*i*Home: IoT based Home Security System using Raspberry Pi with Email and Voice alert

Submitted By
Yahya Riaz (12280)
Inzamam (12998)

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Supervised By
Latif Jan

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FINAL APPROVAL

This is certified that we have studied this report, title "*i*Home: IoT based Home Security System using Raspberry Pi with Email and Voice alert" submitted by **Yahya Riaz** and **Inzamam** under the university registration No. **12280** & **12998**. We conclude that this project report is of sufficient standard to warrant its acceptance by the **IQRA National University, Peshawar** for the award of degree of Bachelor of Science in Software Engineering BS(SE) or (CS).

Approved By:

Mr. Latif Jan   Supervisor

Internal Examiner Name   Internal Examiner

Mr. Shahab-ul-Islam   FYP Coordinator

Dr. Atif Ishtiaq   Chairman

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examinations, it's further declared, that I have fulfilled all the requirements in line with the Quality Assurance Guidelines of the Higher Education Commission.

Yahya Riaz
ID. 12280

Inzamam
ID. 12998

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All acclamation and appreciations are for Al mighty Allah, who bestowed mankind with knowledge and wisdom. I bow before his compassionate endowment. I also pay my respect to last Holy prophet Hazrat Mohammad (PBUH), who becomes to well-wisher of mankind.

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Yahya Riaz
ID. 12280

Inzamam
ID. 12998

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LIST OF ACRONYMS

ACRONYMS	DESCRIPTION
INU	IQRA National University
WWW	World Wide Web
IoT	Internet of Things
PIR sensor	Passive Infrared sensor
RPi	Raspberry Pi
GSM	Global System for Mobiles
Wi Fi	Wireless Fidelity
SMS	Short Message Service
LDR	Light Dependent Resistor
LED	Light Emitting Diode
LCD	Liquid Crystal Display

ABSTRACT

Nowadays, internet of things (IoT) enabled smart system that can handle all the things intelligently by programming them for the human ease. Human is lazy by nature and cannot handle everything by its own, so for making easy and providing security to their property we came up with an idea of home security system. This system can protect humans from any case of intrusion in their property. We developed IoT based system to alert the registered members through Email whenever human intrusion is detected. In this project our main components are Raspberry Pi 3, Pi camera, buzzer and constant internet connection. In this project we have two operating modes, one is when someone comes in front of the camera, and camera detects it and capture its image. Secondly, when images are being captured, they are compared with defined images. If images match, the system will show (authorized) message. If not the system will send the information to authorized user's Email.

Keywords: IoT (Internet of things), Raspberry Pi, Pi Camera, PIR sensor.

CHAPTER 01

INTRODUCTION

1.1   Introduction

Internet of Things (IoT) is one of the most dynamic and exciting developments in information and communication technology, it is the advert of IoT. IoT is the system where computing devices, mechanical devices and digital machines are interacted. IoT provides unique identifiers to the machines, objects, animals or people and the ability to transfer data without requiring any human to human or human to computer interaction. Raspberry Pi is a hardware which is very cheap device compared with others, it is small in size, connectable, portable and programmable. It is a computer that directly plugs in with monitor screens, TV, keyboard and a mouse. It is capable of doing almost everything you would expect a desktop computer to do, from browsing the internet, playing high definition videos, making spread sheets, word processing and playing games [4].

The most basic definition of any security system is found in its name. It literally a means or method by which something is secured through a system of interworking components and devices. Home Security System which are networks of integrated electronic devices working together with a central control panel to protect against burglars and other potential home intruders [5].
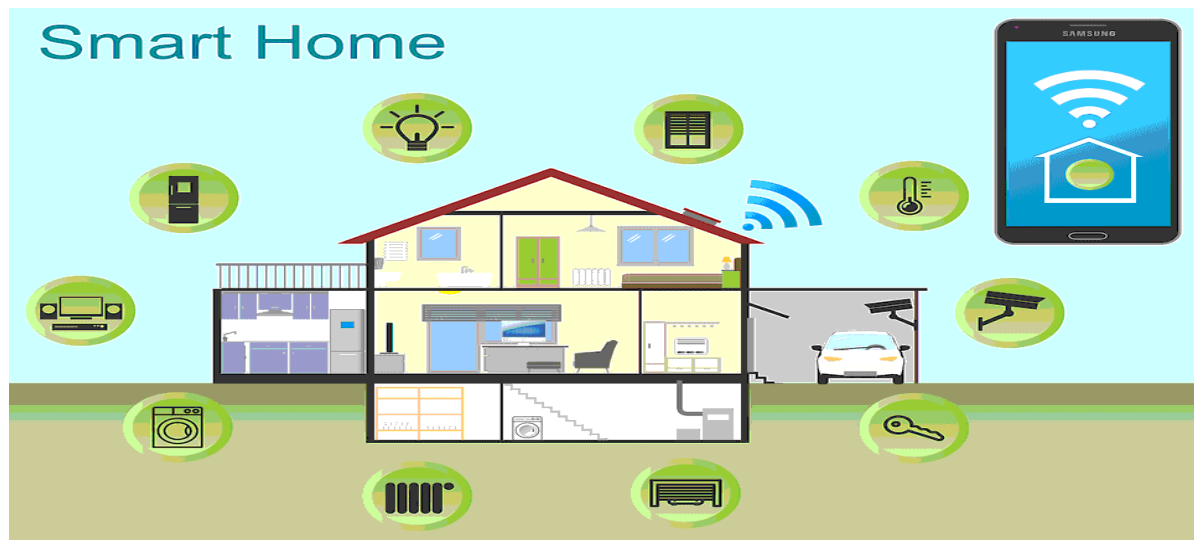

Figure 1: Smart Home Concept [7]

