DESIGN AND IMPLEMENTATION BASED OF AN IOT BASED SMART HOME SECURITY SYSTEM

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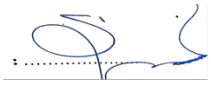

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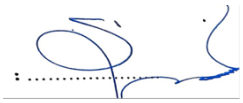
Signature	:	
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DESIGN AND IMPLEMENTATION BASED OF AN IOT BASED SMART HOME SECURITY SYSTEM

OMEED AZAD ABUBAKER

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Bachelor of Computer Science (Network & Security)

School of Computing
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Universiti Teknologi Malaysia

JULY 2022

DECLARATION

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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

ACKNOWLEDGEMENT

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ABSTRACT

IoT is one of the most useful ways to solve the problem in this century, digitalizing the systems makes them more efficient and more reliable. The majority of current systems either get notifications or have security cameras that do not alert in emergency situations. Receiving notice without access to a live camera to view the issue's origin is not very helpful since a live camera without access to notification is a significant time waster. The user cannot always keep an eye on the camera. System aims to create a secured environment for users by providing a camera to see an authorized entrance whenever they get a notification through the system and having the captured moments as evidence. To get advantage from very simple devices in life to connect them to internet and gain a secure system. Combining these simple devices together and building such a reliable system so it can use them to protect our important stuffs in least possible cost. As home security system is one of the crucial subjects, many systems are developed to fulfil the user's need. Design and implementation of IoT based on smart home security system has two major parts. Hardware and software. The hardware part is responsible for the input and output of the system, input is consisting of motion sensors and cameras for sending signals for output. GSM module and SD card are used as output hardware, and the software part is the operator part between input and output devices with the help of Arduino that acts as like microcontroller of the system.

ABSTRAK

IoT ialah salah satu cara yang paling berguna untuk menyelesaikan masalah pada abad ini, pendigitalan sistem menjadikannya lebih cekap dan lebih dipercayai. Majoriti sistem semasa sama ada mendapat pemberitahuan atau mempunyai kamera keselamatan yang tidak memberi amaran dalam situasi kecemasan. Menerima notis tanpa akses kepada kamera langsung untuk melihat asal isu tidak begitu membantu kerana kamera langsung tanpa akses kepada pemberitahuan adalah pembaziran masa yang ketara. Pengguna tidak boleh sentiasa memerhatikan kamera. Sistem bertujuan untuk mewujudkan persekitaran yang selamat untuk pengguna dengan menyediakan kamera untuk melihat pintu masuk yang dibenarkan setiap kali mereka mendapat pemberitahuan melalui sistem dan menjadikan detik yang ditangkap sebagai bukti. Untuk mendapatkan kelebihan daripada peranti yang sangat mudah dalam kehidupan untuk menyambungkannya ke internet dan mendapatkan sistem yang selamat. Menggabungkan peranti mudah ini bersama-sama dan membina sistem yang boleh dipercayai supaya ia boleh menggunakannya untuk melindungi barangan penting kami dengan kos yang paling rendah. Memandangkan sistem keselamatan rumah adalah salah satu subjek penting, banyak sistem dibangunkan untuk memenuhi keperluan pengguna. Reka bentuk dan pelaksanaan IoT berdasarkan sistem keselamatan rumah pintar mempunyai dua bahagian utama. Perkakasan dan perisian. Bahagian perkakasan bertanggungjawab untuk input dan output sistem, input terdiri daripada sensor gerakan dan kamera untuk menghantar isyarat untuk output. Modul GSM dan kad SD digunakan sebagai perkakasan keluaran, dan bahagian perisian adalah bahagian pengendali antara peranti input dan output dengan bantuan Arduino yang bertindak seperti mikropengawal sistem.

Table of Contents

LIST OF TABLES

TABLE NO. **TITLE** **PAGE**

LIST OF FIGURES

FIGURE NO. **TITLE** **PAGE**

LIST OF ABBREVIATIONS

IOT	-	Internet of Things
UML	-	Unified Modelling Language
GUI	-	Graphical User Interface
PSM1	-	Project Sarjana Muda 1
OS	-	Operating System
PSM2	-	Project Sarjana Muda 2
UTM	-	Universiti Teknologi Malaysia

LIST OF APPENDICES

APPENDIX	TITLE	PAGE

Chapter 1

Introduction

1.1. Introduction

When it comes to home automation, security is an important consideration. Home security is one of the most significant aspects of home automation. Home security has expanded rapidly in recent decades and will continue to do so in the future years. Old house security systems were simply having an alarm that would go on if someone passes through the security system, but a smart safe home can do so much more.

As a result, the major goal of this project is to create a system that can send a notification to the user in the event of an unauthorized break-in. The owner will also be able to remotely stop or activate the alarm using only their smartphone and in addition, the moments are captured and stored in SD card. This system can assist users in protecting their homes by installing the system on doors or windows and monitoring activities via their smartphones. Security is an important topic to consider when discussing home automation.

1.2. Problem background

Most existing systems are either getting notifications or security cameras without informing in critical cases. Getting notification without a live camera to see the source of the problem is not helping much as a live camera without notification is a huge waste of time. The user cannot observe the camera all the time. Even after the

accident, the user may need evidence, if there is no SD card that can hold the moments of breaking in then a live camera is useless.

1.3. Project aim

The system aims to create a secured environment for users by providing a camera to see an authorized entrance whenever they get a notification through the system and having the captured moments as evidence.

1.4. Objectives

The objectives of the project are:

i. Study or investigate the security of the house.
ii. To develop home security using Arduino, GSM module, and sensors in IoT.
iii. To test the system and evaluate its performance in real life.

1.5. Scopes

The scopes of the project are:

1. Arduino UNO will be used as the main controller to control the Security home.
2. Movement detection will be detected using the motion sensor.
3. This proposed work needs to have access to internet connection using a sim card as any movement happens.
4. To see what is notification call about will use ring application,

5. The mobile apps will be focused on android and ios.
6. Using SD card for saving captured images.
7. Database for recording motions that happened while using the system.

1.6. Importance of the Project

To get advantage from very simple devices in life to connect them to internet and gain a secure system. Combining these simple devices together and building such a reliable system So it can use them to protect our important stuffs in least possible cost. The efficiency of the system that needs few seconds to deliver warning notification so the user can take quick action. Authorizing user controlling is an additional importance of the system which only allowable users can access to the system according to admin permission.

1.7. Organization of the Report

The paper is organized as follows: 1.1 discuss about the introduction of IOT and its applications. 1.2 talks about the problem background in our life 1.3project aim was clarified. 1.4 discuss about objectives of the system.1.5 Talks about scopes 1.6 talks about project importance and why to use.

Chapter 2

Literature Review

2.1. Introduction

This chapter it starts with determining the source of the problem for the system and the requirements for it, as well as the structure of the system, the place for which we want to supply this system, and analyzing some similar existing systems, and determining the benefits and drawbacks of those systems. Then comparing current systems to determine their strengths and limitations to identify the system's strong points, followed by technologies used in these systems and why they were chosen.

2.2. Current System of Home Securities

Iraqi lifestyle is not helping for using technology and modern solutions for their life as there is lack of public services, even the existing companies for building smart system for houses are doing it with a very high cost that's why using smart systems are not preferable in this area. As smart systems are new for use here there are trust issues as well, that's why old ways are being used. It's either staying home all the time for avoiding an accident or taking all valuable stuff with themselves and depending only on locking the door. both are very weak techniques for providing security.

That's why a very reliable smart system with the least cost is needed for changing the opinion of Iraqis about using smart home security systems. (Abid, Saad. 2009).

2.3. Current System Analysis

In this era, there are many existing home security systems that has been developed. There are numerous sorts of the system developed by a different group. In this section, three types of the existing system are chosen to make a comparison between them.

2.3.1. Exploiting Bluetooth on Android Devices for Home Security

Using Bluetooth for connecting sensors and android mobile applications for managing security commands inside the house. The user can lock/unlock doors and windows, turn on/off the lights ... etc.

In addition to this, the system informs the user about the status of the door whether it's locked or unlocked, and after any action sends confirmation GUI to the user.

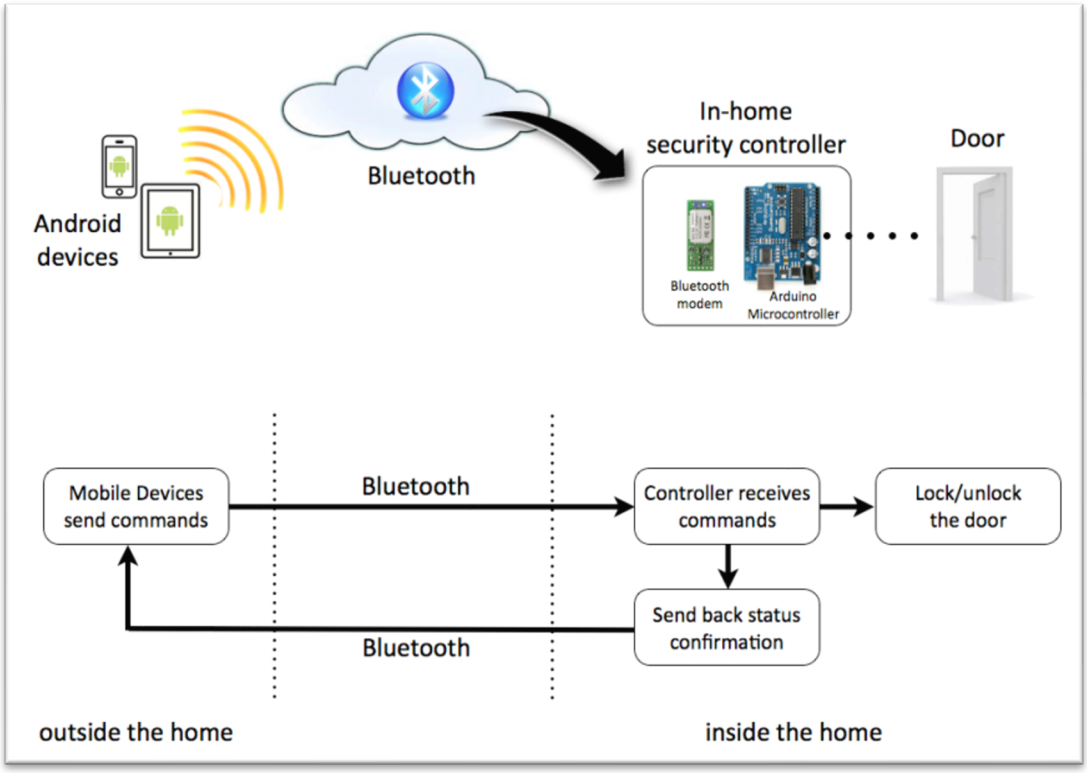

Figure 2-1 Bluetooth on android mobile devices for home security (Potts and S.Sukittanon,2012)

2.3.2. Microcontroller Home Automation Using Bluetooth, GSM, Wi-Fi and DTMF

Controlling the house from outdoor as well as indoor by using this system. There is an internet module that is used to notify the status of home appliances using Twitter, using the internet helps the system to work everywhere. In addition to that uses DTMF for calling the user when the motion sensor is being interacted.

