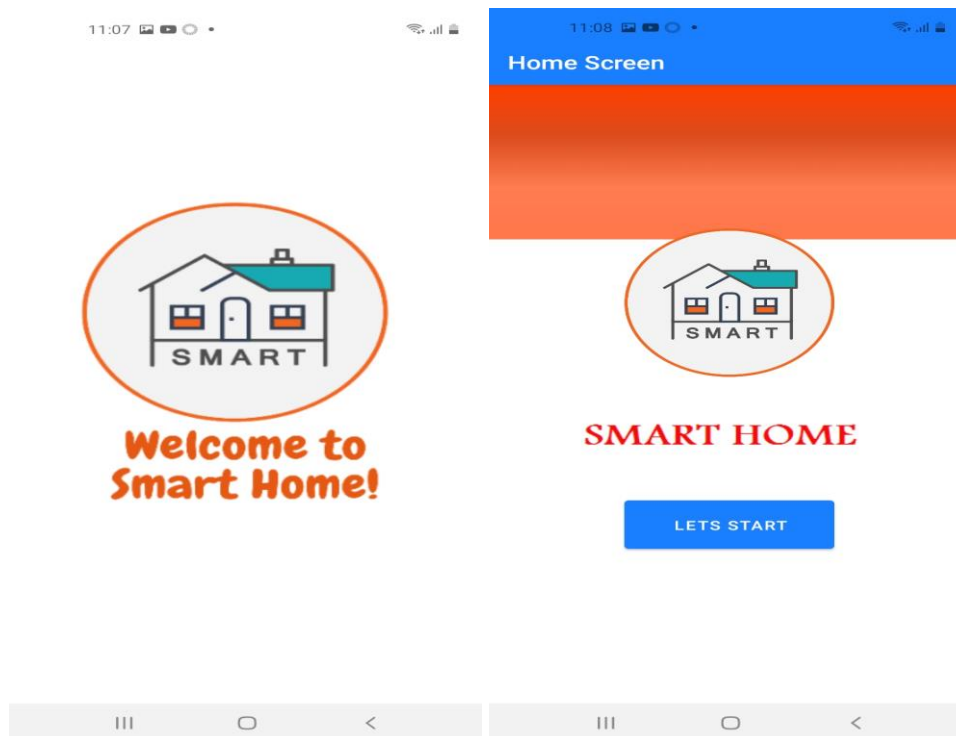
### 1-Software application:

As we mentioned before that we have designed an application that is connected to our home and can control it remotely, and here is the implementation and functionalities of our Home app:

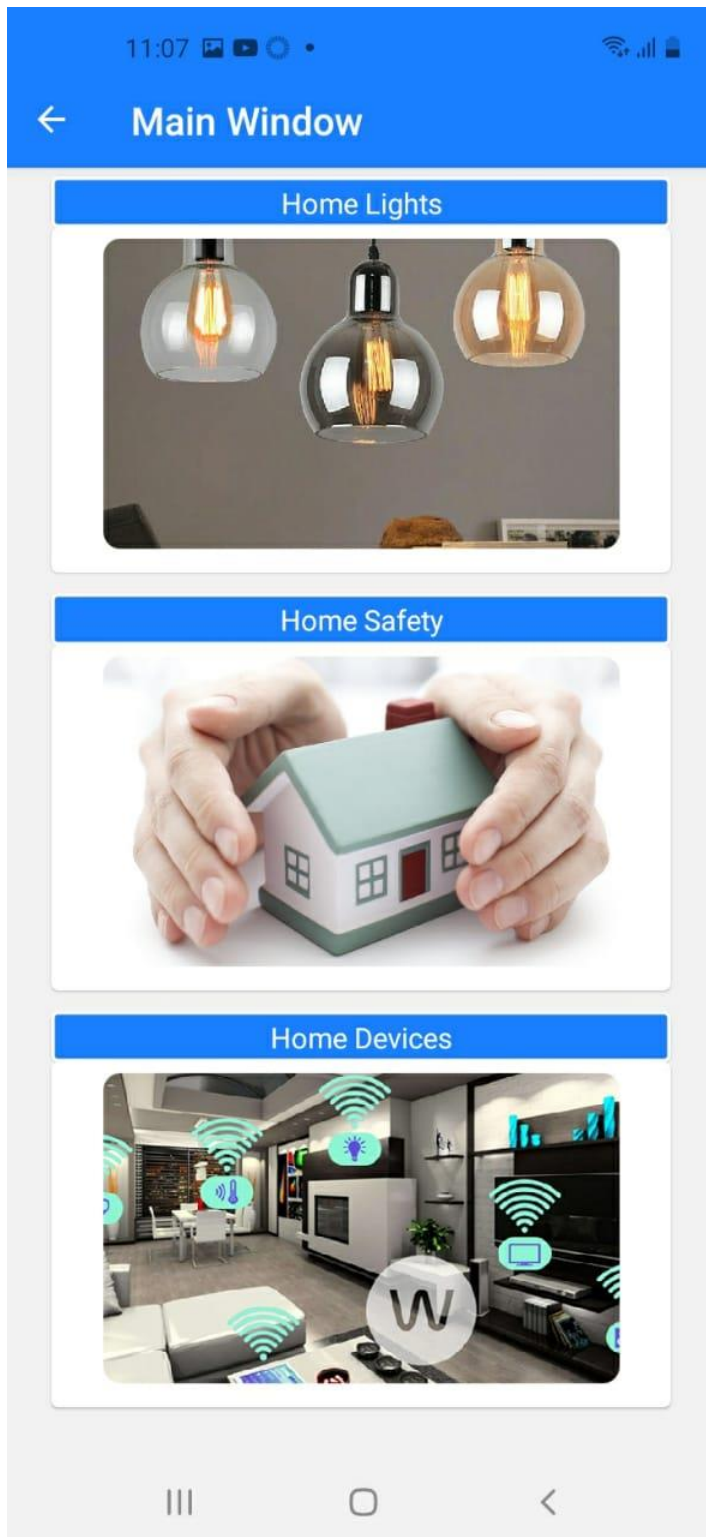
### Frontend of the App:

To implement the UI of our app we use the famous Hybrid mobile app development React Native JavaScript framework, so the application can be running on Android or iOS mobile phones. And this is the final look of our app:

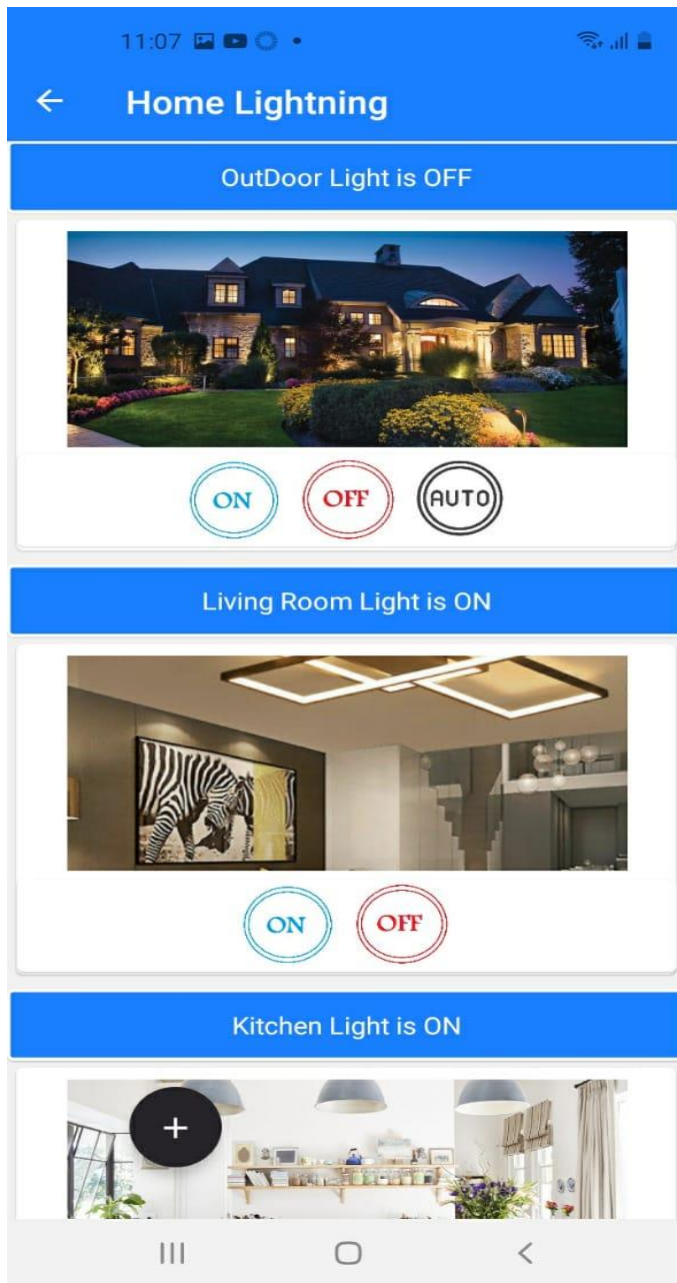
- **Welcome and Start Screens:**



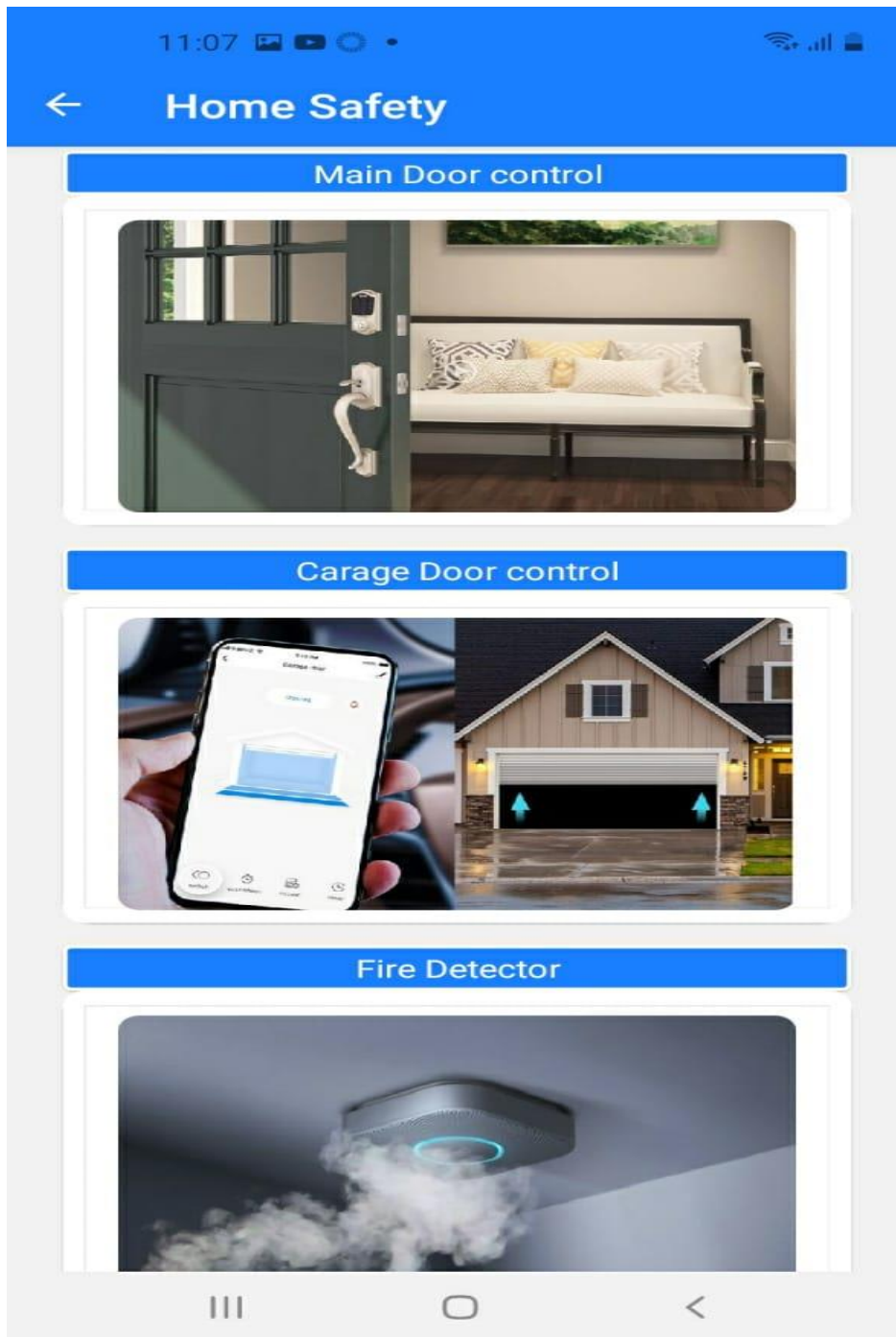
- **Main Screen:** this screen is responsible for taking user to Systems control screens



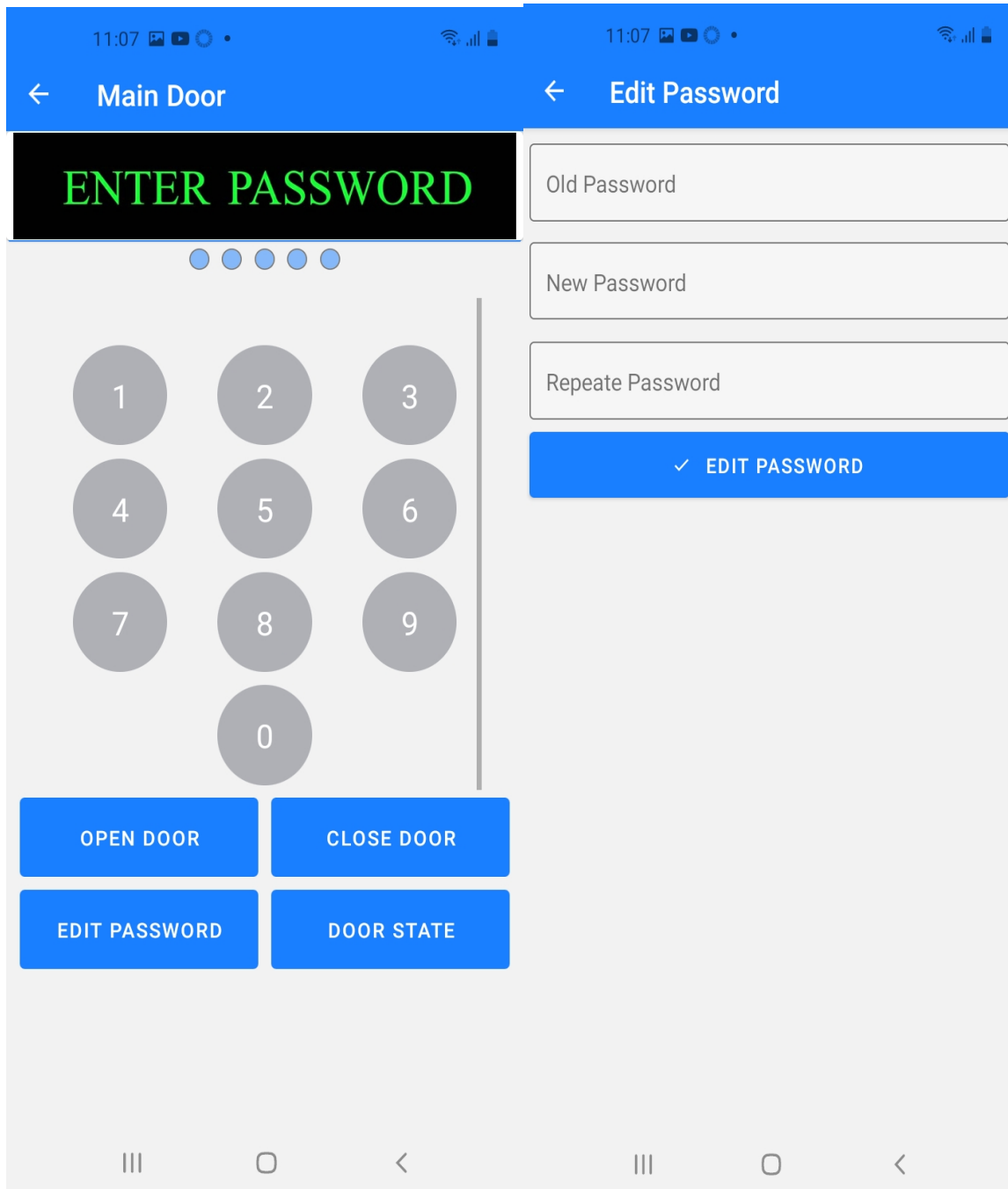
- **Light Control Screen:** user use it to control his/her house lights and see it statuses.



