Smart Home

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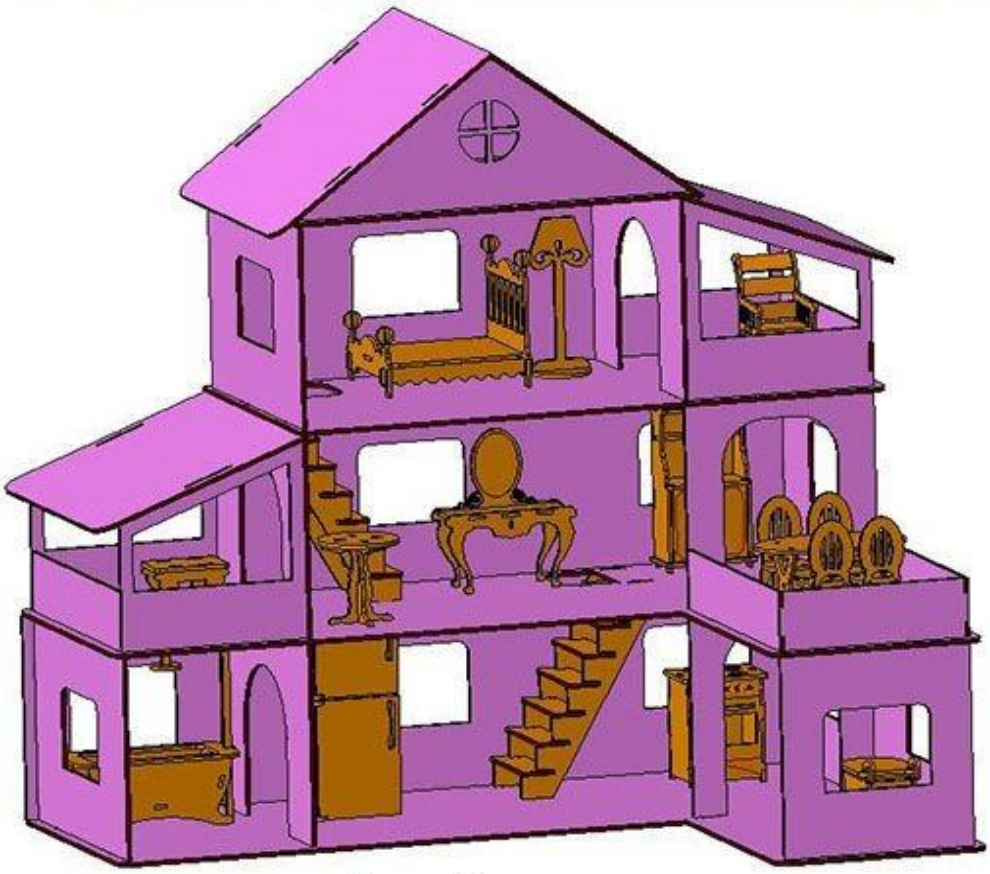
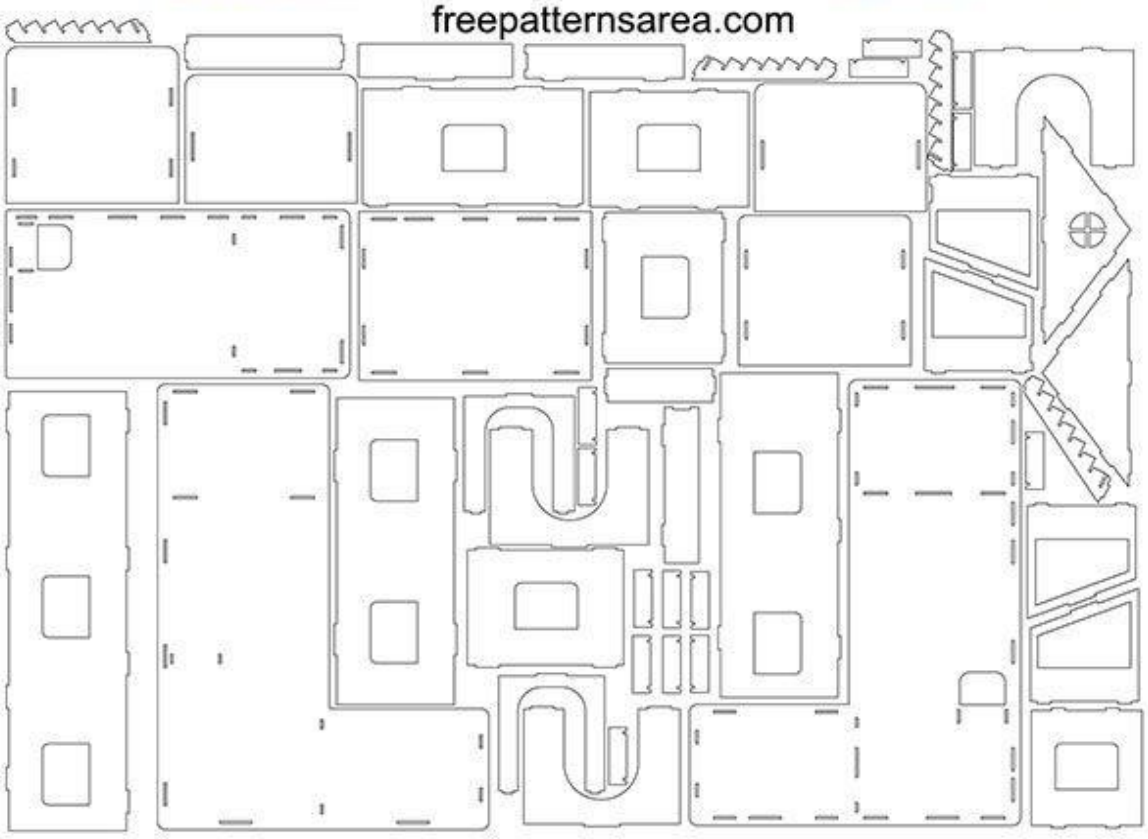
ICILLUSION

Home Automation





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ABSTRACT

Smart home systems achieved great popularity in the last decades as they increase the comfort and quality of life, this project intends to design a smart home System to improve the way that the person can control and monitor all the processes taking place at home.

The smart home system is controlled by smartphone and microcontrollers by using the Arduino electronic parts. A smartphone application is used to control and monitor home functions using wireless communication techniques.

Technology has many different fields and the entry of technology in our lives is important in terms of saving time, effort, and money.

ACKNOWLEDGMENTS

We would take this opportunity to express our sincere thanks and gratitude to our supervisor Dr. Esra'a Alzghoul for her vital support and guidance in completing this project.

We are also thankful to our families and fellows, especially to Heba Azzouqa and Rana Fraihat, for their great moral support and for helping us proofreading and spreading the questionnaire.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation	Page number
UI	User interface	1
I/O	Input/Output	2
IDE	Integrated development environment	3
USB	Universal Serial Bus	3
mm	Millimeter	3
AC	Alternating current	3
DC	Direct current	3
EEPROM	Erasable Programmable Read Only Memory	4
RAM	Random access memory	4
CPU	Central processing unit	4
KB	Kilobyte	4
LED	A light-emitting diode	4
TX	Stands for transmit	6
RX	Stands for receive	6
PC	Personal computer	6
GB	Gigabyte	16
ROI	Return on investment	16
IOT	Internet of things	25
ID	Identity	28
API	Application Programming Interface	31
Wi-Fi	Wireless Fidelity	33
RDBMS	relational database management system	41
GUI	Graphical User Interface	46
IT	Information Technology	47

LIST OF Symbols

Symbol	Stands for	Page number
~	tilde	5

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CHAPTER ONE

Introduction

1.1 Preamble

The smart home system provides an easy and convenient environment for the person, for example control the home lights. In addition to set lock to the home door with alarm system.

The controlling process of this smart home very fast with Arduino and the mobile or desktop application.

We will be using an application connected with Google Assistant to control everything in the project that we will be developing ourselves, with a simple enough UI to allow convenient use.

We will be building the home with simple Arduino parts that are connected together, with a simple control mechanism using a mobile application for wireless commands using Google Assistant.

1.2 Project Motivation

The motivation of our project is to design a smart home System to improve the way that the person can control and monitor all the processes taking place at home.

1.3 Problem Statements

Technology has many different fields and the entry of technology in our lives is important in terms of saving time, effort, money, and increasing security.

1.4 Project Aim and Objectives

The aim of this project is to design a Smart home system controlled by smartphone and microcontrollers by using the Arduino electronic parts.

1.5 Project Scope

All people who use smartphone and interested in Smart Homes.

1.6 Project Software and Hardware Requirements

- **Design Tools:**

We will be using an online website for planning and creating the Arduino studio called Tinkercad.com for Design.

- **Software Requirements:**

We will be using the Android programming language to create and develop the mobile application.

- **Hardware Requirements:**

We will be using conventional Arduino UNO, Sensors, Actuators available to us, and we have a wide range of devices suitable for the development work we are conducting.

Hardware components:

1. **Arduino UNO:** is an open-source microcontroller board based on the Microchip ATmega328p microcontroller and developed by Arduino. The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. As shown in figure 1.1 below:

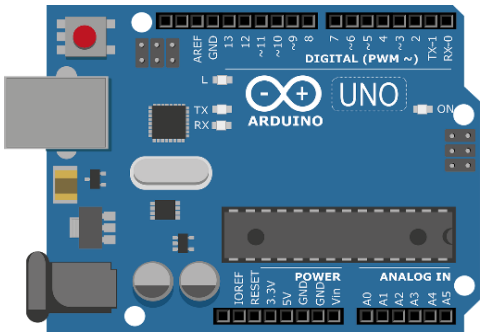


Figure 1.1: Arduino UNO

Some basic parts of Arduino UNO, shown in figure 1.2 below:

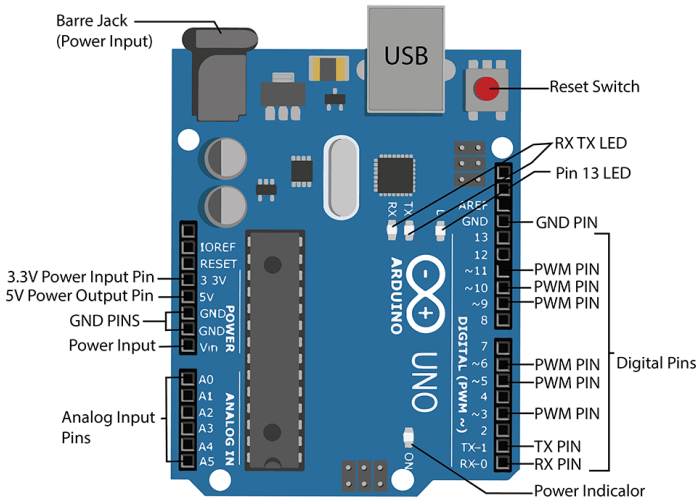


Figure 1.2: The major components of Arduino UNO board

- USB connector: USB port used to load a program from the Arduino IDE onto the Arduino board. The board can also be powered through power port.
- Power port: The Arduino board can be powered through an AC-to-DC adapter or a battery. The power source can be connected by plugging in a 2.1mm center-positive plug, as shown in figure 1.3 below, into the power jack of the board.

Figure 1.3: 2.1mm center positive plug

The Arduino UNO board operates at a voltage of 5 volts, but it can withstand a maximum voltage of 20 volts. If the board is supplied with a higher voltage, there is a voltage regulator (it sits between the power port and USB connector) that protects the board from burning out.

- Microcontroller: It is the most prominent black rectangular chip with 28 pins. Think of it as the brains of your Arduino. The microcontroller used on the UNO board is Atmega328P by Atmel (a major microcontroller manufacturer), As shown in figure

1.4 below. Atmega328P has the following components in it: Flash Memory of 32KB, RAM of 2KB, CPU, Electrically Erasable Programmable Read Only Memory (EEPROM) of 1KB.

Atmega328P is pre-programmed with bootloader. This allows you to directly upload a new Arduino program into the device, without using any external hardware programmer, making the Arduino UNO board easy to use.

Figure 1.4: Atmega328P microcontroller

- Analog input pins: The Arduino UNO board has 6 analog input pins, labeled "Analog 0 to 5." These pins can read the signal from an analog sensor like a temperature sensor and convert it into a digital value so that the system understands. These pins just measure voltage and not the current because they have very high internal resistance. Hence, only a small amount of current flows through these pins.

  Although these pins are labeled analog and are analog input by default, these pins can also be used for digital input or output, as shown in figure 1.5 below.

- Digital pins: You can find these pins labeled "Digital 0 to 13." These pins can be used as either input or output pins. When used as output, these pins act as a power supply source for the components connected to them. When used as input pins, they read the signals from the component connected to them.

  When digital pins are used as output pins, they supply 40 milliamps of current at 5 volts, which is more than enough to light an LED.

Some of the digital pins are labeled with tilde (~) symbol next to the pin numbers (pin numbers 3, 5, 6, 9, 10, and 11), as shown in figure 1.5 below. These pins act as normal digital pins but can also be used for Pulse-Width Modulation (PWM), which simulates analog output like fading an LED in and out.

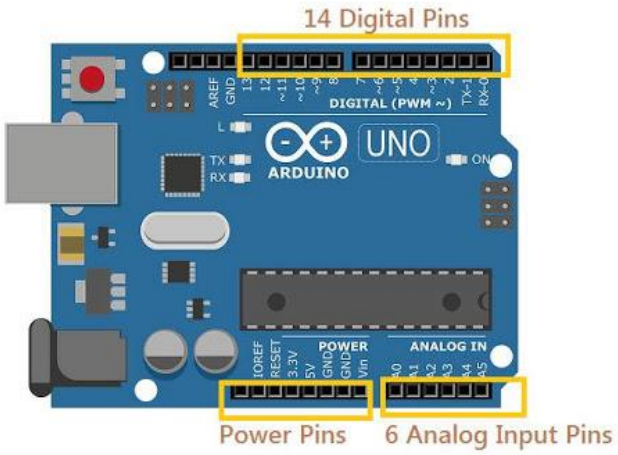


Figure 1.5: Digital and Analog pins

- Reset switch: When this switch is clicked, it sends a logical pulse to the reset pin of the Microcontroller, and now runs the program again from the start. This can be very useful if your code doesn't repeat, but you want to test it multiple times.
- Crystal oscillator: This is a quartz crystal oscillator, As shown in figure 1.6 below, which ticks 16 million times a second. On each tick, the microcontroller performs one operation, for example, addition, subtraction, etc.

