Remote control of smart home via the Internet of Things using an Android app.

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Abstract

Remote Control for the Smart House project aims to make life easier and more flexible for people with physical limitations, such as the elderly, by providing a remote controller for some of the house's equipment in the form of an Android application. Bluetooth serves as the connection point between the application and these devices; therefore, they must be within the same range. The "Smart House" application allows users to turn lights on and off, adjust their brightness, and change their color. This functionality is one of the many capabilities that are available in the application. In addition, it offers a protection system against fires by detecting gas leaks and providing an alarm for those leaks. A security system, consisting of a door with a password, is one of its features. And a great deal more in just a single application. To construct and develop the application, An Android Studio platform was utilized. In addition, the Arduino Software IDE was used to program the components (home devices).

Keywords— Smart House; Remote Control; Automation System; The internet of Things; Smart Home Applications; House Controller Computer vision.

I. INTRODUCTION

Technology is one of the things that makes the modern world so fascinating, incredible, and exciting to look forward to. When it comes to something as significant as the Smart House (remotely controllable), it attracts all attention, and many considerations can operate the house from a far distance. It is the case when it comes to the Smart House. The Internet of Things (IoT) has rapidly expanded its global reach. It is a system of interconnected electronic devices that can be controlled, monitored, and managed remotely from anywhere in the world using the internet. The concept of IoT has advanced significantly during the past several years. (Debnath, B.; Dey, R.; Roy, S,2019)

Kevin Ashton introduced the idea that would later become known as the IoT at one of his lectures in 1999 (IRMA, 2017). It means members of the following internet generation that enable devices, household appliances, sensors, actuators, and other types of things to connect. Any item can acquire "intelligent" capabilities. The IoT also enables users to exercise control over an object even when they are not physically present at the location where the device is located. With the help of the IoT, controlling equipment conveniently from a distance or up close is now conceivable. Several industries, including cloud computing and smart homes, are currently using it (Spadacini, M.; Savazzi, S.; Nicoli, M.2014;Al Razib, M.; Javeed, D.; Khan, M.T.; Alkanhel, R.; Muthanna,2022). There is far too much connectivity between the Internet of Things and the smart home remote. Actuators and sensors make up the wireless bright house of the network, which can link or exchange resources. The most important technology that may be used in home design and construction is this one. A "smart house" is a concept that aims to encompass the home and is a part of the IoT paradigm (Murthy, A.; Irshad, M.; Noman, S.M.; Tang, X.; Hu, B.; Chen, S.; Khader, G.2022; S. Khunchai and C. Thongchaisuratkrul,2019; L. -D. Liao et al,2019). Consumers can remotely monitor and manage their household appliances by connecting that equipment to the internet. A substantial technological advance has been made with this. Today's market is filled with a wide variety of intelligent gadgets, such as voice-activated light switches that can be controlled from a smartphone (Anandhavalli, D.; Mubina, N.S.; Bharath, P.2015;Baraka, K.; Ghobril, M.; Malek, S.; Kanj, R.; Kayssi, A.2013; R. Kaur, P. Vats, M. Mandot, S. S. Biswas and R. Garg,2021). The intelligent system aims to improve our lives by automating home appliances that we can control with our phones. Table 1 shows the proposals of this research for the virtual devices that we use daily in our lives:

Table 1. Suggested devices and their functions

Device	Function	Device	Function
LED Lights	Switched-on/Off	Fan	Switched-on/Off
	Control, the brightness		Control the speed

	Change the color	Garage	Open and Close
Door	Open and Close		Up and Down
	Secure the door with a password	Pool water temperature	Measure, the water temperature
Fire Alarm	Detect the fire		

The problem with research lies in the fact that most homes use an old-fashioned electrical system, which has issues and difficulties in controlling, managing, and interacting with commands. Additionally, for people who have health problems, it will be difficult for them to turn the device on or off. As a result, a lot of people have to go back home to turn off the electrical device because they forgot to turn it off before they left. Therefore, doing so is a poor use of one's time. When you want to turn on or off your light or open your door, you must use an app on your phone. This is because Remote Control for Smart House application solves the problems that have existed in traditional systems and transfer them to a new technique known as the Smart System. The Smart System interacts with devices and your phone through wireless technology known as Bluetooth. In addition, it alters how we live so that it will become more effective and comfortable while simultaneously reducing the amount of energy consumed. The application is intended to assist users in their day-to-day activities and make their lives easier, particularly those of older adults. Additionally, it's becoming more crucial than ever to protect the environment and keep homes safe, thus remote control offers the following advantages:

1. An intuitive interface for a wide variety of home appliances and electronics.

2. Use the Bluetooth connection to access and control devices in the house from anywhere or outside.

3. Decrease the amount of electricity you use.

4. Provides a high level of security for the home by attaching a password to the front door.

5. Raise the price that the house can be sold on the market.

6. With a single touch, take command of the entire home.

This paper follows: Section 2 and covers related work. Section 3 summarizes the research methods. Section 4 presents the model. Section 5 discusses the results. Section 6 conclusion.

II. RELATED WORKS

First, let's ask, "What makes the house smart?" Is it the way it's built, that it's good for the environment, or that it's in a good spot? If none of those things happen, then the smartness of the house comes from how appliances work together to make the whole place made of technology. Also, what is the history of Smart Houses from the beginning to the present? This section talks about that.
 Smart House, at first, was just an idea, but then it developed and expanded through time. Before the concept of Smart House, the house appliances start showing. Between, (1901-1920) house appliances were invented. At that time, it was an outstanding achievement (Mustafa, D. E. M.2022; Katre, S. R., & Rojatkar, D. V. 2017; Ray, A. K., & Bagwari, A.2017) for some of these appliances: in 1907, the first residential vacuum cleaner that was practical, and in 1913, the first home refrigerator(Great achievements, "Household Appliances Timeline".2022) Until nowadays, these house appliances are still invented and developed the existing ones. In (1966), ECHO IV was the first device created with the idea of home automation in mind. It needed lots of room to operate, 3kw (3000 watts) of power, and plenty of technical know-how to use. (Smart Home Technology in 1966.2022;Seo, E., & Yang, W. 2023) Home automation is now more user-friendly and simpler than it formerly was. The popularity of smart homes, or home automation, started to rise in the early 2000s. As a result, new technology started to appear. All of a sudden, consumers could now afford smart homes as a feasible choice. Home networking, domestic technology, and other devices started

to appear in stores. (Seo, E., & Yang, W. 2023). Smart houses today's evolved more than when they first started, so they are not limited to one or two, or even three appliances in the home. We talk about the entire house becoming smart. Also, most of their concepts are about security and saving energy and money. Lately has been added to the intelligent house the idea of remote control from a smartphone. Therefore, it makes it much easier and more flexible. For the future, about making the entire house made of a big screen, you can change the colour of the walls as you want or as your mood, or make your room like you are in the middle of the woods or a garden instead wallpapers(Jadon, Shivani and Choudhary, Arnav and Saini, Himanshu and Dua, Utkarsh and Sharma, Nikhil and Kaushik, Ila,2020). Also, the intelligent kitchen can make your breakfast when you wake up or are out at work and want your dinner ready when you come back, so it's a big help.

Some of the works linked to the proposed work or existing ones have an idea that is either identical to or comparable to the proposed work. It has been put in tabular form (Tables 2,3, and 4) to facilitate comparison. The tables contain the name of the application, the developer, a brief description of the application, and finally, its disadvantages.

Table 2. My Home Plus Application

Application	My Home Plus
Developer	VicinnoSoft LLC.
Description	You can manage every aspect of your home using MYHome Plus. The Nest Thermostat, Nest Protect, Nest Cam, WeMo Switch, WeMo Insight, WeMo Light Switch, and WeMo Motion are just a few examples of accessories that are compatible with Apple HomeKit. To control various items, you are no longer required to switch apps. Extra hardware is not required(myHome Plus Discerption.2020)
Disadvantages	Some of WeMo and Nest's devices are hard to control and don't have enough features, which is a waste of money. They are also not easy to use, and customer service doesn't respond quickly.