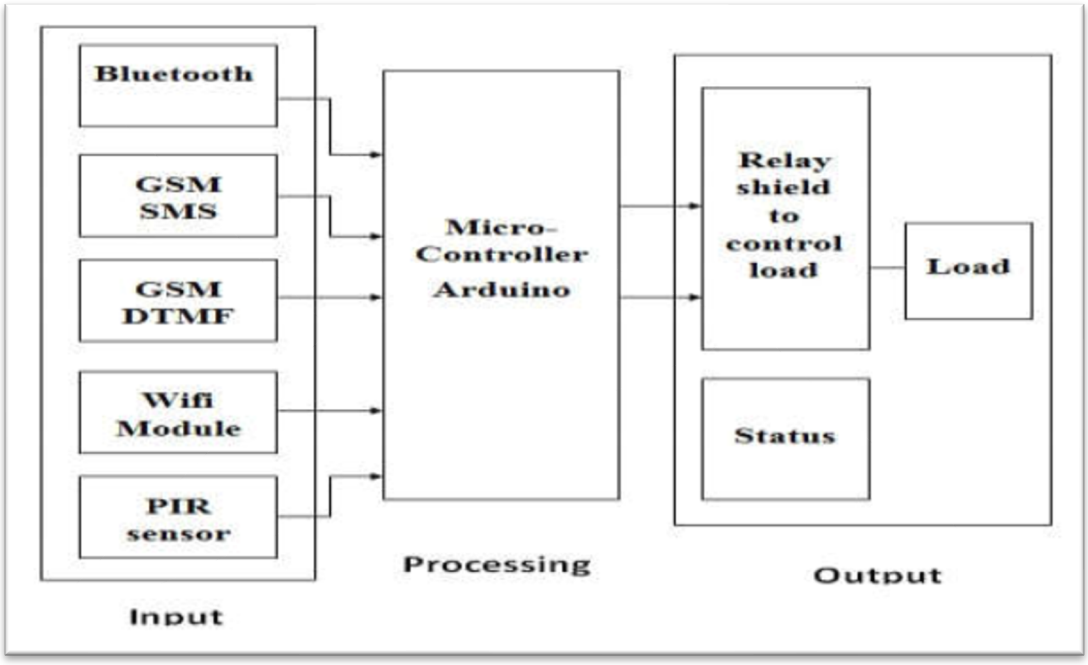

Figure 2-2 Home automation system using bluetooth, GSM, Wi-Fi and DTMF (N.M. Morshed, G.M. Muid-Ur-Rahman, M.R. Karim and H.U. Zaman,2015)

2.3.3. Sensor Based Home Automation and Security System

This system uses sensors for providing security to their system. the user can control doors and windows remotely by using a webpage interface and, an alerting email message is sent to the home owner instantly.

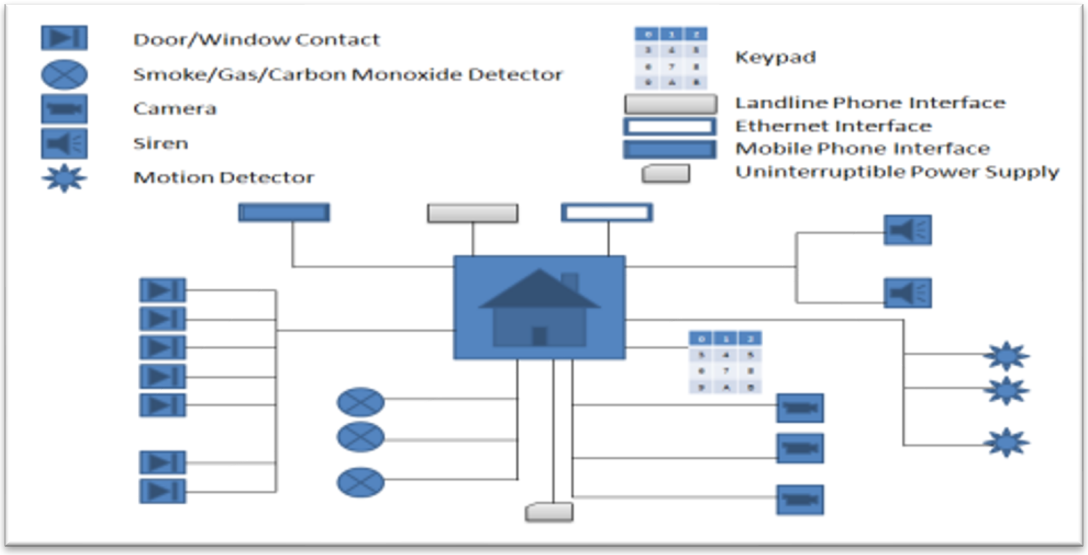

Figure 2-3 Sensor based home automation and security system (Mansour, Assaf & Mootoo, Ronald & Das, Sunil & Petriu, Emil & Groza, Voicu & Biswas, Satyen 2012)

2.4. Current System Analysis

Many technologies are applied in the construction of this sort of system, as shown by a survey of different home automation systems. All of the suggested systems have been presented in this study and contrasted, highlighting some of the systems' advantages and disadvantages. This review covered many home automation options. Systems Because of its effectiveness, simplicity, low cost, and dependability, home automation systems have acquired popularity on the global market.

Table 2-1 Comparing between existing systems

Title	Strength	Weakness
Exploiting Bluetooth on Android Mobile Devices for Home Security Application	Using variable sensors for different purposes makes the system more user interaction. Remotely controlling Easy installing and limited authentication for using the system. High data rate	Limited to Short distance There is no warning alarm on application when unauthorized entered happen. High cost Not supports outdoor usage
Microcontroller Based Home Automation System Using Bluetooth, Wi-Fi and DTMF	Multiple sensors can be connected to it simultaneously. Scalable	Privacy is an issue. It can be a costly affair. Low Security as DTMF is used

	Easy to use	Using Twitter for sending notification as not everyone has account.
Sensor Based Home Automation and Security System	Outdoor usage as long as there is internet coverage. Remote controlling Monitor Scenarios and Activities	As the system is smart home it didn't focus much on home security. Using email as notification might not be efficient way in critical and urgent cases. High cost

2.5. Literature Review of Technologies Used

There are several technologies that needed to be used on the literature review. The requirement for both software and hardware for development is described as follow.

Internet of Things – IoT: The Internet of Things (IoT) is a network of Internet-connected physical items that share data through network devices or routers. The Internet of Things (IoT) allows for remote control of objects using existing network infrastructure. IoT is a great and clever technology for reducing human effort and making physical items more accessible. This method also offers an autonomous control feature that allows it to control any system without requiring any social contact.

Arduino: Arduino is a microcontroller that runs on a single board. Built to make the device more available to particular virtual items and the environment An open-source hardware board based on an Atmel AVR 8-bit or Atmel ARM 32-bit microcontroller is featured in the hardware. Arduino consists of a programmable physical circuit, called a microcontroller. Arduino Integrated Development Environment (IDE) is a cross-platform, Windows, macOS, and Linux technology. Arduino IDE is mostly used to generate and upload code to the Arduino Module. Arduino IDE supports such languages as C and C++.

Raspberry PI: Raspberry Pi is a small one board machine. Raspberry Pi can be used to play HD video for several things your computer does, such as gaming, word processing, spreadsheets, and even. There are two-model Raspberry Pi comes in. The difference between the two versions is that the USB port. Raspberry Pi supports python and other programming languages.

Table 2-2 Comparison between Arduino and Raspberry PI

Hardware	Advantage	Disadvantage
Arduino	Not much experience needed to get started. Cheap in price. The software is well-suited with all kinds of operating system like Linux, Windows, and Macintosh, etc. No requirement for an external program error power supply	The AVR microcontroller fails to understand Sketches and shield scan be hard to change No debugger used for script checking
Raspberry PI	Can be used as Super Computer Use python as a programming language which makes it easy Less power consumption	Expensive Not compatible with other Operating system like windows Complexity in multi-tasking

Application: Ring app It allows you to set up, manage, and control your house, security system, and cameras. You can keep an eye on your home from anywhere and get alerts on your phone or tablet. There are apps for both iOS and Android.

Database: A database is a data system that holds different pieces of information. Most databases contain several table lists, and each list may have many various fields. For example, a company database may include product tables, personnel, and financial records. Each such table will have specific areas related to the information contained in the table. More specifically, a database is an electronic system that makes data easy to access, manage, and update.

Firebase: It provides developers with a variety of tools and services to help them develop quality apps, grow their user base, and earn profit. All the record of the movement will set into the fire base with date and time

2.6. Chapter Summary

This chapter discusses the relevance of the system for home security and why the world needs this initiative, as well as the issues that people confront. The purpose of this discussion is to provide a brief overview of current system researches that are relevant to this system, as well as to analyze the strengths and weaknesses of these researches in terms of performance, security, integrity, and design, and to select strengths and the technology that uses in this project.

Chapter 3

Methodology

3.1. Introduction

Having an efficient system needs good and strong plans to be followed, in this chapter the methodology that has been used for creating the home security is discussed. The tools and technologies used for the system are chosen and developing steps are clarified. The answer of (Why choosing this method/tool/technology?) is answered in detail and how this system adds to other previous systems in the same area.

As a result, a systems methodology is fundamentally a process that involves system-scientific approaches, and also system thinking and simulation tools, and is done by people who have the appropriate systems, applied science, and engineering experience.