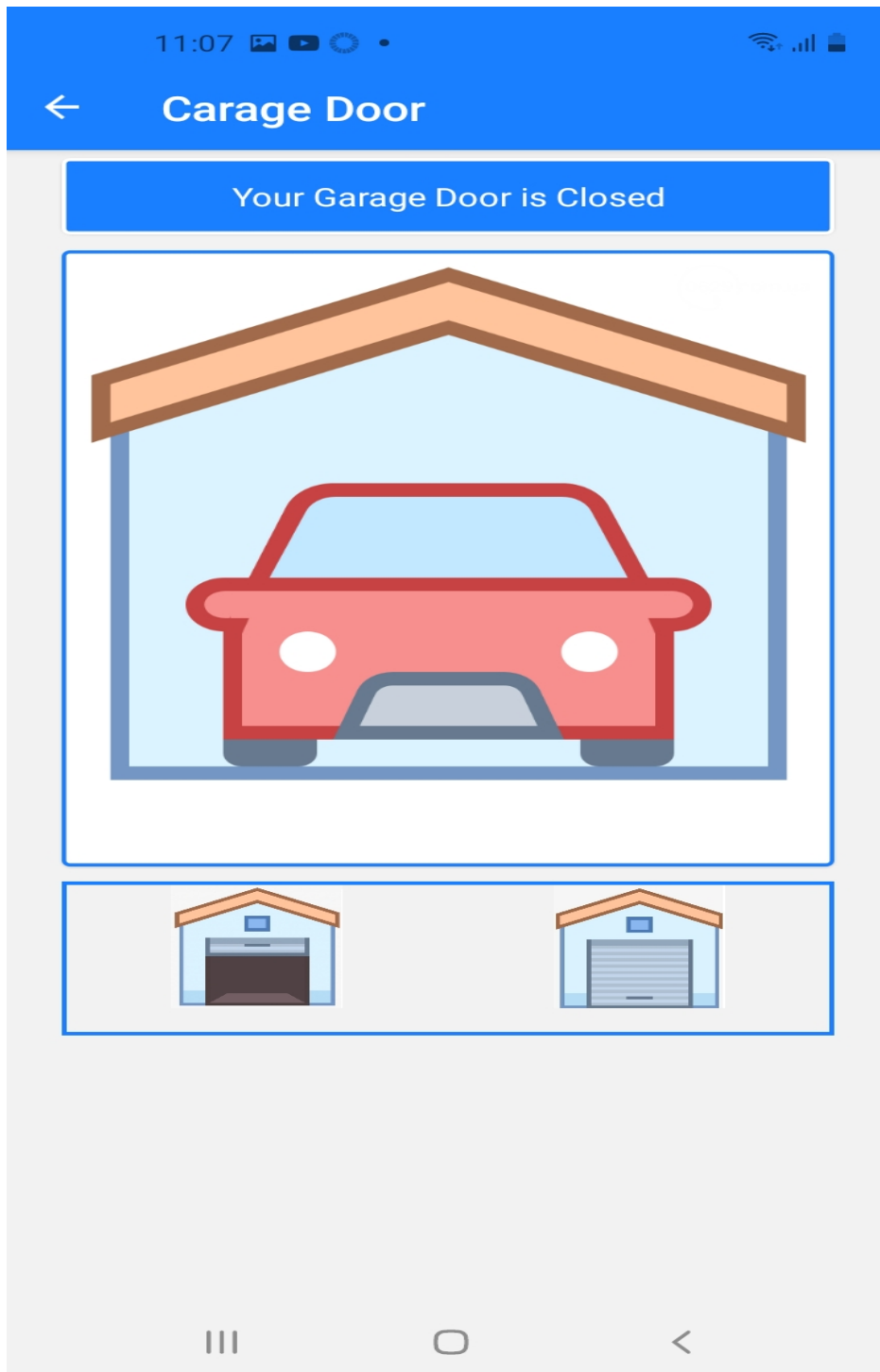
- **Home Safety Screen:** user can navigate from it to house doors and fire detection screens.



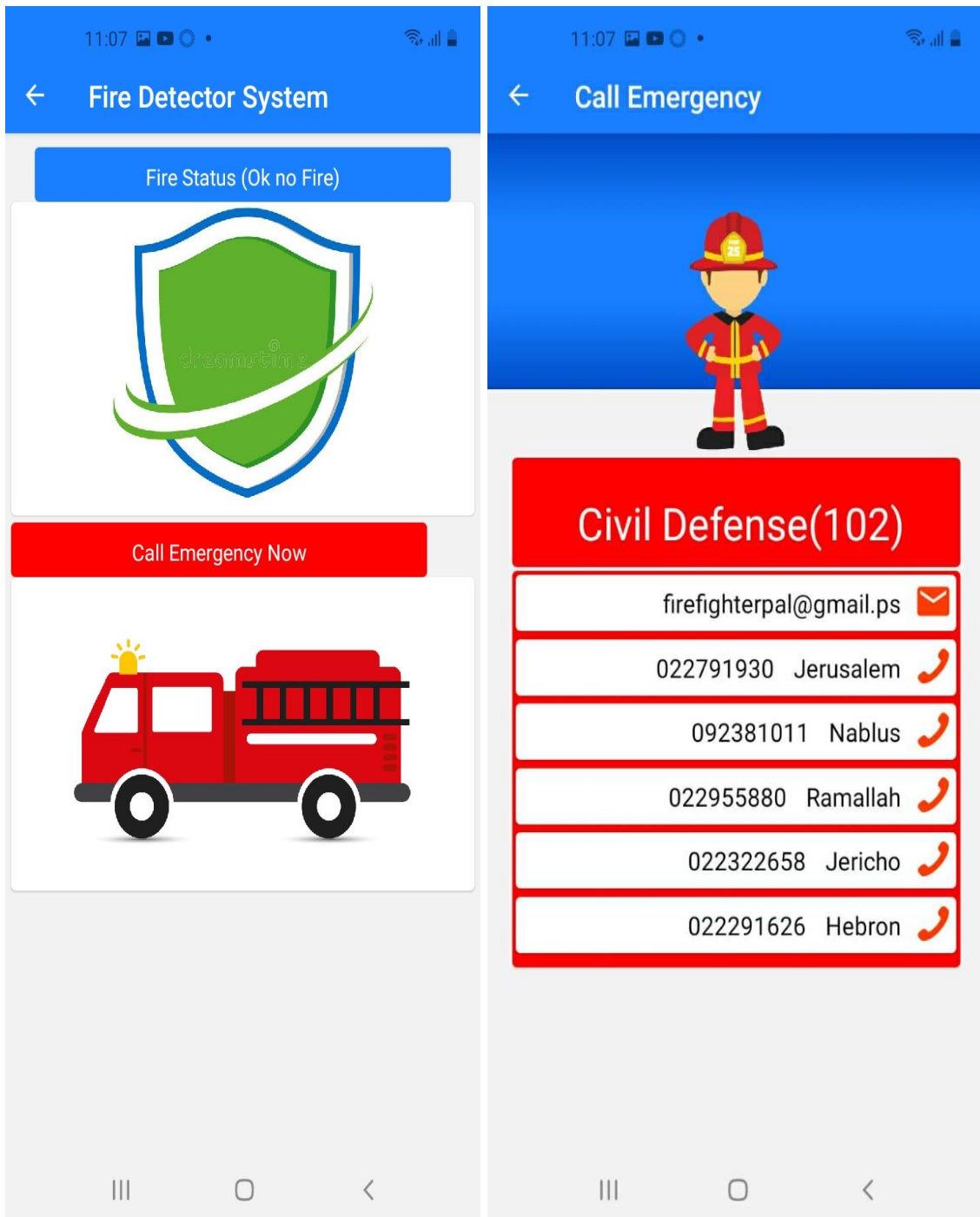
- **Main Door Control Screens:** user use it to enter main door password to open it or to close door and he also navigate from it to edit door password screen.