Table 3. Vivint Smart Home Application

Application	Vivint Smart Home
Developer	Vivint, Inc.
Description	With Vivint's Smart Home system, you can control doorbell cameras, security cameras, smart thermostats, door/window sensors, smoke detectors, and more from a single app. (Vivint Smart Home Discerption.2022)
Disadvantages	John Carlsen writes about Vivint Smart Home in Top Ten Reviews, "It is not compatible with more advanced home automation hardware. For instance, it cannot operate your home entertainment system or automatically open and close window curtains. (Vivint Smart Protect & Control Review.2022)

Table 4. L.G. Smart ThinQ Application

Application	L.G. Smart ThinQ
Developer	L.G. Electronics, Inc
Description	The LG Smart ThinQ Application will connect all of your smart home appliances, such as your refrigerator, washer, dryer, oven, robot vacuum, hairstyle, etc., to provide you a "better life with IoT. (LG Smart ThinQ Discerption.2022)
Disadvantages	There were problems when the app and devices first tried to connect. (50 Beast Smart Home Apps.2022)

Many systems for intelligent things have been devised and implemented in related works, ranging from simple to complex. Simple home automation is a system that manages everyday items like a fan or light. However, a complex system is one that manages bulky objects, like automatic intelligent doors. The core capabilities of home automation are not sufficiently addressed by several currently available approaches. The majority of home control systems do not give a user-friendly interface. In the current technological era, there is a need for an effective home control system that addresses the issues above. (Mahmood, Y., Kama, N., Azmi, A., & Ya'acob, S. 2020)

III. METHODOLOGY

The protocol used for controlling the house is a Bluetooth protocol, which allows the application to send commands (signals) to devices on the same range. Our application (an Android Application) uses the Android Studio program (Java language). It is possible to analyses, describe, and design the system with the assistance of UML Diagrams. In addition, it improves one's overall comprehension of the system in all aspects.

A. Use-case diagram

How users interact with the system is shown in a well-known use-case diagram. (Figure 1) displays the use-case diagram for the Smart House system. This Diagram represents the range of activities the user can perform with the system.
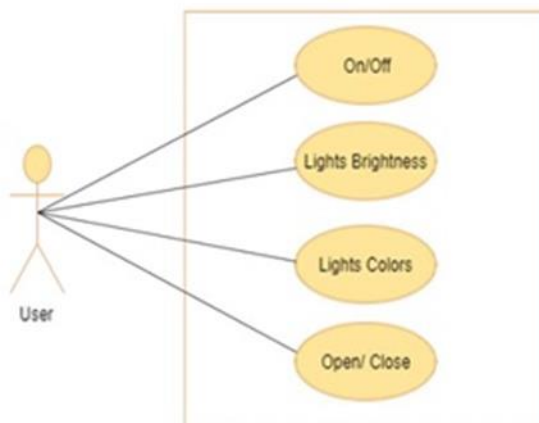
Fig 1. Use-case diagram.

B. Activity diagram

The mobile application's flow and the actions that users take within it are described in the activity diagram. The user's activity diagram within the mobile app is shown in (Figure 2). To demonstrate what the user can do with the house lights, the app opens with the home page before moving on to the first-floor page and the lights page.
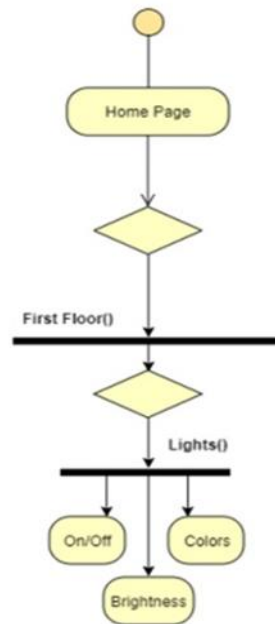
Fig 2. Activity diagram.

C. Sequence diagram

The sequence diagram is one of the most popular interaction diagrams. A sequence diagram demonstrates how different objects interact to form a behavior. Figure 3. shows a flowchart of the commands that users submit to gadgets. The system verifies the device or appliance's status, starting with the first user to ship orders. The machine or device then transmits its position back to the system for display to users.
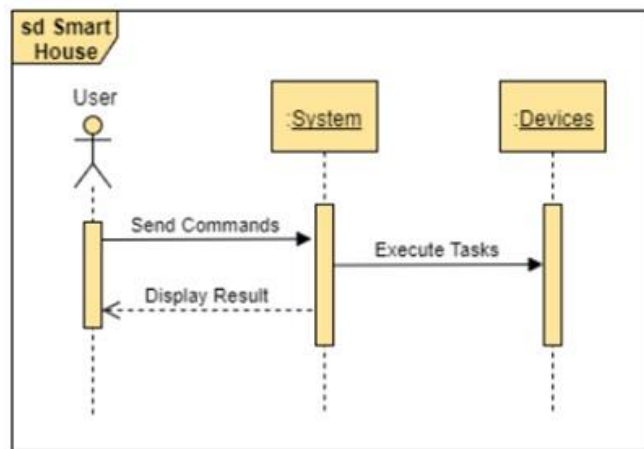

Fig 3. Sequence diagram.