3.2. Methodology Choice and Justification

There are five phases in waterfall system development methodology requirement, design, implementation, verification or testing and deployment and maintenance as shown in figure 3.1

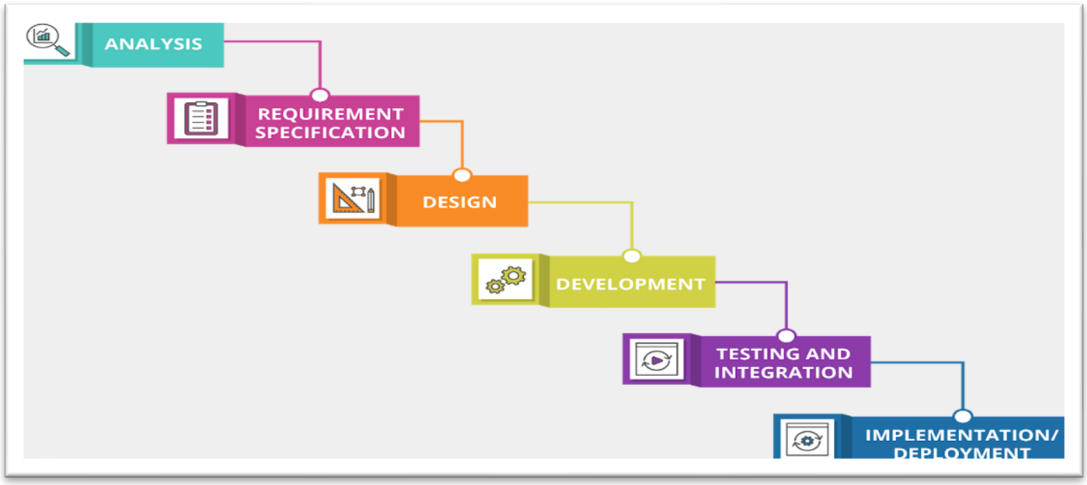

Figure 3-1 Waterfall methodology (Waddell, J)

3.3.Waterfall Methodology

The waterfall methodology is a linear and a waterfall-like development approach that flows through all phases of a project (requirement, design, implementation, testing, and deployment) which must phase be finished in order to start the following phase. The Waterfall technique is a sequential approach that works with set deadlines, requirements, and outcomes. The waterfall model is suitable with the projects that their aim and objective is clear.

3.3.1. Phase 1: Requirement

The purpose of this phase is answering to the question (what problem do we want to solve?) and to understand the needs and requirements of the client. The developing team make their research about the problem and collects data. Then according to collected data the developer estimates the cost, time, and how much can be achieved for releasing the first and last versions after that tools and methods needed for developing are provided and the next phases are planned in detail. For the design and implementation of an IoT-based smart home security system, the needs of the user are clarified and the tools that's leading to the creation of the system is been chosen.

3.3.2. Phase 2: Design

After understanding the problem and achieving the point, using the information that has been collected and tools that's been chosen, the designing phase is ready to be started. smart home security system relies on the scenario of implementation of the system, from the motion notification to the reaction of the user.

3.3.3. Phase 3: Implementation

The implementation phase is turning the design into technical implementation, after all the requirement is been collected and the design is done developing phase starts. Connecting sensors with Arduino UNO and other physical parts of home security system, and writing relating commands to control hardware using C language as software part of the smart home security system. Developing a database to record motions using Firebase.

3.3.4. Phase 4: Verification or testing

Finishing from the implementation phase, the system is constructed and is ready for testing, before delivering it to the user testing team must test the system and make sure that the system is without error. Here the strong point and weak point are taken out.

3.3.5. Phase 5: Deployment and maintenance

The created system that's gone through many phases and has been tested by the developer team is now ready to be delivered to the client. The change and

improvement points will be discussed by the user and developers. When the user asks for a change in the released version the developer team ensures changing according to users' needs.

3.4. Technologies Used Description

The tools and technology required to create and deploy an IoT-based smart home security system are explained in this section.

C language for programming Arduino:

Arduino is the hardware platform that uses the C programming language as the soft controller for hardware parts in the system. The software acts as the brain of the system that manages, monitors, and sends the reaction instruction to the hardware in the system.

3.5. System Requirement Analysis

This project's system requirement includes both hardware and software. Any physical tools, such as electronic devices or computer equipment utilized to offer multiple features such as input, output, computation, and process are considered hardware. The software, on the other side, is a set of instructions. That tells a computer how to accomplish certain tasks, such as developing code and constructing a system. Both components are required for the smart home security system's design and execution.

3.5.1. \Hardware Requirements

Hardware justification is critical in software development to guarantee that it can function. At the optimum level according to the user environment.

Arduino UNO:

Is a programmable open-source microcontroller board that is low-cost, adaptable, and simple to use. It may be used in a range of electronic applications.

Figure 3-2 Arduino Uno(Conrad.com)

Sensor:

Dummy PIR Motion: A motion sensor (also called a motion detector) is a system that controls and detect any movement. Motion sensors are mostly utilized in the house, and they are simple to install. Active ultrasonic sensors generate ultrasonic sound waves that are inaudible to humans. These waves bounce off adjacent objects before returning to the motion sensor and being sent to the Arduino and GSM module, which will make a phone call.

Figure 3-3 Motion detector (alarmgrid.com)

GSM Module sim 800a:

A GSM modem, also called as a GSM module, is a physical device that connects to a remote network using GSM mobile phone technology. They are essentially comparable to a standard mobile phone from the standpoint of the mobile phone network, including the necessity for a SIM to identify oneself to the network

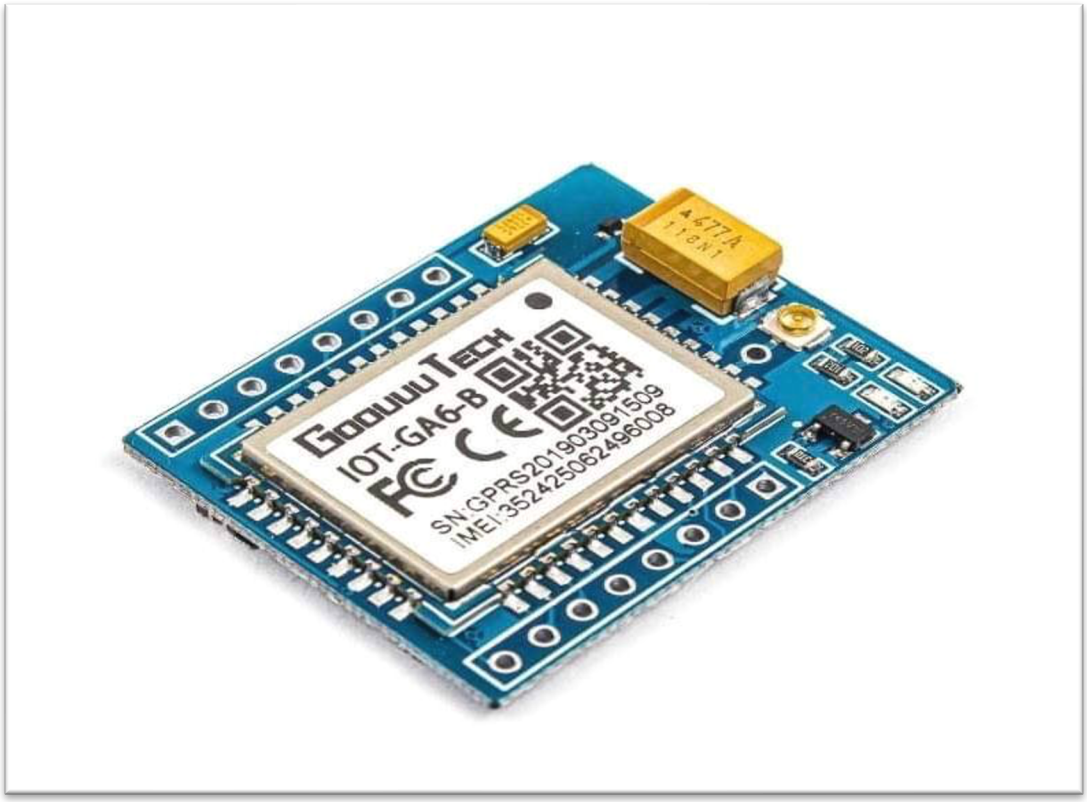

Figure 3-4 GSM Module (Electrpeak.com)

ESP32-Cam-CH340 Development Board:

It is appropriate for IoT applications such as wireless positioning system signals, industrial wireless control, wireless monitoring, QR wireless identification, and smart home gadgets.

Figure 3-5 ESP32-Cam-CH340 Development Board (Electorstore.com)

3.6. Chapter Summary

In this chapter, the methodology used for developing the smart home security system is clarified and the phases are explained in detail. choosing the waterfall method matches with the concept of the system that can handle change and improvement in any time of its life developing process. Hardware and software parts used in creating smart home security system are being introduced briefly.

Chapter 4

Requirements Analysis and Design

4.1. Introduction

This chapter discusses the requirement analysis and design for the Design and Implementation of an IoT-Based Smart Home Security System. Every function in the system should be described by using Unified Modelling Language (UML) to understand the operation, needs, and entities involved in the system development. Use case, sequence, and activity diagram are shown to explain the system flow. Furthermore, database design is also used to determine the relationship in the system. The interface design for smart home security system will be also included in this chapter.

4.2. Requirements Analysis

Requirement analysis is an important phase for the development project to prevent errors in the system. One of the required analyses is user requirement that makes the user can understand the system activity and process. Below is the function for the Homeowner:

- A homeowner can register and log in to the account to access the system application.
- The homeowner can view all actions and attempt in the system.
- The homeowner can view live video inside the home in the system application.
- The homeowner can get the system application notification.
- The homeowner can log out from the system application.

4.2.1. Use Case Diagram

A use case diagram is an illustration form that contains an actor who acts as a user in the system playing their roles and function in the system. Figure 4.1 shows the use case diagram for the smart home security system.