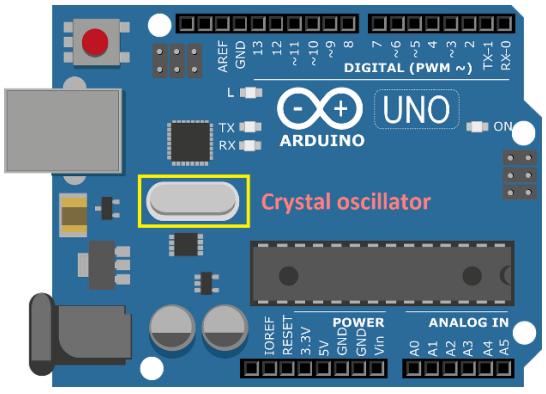


Figure 1.6: Crystal oscillator

- USB interface chip: Think of this as a signal translator. It converts signals in the USB level to a level that an Arduino UNO board understands, as shown in figure 1.7 below:

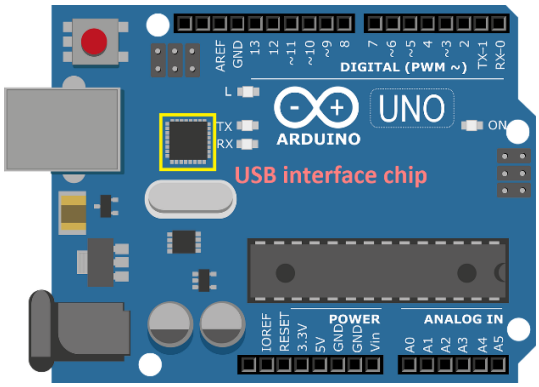


Figure 1.7: USB interface chip

- TX RX LEDs: TX stands for transmit, and RX for receive. These are indicator LEDs which blink whenever the UNO board is transmitting or receiving data.

2. **Bluetooth module:** Bluetooth module is a slave Bluetooth module designed for wireless serial communication. It is a slave module meaning that it can receive serial data when serial data is sent out from a master Bluetooth device (device able to send serial data through the air: smart phones, PC), as shown in figure 1.8 below:

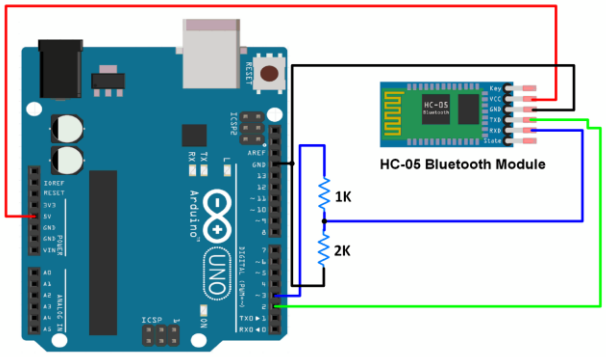


Figure 1.8: Bluetooth module

3. **Breadboard:** Breadboard is a way of constructing electronics without having to use a soldering iron. Components are pushed into the sockets on the breadboard and then extra 'jumper' wires are used to make connections. As shown in figure 1.9 below:

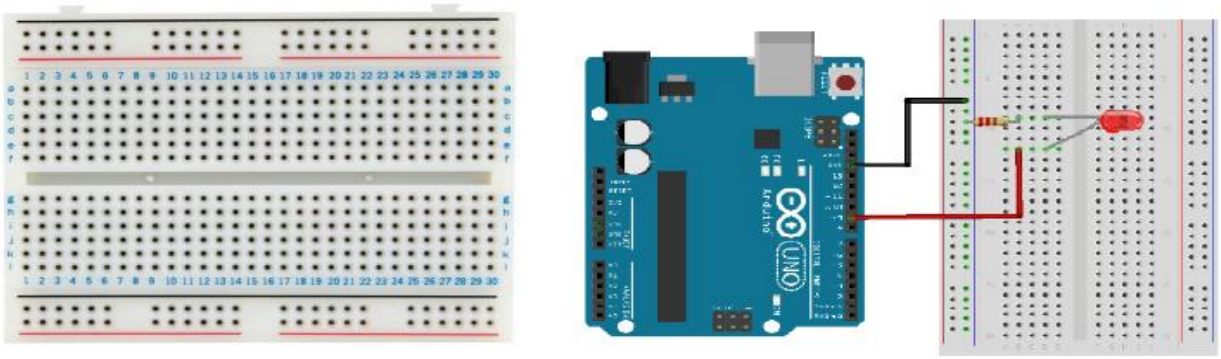


Figure 1.9: Breadboard

4. **Jumper wires**: jumper wire, are used to wire components together when using a solderless breadboard. As shown in figure 1.10 below:

Figure 1.10: Jumper wires

5. **Resistors**: When building your Arduino projects, you use resistors, as shown in figure 1.11 below, to limit the amount of current going to certain components in the circuit, such as LEDs and integrated circuits.

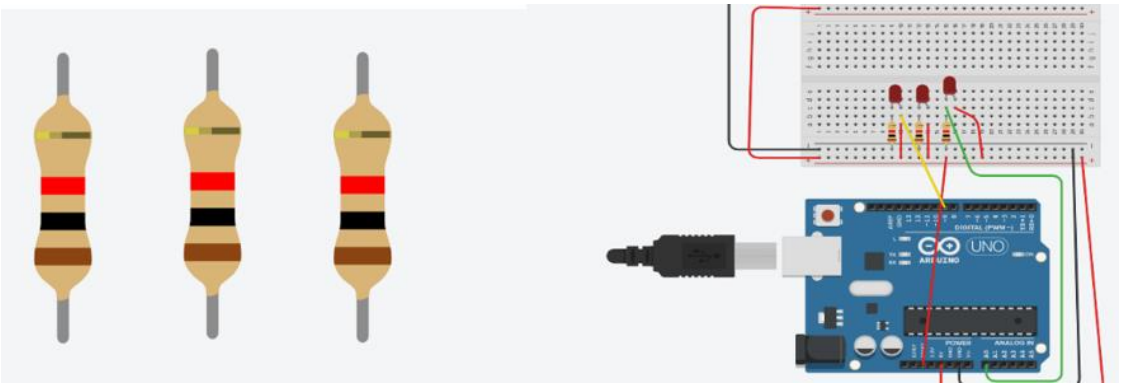


Figure 1.11: Resistors

6. Arduino security modules (sensors):

- **Motion sensor:** sensor allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. As shown in figure 1.12 below:

Figure 1.12: Motion sensor

- **Ultrasonic sensor:** is a device that measures distance to an object using Sound Waves. It works by sending out a sound wave at ultrasonic frequency and waits for it to bounce back from the object. Then, the time delay between transmission of sound and receiving of the sound is used to calculate the distance. As shown in figure 1.13 below:

Figure 1.13: Ultrasonic sensor

- **Camera module:** a camera will use to detect objects or monitor the house. As shown in figure 1.14 below:

Figure 1.14: Camera module

- **Temperature/humidity sensor:** The Temperature Sensor are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. As shown in figure 1.15 below:

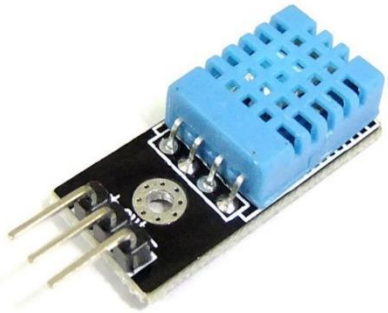


Figure 1.15: Temperature/humidity sensor

- **Buzzer:** It is basically a tiny speaker that you can connect directly to an Arduino. You can make it sound a tone at a frequency you set. The buzzer produces sound based on reverse of the piezoelectric effect. As shown in figure 1.16 below:

Figure 1.16: Buzzer

7. Arduino controlling parts (Actuators):

- **Servo Motor:** a motor that can turn to a specified position. Usually, they have a servo arm that can turn 180 degrees. As shown in figure 1.17 below:

Figure 1.17: Servo motor

- **LED lights:** small lights with different colors. As shown in figure 1.18 below:

Figure 1.18: LED lights

- **NodeMCU:** is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added.

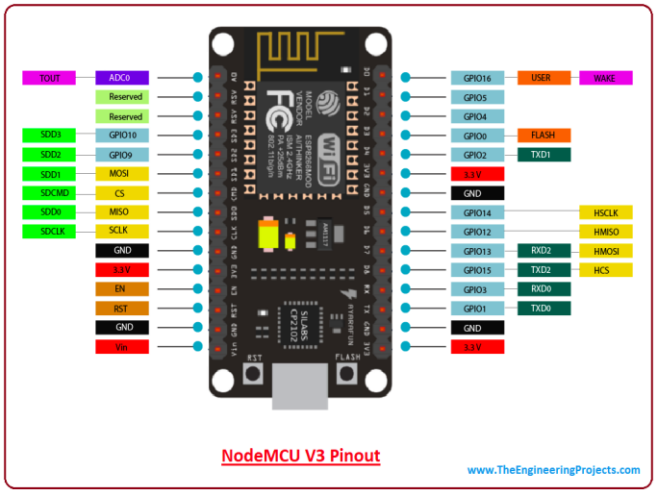


Figure 1.19: NodeMCU

1.7 Project Limitations

Smart home system has significant installation costs, reliable internet connection is crucial, security issues, Helplessness if technology fails, you may lock yourself out of your own house, Smart home technology not suitable for all houses, maintenance, and repair issues.

1.8 Project Expected Output

a small house, with many mechanisms inside that are controlled remotely, providing ease, comfort, and security.

The smart home system is controlled by smartphone and microcontrollers by using the Arduino electronic parts. A smartphone application is used to control and monitor home functions using wireless communication techniques.

1.9 Project Schedule

Table 1.1: Project schedule

Task	Description	Start Time	End Time	Duration	Dependency
T1	Gathering information	8/3/21	21/3/21	2 Week	-
T2	Planning	22/3/21	31/3/21	10 Days	T1
T3	Analysis	1/4/21	15/4/21	15 Days	T1, T2
T4	Design prototype	18/4/21	1/5/21	2 Weeks	T3
T5	Documentation	7/8/21	28/8/21	3 Weeks	T1, T2, T3
T6	Delivery	29/8/21	29/8/21	-	T5

1.10 Report Outline

We will explain what will happen in every chapter.
Chapter One: show introduction about our application.
Chapter Two: show the other application that close to our application.
Chapter Three: show the functional requirements and nonfunctional requirements.
Chapter Four: show the design of our project.
Chapter five: show the details of database and graphical user interface.
Chapter six: show the test of our project.
Chapter seven: show the future work and strength and weakness of our project.

CHAPTER TWO

Related Existing Systems

2.1 Introduction

There are many projects about smart home using Arduino that allowed users to watch, control their homes from far away.

But each application has a certain feature, and existing applications do not meet the needs of users as well, and for each application has an advantages and disadvantage.

2.2 Existing Systems

when we searched for related applications, we found a lot of applications contained activities for smart homes using 1sheeld, as shown in figure 2.1 below. "The 1Sheeld, a single shield that lets you replace all of those other shields with your smartphone".

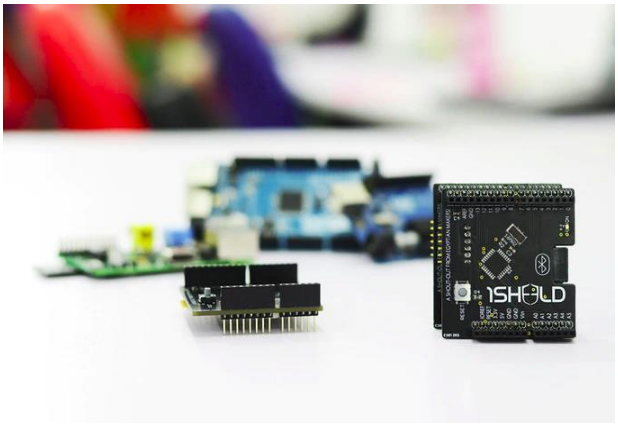


Figure 2.1: 1Sheeld board

you can use 1Sheeld as input or output from Arduino and make use of all the sensors and peripherals already available on your Android smartphone instead of buying the actual shields.

1Sheeld turns your smartphone into 40 different Arduino shields. As shown in figure 1.22 below:

but for us we want to design our smart home using regular sensors not using smartphone sensors because it is cheaper.

We found four home automation companies in Jordan:

- ⇨ LightWave Technologies.
- ⇨ Energy Pack Engineering.
- ⇨ Xiaomi Jordan.
- ⇨ C22 Jordan.

2.3 Overall Problems of Existing Systems

The most systems and applications contain problems and these problems:

- The interface is difficult to use.
- There are no applications similar in our country.
- The 1Sheeld is not affordable.
- Regular sensors are much cheaper than smart mobile only buys it to use its sensors.
- For security we do not know what is inside 1sheeld micro controller.

2.4 Overall Solutions Approach

Through our search for solutions the problems experienced by users, we have proposed solutions provide mobile web applications to keep the user monitor, control

their smart homes from far way using regular sensors without the need for smartphone sensors, plus they can know the micro controller code.

2.5 Summary

In this chapter we introduced an existing system that is related to our project which has been taken into consideration to avoid and its weakness points and improve its strength points and we proposed out solution to make it useful system and more secure.

CHAPTER THREE
SYSTEM REQUIREMENTS ENGINEERING AND ANALYSIS

3.1 Introduction

To implement a good system, it must meet user needs and requirements. Each system has both functional and nonfunctional requirements. To achieve our goal, we gathered the needed requirements and specifications of our project to make sure we were satisfying them in our system.

3.2 Feasibility Study

3.2.1 Technical Feasibility

Our application has been developed by android and will be used for smart phones to support the android system, the primary technical requirement includes making the interface easy to interact with it, easy to understand, the system can also be developed of the new technology is acquired, thus through all ends technical feasibility was met.

- programming language: C++
- Hardware: smart phones that use android system, with 1GB storage free and ATmega328p microcontroller, regular sensors.

3.2.2 Economic Feasibility

The costs were 506JOD as shown in the table 3.1 below.

Table 3.1: Economic Feasibility

11	Component Name	Price	Quantity	Price * Quantity
12	IOT kit Node MCU 1.0V	20	1	20
13	nfrared Flame Detection Sensor	5	1	5
14	Natural Gas (CNG) Sensor – MQ-4	5	1	5
15	USB micro-B Cable - 6 Foot	5	1	5
16	BreadBoard	5	2	10
17	Jumper Wires Pack – M/M	2	120	240
18	LED - Basic Blue 5mm	1	7	7
19	LED - Basic orange 5mm	1	7	7
20	47 Ohm Resisto	1	18	18
21	LED - RGB Addressable, PTH, 5mm	7	1	7
22	House building	120	1	120
23	Cloud hosting server	25	1	25
24	Blynk subscription	30	1	30
25	IFFT subscription	7	1	7
26	Total			506

⇨ Is the system cost effective?
Yes.

3.2.3 Operational Feasibility

The Smart home software operationally feasible. This application provides necessary information to the users such as how to provide the information and regarding different operations according to the database logical definition.

⇨ How do the end-users feel about their role in the new system?
The users will feel happy because they are able to control their smart houses from abroad.

⇨ Will accessibility of information be lost?
No, because it will be cloud database, so data will not get lost.

⇨ Does current mode of operation provide reliable service?
Absolutely, this application provides these services:

- Control the household Devices like fan and light.
- Tells the status of the devices.
- Tells the weather condition of the house (temperature and humidity).
- Sends the snapshot of interior of the house to user via Gmail when required.
- Sends notification in case of intruder, Fire, Guest (also sends photo).