IoT based home security system using Raspberry Pi with email and voice alert, as the name of this project makes it understandable that there will be a system which is based on IoT and it contains a microcontroller, Pi camera, PIR sensor, power supply and is connected with internet all the time. This system is used for tracking the environment around things you need to secure. The system works as if its sensors detect any unnecessary movement, the system will immediately capture the movement and pictures are then captured. The pictures will be sent to the specific email, through which the owner will get updates immediately. The hardware that is required to fulfil this project is: Raspberry Pi, Pi camera and PIR sensor. This system is based on the hardware, human interaction is minimal in it. Hardware communicate with each other to take actions as per need.
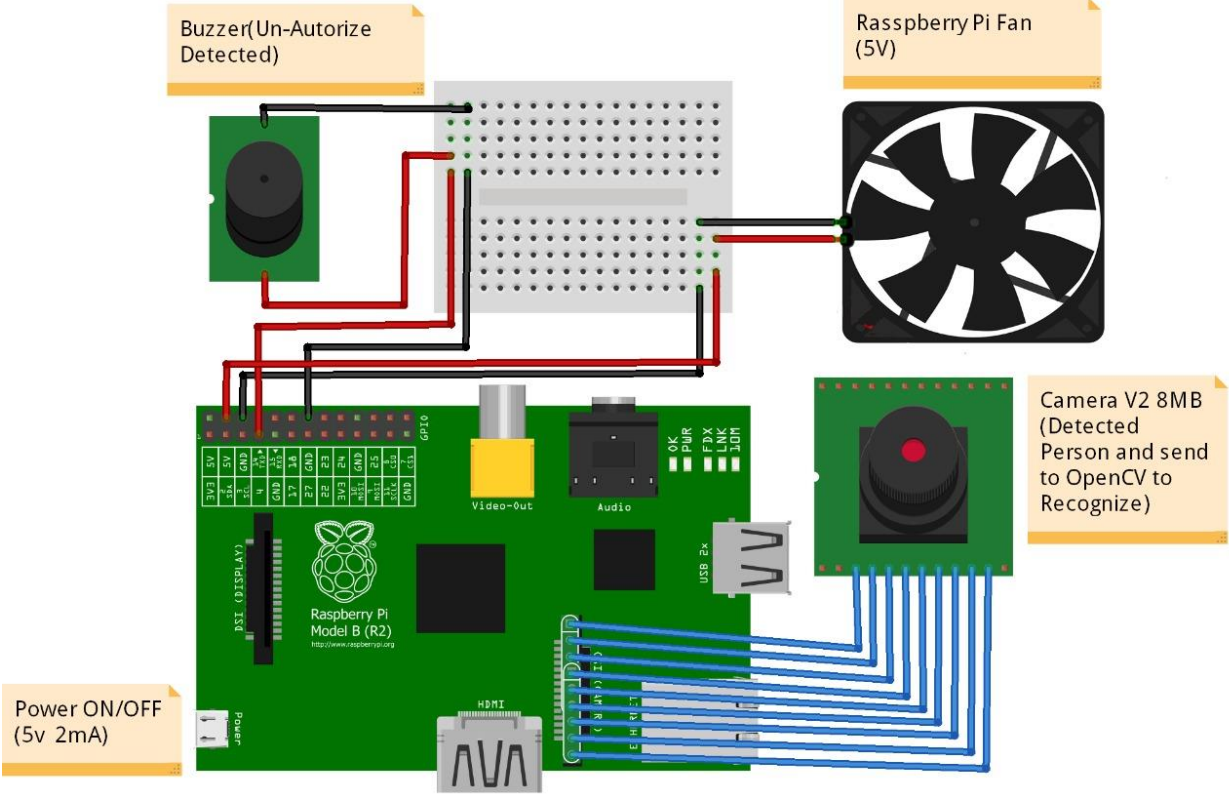

Figure 2: Circuit Diagram of the system (*i*Home)

Flow Chart:

A flowchart is a type of diagram that represents a workflow or process. A flowchart can also be defined as a diagrammatic representation of an algorithm, a step-by-step approach to solving a task. The flowchart shows the steps as boxes of various kinds, and their order by connecting the boxes with arrows [8].
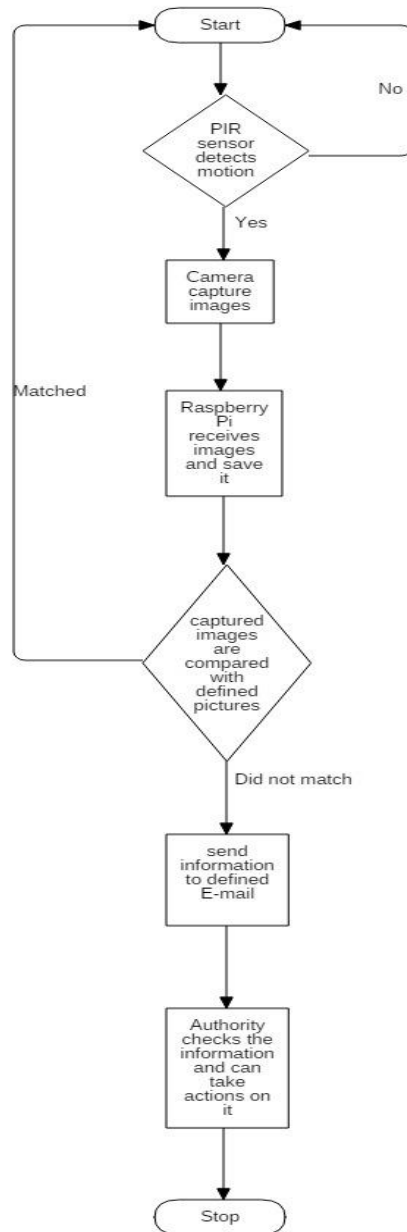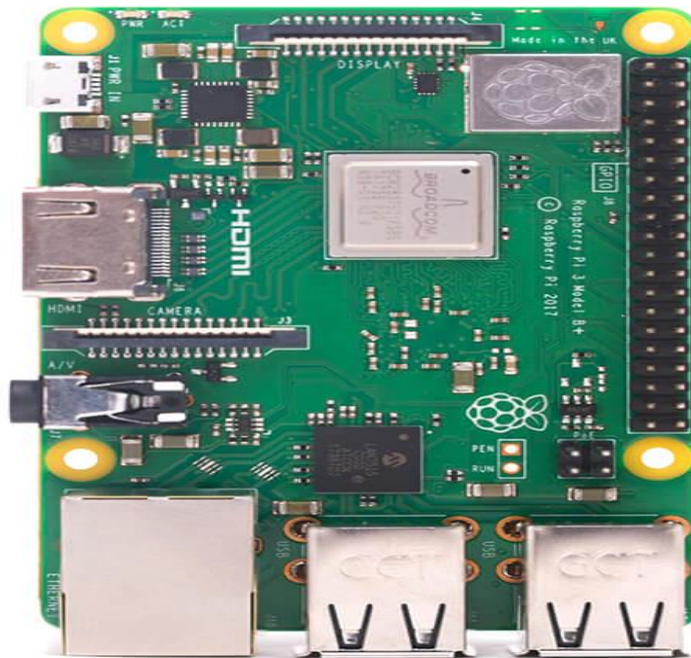