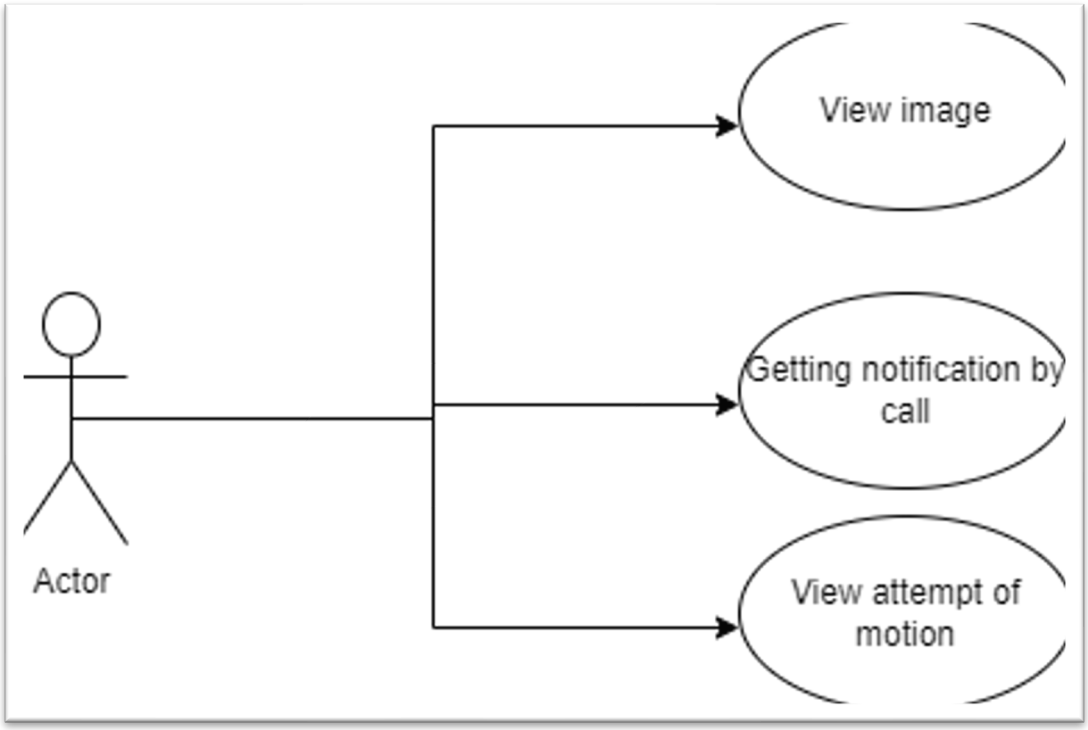

Figure 4-1 Home security System Use Case Diagram

As shown in Figure 4.1, there is one-actor which is the Homeowner for the system. There are three functions in the diagram that each function plays its roles which are registering a new account, view images, view attempts, notification, update user information. The system application.

4.2.1.1. Home owner and Admin Use Case:

Based on Figure 4.1, the Homeowner has several functions that can be accessed which is logging in to the verify account, viewing attempts, get notifications about attempts

that happen in the home. Update the user information such as username, mobile number, and password. Before they can access the system application the users need to register and verify the account first. Table 4.1 shows how each function works.

Table 4-1 Use Case Function for Home owner

Use Case	Description
Login	Login Home owner can login to the database once the account is verified.
Notification	Homeowner can get notification about the if there are any attempts.
View attempts	Homeowner can see the history of attempts

4.2.2. Sequence Diagram

Sequence diagrams are interaction diagram that shows how the system activities, process, or task are being carried out for each function. The sequence diagram is also shown in detail how each function work. There are several functions that users share which are, login, attempts, notification, and updating user information. Figure 4.2, Figure 4.3 and Figure 4.4, below shown functions for Homeowner.

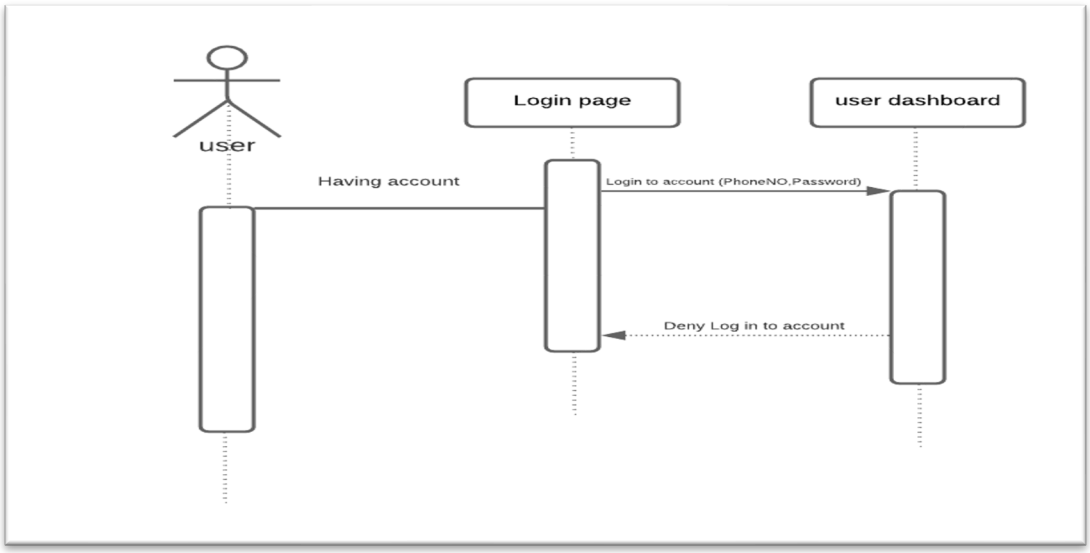

Figure 4-2 User login sequence diagram

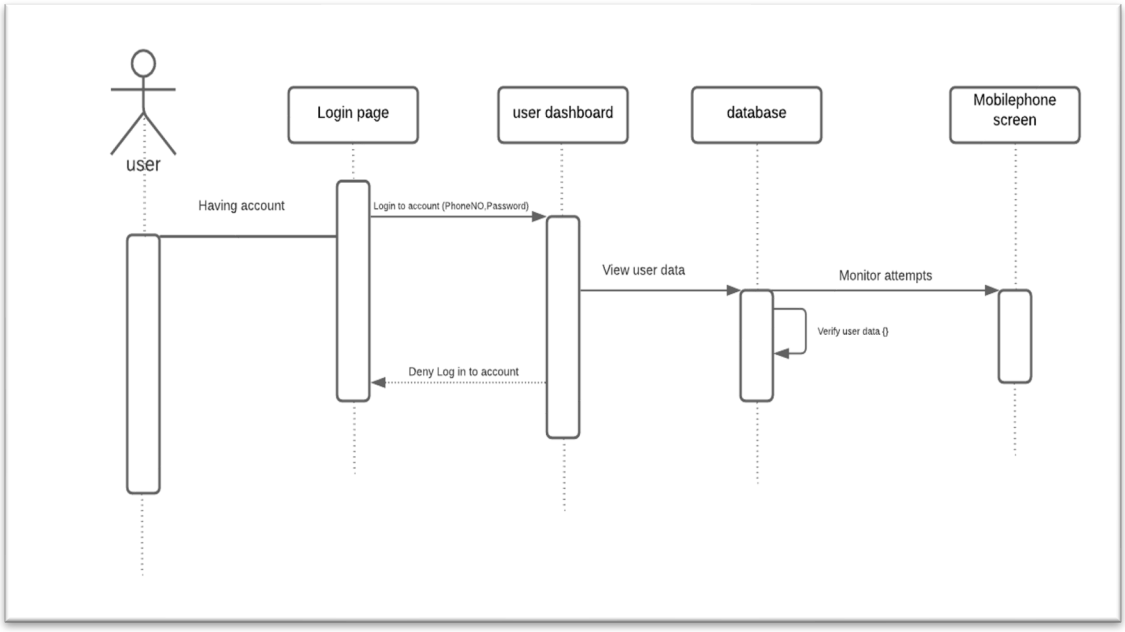

Figure 4-3 View attempts sequence diagram

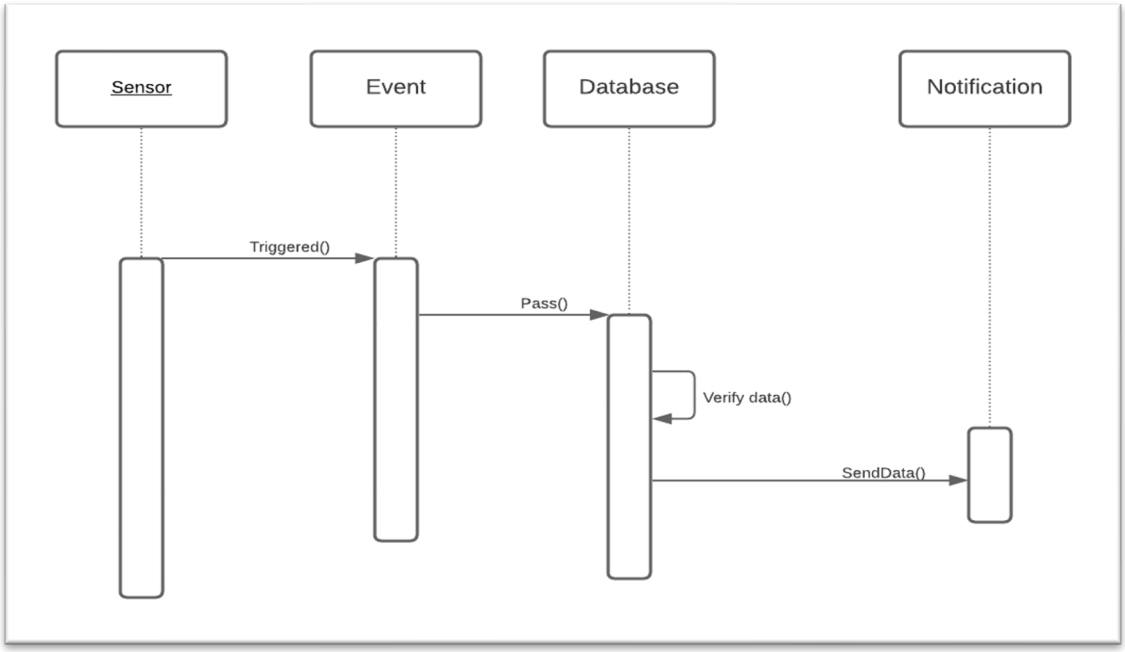

Figure 4-4 notification sequence diagram

4.2.3. Activity Diagram

The activity diagram, which defines dynamic characteristics of the system, is another important behavioral diagram in the UML diagram. The activity diagram is a more advanced version of a flow chart that depicts information movement from one activity to the next. This section will also go through the activity diagrams for the homeowner users in the system application.

User Activity Diagram:

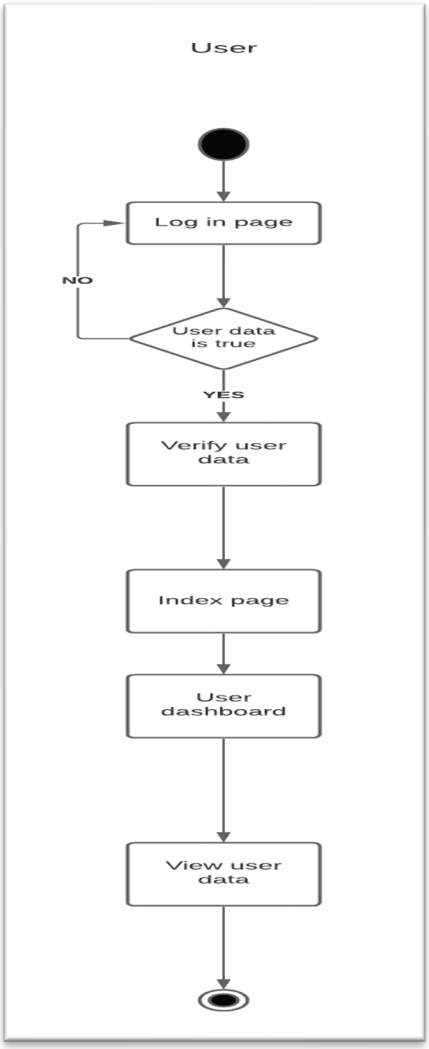

Figure 4-5 User activity diagram

4.3. Project Design

The system architecture and design are to show the relationship between all the related hardware and software that are being used to develop the system.