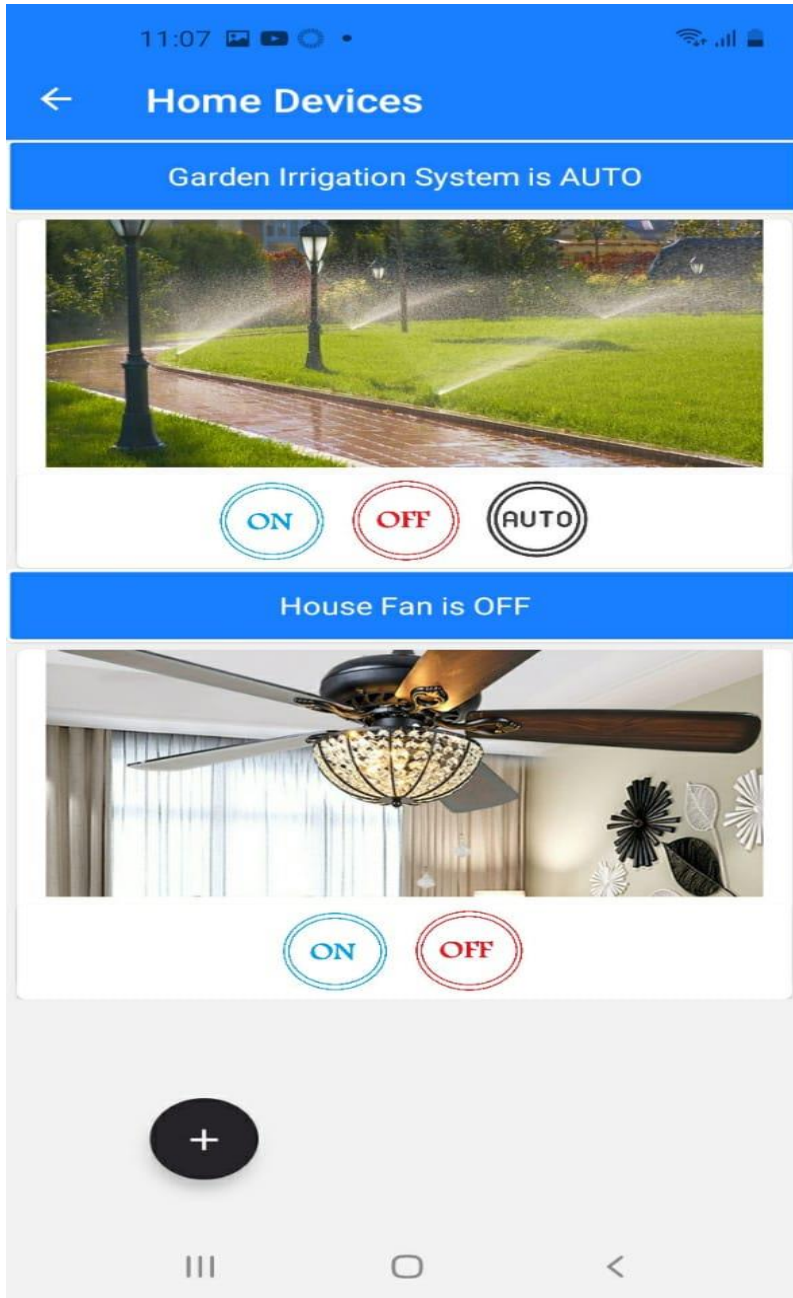
- **Garage Door Control Screen:** user interact with it to open or close the garage.



- **Fire Detector Screens:** this screen show house fire detection system status, also call emergency screen gives list of civil defense numbers.



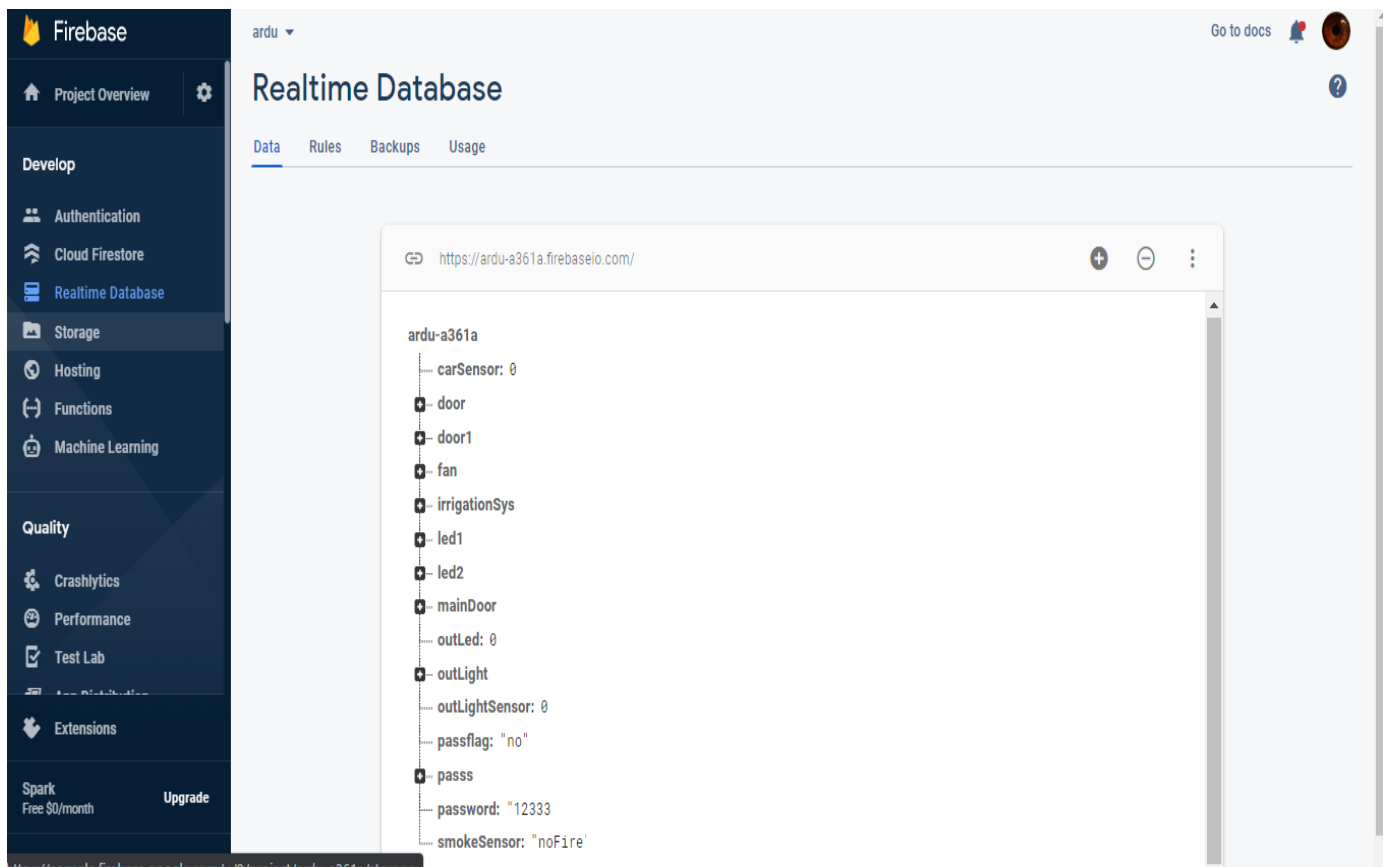
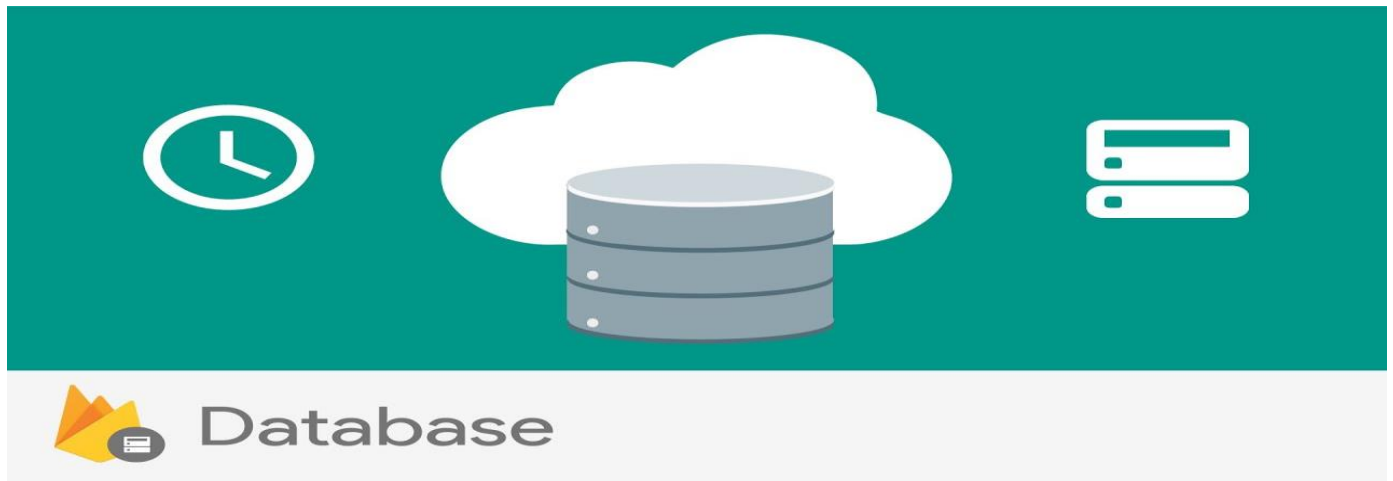
- **System Devices Screen:** other home devices can be added to this screen to be controlled as water pump, fan and any other devices...