Figure 3: Flow Chart of *i*Home

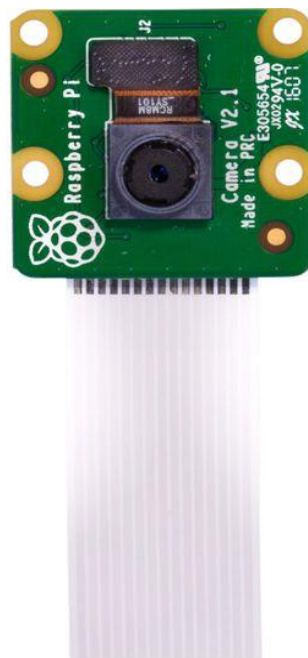Figure 4: Raspberry Pi 3 Model B [13]

Figure 5: Pi Camera (V2.1) [14]

1.2   Objectives

The objective of IoT based Home Security System is that the system provides connectivity of devices which leaves no task for human and those devices which are inter connected, handles all the system. IoT based Home Security System provides highest levels of security and less human work.

The main objectives of the system are:

- To develop an IoT based home security system which shares the maximum information with the user.
- To develop a system which will be working on a microcontroller called Raspberry Pi, which will send the information to the user.
- To develop a system that will send the reports regarding any unnecessary movement that is not expected.
- To develop a system that will minimize break-ins.
- To develop a system that will keep a potential intruder away from your house.

1.3   Problem Statement

There are many problems regarding Home security. This is one of the topmost complaints from all the home security systems owners around the world. Their alarm system or rather, the security system collaboration does not seem to cover the entire breach able areas.

It is also reported as one of the most crucial bugs in almost all the security alarm systems manufactured and distributed around the world. Most of the times, the particular owner who is to be blamed as he/she feel confined of the low budget security systems offered by the companies. Guess what? These packaged deals do not cover all the entry points of the home and hence, leave you unprotected from any well-planned theft or robbery. Nowadays every person wants their property safe, and no other system provides live safety except human itself.

1.4　Assumption & Constraint

Assumptions: We assumed that each of the features defined could be implemented programmatically in in python and using different tools such as OpenCV, Thonny Raspberry Pi. And implement the hardware as per its need.

Constraints: Project should be completed before the deadline.

1.5　Project Scope

This project will provide security to the user without interacting with the system. Security in terms of securing user's property from intruders. If any type of intrusion takes place, the system will capture the details of intruder and it will forward the details to the authority.

CHAPTER 02
REQUIREMENT ANALYSIS

2.1   Literature review

In [1] this system will detect the presence of Intruder and quickly alert the user by sending him an alert mail. This mail will also contain the Picture of the Intruder, captured by Pi camera. Raspberry Pi is used to control the whole system. This system can be installed at the main door of your home or office and you can monitor it from anywhere in the world using your Email over internet. In [2] IoT enable home security system consists of raspberry pi-3, pi-camera, PIR sensor, Microphone, Ultrasonic sensor, buzzer, doorbell button, LED/LCD screen and internet connection. This paper suggests two operating modes for home security. In the first mode, whenever any person motion is detected and that person presses doorbell button, then system will capture an image and decide the person is familiar or unfamiliar with the help of stored database. If the person is not familiar then system will alert through e-mail notification to the user and registered members by sending captured image, video and audio clip of that person. If the person is familiar then system will capture an image of that person and stored in the system. In [3] the way the system works is that a laser is focused towards a LDR sensor and the moment that the contact of laser to LDR sensor breaks, the alarm connected to the sensor goes off alerting the neighbors and sends a SMS to the owner. This system solves the problem of covering the places which are out of range from the fixed cameras but faces the same difficulties which are faced with systems consisting of GSM modules to send text messages, which is that the delivery of message is dependent on network coverage. Also due to the nature of lasers being a straight beam, it can be avoided by intruders who know about the system and are capable of dodging the lasers, rendering the whole system useless. A novel way to design an electronic lock using Morse code and IoT technology. In [6] the system can image the way through, outsider invasion, fire and other indoor anomalies automatically determine. Its advanced intelligence primarily reflected in the following two areas. Firstly, system could adapt to the background environment changes through self-learning so that it can be available in different environment. Secondly, for the critical state, the software will automatically start tracking monitor. More accurately