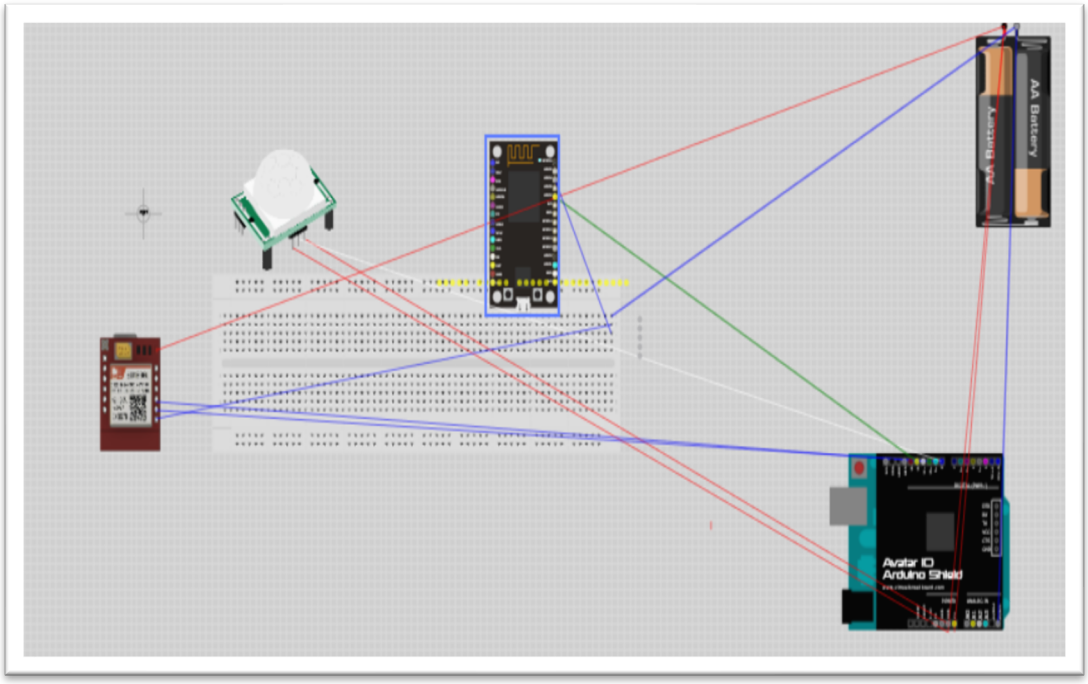

Figure 4-6 Connection schematic diagram

4.4. Database Design

Database design is used to show the relationship between each data in the system application. The database design determines how the elements of data interact with each other and what data must be stored. The entity Relationship Diagram (ERD) is used to design the database. Figure 4.7 shows the system application database design.

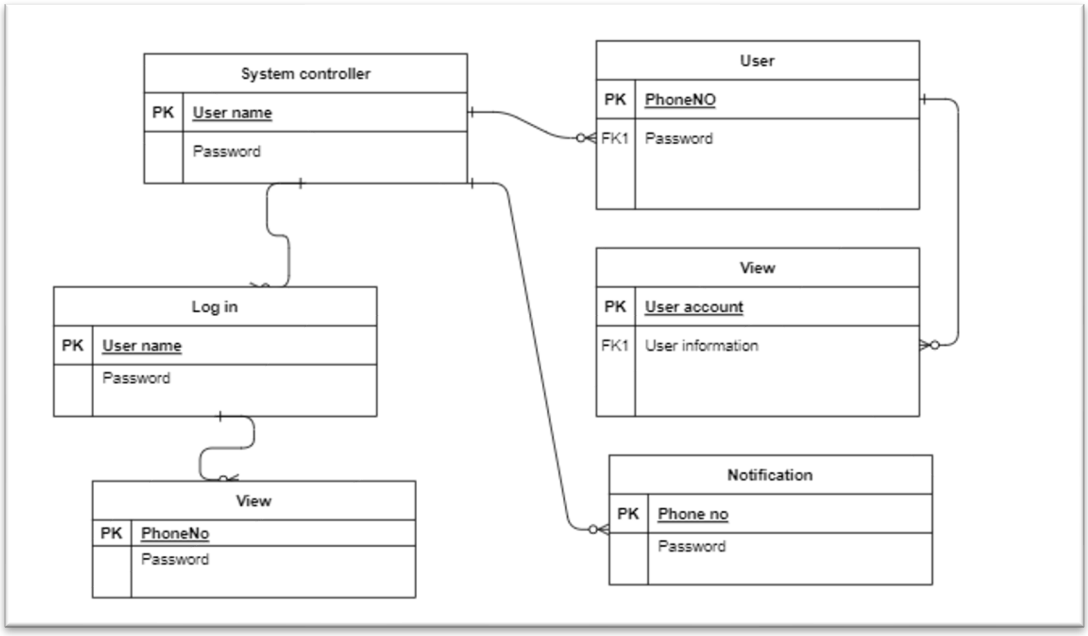

Figure 4-7 Design and Implementation of an IoT-Based Smart Home Security System Database Design

4.5. Interface Design

Interface design is a graphic user interface (GUI) where users can interact with the system application. The interface design must be simple and user-friendly to make the user easy to understand to use the system. Below is the user interface for each function in this system application.

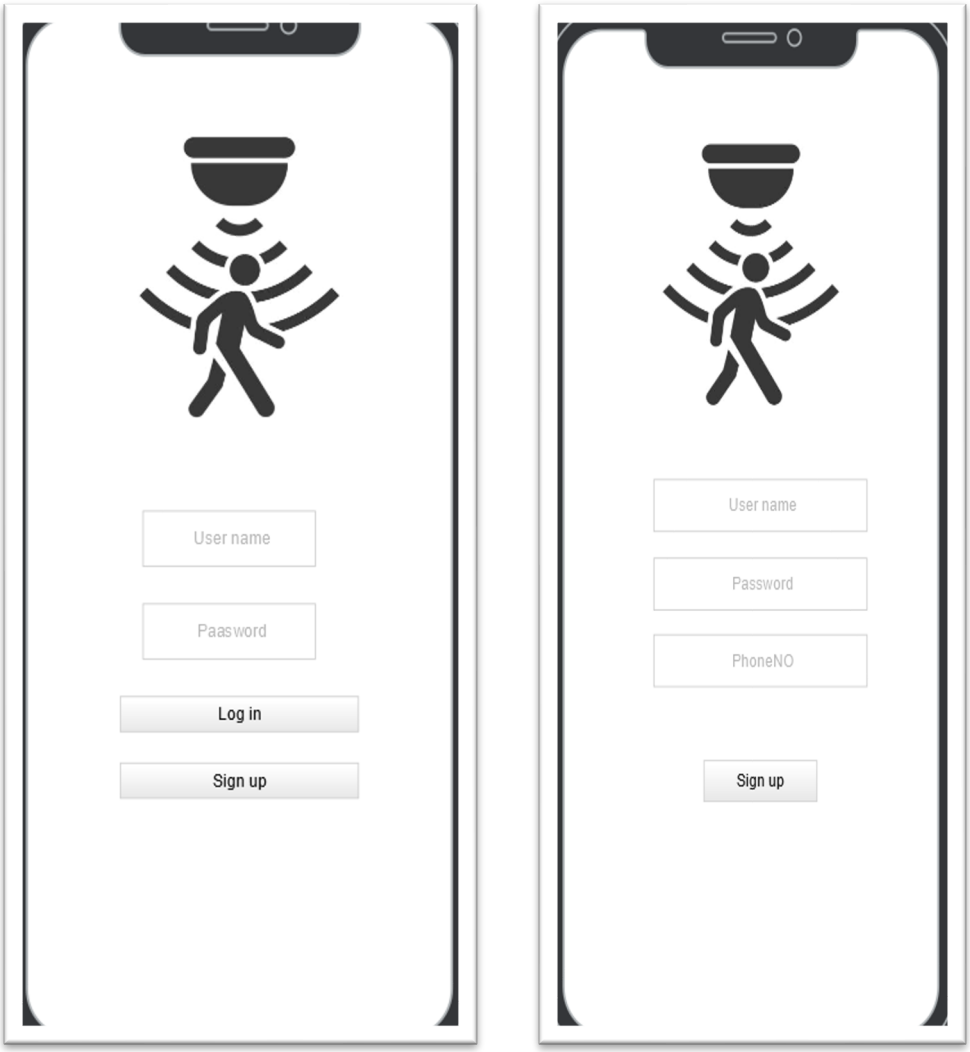

Figure 4-8 Database login Screen

Figure 4.8 shows the login interface and sign-up interface for the user. For the Homeowner when they first time using the system application, they need to sign up first before they can log in into the Database.