## Backend of the App:

- ❖ To be able to control our home remotely from anywhere we surely need a database that will contain the status of home devices, systems information and door password, to achieve this we use:

## Firestore Realtime Database:

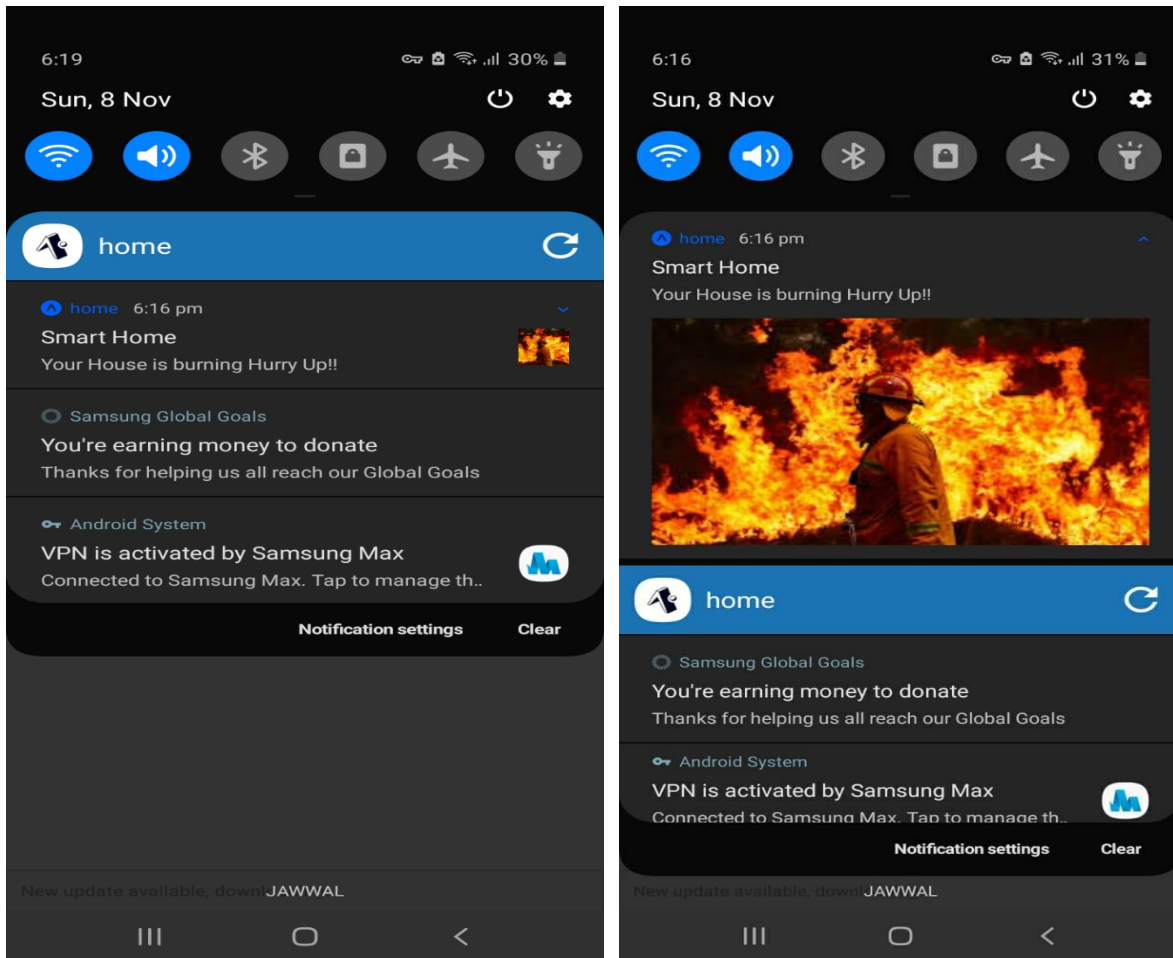


We also use Expo developer tools in developing our app and use expo push notifications with firebase cloud functions to send notification to our app:



### Expo Push Notifications:

As we mentioned that our fire detection system sends notification to user if there is a fire in his house to alarm him:



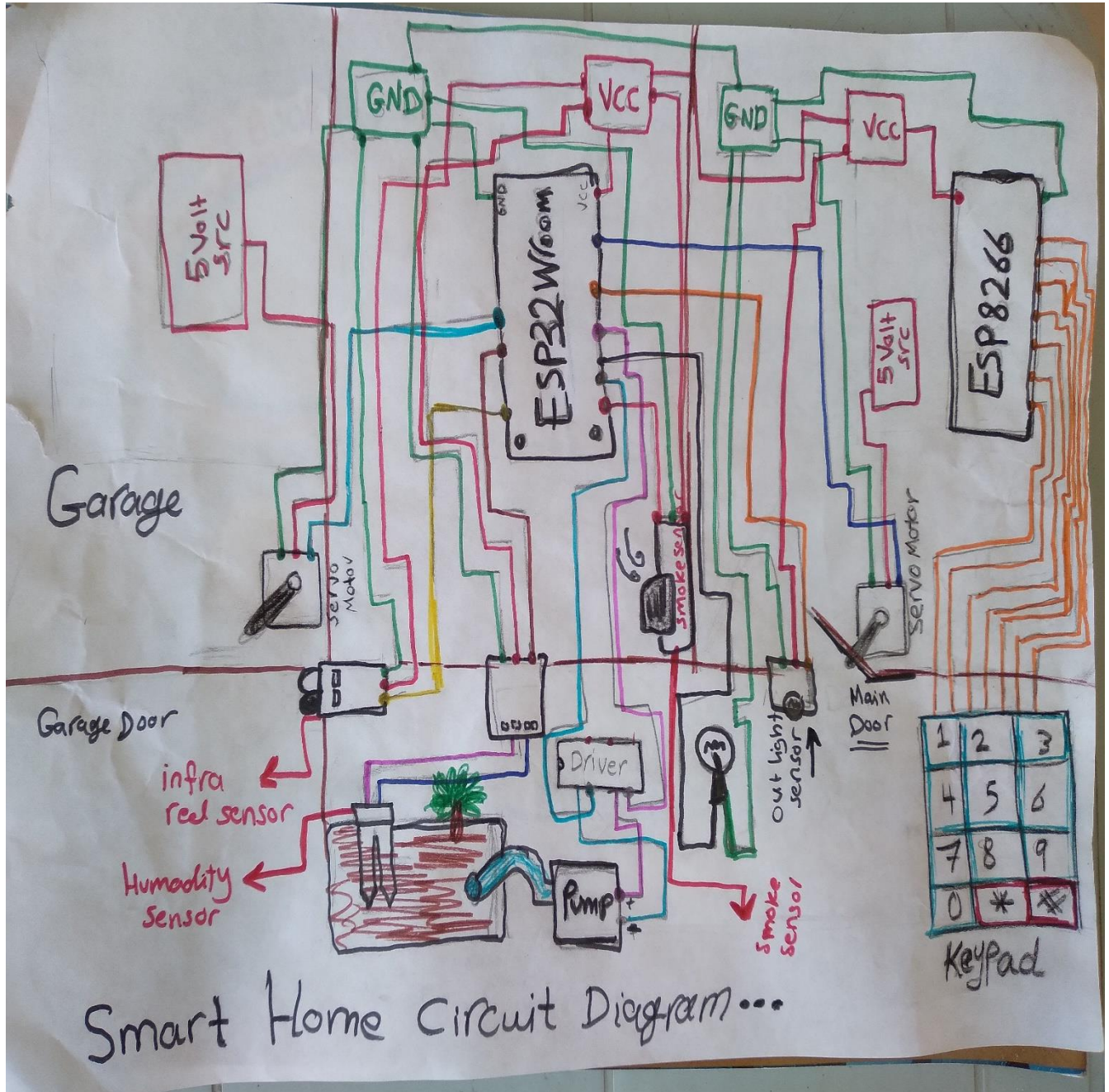
## **2-Hardware code:**

After developing the application and setting up the database we need to program the two controllers we have to be able to get or edit database values according to status of different house lights, doors and devices, so we use the Arduino IDE to write and upload our C# code to the controllers, for the ESP32Wroom controller we write a code that reads all sensors data and save it to the firebase, then control all components as lights, motors, buzzer and pumps to be on or off according to sensors reading with user commands from the application.

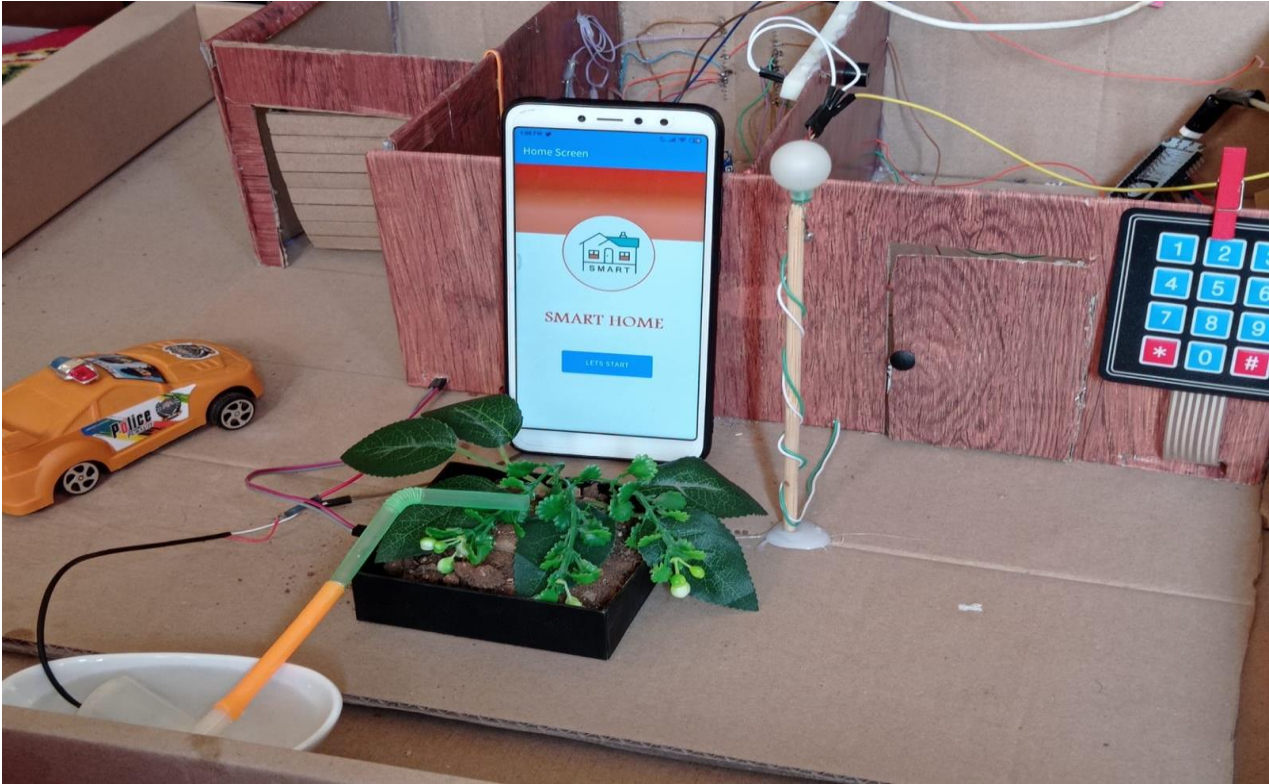
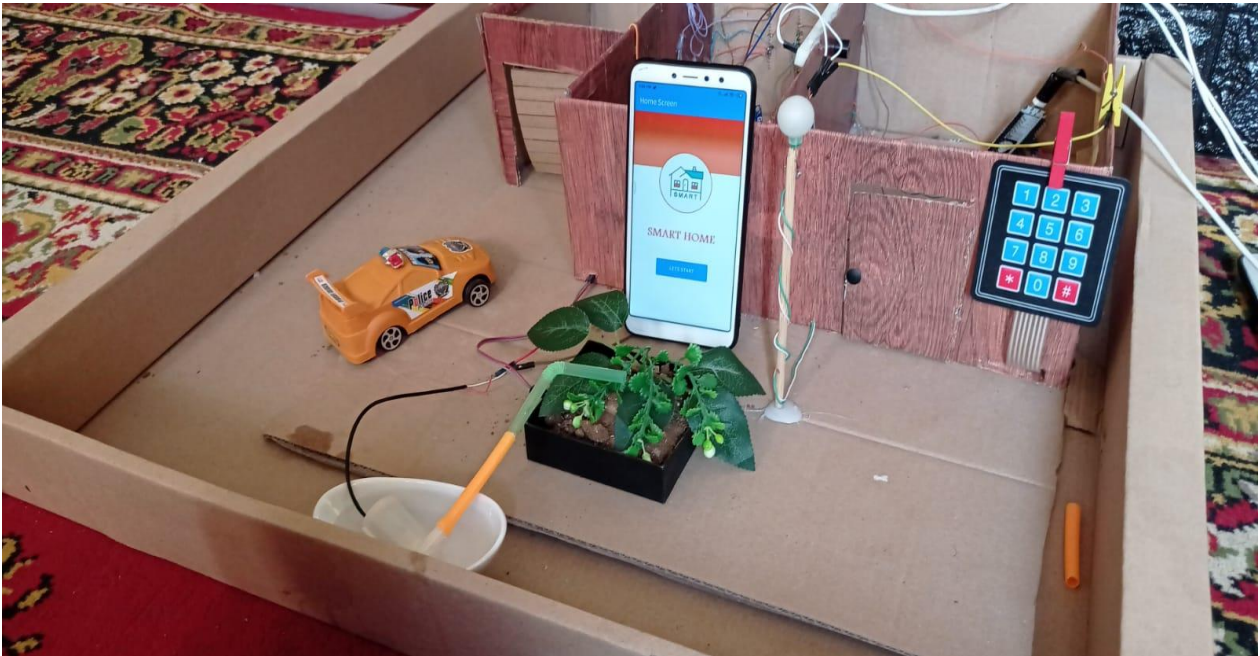
For the ESP8266 controller we write a code that just get keypad input and compare it with password stored in database to set the door password, there were no need for this controller except the fact that keypad needs 7 inputs and connecting it with the other component on main controller would be annoying and would generate some problems, so we chose to use this unused controller to give us the ability of controlling main door with a keypad.