monitoring can be achieved, with more pictures are taken. Based on the difference in background and the difference between frames, the system uses a combination of static and dynamic threshold. The main objectives of the testing process, including image pretreatment, quantify motion detection function (or small target tracking detection), unusual situation and determine treatment. In [9] the author has come up with the technology for home automation and security by using a Bluetooth based system. The home appliances that are to be controlled are connected to the input/output ports of the Arduino BT board via relays. Passwords are provided for the purpose of protection so that only the authorized users can access the home appliances. The python script is used for programming purpose as it is portable and can run on any platform. A feedback circuit is used to indicate the status of the home appliances after receiving a command from the phone. The disadvantages includes: Less Range (<50) for controlling Devices, Pairing Process, and Requires Human Involvement for control. No Remote Control or Monitoring. In [10] the author's implements home automation system using Arduino board that comes along with various sensors such as PIR motion sensor etc. and uses a GSM technology. The status of all the devices connected is sensed by the Arduino board for further processing. This system ensures home automation and security. Arduino board is an advanced version of microcontroller. It has various disadvantages similar to microcontrollers: Less Friendly Environment for development, Less Flexible, Maintenance Overhead. In [11] the author's has proposed a home automation system using Arduino board based on IOT domain. This particular system uses an internet protocol-based communication. This system makes use of three operating modes: manual mode, automated mode and security mode. The manual mode is based on web supporting device, automated mode is based on sensor reading and security mode is based on safety. The simple execution is provided by Arduino microcontrollers that are used in this project as compared to other controllers. This particular prototype also uses Wi-Fi routers. The shortcomings are: Less Friendly Environment for development, Less Flexible, Maintenance Overhead. In [12] the author presents the implementation of WiFi based home automation system. WiFi technology is used for connecting various parts of the infrastructure. The proposed system includes a server where the status of each connected device is updated anytime it changes so that the user or system administrator can remotely control as well as monitor the system. It also includes hardware interface modules for connecting various sensors and actuators. This system provides power management and security. The disadvantages are: since WiFi usage involves a range, it is not possible for remote monitoring. It is not much

reliable since the WiFi may go down at any point of time. In [13] the author has designed a PIC microcontroller using ZigBee technology. The home appliances are controlled by using two technologies namely GSM network technology and speech recognition. In case smoke is detected in the house the SMS is sent to the mobile by using a GSM modem which is connected to the PIC controller. The ZigBee and GSM technologies are used for wireless communication among various modules. The microcontroller senses the signals generated at its pins based on the command received by ZigBee modules. This system is useful in case of fire accidents. It has disadvantages such as: use of Microcontroller – Requires Burning of Code for every Changes, Interface Problems, Maintenance overheads, Low processing power, Less Flexible due to complex architecture. In [14] this paper describes the WSN based surveillance system monitored by Programmable System on Chip (PSOC) devices. Here Zigbee module is used for wireless transmission. The system mainly concentrates on sensor based alerts and it lacks improved techniques like camera, web server for uploading files etc. In [15] this paper describes an improved real time home security system using Beagle Board and Zigbee Remote alert on fire and intruder detection are the main features of the system. It uses improved techniques such as camera, GSM, FTP server etc. But it is not utilizing the advantage of live streaming and alerting techniques such as phone calls, SMS and email etc. In [16] this paper describes the Internet of Things approach for motion detection using Raspberry Pi. It utilizes FTP server for camera feeds and it alerts user through email. The system does not have SMS and phone call alerts and other sensor alerts such as detection of fire, gas etc. In [17] this paper explains a WSN based fire alarm system using Arduino. The system is purely based on sensor alerts and it lacks other features like camera, web server etc. In [18] this paper describes the surveillance technique using IP camera and Arduino board. In this paper, user can view remote desktop using team viewer application whenever he needs to monitor his home from outside. This system is not sending any notification to user whenever any event occurs in his home. User has to monitor his home continuously and also it lacks sensor based alerts. In [19] this paper describes the security surveillance system using raspberry pi. It utilizes the advantage of live streaming. But we need to type the IP address every time to watch the live video which is placed in webpage.

2.2   Stakeholders list (Actors)

- Developers.
- Supervisor.
- University.
- Authority.
- Users.
- System Maintainer.

2.3   Requirements elicitation

The idea of smart home security system came into my mind after a real life scenario when any type of heist took place, people and security organizations started investigating about the heist. What actually happened on the crime scene, no one knew about it and the thief, robber, burglar, trespasser etc. so we took a step further to start looking for the solutions and we started doing research on the specific topic. After doing some research, we found a lot of security systems regarding intrusion, all those systems were providing security but they weren't providing online reports about any type of intrusion.

After that we decided to connect the system to the authority's Email, so that he can get online reports about any type of intrusion and can even define faces that are not supposed to be reported.

2.3.1 Functional requirements

- **Power supply:** The system needs a constant power supply that will keep the system awake.
- **Internet connection:** Internet connection is necessary because the information will be sent to the authority's Email.
- **Motion detection:** Motion detection will give signal to the camera which will further capture the movement of the person.
- **Capturing images and image processing:** Capturing information of the person, if the person is predefined, the system will end the process and if the person is unknown, the system will capture its details.
- **Sending information:** The captured details of intruder will be sent to the defined Email.

2.3.2 Non-functional requirements

- **Burglar alarm:** The system will start siren after unauthorized person is detected.
- **Response time:** The system will send the details right after it captured or detected any type intrusion.
- **System (on/off):** Power supply for the system, that is up to the user if he/she wants to activate the system or not.
- **Reliability:** The system will capture all the details and will send it to Email.