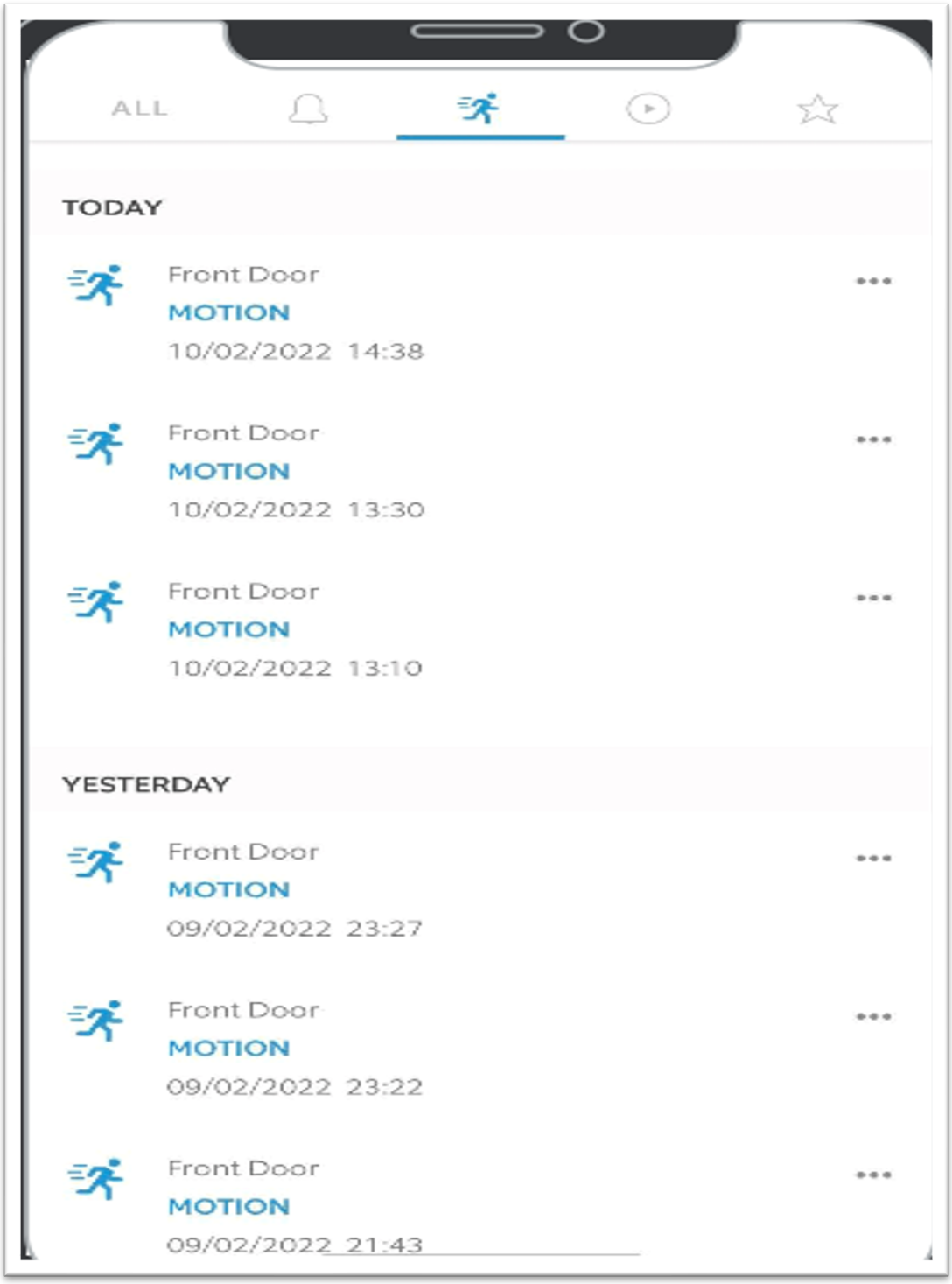

Figure 4-9 View attempts

Figure 4.9 shows the History page of motions here homeowner can see the attempts.

4.6. Chapter Summary

This chapter discusses the requirement analysis and design for the development of the system application. On the requirement analysis part, the Unified Modelling Language (UML) is used which is use cases diagram, sequence diagram, and activity diagram. In addition, the database also was designed in this chapter to relate the relationship between each table in the system application using an entity-relationship diagram (ERD). Lastly, the interface for the system application was designed.

Chapter 5

Implementation, and Testing

5.1. Introduction

As we reached the most important chapter which is implementation and testing, the process from coding and combining devices, to the outcome and implementation of the system is discussed in this chapter. In addition to that testing is explained. During passing through this chapter the bugs, weak points, and the problem faced by the system are shown. Showing the result of the system as user test and testing the codes is what this chapter is about.

5.2. Coding of System Main Functions

The software part used in DESIGN AND IMPLEMENTATION OF AN IOT-BASED SMART HOME SECURITY SYSTEM as explained in other chapters is C++ and firebase for the database to record the date and time of the motion trigged. For hardware part sensors, motion detector, Arduino UNO, camera, GSM sim 800A, and jumpers with a breadboard. Through this section, the main functionality of the system will be explained.

5.2.1. Part code of motion detector

When motion sensor detects a motion, it will send signals to Arduino and then the Arduino sends signal to GSM module, the code below is the coding of motion-detecting as motion system is trigged.

```
#include <SoftwareSerial.h>
SoftwareSerial mySerial(10, 11); //SIM800L Tx & Rx is connected to Arduino
const byte PIR_PIN = 8;
const byte PIR_Statue = 9;
byte PIR_State = 0;
void setup(){
  Serial.begin(9600);
  //Begin serial communication with Arduino and SIM800L
  mySerial.begin(9600);
  Serial.println("Initializing...");
  delay(12000); // wait for 20 seconds...
  pinMode(PIR_PIN, INPUT);
  pinMode(PIR_Statue, OUTPUT);
  digitalWrite(PIR_Statue, HIGH);

  mySerial.println("AT"); //Once the handshake test is successful, i t will
back to OK
  updateSerial();
  Call();
}
void loop(){
  PIR_State = digitalRead(PIR_PIN);
  if(PIR_State){
    digitalWrite(PIR_Statue, LOW);
    delay(1000);
    digitalWrite(PIR_Statue, HIGH);
    Call();
  }
}
void Call(){
  mySerial.println("ATD+9647510372002;"); //  change ZZ with country code
and xxxxxxxxxx with phone number to dial
  updateSerial();
  delay(30000); // wait for 20 seconds...
  mySerial.println("ATH"); //hang up
  updateSerial();
}
void updateSerial(){
  delay(500);
  while (Serial.available())
  {
    mySerial.write(Serial.read());//Forward what Serial received to
Software Serial Port
  }
  while(mySerial.available())
  {
    Serial.write(mySerial.read());//Forward what Software Serial received
to Serial Port
  }
}
```

Figure 5-1 Code of PIR motion detector

5.2.2. Part code of GSM module

As the signal reaches to GSM module, the user gets a phone call, that lasts for 20 seconds, and determines un-authorized movement. as shown in the code below, the system can adjust to the user's requests anytime they want to alter their number, and it will modify the phone call to the desired number as well as the 20 seconds if they want to shorten or lengthen them.

```
#include <SoftwareSerial.h>
SoftwareSerial mySerial(10, 11); //SIM800L Tx & Rx is connected to Arduino
const byte PIR_PIN = 8;
const byte PIR_Statue = 9;
byte PIR_State = 0;
void setup(){
  Serial.begin(9600);
  //Begin serial communication with Arduino and SIM800L
  mySerial.begin(9600);
  Serial.println("Initializing...");
  delay(12000); // wait for 20 seconds...
  pinMode(PIR_PIN, INPUT);
  pinMode(PIR_Statue, OUTPUT);
  digitalWrite(PIR_Statue, HIGH);
  mySerial.println("AT"); //Once the handshake test is successful, i t will
back to OK
  updateSerial();
  Call();
}
void loop(){
  PIR_State = digitalRead(PIR_PIN);
  if(PIR_State){
    digitalWrite(PIR_Statue, LOW);
    delay(1000);
    digitalWrite(PIR_Statue, HIGH);
    Call();
  }
}
void Call(){
  mySerial.println("ATD+9647510372002;"); //  change ZZ with country code
  updateSerial();
  delay(30000); // wait for 20 seconds...
  mySerial.println("ATH"); //hang up
  updateSerial();
}
void updateSerial(){
  delay(500);
  while (Serial.available())
  {
    mySerial.write(Serial.read());//Forward what Serial received to
Software Serial Port
  }
  while(mySerial.available())
  {
    Serial.write(mySerial.read());//Forward what Software Serial received
to Serial Port
  }
}
```

Figure 5-2 Code of GSM Module

5.2.3. Part code of ESP32-CAM WIFI

In addition to a phone call, the system captures the movement when the motion sensor sends the signal, the photos will be inserted into memory. ESP32-CAM is working on Wi-Fi, and sends date and time to firebase for recording in the database.

```
  camera_config_t config;
  config.ledc_channel = LEDC_CHANNEL_0;
  config.ledc_timer = LEDC_TIMER_0;
  config.pin_d0 = Y2_GPIO_NUM;
  config.pin_d1 = Y3_GPIO_NUM;
  config.pin_d2 = Y4_GPIO_NUM;
  config.pin_d3 = Y5_GPIO_NUM;
  config.pin_d4 = Y6_GPIO_NUM;
  config.pin_d5 = Y7_GPIO_NUM;
  config.pin_d6 = Y8_GPIO_NUM;
  config.pin_d7 = Y9_GPIO_NUM;
  config.pin_xclk = XCLK_GPIO_NUM;
  config.pin_pclk = PCLK_GPIO_NUM;
  config.pin_vsync = VSYNC_GPIO_NUM;
  config.pin_href = HREF_GPIO_NUM;
  config.pin_sscb_sda = SIOD_GPIO_NUM;
  config.pin_sscb_scl = SIOC_GPIO_NUM;
  config.pin_pwdn = PWDN_GPIO_NUM;
  config.pin_reset = RESET_GPIO_NUM;
  config.xclk_freq_hz = 20000000;
  config.pixel_format = PIXFORMAT_JPEG;
  pinMode(4, INPUT);
  digitalWrite(4, LOW);
  rtc_gpio_hold_dis(GPIO_NUM_4);
  if(psramFound()){
    config.frame_size = FRAMESIZE_UXGA; // FRAMESIZE_ +
QVGA|CIF|VGA|SVGA|XGA|SXGA|UXGA
    config.jpeg_quality = 10;
    config.fb_count = 2;
  }
  else{
    config.frame_size = FRAMESIZE_SVGA;
    config.jpeg_quality = 12;
    config.fb_count = 1;
  }
  // Init Camera
  esp_err_t err = esp_camera_init(&config);
  if (err != ESP_OK) {
    Serial.printf("Camera init failed with error 0x%x", err);
    return;
  }
  Serial.println("Starting SD Card");
  delay(500);
  if(!SD_MMC.begin()){
    Serial.println("SD Card Mount Failed");
    return;
  }
  uint8_t cardType = SD_MMC.cardType();
  if(cardType == CARD_NONE){
    Serial.println("No SD Card attached");
    return;
  }
  camera_fb_t * fb = NULL;
```

```
  // Take Picture with Camera
  fb = esp_camera_fb_get();
  if(!fb) {
    Serial.println("Camera capture failed");
    return;
  }
  // initialize EEPROM with predefined size
  EEPROM.begin(EEPROM_SIZE);
  pictureNumber = EEPROM.read(0) + 1;
  // Path where new picture will be saved in SD Card
  String path = "/picture" + String(pictureNumber) +".jpg";
  fs::FS &fs = SD_MMC;
  Serial.printf("Picture file name: %s\n", path.c_str());
  File file = fs.open(path.c_str(), FILE_WRITE);
  if(!file){
    Serial.println("Failed to open file in writing mode");
  }
  else {
    file.write(fb->buf, fb->len); // payload (image), payload length
    Serial.printf("Saved file to path: %s\n", path.c_str());
    EEPROM.write(0, pictureNumber);
    EEPROM.commit();
  }
  file.close();
  esp_camera_fb_return(fb);

  delay(1000);

  // Turns off the ESP32-CAM white on-board LED (flash) connected to GPIO 4
  pinMode(4, OUTPUT);
  digitalWrite(4, LOW);
  rtc_gpio_hold_en(GPIO_NUM_4);
  esp_sleep_enable_ext0_wakeup(GPIO_NUM_13, 0);
  timeClient.begin();
  timeClient.update();
  unsigned long unix_epoch = timeClient.getEpochTime();    // Get Unix
epoch time from the NTP server
  second_ = second(unix_epoch);
  minute_ = minute(unix_epoch);
  hour_   = hour(unix_epoch);
  day_    = day(unix_epoch);
  month_  = month(unix_epoch);
  year_   = year(unix_epoch);
  Time[12] = second_ % 10 + 48;
  Time[11] = second_ / 10 + 48;
  Time[9]  = minute_ % 10 + 48;
  Time[8]  = minute_ / 10 + 48;
  Time[6]  = hour_   % 10 + 48;
  Time[5]  = hour_   / 10 + 48;
  Date[5]  = day_    / 10 + 48;
  Date[6]  = day_    % 10 + 48;
  Date[8]  = month_  / 10 + 48;
  Date[9]  = month_  % 10 + 48;
  Date[13] = (year_   / 10) % 10 + 48;
  Date[14] = year_   % 10 % 10 + 48;
  Serial.println("Going to sleep now");
  delay(1000);
  esp_deep_sleep_start();
  Serial.println("This will never be printed");
}
```