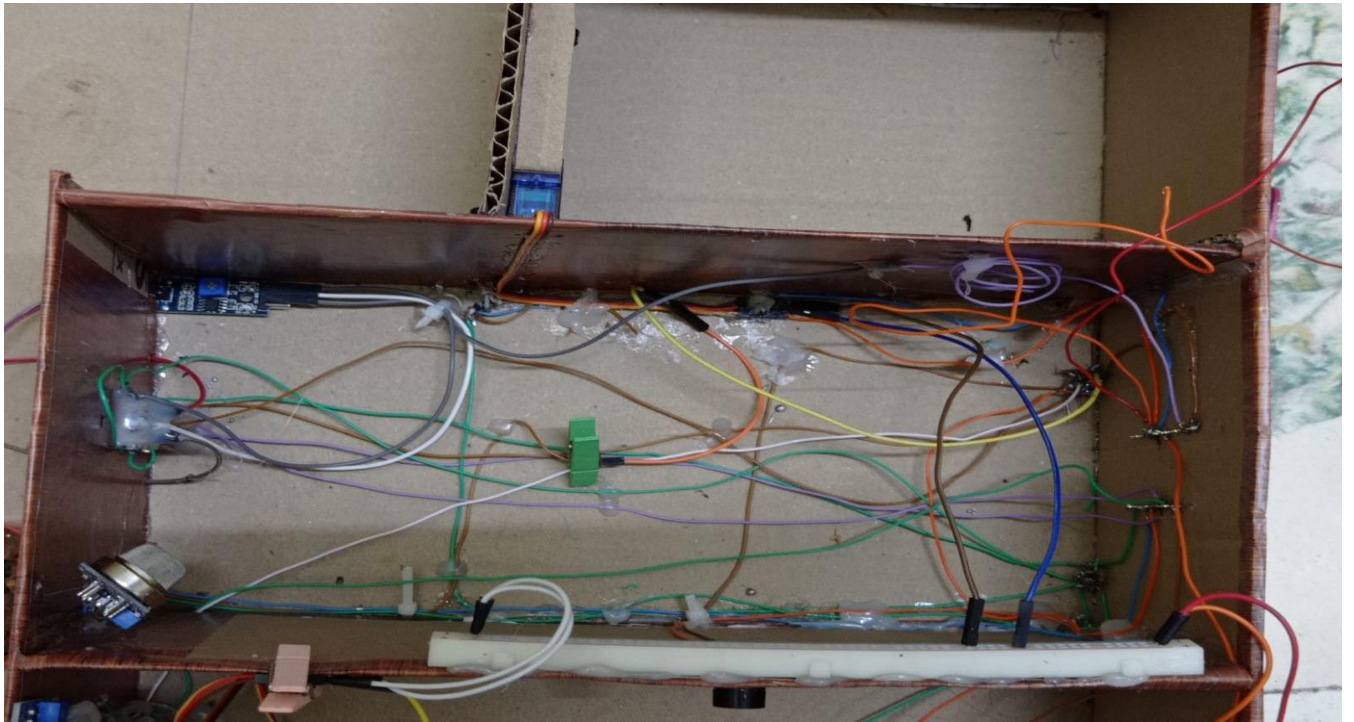
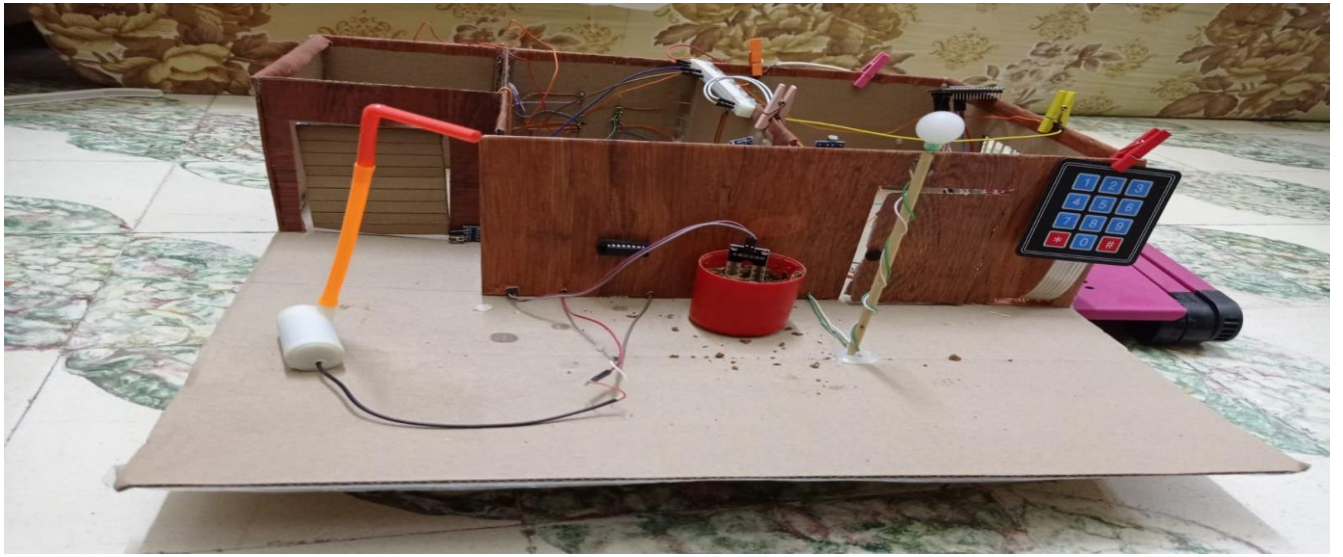
### 3- Final Connection of home

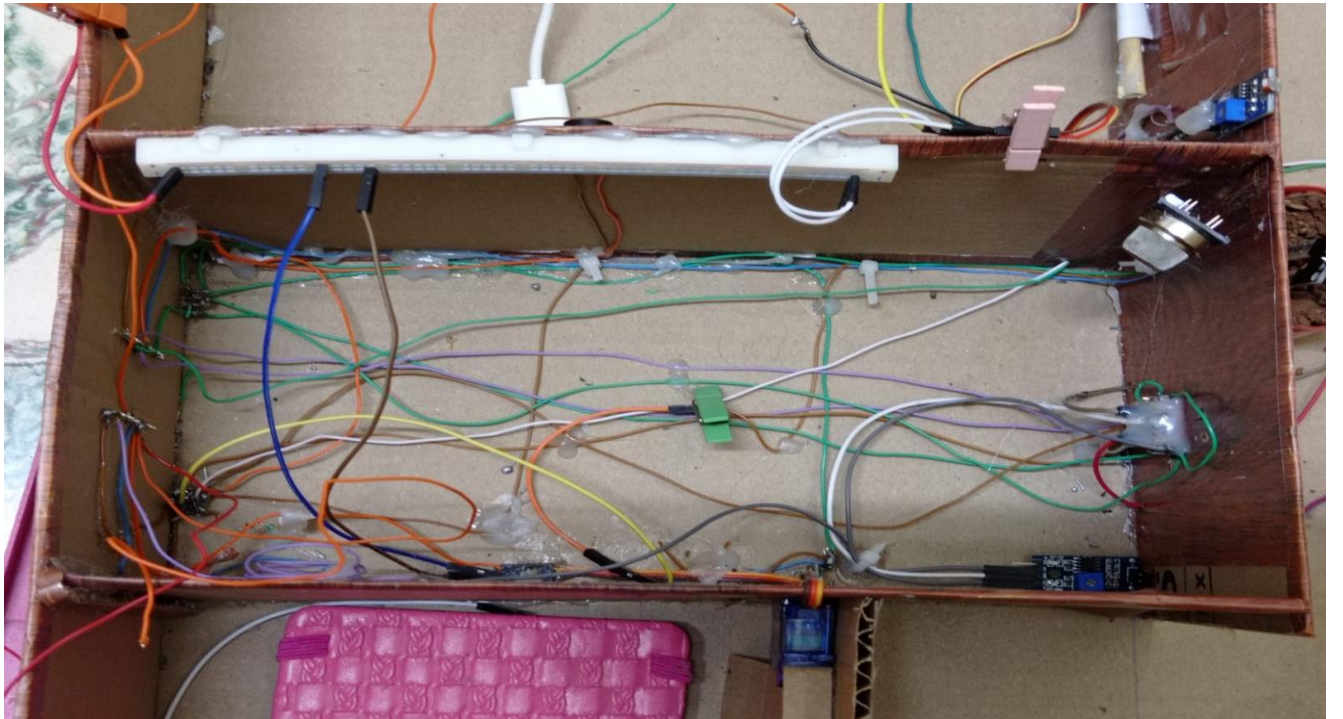
After building our application, setting up the database and programming the controllers to connect with wi-fi and database, and using its datasheets to get input and output pins we start connecting the resulted circuit:



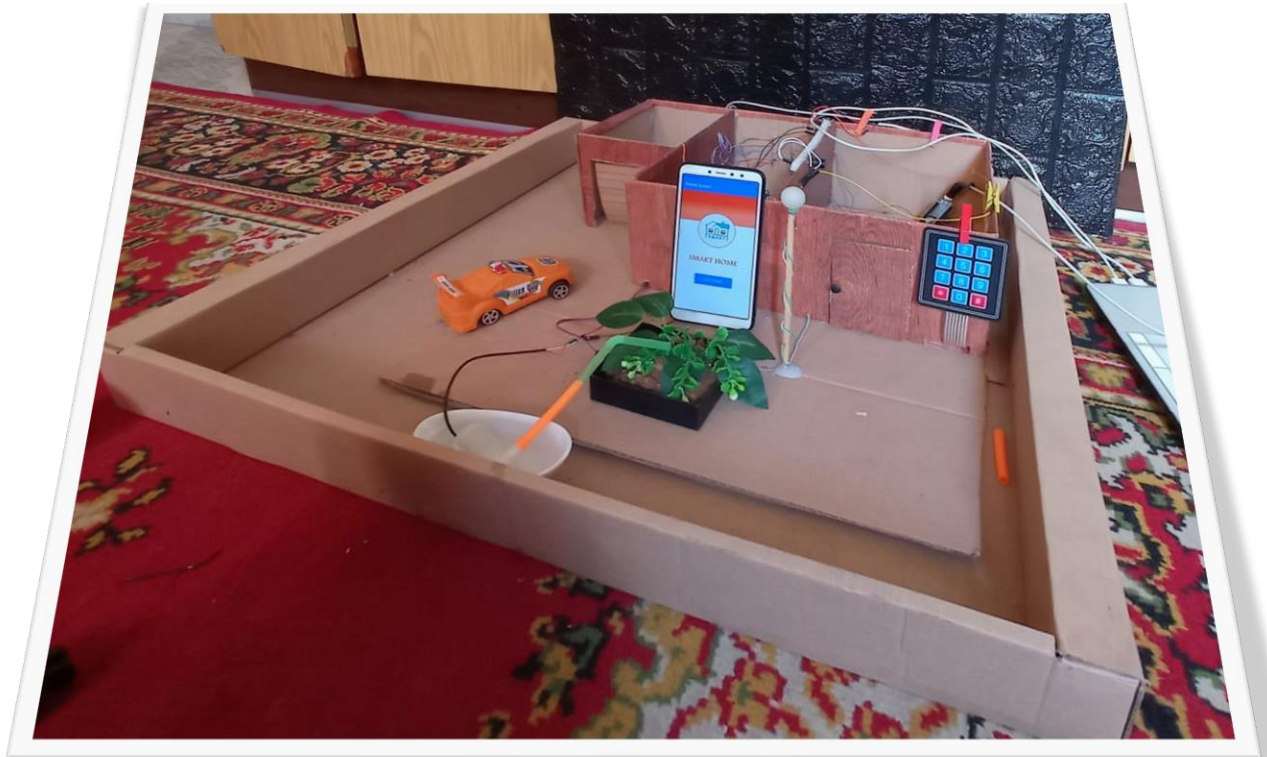
Our mini home after connecting the circuit:







General View to our Home:



And this was about our home design and programming.

## Pros of Smart Home Automation:

There are a lot of advantages for smart home systems, here are some of them:

### 1- Security:

One of the main advantages of smart home automation is that remote monitoring can relax you while you're away from the house. With remote dashboards, lights and lamps can be turned on and off, and devices can be controlled to run or to stop. These capabilities – combined with automated security systems – can help you limit the risks of intrusions, as you will be alerted if something abnormal happens.



### 2- Energy Savings:

Home automation systems have definitely proven themselves in this arena, automated systems that pre-programmed to work only on need, for example automated water pump just work once ground is dry and when it becomes wet enough it will immediately stop, while in manual pumps the user need to keep watching it and sometimes he might forget it running and waste more water or even destroy plants, another example is automated out lights that works only at night then it turned off at morning so no chance for user to forget it and waste electric power.



There are many examples of systems used in smart homes that achieve energy savings concept and that save user resources and use it in the best efficient way.

### **3- Convenience:**

This is seeming to be the main and one of the most important advantages for smart home automation, as in our days the less you spent effort and the less you must worry about are better.

User in smart home can control lights, devices doors and many things remotely and automatically, so this cost less effort and worry.



## Chapter 5 Conclusion:

In this project we proposed the idea of smart home automation systems and designed a small home with a smart mobile app as a simple application for this idea.

To conclude we could say that smart home automation using Internet of Things is experimentally proved to work very well by connecting simple devices to it and the devices were successfully controlled remotely through internet. The system doesn't just monitor data that sensors read as smoke, temperature, gas or light, but also do a process according to the requirement, for example turning lights on or off when it gets dark. It also stores the values that sensors get in the cloud in a timely manner. This will help the user to analyze the condition of various parameters in the home anytime anywhere.

As a future work that can be done to develop the system and make it more effective, we can do the following:

- Enhance the lightening system to make it work according to user movement in house, for example add a vision and motion system that can detect if there's someone in the room or someone passing by corridor and to turn the light on and off according to this movement.
- We also can Enhance security system to notify the homeowner if there's anyone trying to enter the home by not using the main door, this would require adding motion system around whole home.
- Add more connectivity between devices and systems for example: once the user enters the door password and enter the house the light turns on automatically and some other devices start running sequentially, so we can make our house much connected and smart.
- We can add more systems and devices.

## References:

Here are the references for the most effective websites that do really help us in our project:

- 1- <https://www.instructables.com/Esp8266-Firebase-Connection/>
- 2- <https://www.arduino.cc/reference/en/libraries/>
- 3- <https://www.arduino.cc/reference/en/libraries/servo/>
- 4- [ESP32 Firebase Tutorial, Setup Google Firebase account, Send Sensor Data to Firebase Database, IoT](#)
- 5- <https://iotdesignpro.com/projects/iot-controlled-led-using-firebase-database-and-esp32>
- 6- [React Native + Firebase #6 Send Push Notifications \( Expo + Firebase Cloud Functions\)](#)
- 7- <https://reactnative.dev/docs/>
- 8- <https://docs.expo.io/>
- 9- <https://rnfirebase.io/>
- 10- <https://lastminuteengineers.com/l293d-dc-motor-arduino-tutorial/>
- 11- <https://www.instructables.com/How-to-use-the-L293D-Motor-Driver-Arduino-Tutorial/>
- 12- <https://www.electronicshub.org/home-automation-projects/>