3.3 Requirements Elicitation Techniques

We made a questionnaire and spread it through Facebook groups of University of Jordan and Prince Sultan University.

3.3.1 Questionnaire

Smart Home

Smart home systems achieved great popularity in the last decades as they increase the comfort and quality of life.
We would like to hear your thoughts on the important topic of Smart Home Technology and how it makes our lives easier!
This survey will help us find out how we could implement the use of Smart Homes Technology. Thank you in participating and sharing your thoughts.

*Required

Do you use smart home tech in your home/ apartment? *

- ◯ Yes
- ◯ No
- ◯ Maybe

Do you think that the level of security provided in your home is enough to make you feel safe? *

- ◯ Yes
- ◯ No
- ◯ Maybe

Do you approve of using cameras inside the house to maintain security and safety? *

- ◯ Yes
- ◯ No
- ◯ Maybe

Do you approve of using a keypad at the door to enter a security password to provide clearance of entering? *

- ◯ Yes
- ◯ No
- ◯ Maybe

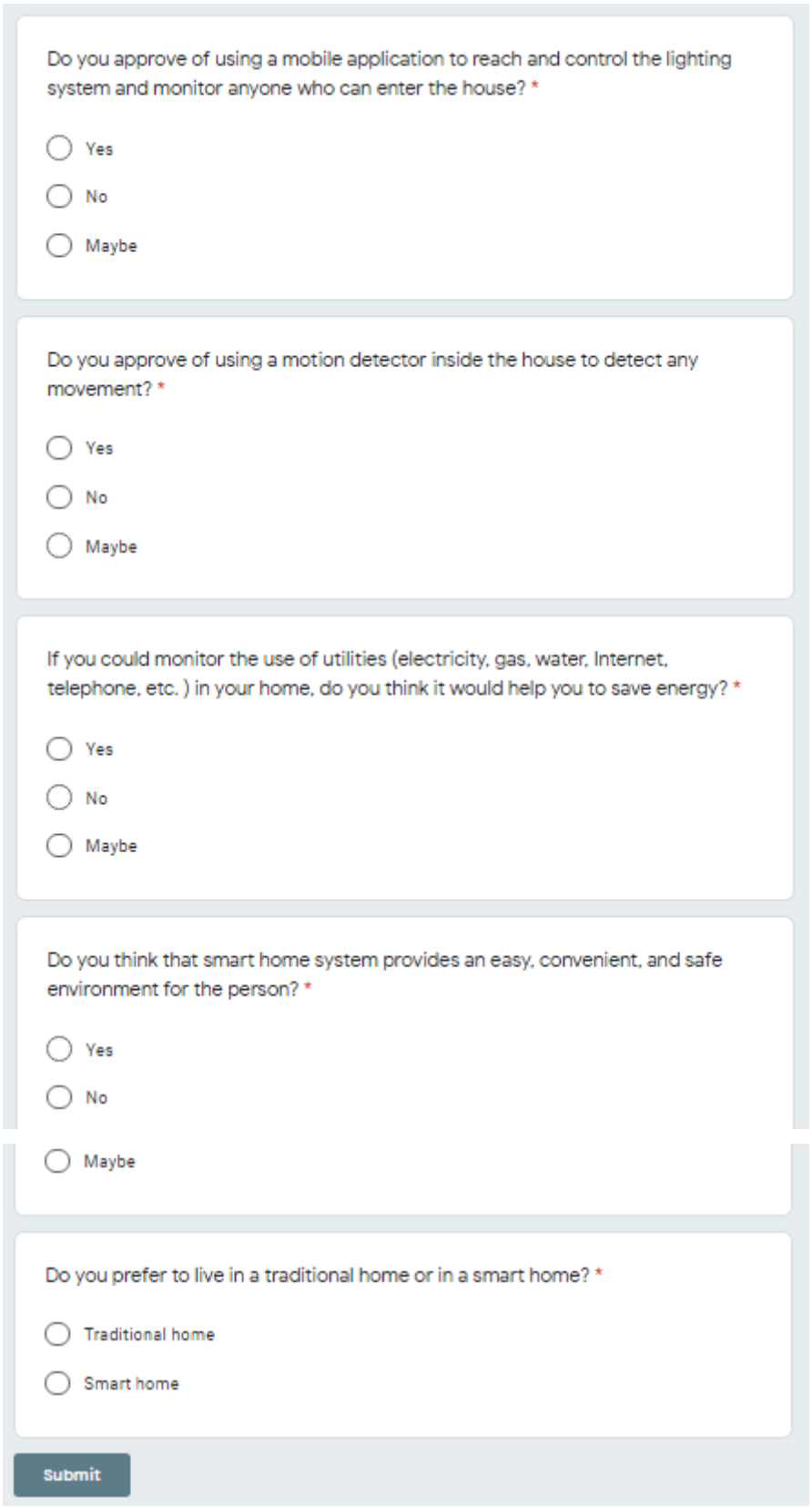
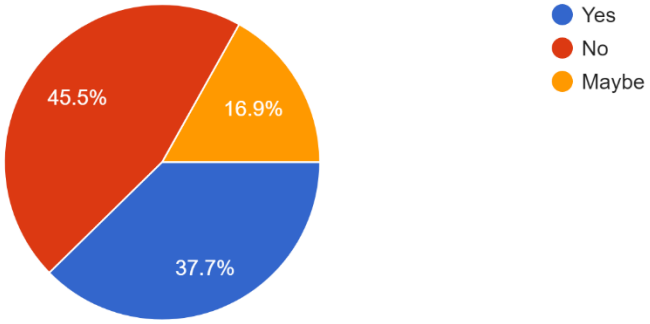


Figure 3.1: Questionnaire form

3.3.2 Responses of Questionnaire

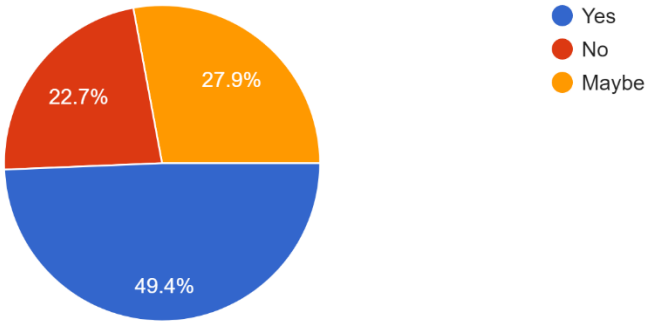
Do you use smart home tech in your home/ apartment?

154 responses



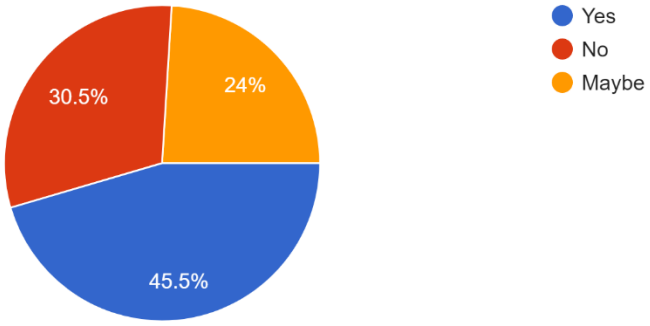
Do you think that the level of security provided in your home is enough to make you feel safe?

154 responses



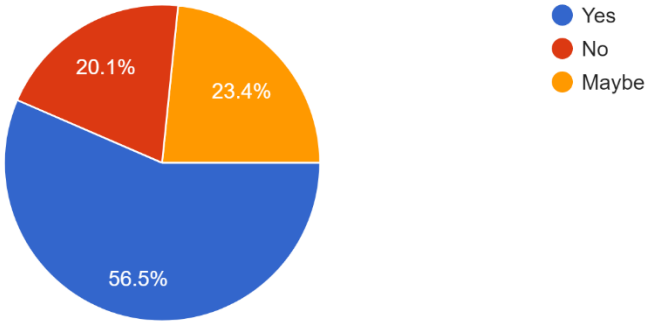
Do you approve of using cameras inside the house to maintain security and safety?

154 responses



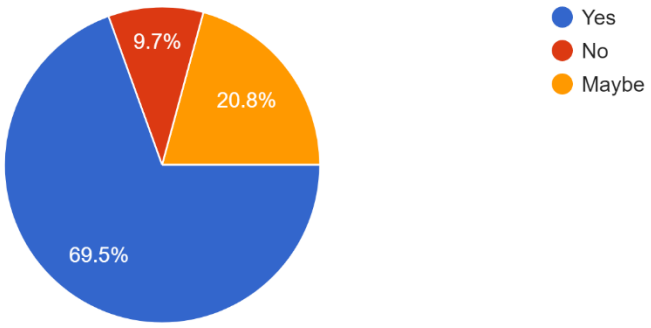
Do you approve of using a keypad at the door to enter a security password to provide clearance of entering?

154 responses



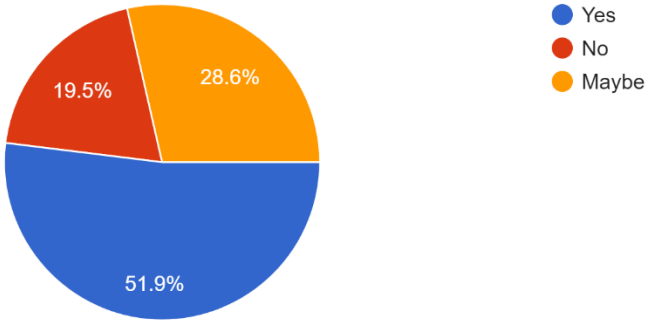
Do you approve of using a mobile application to reach and control the lighting system and monitor anyone who can enter the house?

154 responses



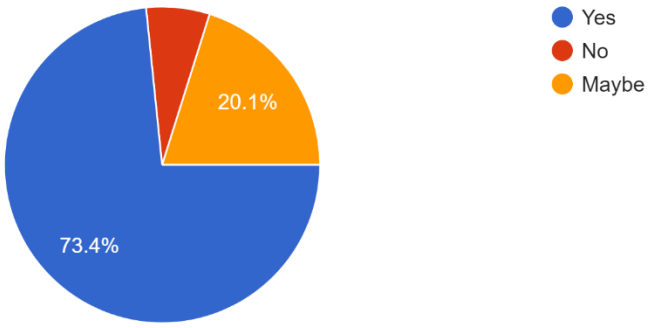
Do you approve of using a motion detector inside the house to detect any movement?

154 responses



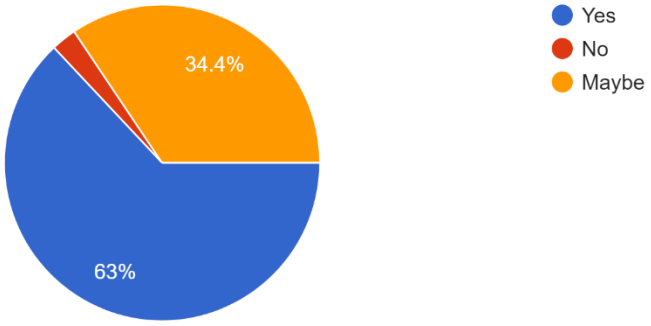
If you could monitor the use of utilities (electricity, gas, water, Internet, telephone, etc.) in your home, do you think it would help you to save energy?

154 responses



Do you think that smart home system provides an easy, convenient, and safe environment for the person?

154 responses



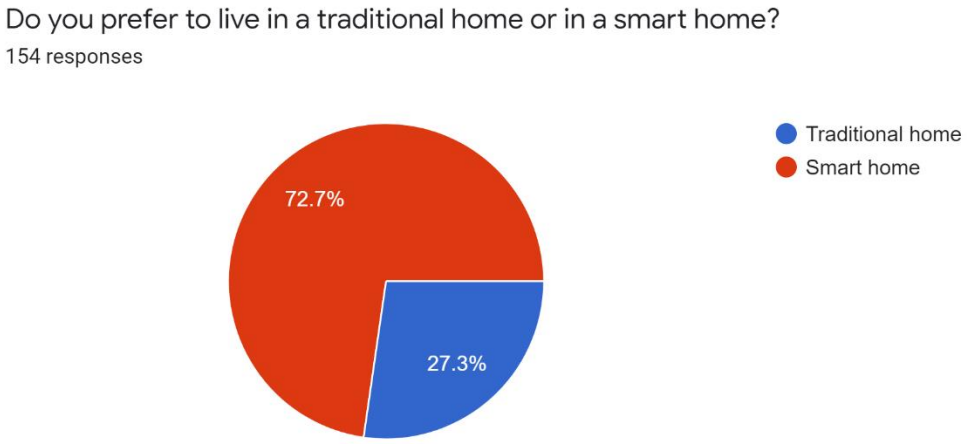


Figure 3.2: Results of questionnaire

3.3.3 Interview

Interviewer: Leena Azzouqa.

Person interviewed: Mohammed Habash.

Date: 6, May 2021.

Summary of Interview:

Mohammed Habash said: Smart home is a great idea and its one of the most obvious apps of IOT and I imagine that it would ease our lives if we applied it correctly. If there was a mobile application controls my home, I will use it. I prefer to live in a smart home because it is easier for me. And I don't think there will be a lot of disadvantages about smart homes, if it's about security concerns so it's always existed, so I don't see a big disadvantage of smart homes".

When told about the idea of our application, he responded with: "It's so amazing, and I imagine if there will be a voice control, and an easy beautiful interface it would be great".

Interviewer: Leena Azzouqa.

Person interviewed: Ahmad Rajeh.

Date: 6, May 2021.

Summary of Interview:

Ahmad Rajeh said:" I definitely would live in a smart home, I believe smart homes are the future and there's nothing wrong with that except that we'll become lazier, it's a great idea to have an app universal for as much devices as possible as these devices normally has 1 app per every piece which is not convenient to operate one home, so I'm down to use 1 app for all of them".

When told about the idea of our application, he responded with: "I think it's a creative idea if it's possible, I would definitely use it whenever my house become smart home".

Interviewer: Leena Azzouqa.

Person interviewed: Yasmeen Imad.

Date: 7, May 2021.

Summary of Interview:

Yasmeen Imad said:" I think it's a great idea! It makes your home more secure and safe.

You can easily lock your house with a click of a button, who wouldn't love that !

It makes everyday tasks easier like turning on and off the lights, closing the garage door, and locking your house. If i had the choice to live in a smart home and have this amazing experience i wouldn't say no".

When told about the idea of our application, she responded with: “I would love to test it out and try everything out and think that most people will enjoy this experience”.

Interviewer: Leena Azzouqa.

Person interviewed: Shahed Ahmed Kwarah.

Date: 8, May 2021.

Summary of Interview:

Shahed Ahmed Kwarah said: “In my opinion, smart homes are really helpful for many different users because it supports their differences. For example, users with some disabilities need to have some technology that helps them to make their lives more easily. Also, smart homes allow for a more flexible, easy, and functional alternative to traditional homes that allows everyone to use it and it's so easy to modify and improve. In my point of view, I see that this technology may have some issues, but they can be strengthened to improve privacy and security.”

When told about the idea of our application, she responded with: “I advise everyone to change their homes to be smarter, and when available I will do the same.”