Figure 5-3 Code of ESP32CAM

5.2.4. Part code of Firebase

The database of the system is to record the date and time according to the user's location. For this system, firebase is used. The user has their own username and password to access the database. He/she can see all the dates and at which specific time the unauthorized movement happened.

```
#include <WiFi.h>
#include <WiFiUdp.h>
#include <NTPClient.h>
#include <TimeLib.h>
WiFiUDP ntpUDP;
//You Need Use Time Zone  Iraq +3   (3 * 60 * 60 = 10800)
NTPClient timeClient(ntpUDP, "asia.pool.ntp.org", 10800, 10800);
char Time[ ] = "TIME:00:00:00";
char Date[ ] = "DATE:00/00/2000";
byte second_, minute_, hour_, day_, month_;
int year_;
String RTC = "";
#include "esp_camera.h"
#include "Arduino.h"
#include "FS.h"                // SD Card ESP32
#include "SD_MMC.h"            // SD Card ESP32
#include "soc/soc.h"           // Disable brownour problems
#include "soc/rtc_cntl_reg.h"  // Disable brownour problems
#include "driver/rtc_io.h"
#include <EEPROM.h>            // read and write from flash memory
// define the number of bytes you want to access
#define EEPROM_SIZE 1
RTC_DATA_ATTR int bootCount = 0;
  RTC = String(Date) + " , " + String(Time);
  Serial.println(RTC);
  delay(500);
  Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);
  Firebase.reconnectWiFi(true);
  if (Firebase.setString(firebaseData, "/Pictore: " +
String(pictureNumber), RTC) == true) {
    Serial.println("Data Sent.");
  }
```

Figure 5-4 Code of Firebase

5.3. Testing

Our main goal of this section is to determine whether the requirement matches the output, to evaluate the performance of the system in both software and hardware part.

5.3.1. Black-Box Testing

As more focus is given on the input and output produced by the system during box black testing, it is not necessary for the tester to understand what is happening on the code side to determine how the system responds to expected and unexpected user behavior, response time, usability, and reliability issues.

Table 5-1 Black box testing

Inputs	Expected results	Actual results	status
In case of motion and connected to Wi-Fi	A successful Phone call, record date and time, capturing the image, and saving to SD card.	Phone call, record date and time, capturing the image, and saving to SD card.	pass
In case of no motion and connected to Wi-Fi	An unsuccessful Phone call, record the date and time, capture the image, and save to the SD card.	Unsuccessful Phone call, record date and time , capturing the image and saving to SD card.	pass
No Wi-Fi connection	A successful phone call, but unsuccessful in recording date and time, capturing the image, and saving to SD card.	A successful phone call, but unsuccessful in recording date and time, capturing the image, and saving to SD card.	pass

5.3.2. White Box Testing

White box testing is a process where the internal configuration, code, and structure of the program are examined to verify an input and output flow and enhance design, usability, and security. The optimization of code by finding hidden defects is one advantage of employing white box testing.

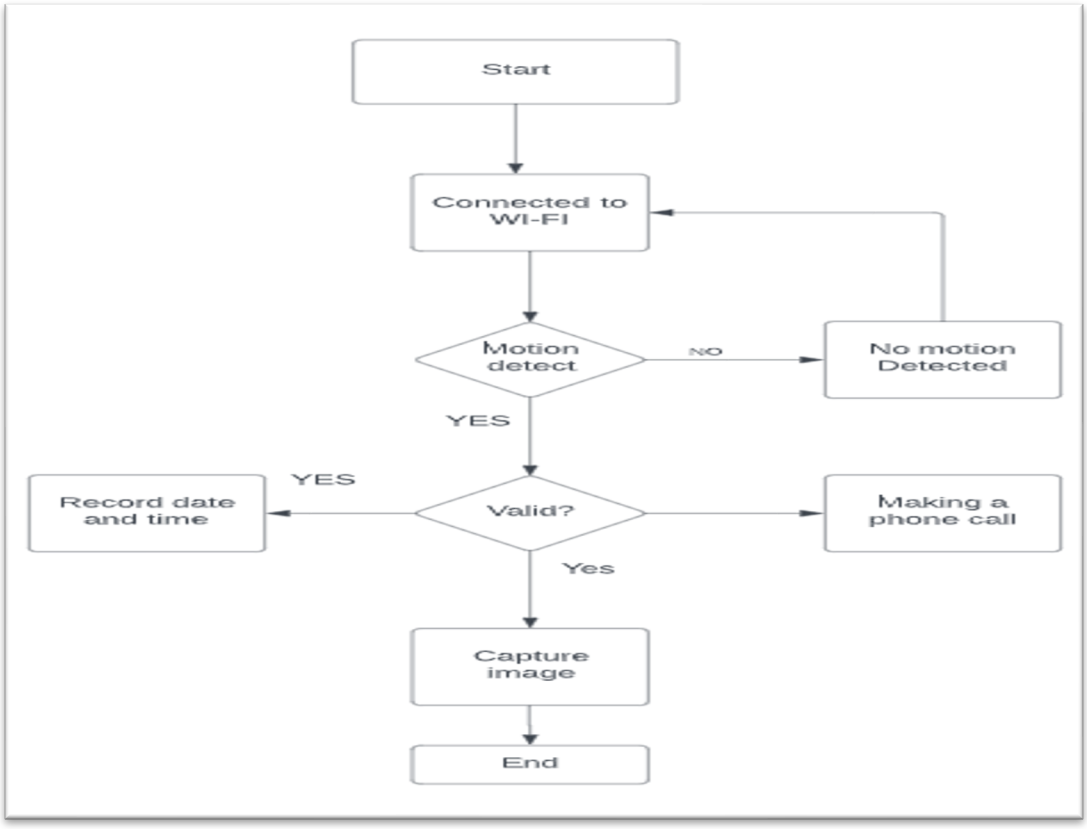

Figure 5-5 White Box flow chart

5.3.3. User Acceptance Testing

End users evaluate software during user acceptance testing (UAT), also known as end-user testing, to determine if it is satisfactory or not. A final test is performed following the completion of the functional, system, and regression tests. The purpose of the testing is to confirm that the system adheres to the specification. The validation testing was carried out by an end user who is familiar with the business requirement.

Student from Qaiwan International University is a trusted user to do this work during user testing, as shown in the table below.

Table 5-2 User acceptance test motion detection and getting phone call with recording date, time and the image

Name of tester: Shakar anwar		
Date:20 June 2022		
Module: motion detection and getting phone call with recording date , time and the image		
instruction	**Expected results**	**Status**
1- Move in front of PIR sensor	1- receiving phone call 2- capturing image 3- recording date and time to data base	pass

5.4. Chapter Summary

The phase of implementation and testing is covered in this chapter. All of the requirements that were acquired during the gathering phase are expressed into a system that completely functions and also fulfils the need during the implementation phase. The coding activities must be properly executed to guarantee that the necessary functionalities may be incorporated in the system in order to interpret all the requirements into the system. To make sure the system created is free of any defects, the encoding operations performed throughout the implementation process should be extensively checked during the testing phase.

Chapter 6

Conclusion

6.1. Introduction

This chapter would go over the outcomes and achievements of the DESIGN AND IMPLEMENTATION OF AN IoT BASED ON SMART HOME SECURITY SYSTEM along with the recommendation for future advancements

6.2. Achievement of Project Objectives

The goal of the project was to leverage IoT to increase home security so that you may obtain high-quality professional protection. After completion, a problem background with the existing situation and system has been recognized, leading to a suggested remedy for resolving such issues.

This section has included a review of the three other existing systems as well as the present system. Systems are chosen based on how closely they resemble the proposed system in terms of features and operation. All components and characteristics that could be valuable are considered for the proposed system throughout the study.

Chapter 3 provides a thorough explanation of system approach. The water fall approach that was chosen has been discussed and supported for the model that was chosen. From the conception phase until the transition phase, every aspect of the approach that was chosen is covered. In addition, this chapter covers the software and hardware-related topic of requirement analysis.

Chapter 4 of this project discusses the most crucial specifics. This chapter is primarily concerned with system analysis and design, which covers all crucial information from requirement analysis, system flow, database design, diagrams (use case, sequence, and activity), and so on. This chapter also includes an early interface design for the technology under consideration.

Chapter 5 discusses the project's implementation and testing. The development phase, which includes the coding and implementation of the system's key features including receiving a call, noting the date and time, taking a picture, and saving it to SD memory, is the subject of this chapter. Next, the testing phase was completed successfully by conducting user acceptability testing, white box testing, and black box testing to identify problems and mistakes.

6.3. Suggestions for Future Improvement

To improve the system and one of the future works of the system is to send the image directly to the database and email. In addition to that instead of capturing photos, the system records live video when the sensor detects a movement. sending a notification by SMS to a number of users that the user has selected. One of the most important future aims is to get verification from the government to use the system as an official security system.