D. Class diagram

The link between objects, classes, attributes, and operations is shown in the class diagram to illustrate the system's structure. The class diagram for the intelligent home system and the connections between kinds are shown in Figure 4. To describe the relationship between the User class and the device's class, the term "association" is used. The device categorizes its parts as sensors, indicating that it cannot function without them.
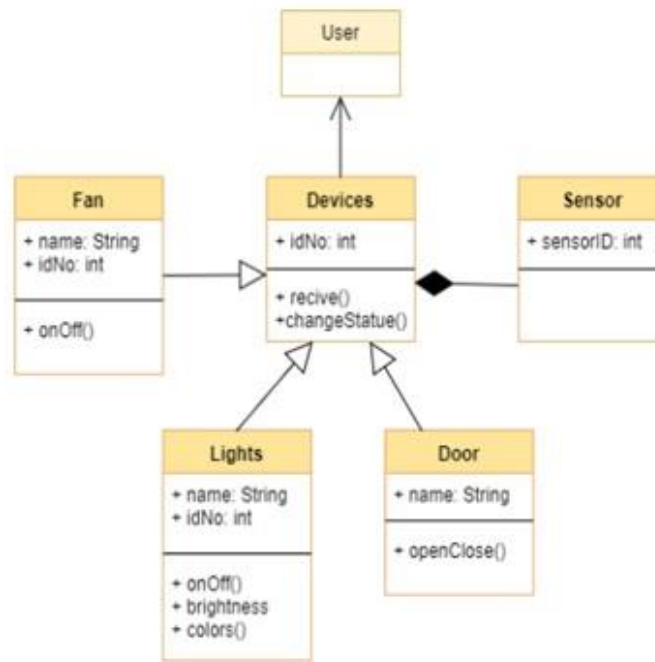
Fig 4. Class diagram.

IV.   THE PHYSICAL COMPONENTS

The proposed method offers inexpensive and efficient monitoring using IoT-based devices. (Adiono, T., Fuada, S., Anindya, S. F., Purwanda, I. G., & Fathany, M. Y. 2019) The components of a smart home are shown in Table 5.

Table 5 Show the hardware Components

Component Picture	Component Name	Component Picture	Component Name	Component Picture	Component Name
	Arduino UNO		Breadboard		Gas sensor
	fan		Digital temperature sensor		LCD screen
	Motion sensor		Piezoelectric sounder (Buzzer)		Humidity and temperature sensor

	Stepper motor		Bluetooth module		Resistor
	LED lights		Keypad		

There are a variety of protocols for home automation, which may be broken down into wired and wireless categories. A protocol can be considered a language that enables different devices to communicate. Table 5 shows the protocols used in remote control for an intelligent house application.

Table 6. protocol wireless connection

Protocol	Reasons for choosing
Wi-Fi	Because it is quick, dependable, and long-range, the Wi-Fi protocol makes it possible to communicate with devices located at a great distance.
Bluetooth	The Bluetooth feature, standard on most modern gadgets, allows for cordless phone pairing, although its range is limited.

V. RESULTS AND DISCUSSION

The house model consists of four parts: the first floor, the second floor, the garage, and the garden.

A. Experimental Validation

Figure 5 show application colors. For the application colors, they are:
Maverick - #CAB7C0
 Beauty Bush - #E5B9B8
Sweet Pink - #EC9F9C
Hop bush - #C46E9A
 Lipstick - #993366
Night Shads - #A04953

Fig 5. Application Colors

On the home page, the five main pages and an "About Us" page are in the title bar figure 6 show home page
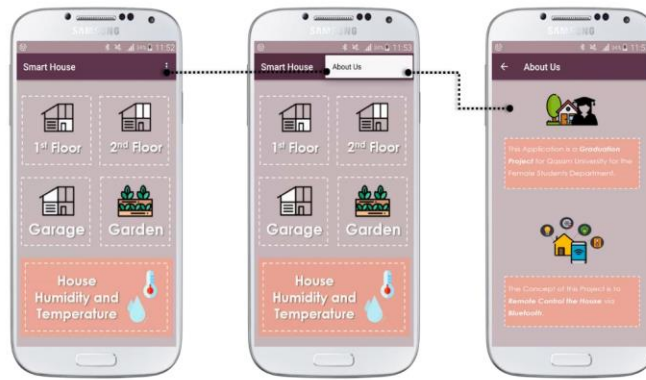.