2.3.3 Requirements traceability matric

2.4 Use case descriptions

Use Case Name	*i*Home
Scenario	Camera detects movement and captures information, if the information matches with the predefined information, the system will start over again. And if unauthorized person is detected, the information is sent to the authority.
Triggering event	Unauthorized person is detected.
Actors	Authority, User, Maintenance.
Stakeholders	Developers, Supervisor, University, Authority, Users, System Maintainer.
Preconditions	Camera detects an unauthorized person.

Flow of Activities	- Camera detects movement. - Camera captures images of the person. - Captured images are processed and compared with predefined images. Maintainer can inject the sample images to which the captured images will be compared. - If the images match the predefined pictures, authorized person will pop up as a message. - If images does not match predefined pictures, unauthorized person will be shown. And buzzer is activated. - Raspberry Pi collects the information of unauthorized person. - And stores the information, authority and user can access that information and maintenance team can access it too. - Stored information is sent to the defined Email, maintainer can define and modify the email as per need. - Authority and User collects the information through the Email.
Exception conditions	If person is authorized, show authorized.

Table 1: Use case Description.

2.5   Use case design

A use case diagram is a graphic representation of the interactions among the elements of a system. A use case is a methodology used in system analysis to identify, clarify, and organize system requirements [22].
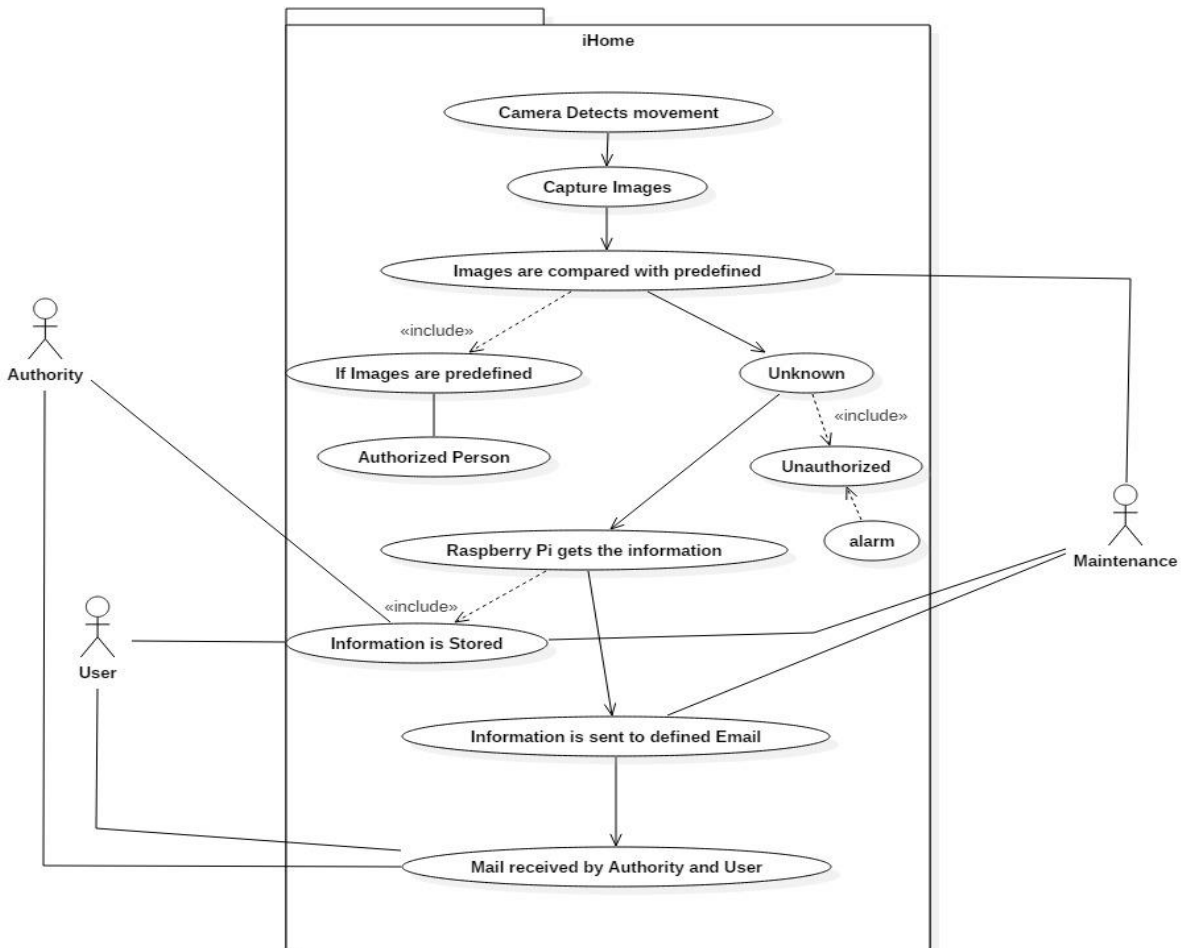