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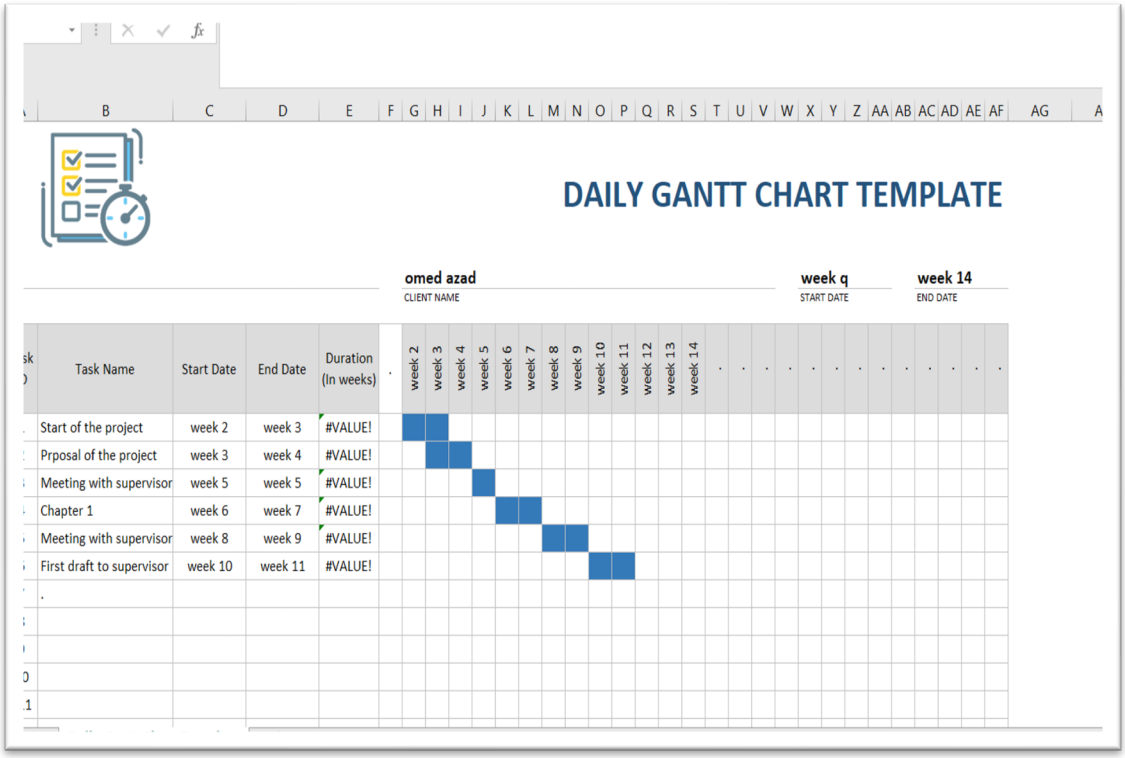
Arduino vs Raspberry PI [online] Available at: https://flaviocopes.com/arduino-vsraspberrypi/#:~:text=The%20Raspberry%20Pi%20comes%20with%20a%2064%2Dbit%20microprocessor.&text=In%20terms%20of%20I%2FO,set%20of%20I%2FO%20pins.&text=Raspberry%20Pi%20runs%20an%20operating,Arduino%20is%20much%20more%20simple.

Appendix A

Gantt chart



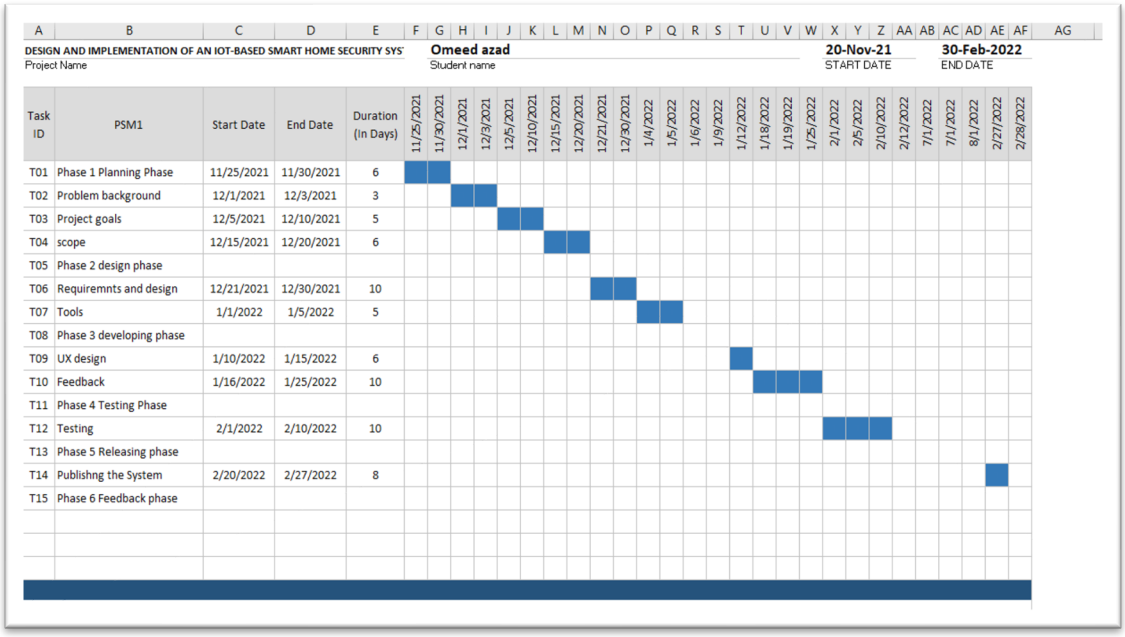
DAILY GANTT CHART TEMPLATE

omed azad — CLIENT NAME | week q — START DATE | week 14 — END DATE

Task Name	Start Date	End Date	Duration (In weeks)
Start of the project	week 2	week 3	#VALUE!
Prposal of the project	week 3	week 4	#VALUE!
Meeting with supervisor	week 5	week 5	#VALUE!
Chapter 1	week 6	week 7	#VALUE!
Meeting with supervisor	week 8	week 9	#VALUE!
First draft to supervisor	week 10	week 11	#VALUE!

week 2 | week 3 | week 4 | week 5 | week 6 | week 7 | week 8 | week 9 | week 10 | week 11 | week 12 | week 13 | week 14

Figure 0-1 weekly Gantt chart



DESIGN AND IMPLEMENTATION OF AN IOT-BASED SMART HOME SECURITY SYS — Project Name

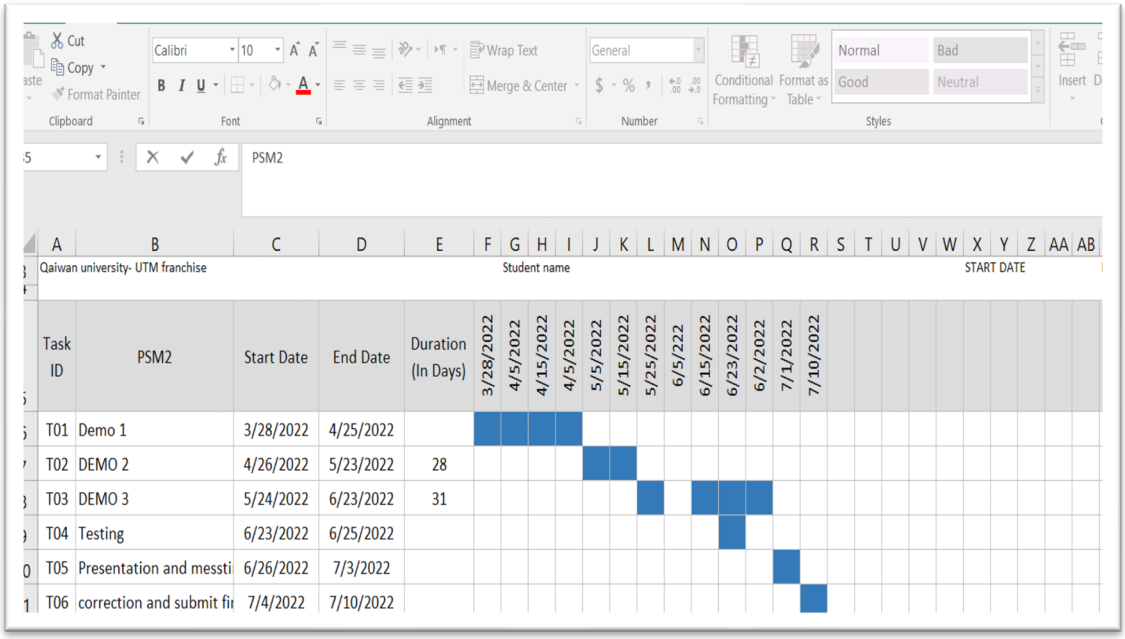
Omeed azad — Student name

20-Nov-21 — START DATE | 30-Feb-2022 — END DATE

Task ID	PSM1	Start Date	End Date	Duration (In Days)
T01	Phase 1 Planning Phase	11/25/2021	11/30/2021	6
T02	Problem background	12/1/2021	12/3/2021	3
T03	Project goals	12/5/2021	12/10/2021	5
T04	scope	12/15/2021	12/20/2021	6
T05	Phase 2 design phase			
T06	Requiremnts and design	12/21/2021	12/30/2021	10
T07	Tools	1/1/2022	1/5/2022	5
T08	Phase 3 developing phase			
T09	UX design	1/10/2022	1/15/2022	6
T10	Feedback	1/16/2022	1/25/2022	10
T11	Phase 4 Testing Phase			
T12	Testing	2/1/2022	2/10/2022	10
T13	Phase 5 Releasing phase			
T14	Publishng the System	2/20/2022	2/27/2022	8
T15	Phase 6 Feedback phase			

11/25/2021 | 11/30/2021 | 12/1/2021 | 12/3/2021 | 12/5/2021 | 12/10/2021 | 12/15/2021 | 12/20/2021 | 12/21/2021 | 12/30/2021 | 1/4/2022 | 1/5/2022 | 1/6/2022 | 1/9/2022 | 1/12/2022 | 1/18/2022 | 1/19/2022 | 1/25/2022 | 2/1/2022 | 2/5/2022 | 2/10/2022 | 2/12/2022 | 7/1/2022 | 7/1/2022 | 8/1/2022 | 2/27/2022 | 2/28/2022

Figure 0-2 weekly Gantt chart



Task ID	PSM2	Start Date	End Date	Duration (In Days)
T01	Demo 1	3/28/2022	4/25/2022	
T02	DEMO 2	4/26/2022	5/23/2022	28
T03	DEMO 3	5/24/2022	6/23/2022	31
T04	Testing	6/23/2022	6/25/2022	
T05	Presentation and messti	6/26/2022	7/3/2022	
T06	correction and submit fi	7/4/2022	7/10/2022	

Figure 0-3 weekly Gantt chart