Interviewer: Leena Azzouqa.

Person interviewed: Darin Al-Zoubi.

Date: 8, May 2021.

Summary of Interview:

Darin Al-Zoubi said: “In my perspective, smart homes are becoming a necessity rather than a luxury. Our fast-based lives made it fundamental for our homes to adapt to such lifestyles. Switching to smart homes can offer flexibility, comfort, and adaptability for all users.”

When told about the idea of our application, she responded with: “I find your idea interesting, and I would definitely like it to be implemented in my house.”

3.4 Targeted Users

All people who use smartphone and interested in Smart Homes.

3.5 Functional Requirements Definition

Table 3.2: Functional Requirements Definition

#R	Requirements	Definition
1	Registration (Sign Up)	The users must register and fill some information to use the application
2	Sign In	The users can sign in using their email and password
3	Logout	If the client wants to logout from the application or change, deactivate their accounts they can
4	Collected Information	-Personal Information -Session Details
5	Home Page	Home Page that contains the start page when user log in
6	Sensors Page	Contain page user can control Home Sensors from it
7	Lighting Page	Contain page user can control Home Lighting from it
8	Devices Page	Contain page user can control Home Devices from it
9	Settings Page	Contain page user can change, configure new setting
10	Contact Us	Customers can communicate supporting team

3.6 Functional Requirements Specifications

Table 3.3: Functional Requirements Specifications

#R	Requirements	Definition
1	Registration (Sign Up)	User steps for sign up: -click on register button -enter your email -fill needed information: * Full name * Age * Phone Number * Password
2	Sign In	User steps for sign in: -Enter username (Email) and password -click login button -if valid, log in to applications -if not return “renter your information”
3	Logout	Users steps for logout: -Click on “log out” button
4	Collected Information	Users steps to view their information -Click on “View Information.” -You can see all the information you fill it out in registration. -Can edit this information -After edit must click on “Save” button
5	Home Page	-Home Page contain 4 buttons:

		-Sensors Page Button -Lighting Page Button -Devices Page Button -Settings Page Button
6	Sensors Page	User steps to view house sensors: -View button to view sensors status -Switcher button to change sensors status
7	Lighting Page	User steps to view house lights: -View button to view lights status -Switcher button to change lights status
8	Devices Page	User steps to view house Devices that may be connected to the app(optional): -View button to device lights status -Switcher button to change device status -For devices like Alexa, google assistant user can connect to it using single sign on.
9	Settings Page	User steps to change settings: -Change setting * Privacy settings * Personal settings
10	Contact Us	User steps to contact us: -Click on contact us will give the user phone number, and our email

3.7 Nonfunctional Requirements

Table 3.4: Nonfunctional requirements

Number	Requirement	Description
1	Performance	a) Speed and Response Time: The system must have a response time of 2 seconds in cases of errors. b) User Interface: System's user-interface must be easy to navigate through and use for all users.
2	Security	The system protects the customer data by preventing access to any user information using these authentications: a) customer ID and fingerprint b) Login ID c) Modification
3	Reliability	This application understands how the client uses the application and develop solutions to problems that the client may face e.g., Add a reset button to specify a new password.
4	Simplicity	System must use simple language understandable by all users of the system.
5	Availability	The system must be available all the time.

6	Safety	Human errors System must be immune to some common human errors.
7	Software Quality	Good quality of the framework gives the system great credibility of use.
8	Maintainability	Backup of the system's data must be a part of the system.

3.8 Summary

This chapter includes a feasibility study, project cost, target people, some interviews, and a survey to find out how interested people are in the idea of the project, it also included functional and non-functional requirements of the system.

CHAPTER FOUR

System Design

4.1 Introduction

The Unified Modeling Language is a general-purpose, developmental, modeling language in the field of software engineering that is intended to provide a standard way to visualize the design of a system.

In this chapter we will describe the context diagram, data flow diagram, entity relationship diagram, UML use case diagram, UML sequence diagram, UML class diagram, and graphical user interface design.

4.2 Context Diagram

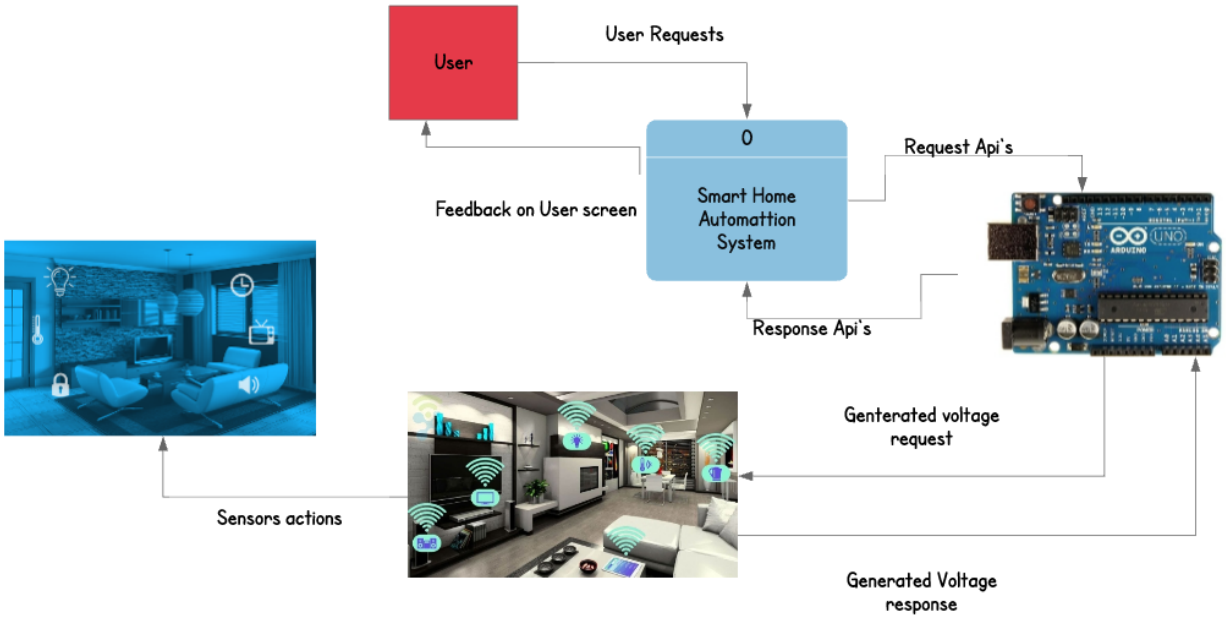


Figure 4.1: Context Diagram

4.3 Data Flow Diagram (DFD)

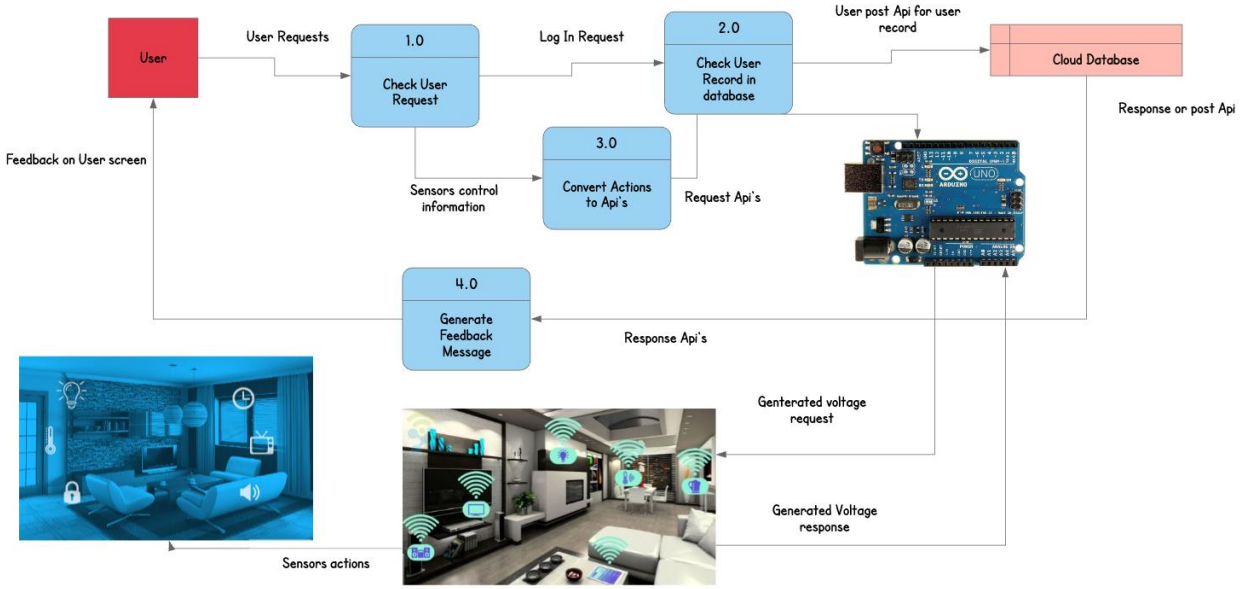


Figure 4.2: Data Flow Diagram

4.4 Entity Relationship Diagram (ERD)

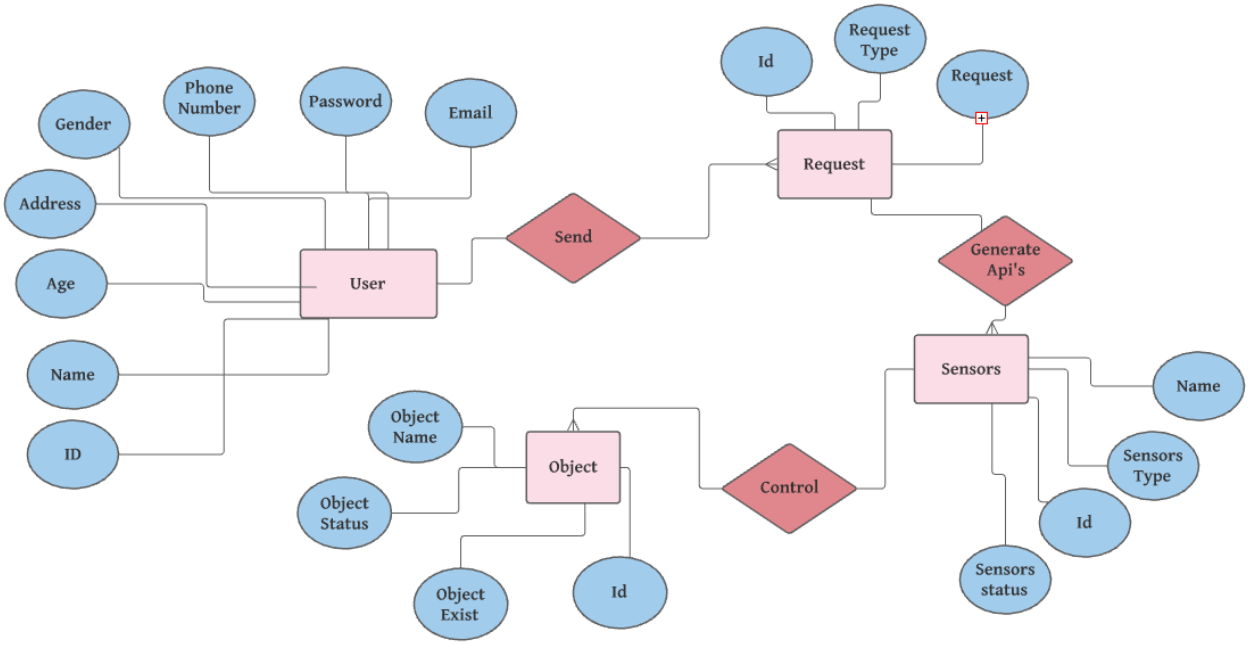


Figure 4.3: Entity Relationship Diagram

4.5 UML Use Case Diagram

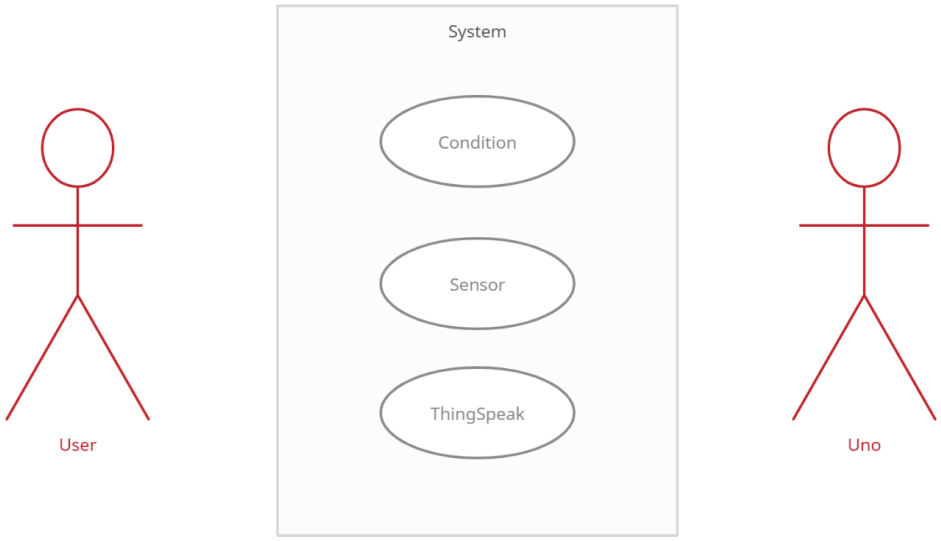


Figure 4.4: UML Use Case Diagram

4.6 UML Sequence Diagram

Sequence Diagrams are interaction diagrams that detail how operations are carried out. Sequence Diagrams are time focused, and they show the order of the interactions visually by using the vertical axis of the diagram to represent what time messages were sent.