Figure 6: Use case diagram of *i*Home

2.6 Software development life cycle model

The prototyping model is a systems development method in which a prototype is built, tested and then reworked as necessary until an acceptable outcome is achieved from which the complete system or product can be developed [27].
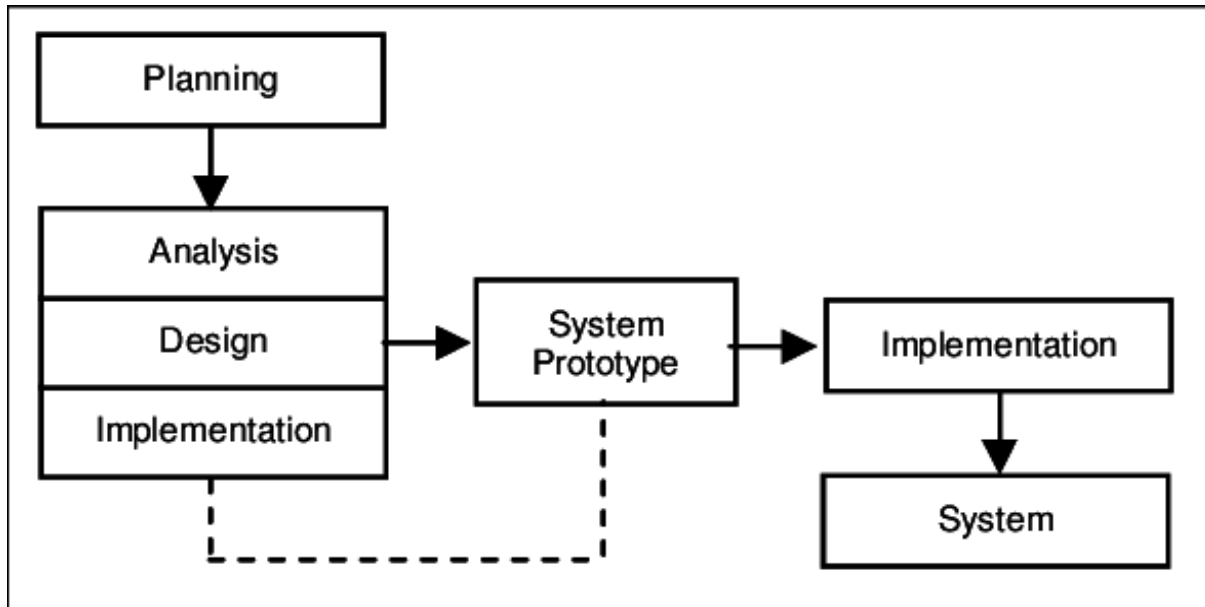

Figure 7: Prototype modeling [26].

CHAPTER 03
SYSTEM DESIGN

3.1   Work Breakdown Structure (WBS)

The Work Breakdown Structure is a method for getting a complex, multi-step project done. It's a way to divide and conquer large projects so you can get things done faster and more efficiently. Work breakdown structure is a hierarchical tree structure that outlines your project and breaks it down into smaller, more manageable portions [28].
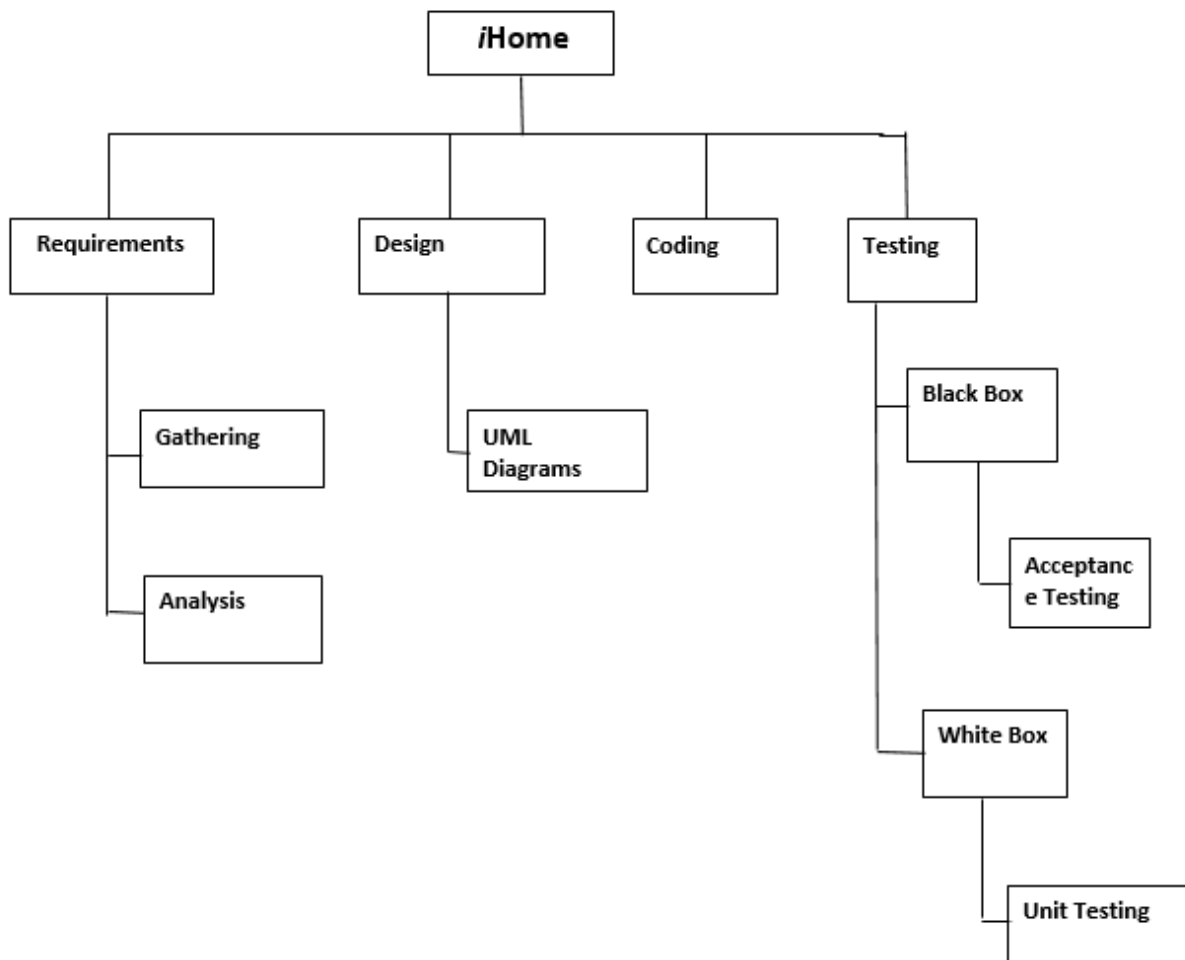
Figure 8: Work Breakdown Structure of *i*Home