Fig 6. Homepage

The First Floor and Second Floor pages, has a Lights and Fan sub-pages. figure 7 show first floor page.

Fig 7. First Floor page

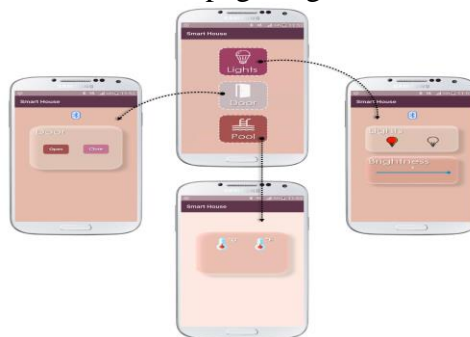The Garden page has a Lights, Door, and Pool sub-pages figure 8 show garden page

Fig 8. Garden page

To make an android application, it has used the Android Studio Program (version 3.1.4). Also, good knowledge in Java programming language.

B. **Android Studio Program:**

It's an integrated development environment (IDE) for Google's Android operating system, built on Jet Brains IntelliJ IDEA software and designed specifically for Android development. (P. U. Okorie, A. Abdu Ibraim and D. Auwal.2020) Android Studio supports three programming languages: Java, C++, and Katlin. One of its features it can work in any OS such as Windows and Mac OS. To make the application communicate with the Arduino UNO board, it has used the Arduino IDE (version 1.8.7).

C. **Arduino IDE Program:**

Its an open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. (Create UI test with Espresso Recorder.2022)

D. **some codes sample of the application**

Table 7. show application codes sample

Description	Code
| Code to control the brightness of the first floor lights. | ```java
brightness.setOnSeekBarChangeListener(new
SeekBar.OnSeekBarChangeListener() {
@Override
public void onProgressChanged(SeekBar
seekBar, int progress, boolean fromUser) {
current= progress + min;
textView.setText("" + current);
if (current == 1){
bluetooth.send(FIRST1, true);
}
else if (current == 2){
bluetooth.send(SECOND1, true);
}
else if (current == 3){
bluetooth.send(THIRD1, true);
}
else if (current == 4){
bluetooth.send(FOURTH1, true);
}
}
@Override
public void onStartTrackingTouch(SeekBar
seekBar) {
}
@Override
public void onStopTrackingTouch(SeekBar
seekBar) {
}
});
``` |
| Code to open the fan on the First Floor with Toast appears when it open. | ```java
fan_on.setOnClickListener(new
View.OnClickListener() {
@Override
public void onClick(View v) {
bluetooth.send(ON, true);
Toast.makeText(getBaseContext(), "Fan
On", Toast.LENGTH_SHORT).show();
}
});
``` |

Table 7 application codes sample

Table 8 show some codes sample of the Arduino UNO

Table 8 Arduino UNO Codes Sample

Description	Code	
	Void Setup()	**Void Loop()**
Gas sensor: If the smoke reaches threshold value the buzzer sound work.	```pinMode(buzzer, OUTPUT); pinMode(smoke, INPUT);```	```int gasSensor = analogRead(smoke); if (gasSensor > sensorThres) { tone(buzzer, 1000, 200); } else { noTone(buzzer); } delay(100); }```
Stepper motor: If the letter 'p' entered, it will send a command to open the door through the motor. And if the letter 'c' entered, it will send a command to close the door.	```stepper.setSpeed(500);```	```int value = Serial.read(); if (value == 'p') { int val= 2400; stepper.step(val); } else if (value == 'c') { int val2= -2400; stepper.step(val2); }```
4-pin LED light: The RGB color used to show more colors. Here the letter 'w' for white color and 'g' for green color.	```pinMode(redPin, OUTPUT); pinMode(greenPin, OUTPUT);```	```int value = Serial.read(); if (value == 'w') { setColor(255,255,255); delay(1000); } else if (value == 'g') { setColor(0,255,0); delay(1000); }```
Temperature and humidity: If '-' sign entered, it will send a command to show the humidity. And if '+' sign entered, it will send a command to show the temperature.	```DHT11.attach(3);```	```int value = Serial.read(); if (value == '-'){ int chk = DHT11.read(); switch (chk) { case 0: Serial.println(DHT11.humidity, DEC); break; } } else if (value == '+') { int chk = DHT11.read(); switch (chk) { case 0: Serial.println(DHT11.temperature, DEC); break; }```