The figure 4.5 below shows the User Change Password Sequence Diagram:

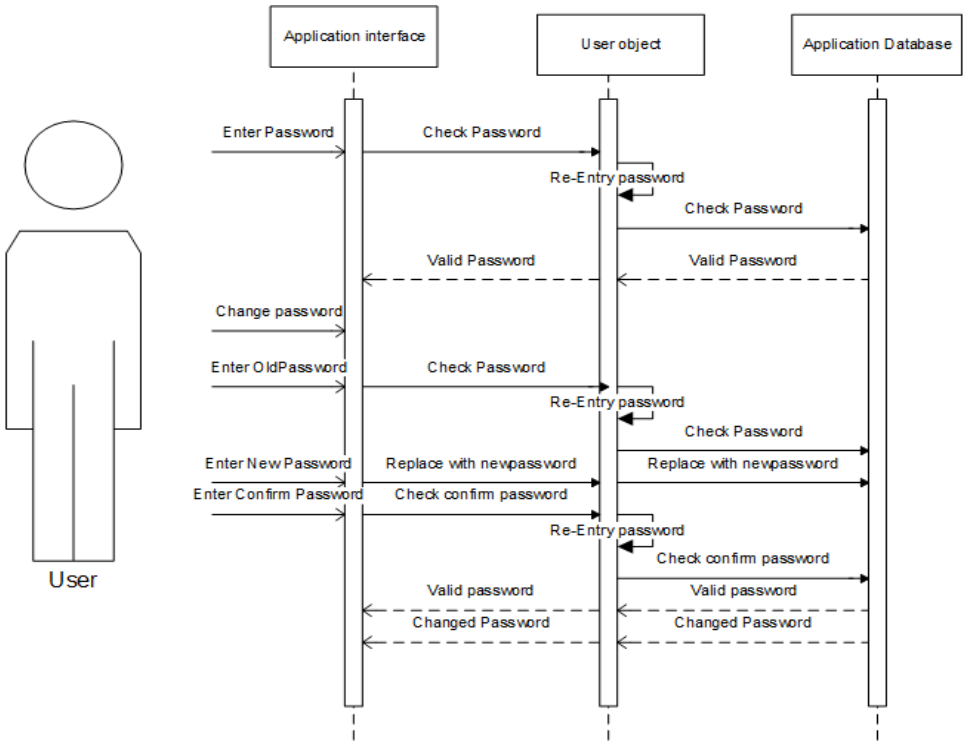


Figure 4.5: User Change Password Sequence Diagram

The figure 4.6 below shows the object Detection Sequence Diagram:

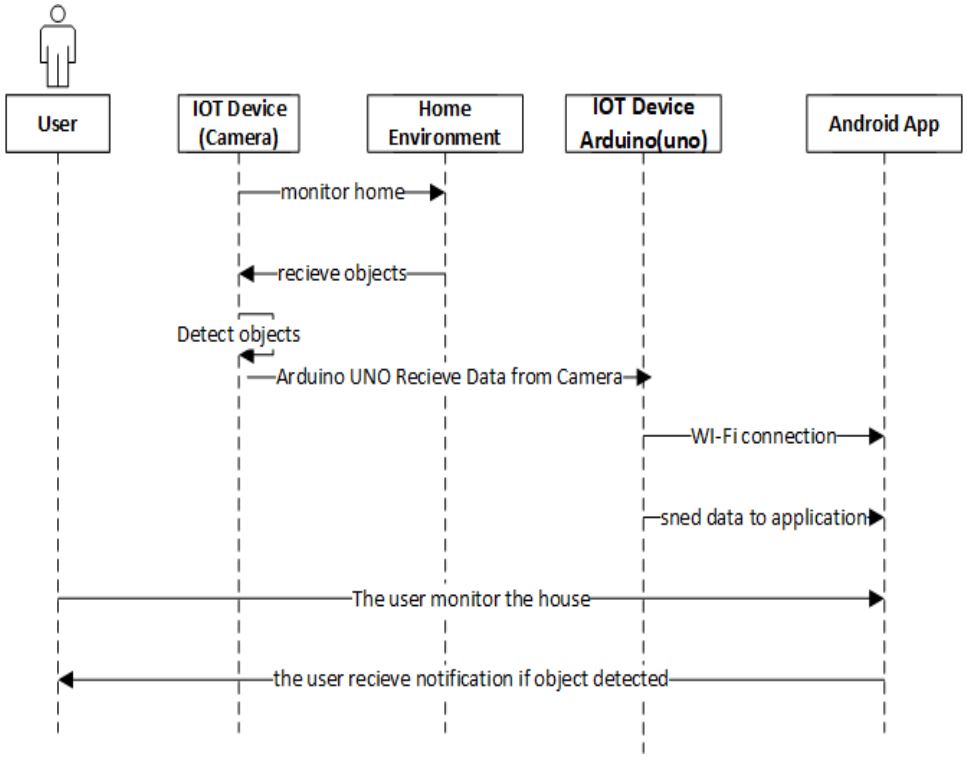


Figure 4.6: Object Detection Sequence Diagram

The figure 4.7 below shows the sensors Sequence Diagram:

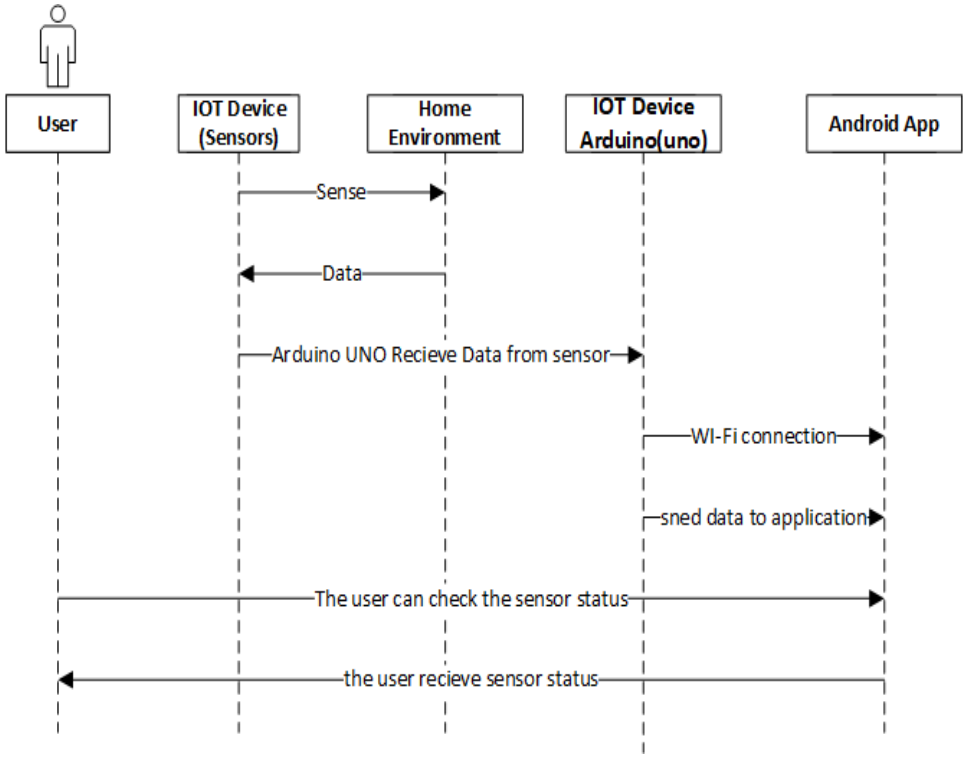


Figure 4.7: Sensors Sequence Diagram

The figure 4.8 below for the lights (turn on/off) Sequence Diagram:

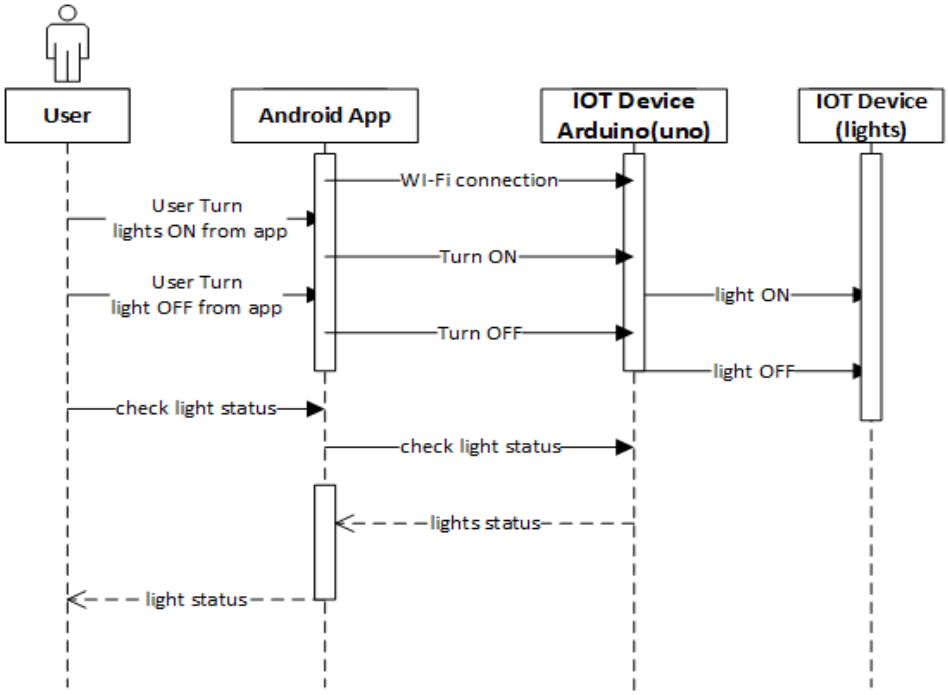


Figure 4.8: Lights (turn on/off) Sequence Diagram

4.7 UML Class Diagram

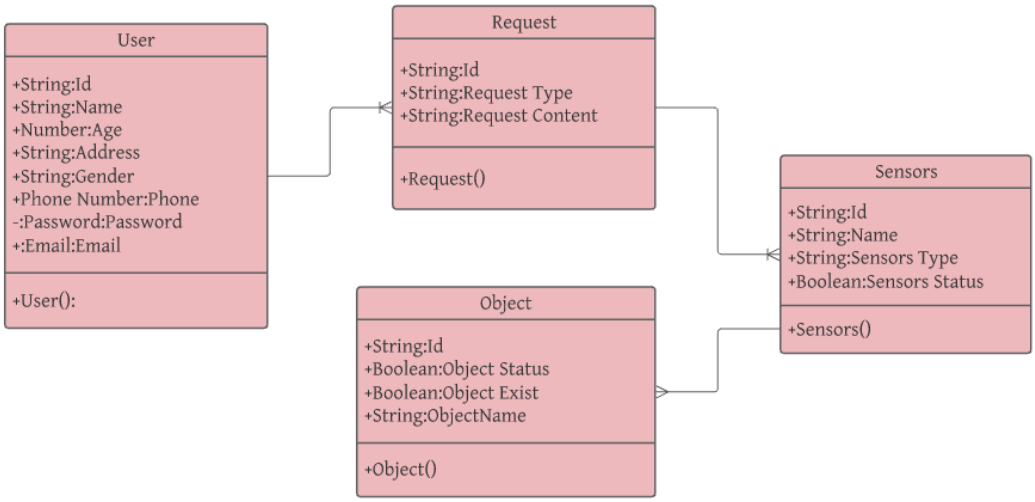
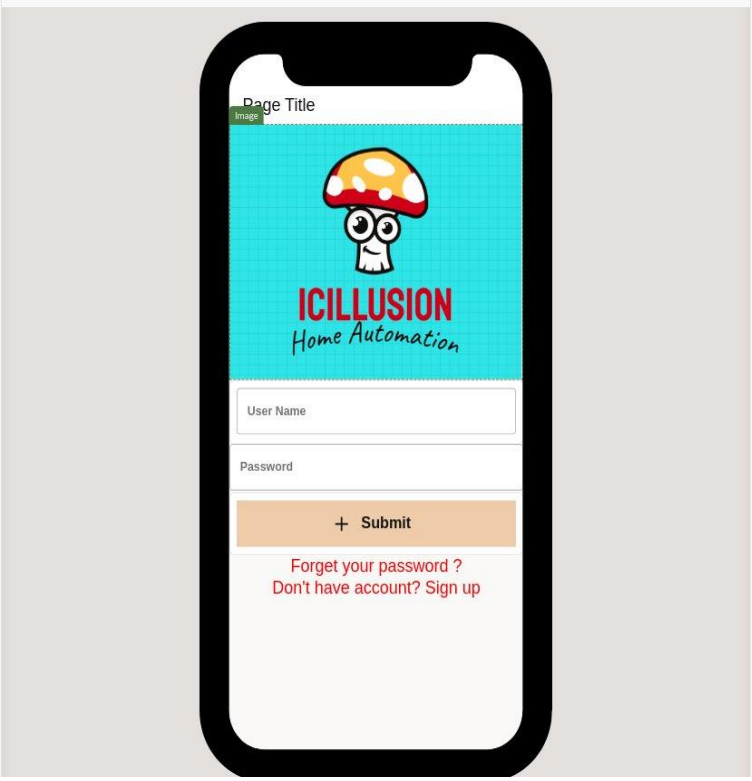


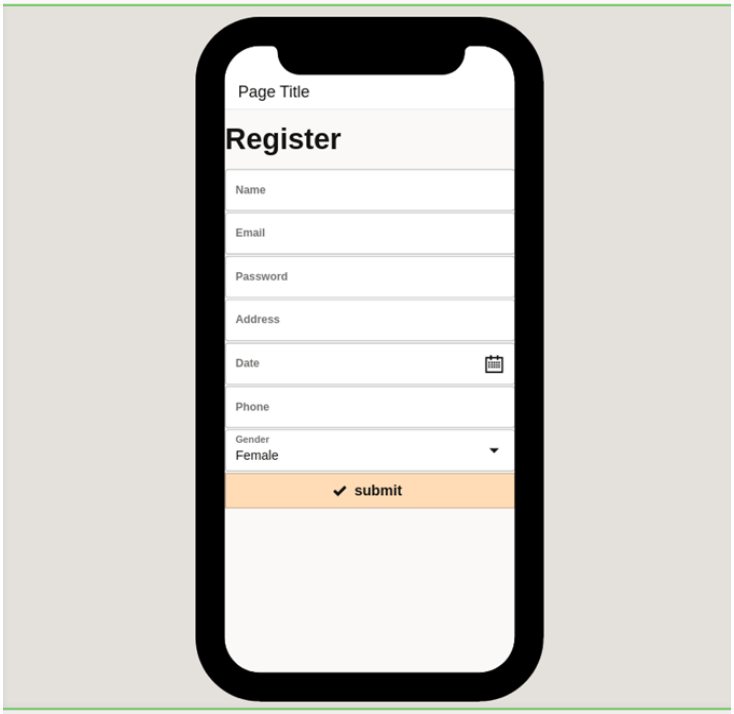
Figure 4.9: UML Class Diagram

4.8 Graphical User Interface (GUI) Design

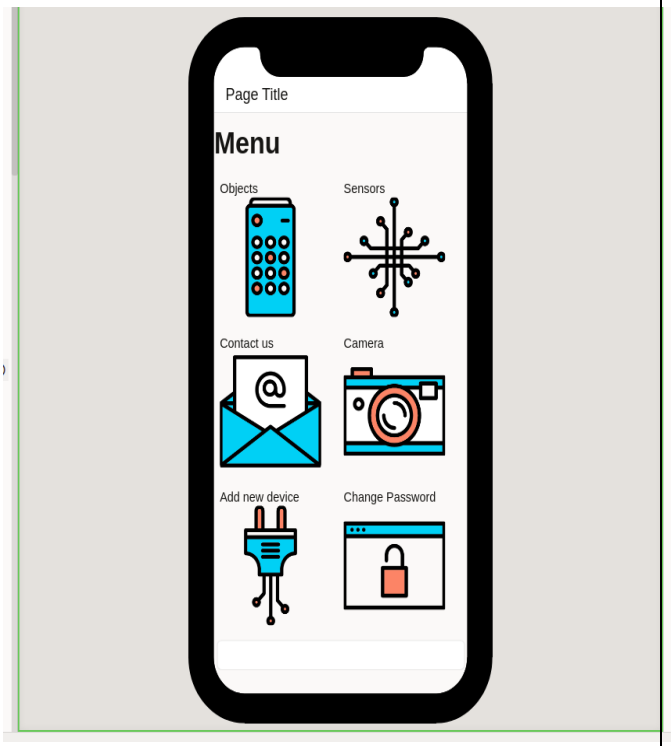
Login page:



Register page:

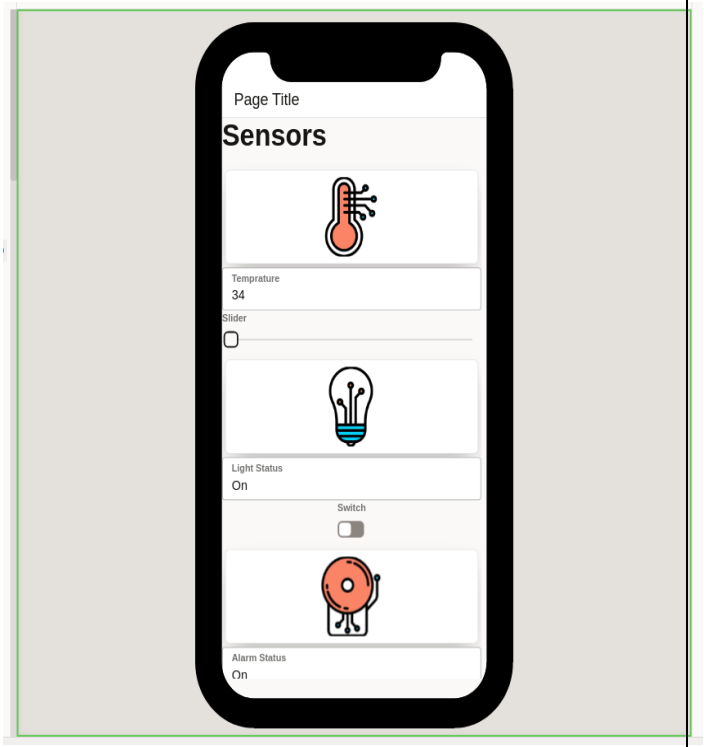


Menu Page:

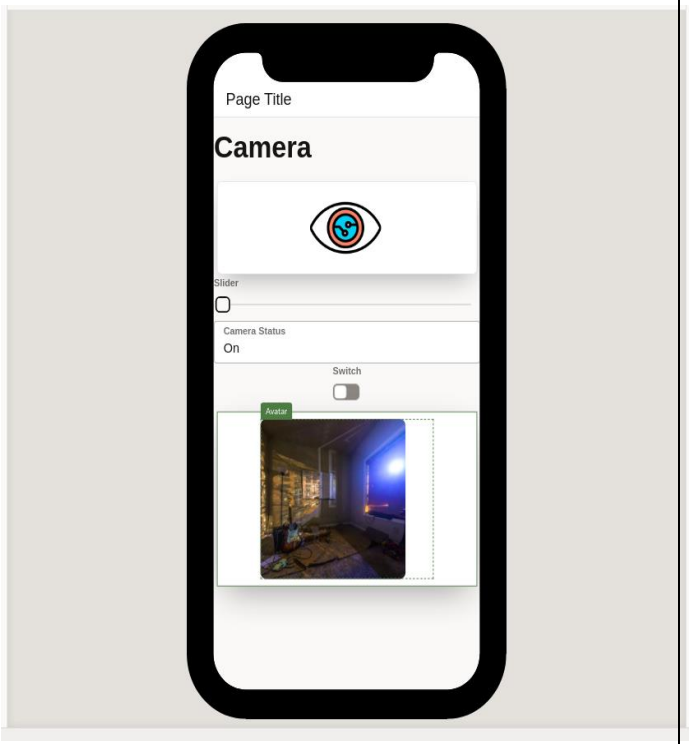


Objects page:

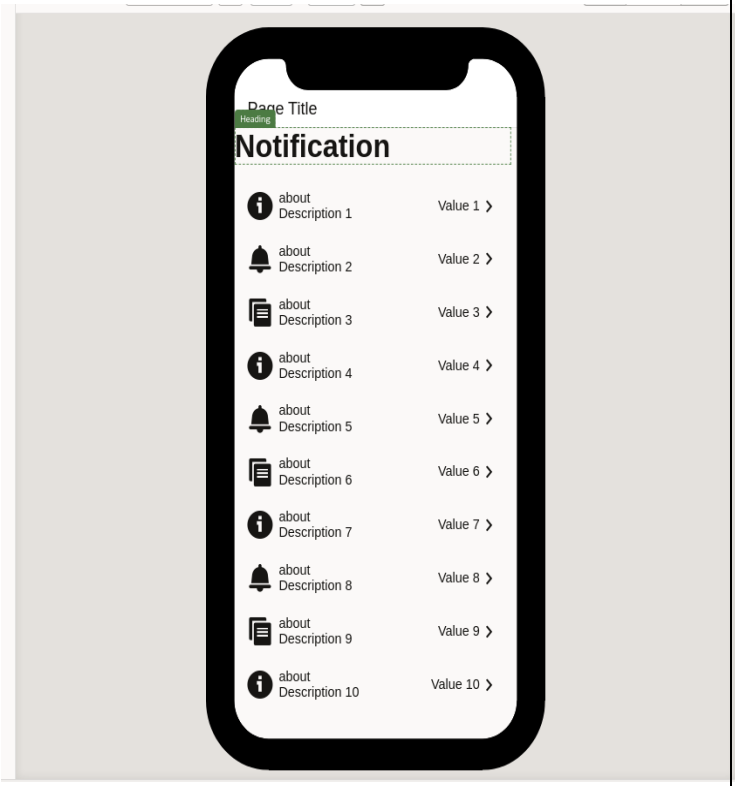
Sensors page:



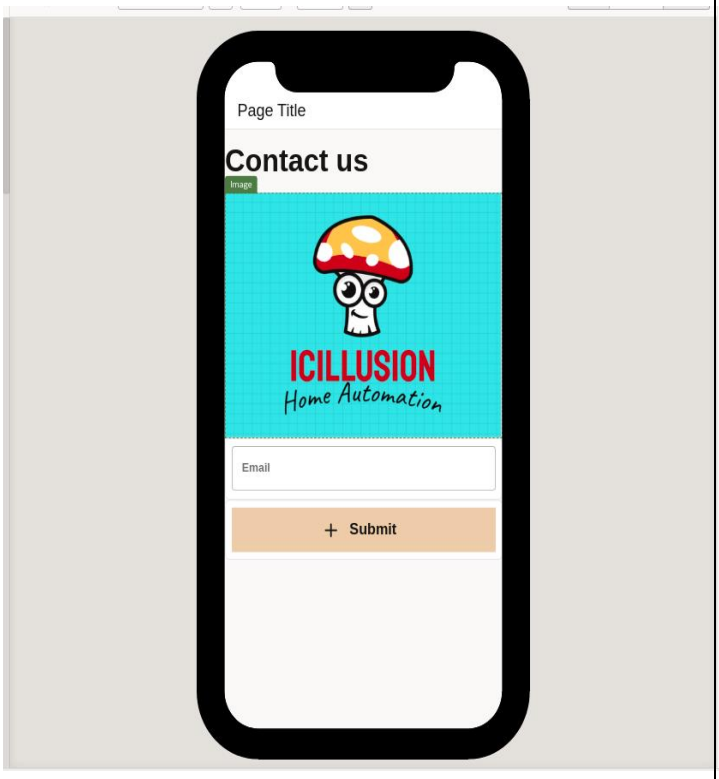
Camera page:



Notifications page:



Contact us page:



4.9 Summary

System modeling is an easier requirement gathering and enhanced understanding across multiple teams leading to better feedback and collaboration that helps the analyst to understand the functionality of the system and models are used to communicate with customers.

CHAPTER FIVE

System Implementation

5.1 Introduction

Systems implementation is the process of defining how the information system should be built, ensuring that the information system is operational and used, ensuring that the information system meets quality standard.

5.2 Database Implementation

We used MySQL which is an open-source relational database management system (RDBMS). MySQL appeal originates in its relative simplicity and ease of use, which is enabled by an ecosystem of open-source tools such as phpMyAdmin. The figure 5.1 below shows our MySQL database.

	#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
☐	1	Name	varchar(20)	utf8mb4_general_ci		No	*None*			Change Drop More
☐	2	email	varchar(30)	utf8mb4_general_ci		No	*None*			Change Drop More
☐	3	password	varchar(15)	utf8mb4_general_ci		No	*None*			Change Drop More
☐	4	address	varchar(20)	utf8mb4_general_ci		No	*None*			Change Drop More
☐	5	date	date			No	*None*			Change Drop More
☐	6	phone	int(10)			No	*None*			Change Drop More
☐	7	gender	varchar(6)	utf8mb4_general_ci		No	*None*			Change Drop More

	#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
☐	1	username	varchar(20)	utf8mb4_general_ci		No	*None*			Change Drop More
☐	2	password	varchar(15)	utf8mb4_general_ci		No	*None*			Change Drop More

Figure 5.1: MySQL database

5.3 Graphical User Interface Implementation

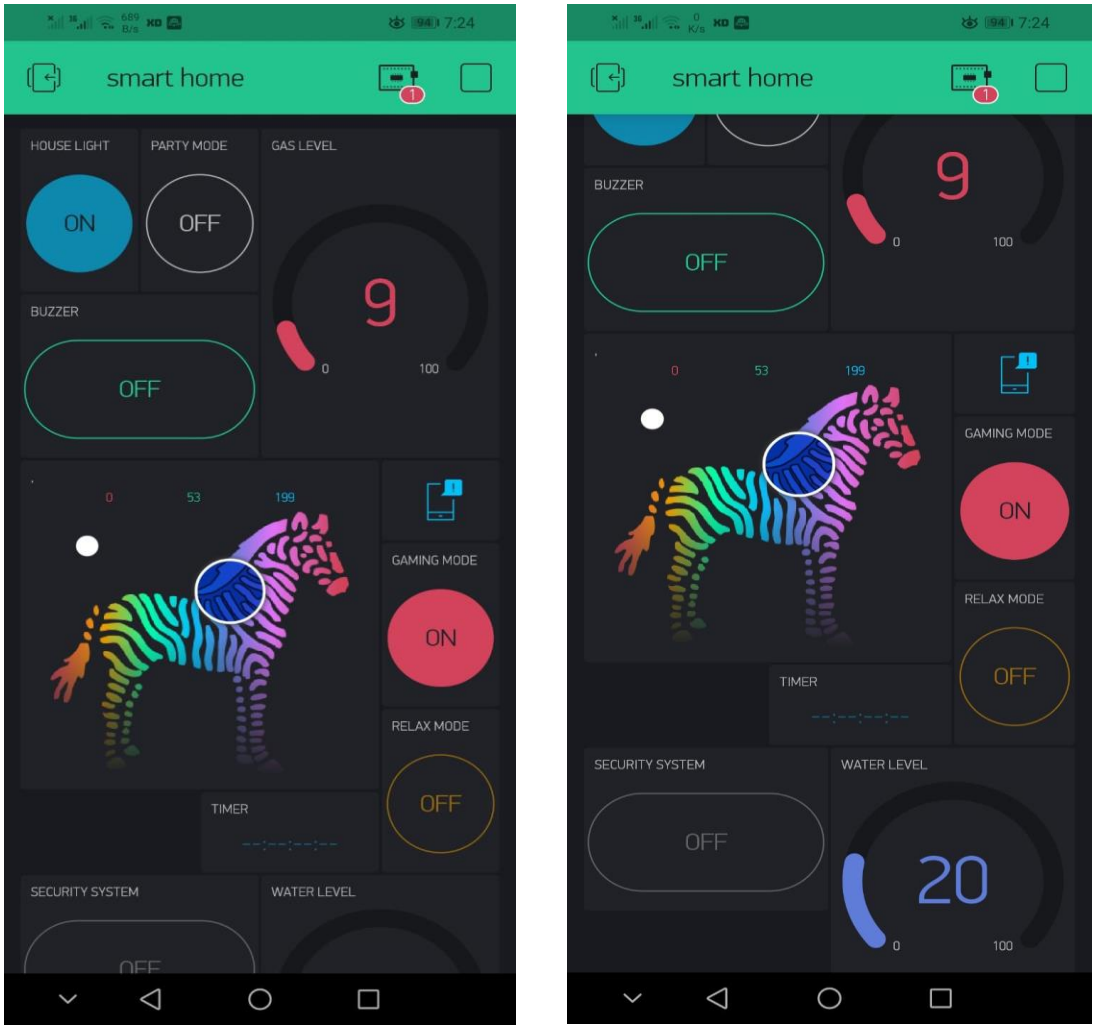


Figure 5.2: GUI

- ⇨ To switch the house light on/off, click on “House light” button.
- ⇨ To turn party mode on/off, click on “Party mode” button.
- ⇨ Gass level shows the percentage of the gas in the house.
- ⇨ To turn the buzzer on/off, click on “Buzzer” button.
- ⇨ The horse shows the shades of lights that you can select for the house lights.
- ⇨ To turn gaming mode on/off, click on “Gaming Mode” button.
- ⇨ To turn relax mode on/off, click on “Relax Mode” button.
- ⇨ Timer is a timing for buzzer.
- ⇨ To turn on/off security system, click on “Security System” button.
- ⇨ Water level shows the percentage of water in the water tank.

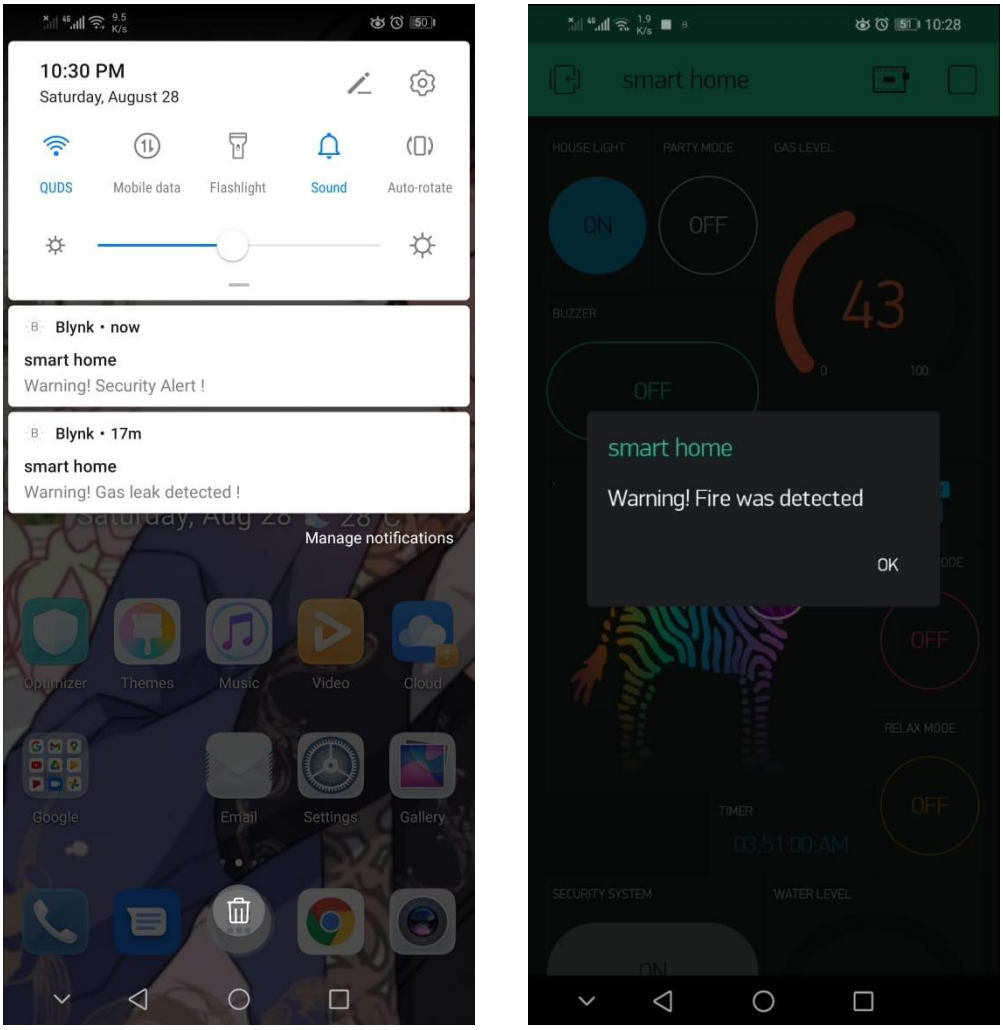


Figure 5.3: Notifications

- ⇨ If you are not using the app, you will deliver the notifications in notification panel.
- ⇨ If you are using the app notifications will be shown as pop-up notifications.