3.2   ACTIVITY DIAGRAM

Activity diagram is another important diagram in UML to describe the dynamic aspects of the system. Activity diagram is basically a flowchart to represent the flow from one activity to another activity. The activity can be described as an operation of the system. The control flow is drawn from one operation to another [25].
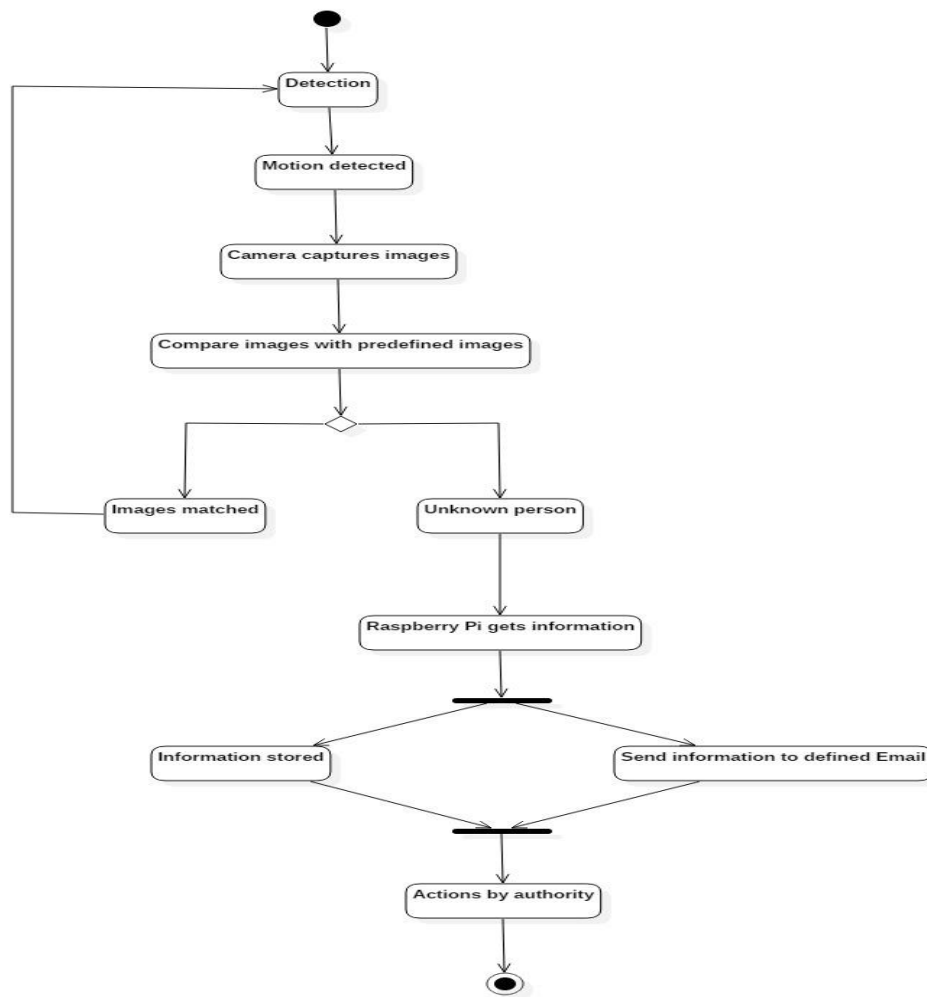