E. **In this paper, a lot of hardware had used.**

PC.
 Android Phone: Samsung Galaxy S4.
Arduino UNO: contains (Bluetooth, Stepper Motor, Gas Sensor, Buzzer,
LED Lights, Fan, Water Temperature, Humidity and Temperature sensor,
Keypad, LCD Screen, and Motion Sensor).
Wires.
There are several types of testing, the application was tested in two types of Testing:
Table 9 Explanation Testing the System/Application on two different devices (Android Phone):

Table 9. Device Testing

Device (Android Phone)	Version	Results
Galaxy S4	5.0.1	The buttons fit perfectly with the size of the screen. It also works with no error.
OnePlus 3T	8.0.0	The buttons are small since the screen is big. It works with no error.

Testing the UI with Espresso Test Recorder:

Espresso Test Recorder is a tool lets you create UI tests for your app without writing any test code. By recording a test scenario, you can record your interactions with a device and add assertions to verify UI elements in particular snapshots of your app. Espresso Test Recorder then takes the saved recording and automatically generates a corresponding UI test that you can run to test your app. (. (Create UI test with Espresso Recorder.2022)

To make Espresso Test Recorder in Android Studio from the toolbar:

Run > Record Espresso Test. As shown in Figure 9.

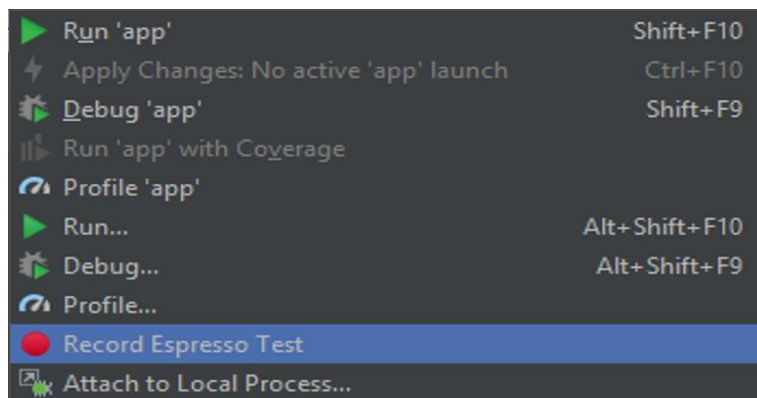Fig 9. Record Espresso Test

Figure 10 show the Lights on the First Floor testing.

Fig 10. First Floor Lights Testing

Table 10 Explanation of Figure 10

1	2	3	4	5	6	7	8
Open the First Floor page	Open the Lights page.	Press on Bluetooth Button.	Select the Bluetooth.	Open the Light.	Select color Red.	Select color Green.	Close the Light.

Figure 11 show Testing the Fan in First Floor:

Fig 11. First Floor Fan Testing

Table 11 show the Explanation of Figure 11

Table 11. Explanation of Figure 11

1	2	3	4	5	6
Back from Lights page.	Open the Fan page.	Press on Bluetooth Button.	Select the Bluetooth.	Open the Fan.	Close the Fan.

VI. CONCLUSION

Remote Control for Smart House seeks to help people, especially persons who are physically disabled, by giving them a remote controller for some devices in the house. Therefore, it will be a good choice for people interested in security, comfort, flexibility, and saving energy. The aim of this project; is to offer an easy-to-use application with a simple graphical user interface as a remote controller, serving LED lights, fans, garage, and doors, including multiple functions for each of them. It also offers a reading for the humidity and temperature of the house and a reading water temperature for the indoor pool.

VII. FUTURE WORK

Using Wi-Fi for wide range instead of Bluetooth.

Add new devices to the application.

Use the application on a real house instead of house model.

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