5.4 Other Components Implementation

Our circuit made of:

- ⇨ nodeMCU which is a low-cost open source IoT platform.
- ⇨ Two breadboards.
- ⇨ Ultrasonic which is an instrument that measures the distance to an object using ultrasonic sound waves.
- ⇨ USB cable type A/B, used to connect nodeMCU with the USB female A port of your computer.
- ⇨ Jumper wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering.
- ⇨ Flame sensor is an important safety element on your gas heating equipment.
- ⇨ Buzzer or beeper is an audio signaling device.
- ⇨ RGB LED light is an acronym for the colors red, green, and blue. When those three colors of lights are combined and used together in a single unit, it's able to create and display over 16 million color options.
- ⇨ Bunch of LED lights
- ⇨ Resistors to limit the amount of current going to certain components in the circuit.
- ⇨ Gas sensor to detect gas leakage.

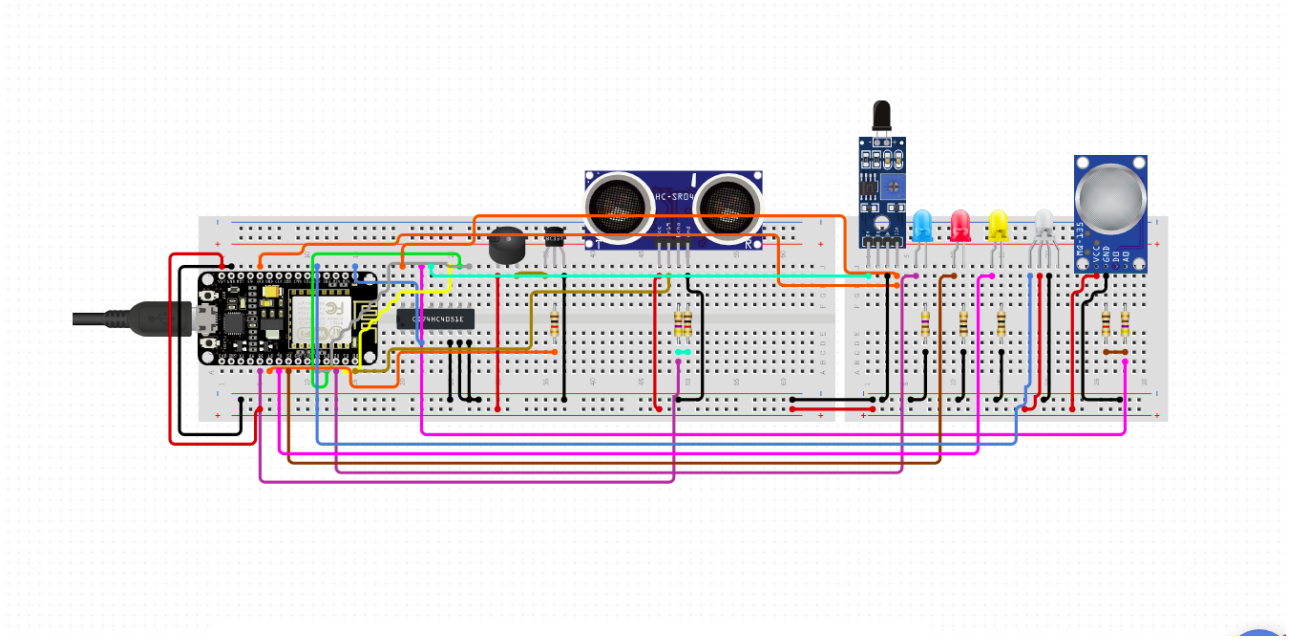


Figure 5.4: Smart Home Circuit

we connected the application with Google Assistant:

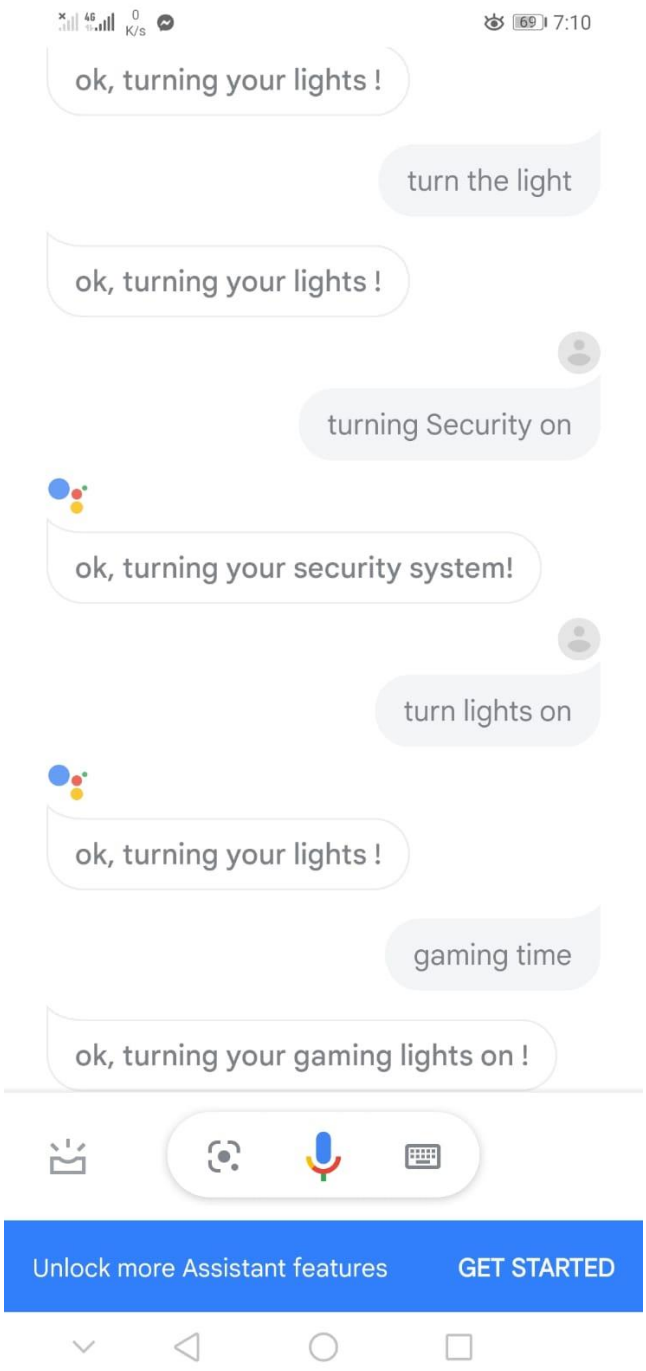


Figure 5.5: Google Assistant

5.5 Summary

In this chapter, we discussed the database and GUI implementation of the system and smart home circuit and Google Assistant.

CHAPTER SIX

System Testing and Installation

6.1 Introduction

Testing phase is an evaluation conducted to provide information about the quality of the system which is being developed. it is the process of verifying and validating that an application is working as expected and satisfies both functional and non-functional requirements.

System testing is divided into various levels including Unit Testing, System Testing and Acceptance Testing, they are all performed during the testing phase. However, Unit and System Testing are performed by the testing team and developers, whereas Acceptance Testing is done by the end user.

This chapter clarifies how heuristic and cooperative evaluation techniques are used to test the Usability of our application which can be found in section 6.2 and 6.3, respectively. Section 6.4 deals with the Requirements Validation and Completeness. Section 6.5 clarifies System Installation steps needed to be done to implement and run our application, lastly section 6.6 summarizes the overall conclusion of this chapter.

6.2 Heuristic Evaluation

Heuristic evaluation is usability experts review your user interface such as lists, combo box, and database connection and compare it against accepted usability principles. This evaluation was performed on Android application by Three Information Technology (IT) experts who basically examined the interface and judged its compliance with recognized usability principles known as heuristics. Kindly find the actual Heuristic Evaluation forms of our application included in Appendix A.

Furthermore, the next table lists the heuristics of usability evaluation and their descriptions.

6.3 Cooperative Evaluation

Please indicate the extent to which you agree or disagree with each of the following statements regarding to your experience with the system.

Cooperative Evaluation:

Table 6.1: Participants Details

No.	Criteria	Participant 1	Participant 2	Participant 3
1.	**Gender**	Female	Female	Male
2.	**Age**	22	21	22
3.	**Educational Level**	BA	BA	BA
4.	**Programmer Taken**	Mariam	Leena	Ahmad
5.	**Institution**	University of Jordan	University of Jordan	University of Jordan

Pre-Evaluation Procedures:

Participants were contacted through telephone conversations asking them the possibility to participate in the co-operative evaluation. A brief introduction to was given to the participants 10 minutes before they started the evaluation, and participants were asked to read that introductory document. The document also has a list of tasks, which will be performed by the participants throughout the co-operative evaluation. Users were told that they need to think aloud when facing any problem in the system. They were also told that, each task they perform is monitored and timed.

Evaluation Procedures:

During the evaluation session, a moderator accompanied the users to do the co-operative evaluation. A comment from shown in Appendix B was used by the moderator to write down the comments of each user for each task. Users were helped when they really face serious problems performing the tasks. The following tables show the comments from pre-pared by the moderator for each participant.

Table 6.2: Cooperative Evaluation for smart home application (1) for participant 1

Task No.	Test	Time Taken to Complete the Task	Comments
A.	Administrator		
1.	Login	20 seconds	
2.	Logout	5 seconds	
3.	Mange users	60 seconds	
4.	Subscriptions management	60 seconds	
5.	System report	60 seconds	
B.	Users		

1.	Login	20 seconds	
2.	Logout	5 seconds	
3.	Turn Security System	5 seconds	
4.	Turn Buzzer	1 second	
5.	Check water level	1 second	
6.	Check fire detection	1 second	
7.	Check gas detection	1 second	
8.	Build a timer for the project	5 seconds	

Table 6.3: Cooperative Evaluation for smart home application (1) for participant 2

Task No.	Test	Time Taken to Complete the Task	Comments
A.	Administrator		
1.	Login	20 seconds	
2.	Logout	5 seconds	
3.	Mange users	60 seconds	
4.	Subscriptions management	60 seconds	
5.	System report	60 seconds	
B.	Users		
1.	Login	20 seconds	
2.	Logout	5 seconds	
3.	Turn Security System	5 seconds	
4.	Turn Buzzer	1 second	
5.	Check water level	1 second	
6.	Check fire detection	1 second	
7.	Check gas detection	1 second	
8.	Build a timer for the project	5 seconds	

Table 6.4: Cooperative Evaluation for smart home application (1) for participant 3

Task No.	Test	Time Taken to Complete the Task	Comments
A.	Administrator		
1.	Login	20 seconds	
2.	Logout	5 seconds	
3.	Mange users	60 seconds	

4.	Subscriptions management	60 seconds	
5.	System report	60 seconds	
B.	Users		
1.	Login	20 seconds	
2.	Logout	5 seconds	
3.	Turn Security System	5 seconds	
4.	Turn Buzzer	1 second	
5.	Check water level	1 second	
6.	Check fire detection	1 second	
7.	Check gas detection	1 second	
8.	Build a timer for the project	5 seconds	

It is important to compare the time taken by each participant to complete each single task com-pared to the default time allocated by the moderator as shown in next table.

Table 6.5: Task Completion Times in Minutes and Seconds

Task No.	**Default**	**Participant 1**	**Participant 2**	**Participant 3**
A. Administrator Activity				
1.	20 seconds	20 seconds	20 seconds	20 seconds
2.	5 seconds	5 seconds	5 seconds	5 seconds
3.	60 seconds	60 seconds	60 seconds	60 seconds
4.	60 seconds	60 seconds	60 seconds	60 seconds
5.	60 seconds	60 seconds	60 seconds	60 seconds
B. Users Activity				

1.	20 seconds	20 seconds	20 seconds	20 seconds
2.	5 seconds	5 seconds	5 seconds	5 seconds
3.	20 seconds	20 seconds	20 seconds	20 seconds
4.	5 seconds	5 seconds	5 seconds	5 seconds
5.	5 seconds	5 seconds	5 seconds	5 seconds
Total Completion Time	2.6 minutes	2.6 minutes	2.6 minutes	2.6 minutes

Post-Evaluation Procedures:

After completing the co-operative evaluation, participants were given a post-test questionnaire to fill in, which is shown in Appendix B. This questionnaire was important to capture their thoughts and feelings about smart home application performance while they were still fresh. The questionnaire was then followed by a short interview and discussion, which mainly focused on the initial modified design of smart home app process. Table (6.6) shows the responses of the 3 participants to the post-test questionnaire.

Table 6.6: Participants Responses to the Post-Test Questionnaire

No.	Statement	Participant 1	Participant 2	Participant 3	Average
1	Is the system stable?	5	4	4	**4.3**
2	Is the system ease of use?	5	5	5	**3**
3.	Are the functionality of the system achieve user's needs?	5	4	5	**4.6**
Average		**5**	**4.3**	**4.6**	

6.4 Requirements Validation and Completeness

- ⇨ “House light” button

This function was explained in 5.3

- ⇨ “Party mode” button

This function was explained in 5.3

- ⇨ “Buzzer” button

This function was explained in 5.3

- ⇨ Gas level

This function was explained in 5.3

- ⇨ The horse colors

This function was explained in 5.3

- ⇨ “Gaming Mode” button

This function was explained in 5.3

- ⇨ “Relax Mode” button

This function was explained in 5.3

- ⇨ Timer

This function was explained in 5.3

- ⇨ “Security System” button.