Figure 9: Activity Diagram of *i*Home

3.3   SEQUENCE DIAGRAM

A sequence diagram simply depicts interaction between objects in a sequential order i.e. the order in which these interactions take place. We can also use the terms event diagrams or event scenarios to refer to a sequence diagram. Sequence diagrams describe how and in what order the objects in a system function [23].
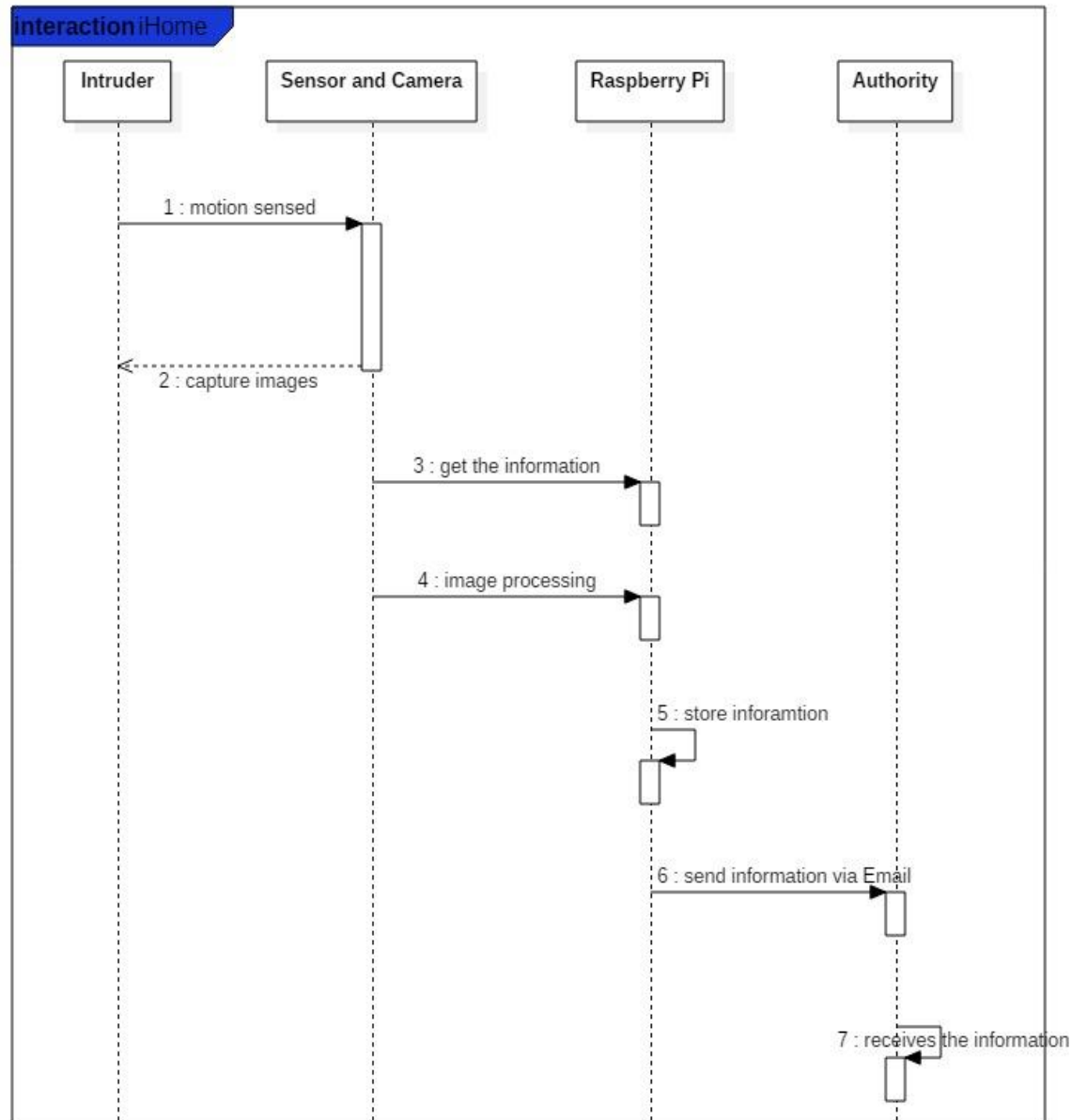

Figure 10: Sequence Diagram of *i*Home

3.5   CLASS DIAGRAM

Class diagram is a static diagram. It represents the static view of an application. Class diagram is not only used for visualizing, describing, and documenting different aspects of a system but also for constructing executable code of the software application.

Class diagram describes the attributes and operations of a class and also the constraints imposed on the system. Class diagram shows a collection of classes, interfaces, associations, collaborations, and constraints. It is also known as a structural diagram [24].
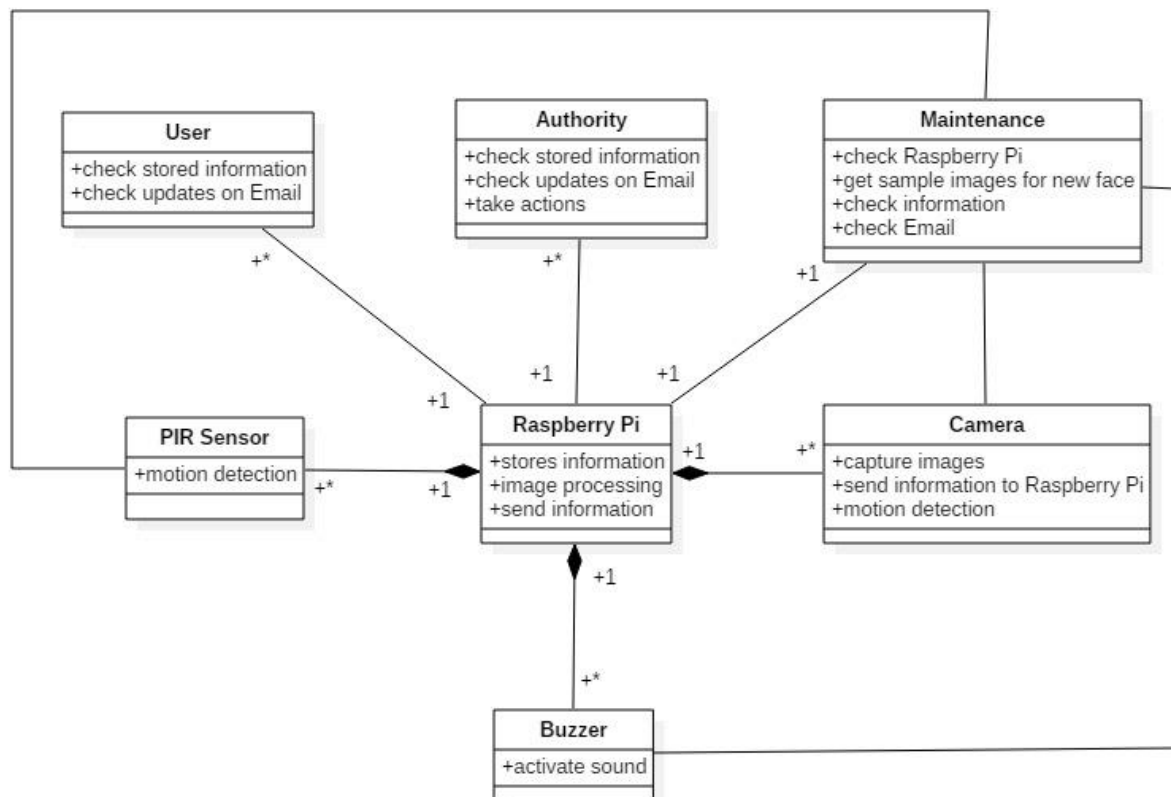

Figure 11: Class Diagram of *i*Home

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