This function was explained in 5.3

- ⇨ Water level

This function was explained in 5.3

6.5 System Installation

- ⇨ Blynk platform

https://blynk.io/

- ⇨ Arduino editor

thttps://create.arduino.cc/editor

- ⇨ Ubuntu Linux

https://www.linux.org/pages/download/

- ⇨ Microsoft Office 2013

http://www.microsoftstore.com/store/msusa/en_US/cat/All-Office/categoryID.69403900

- ⇨ Microsoft Office Visio 2013

https://products.office.com/en/visio/flowchart-software

⇨ Flowcharts Online Maker

https://draw.io/

⇨ Smart Sheets Online Maker

https://www.smartsheet.com/

⇨ 6.2.8 IFFT platform for google assistant

https://ifttt.com/home

6.6 Summary

This chapter showed an intestine testing and evaluation for smart home app The heuristic evaluation was conducted system with 3 expert users.

The Heuristic and cooperative evaluation have also shown competitive and acceptable performance for the system indicating that system is easy to use and has less usability problems.

CHAPTER SEVEN

Project Conclusion and Future Work

7.1 Introduction

Each project is made for a specific goal, and each goal needs several stages to be completed. In this chapter we will discuss overall weaknesses, overall strengths, and future work.

7.2 Overall Weaknesses

1) Significant installation costs.
2) Reliable internet connection is crucial.
3) Security issues.
4) Technological problems in connected homes.
5) You may lock yourself out of your own house.
6) Helplessness if technology fails.
7) Some people may not like smart technologies.
8) Maintenance and repair issues.
9) Some initial learning efforts necessary.
10) Compatibility problems between devices.
11) Surges are possible.
12) Smart home technology not suitable for all houses.
13) Technology may become outdated soon.
14) Privacy concerns.

7.3 Overall Strengths

1) Increase in convenience.
2) Full control over all smart appliances with only one device.
3) Time savings.
4) Higher quality of life.
5) Notifications in case of trouble.
6) Good tool to let people in from remote.
7) Energy savings.
8) Cost savings in the long run.
9) Smart homes can be customized to your needs.
10) Safety improvements compared to conventional locks.
11) Insurance benefits.
12) Government subsidies and tax benefits for going green.
13) Support for the older generation.
14) Smart homes may be suitable for disabled persons.

15) Resale value might increase.
16) May be fun for children to play around.

7.4 Future Work

We have some plans in our project that contain:

1) Develop our project in IOS system.
2) Develop a more efficient and more smart home system.
3) We look forward to full cooperation with all smart home offices in Jordan.

7.5 Summary

In this chapter, we explained our project weaknesses and strengths, and we mentioned our future work steps.

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REFERENCES

1. https://www.hackerearth.com/blog/developers/a-tour-of-the-arduino-uno-board/
2. https://www.arduino.cc/
3. https://www.youtube.com/watch?v=EaKBULiyWQE
4. https://create.arduino.cc/projecthub/amrmostaafaa/how-to-build-a-diy-arduino-based-smart-home-hub-with-1sheeld-79d405?fbclid=IwAR3KXdGWqUGfghDMSDO45Qjf4Wk_6wA8wnJvtM1hrukAdPW7RgHvg1mTqeg
5. https://create.arduino.cc/projecthub/ihacklab/smart-apps-for-smart-home-67b07e?fbclid=IwAR10DOsJQaJCOEYdm5hMAIVKOBa_dxSkJ7jkQ9ge51HSESMCEnnJk6S7YEY
6. https://predictabledesigns.com/home-automation-with-an-arduino-a-basic-tutorial/?fbclid=IwAR3D457YxjNEHNE4Kqe4TQjEn_EC0T97bdOZ9EYZnUQkpZDVbRvFECOT-vI
7. https://www.youtube.com/playlist?list=PLmotdda810ImH-Nldpl5QOTkHywj3dKE_
8. https://www.phpmyadmin.net/
9. https://creately.com/
10. https://www.sololearn.com/
11. https://environmental-conscience.com/smart-homes-pros-cons/

APPENDIX A

Heuristic Evaluation – A System Checklist

Disclaimer: This list is a simplified one of the original list which was developed by Xerox Corporation (© Usability Analysis & Design, Xerox Corporation, 1995) and was downloaded from ftp://cs.uregina.ca/pub/class/305/lab2/example-he.html. It has been simplified to suite the purpose it is used for, which is to evaluate the smarth home app in order to identify current problems as experienced by the users, which is part of our graduation project that is submitted to King Abdullah II School for Information Technology, The University of Jordan. The number of questions was reduced; however, the individual questions were left intact.

Please fill in the evaluation form below, which is a form of checklist, by writing "X" in the appropriate place which mostly describes the best answer to the corresponding criterion. This form is to be filled after you have investigated the system interface i.e. have looked at, and examined the interface. The answer to each criterion is either:

- "**0**" which means "I don't agree that this is a usability problem at all".
- "**1**" which means "Cosmetic problem only: need not be fixed unless extra time is available on project".
- "**2**" which means "Minor usability problem: fixing this should be given low priority".
- "**3**" which means "Major usability problem: important to fix, so should be given high priority".

- "**4**" which means ”Usability catastrophe: imperative to fix this before product can be released".

Thank you for your willingness to evaluate this system. Your time and effort are highly appreciated.

H1. Visibility of System Status

The system should always keep user informed about what is going on, through appropriate feedback within reasonable time.

Number	Review Checklist	0 1 2 3 4	Comments
1.1	Does every display begin with a title or header that describes screen contents?	( ) ( ) ( ) ( ) ( )	
1.2	Do menu instructions, prompts, and error messages appear in the same place(s) on each menu?	( ) ( ) ( ) ( ) ( )	
1.3	Is there some form of system feedback for every operator action?	( ) ( ) ( ) ( ) ( )	
1.4	Are responses times appropriate to the users cognitive processing?	( ) ( ) ( ) ( ) ( )	
1.5	Is there visual feedback in menus or dialog boxes about which choices are selectable?	( ) ( ) ( ) ( ) ( )	

H2. Match between System and the Real World

The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

Number	Review Checklist	0 1 2 3 4	Comments
2.1	Are icons concrete and familiar?	( ) ( ) ( ) ( ) ( )	
2.2	Are menu choices ordered in the most logical way, given the user, the item names, and the task variables?	( ) ( ) ( ) ( ) ( )	
2.3	Do related and interdependent fields appear on the same screen?	( ) ( ) ( ) ( ) ( )	
2.4	When prompts imply a necessary action, are the words in the message consistent with that action?	( ) ( ) ( ) ( ) ( )	
2.5	On data entry screens, are tasks described in terminology familiar to users?	( ) ( ) ( ) ( ) ( )	

H3. User Control and Freedom

Users should be free to select and sequence tasks (when appropriate), rather than having the system does this for them. Users often choose system functions by mistake and will need a clearly marked “emergency exit” to leave the unwanted state without having to go through an extended dialogue. Users should make their own decisions (with clear information) regarding the costs of exiting current work. The system should support undo and redo.

Number	Review Checklist	0 1 2 3 4	Comments
3.1	When a user's task is complete, does the system wait for a signal from the user before processing?	( ) ( ) ( ) ( ) ( )	
3.2	Are users prompted to confirm commands that have drastic, destructive consequences?	( ) ( ) ( ) ( ) ( )	
3.3	Are character edits allowed in data entry fields?	( ) ( ) ( ) ( ) ( )	
3.4	If menu lists are long (more than seven items), can users select an item either by moving the cursor or by typing a mnemonic code?	( ) ( ) ( ) ( ) ( )	
3.5	If the system uses a pointing device, do users have the option of either clicking on menu items or using a keyboard shortcut?	( ) ( ) ( ) ( ) ( )	

H4. Consistency and Standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

Number	Review Checklist	0 1 2 3 4	Comments
4.1	Has a heavy use of all uppercase letters on a screen been avoided?	( ) ( ) ( ) ( ) ( )	
4.2	Are icons labeled?	( ) ( ) ( ) ( ) ( )	
4.3	Are there no more than twelve to twenty icon types?	( ) ( ) ( ) ( ) ( )	
4.4	Does each window have a title?	( ) ( ) ( ) ( ) ( )	
4.5	Is vertical and horizontal scrolling possible in each window?	( ) ( ) ( ) ( ) ( )	
4.6	Are menu choice lists presented vertically?	( ) ( ) ( ) ( ) ( )	
4.7	Are menu titles either centered or left-justified?	( ) ( ) ( ) ( ) ( )	
4.8	Are menu items left-justified, with the item number or mnemonic preceding the name?	( ) ( ) ( ) ( ) ( )	
4.9	Do embedded field-level prompts appear to the right of the field label?	( ) ( ) ( ) ( ) ( )	
4.10	Are attention-getting techniques used with care?	( ) ( ) ( ) ( ) ( )	

H5. Help Users Recognize, Diagnose, and Recover From Errors

Error messages should be expressed in plain language (NO CODES).

Number	Review Checklist	0 1 2 3 4	Comments
5.1	Is sound used to signal an error?	( ) ( ) ( ) ( ) ( )	
5.2	Are error messages worded so that the system, not the user, takes the blame?	( ) ( ) ( ) ( ) ( )	
5.3	Do error messages suggest the cause of the problem?	( ) ( ) ( ) ( ) ( )	
5.4	Do error messages indicate what action the user needs to take to correct the error?	( ) ( ) ( ) ( ) ( )	
5.5	If the system supports both novice and expert users, are multiple levels of error-message detail available?	( ) ( ) ( ) ( ) ( )	
5.6	If an error is detected in a data entry field, does the system place the cursor in that field or highlight the error?	( ) ( ) ( ) ( ) ( )	
5.7	Do error messages inform the user of the error's severity?	( ) ( ) ( ) ( ) ( )	

H6. Error Prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

Number	Review Checklist	0 1 2 3 4	Comments
6.1	Are menu choices logical, distinctive, and mutually exclusive?	( ) ( ) ( ) ( ) ( )	
6.2	Are data inputs case-blind whenever possible?	( ) ( ) ( ) ( ) ( )	
6.3	Does the system prevent users from making errors whenever possible?	( ) ( ) ( ) ( ) ( )	
6.4	Does the system warn users if they are about to make a potentially serious error?	( ) ( ) ( ) ( ) ( )	
6.5	Do data entry screens and dialog boxes indicate the number of character spaces available in a field?	( ) ( ) ( ) ( ) ( )	
6.6	Do fields in data entry screens and dialog boxes contain default values when appropriate?	( ) ( ) ( ) ( ) ( )	

H7. Recognition Rather Than Recall

Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

Number	Review Checklist	0 1 2 3 4	Comments
7.1	For question and answer interfaces, are visual cues and white space used to distinguish questions, prompts, instructions, and user input?	( ) ( ) ( ) ( ) ( )	
7.2	Are inactive menu items grayed out or omitted?	( ) ( ) ( ) ( ) ( )	
7.3	Do data entry screens and dialog boxes indicate when fields are optional?	( ) ( ) ( ) ( ) ( )	
7.4	Are prompts, cues, and messages placed where the eye is likely to be looking on the screen?	( ) ( ) ( ) ( ) ( )	
7.5	Are field labels close to fields, but separated by at least one space?	( ) ( ) ( ) ( ) ( )	
7.6	Have items been grouped into logical zones, and have headings been used to distinguish between zones?	( ) ( ) ( ) ( ) ( )	
7.7	Are borders used to identify meaningful groups?	( ) ( ) ( ) ( ) ( )	
7.8	Is color coding consistent throughout the system?	( ) ( ) ( ) ( ) ( )	

H8. Flexibility and Minimalist Design

Accelerators-unseen by the novice user-may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions. Provide alternative means of access and operation for users who differ from the "average" user (e.g., physical or cognitive ability, culture, language, etc.)

Number	Review Checklist	0 1 2 3 4	Comments
8.1	If menu lists are short (seven items or fewer), can users select an item by moving the cursor?	( ) ( ) ( ) ( ) ( )	
8.2	If the system uses a pointing device, do users have the option of either clicking on fields or using a keyboard shortcut?	( ) ( ) ( ) ( ) ( )	
8.3	On data entry screens, do users have the option of either clicking directly on a field or using a keyboard shortcut?	( ) ( ) ( ) ( ) ( )	
8.4	On menus, do users have the option of either clicking directly on a menu item or using a keyboard shortcut?	( ) ( ) ( ) ( ) ( )	
8.5	In dialog boxes, do users have the option of either clicking directly on a dialog box option or using a keyboard shortcut?	( ) ( ) ( ) ( ) ( )	

H9. Aesthetic and Minimalist Design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

Number	Review Checklist	0 1 2 3 4	Comments
9.1	Are all icons in a set visually and conceptually distinct?	( ) ( ) ( ) ( ) ( )	
9.2	Does each icon stand out from its background?	( ) ( ) ( ) ( ) ( )	
9.3	Does each data entry screen have a short, simple, clear, distinctive title?	( ) ( ) ( ) ( ) ( )	
9.4	Are field labels brief, familiar, and descriptive?	( ) ( ) ( ) ( ) ( )	
9.5	Are there pop-up or pull-down menus within data entry fields that have many, but well-defined, entry options?	( ) ( ) ( ) ( ) ( )	

H10. Help and Documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Number	Review Checklist	0 1 2 3 4	Comments
10.1	Are on-line instructions visually distinct?	( ) ( ) ( ) ( ) ( )	
10.2	If menu choices are ambiguous, does the system provide additional explanatory information when an item is selected?	( ) ( ) ( ) ( ) ( )	
10.3	Is the help function visible; for example, a key labeled help or a special menu?	( ) ( ) ( ) ( ) ( )	
10.4	Navigation: Is information easy to find?	( ) ( ) ( ) ( ) ( )	
10.5	Presentation: Is the visual layout well designed?	( ) ( ) ( ) ( ) ( )	
10.6	Conversation: Is the information accurate, complete, and understandable?	( ) ( ) ( ) ( ) ( )	
10.7	Is the information relevant?	( ) ( ) ( ) ( ) ( )	
10.8	Can users easily switch between help and their work?	( ) ( ) ( ) ( ) ( )	
10.9	Is it easy to access and return from the help system?	( ) ( ) ( ) ( ) ( )	
10.10	Can users resume work where they left off after accessing help?	( ) ( ) ( ) ( ) ( )	

APPENDIX B

Cooperative for Smart Home app

Task No.	Test	Time Taken to Complete the Task	Comments
A.	Administrator		
1.	Login		
2.	Logout		
3.	Mange users		
4.	Subscriptions management		
5.	System report		
B.	Users		
1.	Login		
2.	Logout		
3.	Turn Security System		
4.	Turn Buzzer		
5.	Check water level		
6.	Check fire detection		
7.	Check gas detection		

APPENDIX C

Smart home app Test (Post-test Questionnaire)

Gender: M / F **Age:** _____

Educational Level: _____

Programmer Taken: _____

Institution: _____

After using the system and answering smart home test, please indicate the extent to which you agree or disagree with each of the following statements regarding to your experience with the system.

No.	Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
1.	Is the system stable?					
2.	Is the system ease of use?					
3.	Do the functionality of the system achieve user's needs?					