SUPERIOR UNIVERSITY LAHORE

Faculty of Computer Science & IT

Final Year Project
PROJECT REPORT

Smart Scout

Project ID: **001**

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PROJECT SUPERVISOR

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Date:_____ Signature:_____

PROJECT MANAGER

Comments: _____

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Date:_____ Signature:_____

HEAD OF THE DEPARTMENT

Comments: _____

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Date:_____ Signature:_____

Dedication

I dedicate it to my parents, my family and my teachers, because their prayers, devotions, care and motivation made me able to complete this project. Especially to Sir Talha Irfan because they helped us a lot to clarify scope of this project and motivated us to do hard work so that this project can proceed to conclusion. (Zeewaqar)

I dedicate this Project to my father, who always qualified me with the best knowledge which he learned from his life experience. I also dedicate this project to my mother, (Abdullah Tahir)

I dedicate my study work to my family and my friends. I want pay special thanks to my loving parents, Zeewaqar and Abdullah Tahir whose words of encouragement and push for persistence ring in my ears. My Teacher Sir Waqas Arshad has never left my side and is very special. (Nadeem Cheema)

Acknowledgements

Throughout the process of organizing and completing this project, we have received many assistance and guidance from various parties. Without these individuals who are willing to share their experiences and time to give me a helping hand, we may not have completed the project on time or in a better quality. Thus, in this section, we would like to express our deepest gratefulness to all of these individuals who had supported me.

Firstly, we would like to thank our supervisor, Sir Waqas Arshad who has guided us on how to prepare high-quality documentation and presentation for the project. He had also inspired us with his ideas on how to further enhance the application which is being developed. Thanks to his concerns on the project scopes that we proposed, we could also make a better evaluation on whether or not each proposed scope is feasible. Plus, with his constructive comments and suggestion, we could clearly see where our mistakes are and improve myself further throughout the processes in developing.

Next, we would also like to thank our family members who have constantly provided us financial and mental support especially during hard times. Without their encouragement, we may not be able to withstand the stress being faced and eventually become demotivated.

Last but not least, we would also like to thank Faculty of Information Technology for providing facilities such as computer labs and Internet connection which had facilitated our progress toward finishing the project.

Executive Summary

Smart Scout is an innovative solution for detecting a person whose health in danger and informing concerned persons about that danger. It is a smart device application system that provide patient care and health monitoring 24/7. This Smart Scout band capable of reading a human's Pulse Rate and SpO_2. First of all, we will develop the band to sense the subject's physical parameters (like pulse-rate, SPO2). This band will send the data to the mobile app.

Mobile App send data to cloud hosting (Google Firebase Real Time Database) and receive data from cloud hosting (Google firebase). Mobile send notification to the guardian in case of any danger (SMS or call).

Machine Learning (both Regression and Classification) to analyze subject parameter and hence determine whether subject is in normal or critical condition and prompt the physician or close relatives of the subject if user is in the danger.

Second main feature of our app will be to use ensemble of sensor readings for anomaly detection of a faulty reading from any sensor of the two (whether it's through interference, attenuation or some other factor).

There are many health issues that are completely impulsive. People they are at the risk of, heart attack, collapsing and stroke are most probable to be found dead when too late to approach. According to CDC, heart-failure ranks first in their list of the top leading causes of death while stroke ranks fourth. According to a statistical research conducted by the Centers for Disease Control and Prevention (CDC). The leading cause of death was heart diseases while stoke ranked 5th. Some of the causes of death had the same thing in common, they were quite unpredictable.

Table of Contents

Chapter 1

Introduction

Chapter 1: Introduction

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1.1. Background

There are many health issues that are completely impulsive. People they are at the risk of, heart attack, collapsing and stroke are most probable to be found dead when too late to approach. According to CDC, heart-failure ranks first in their list of the top leading causes of death while stroke ranks fourth. According to a statistical research conducted by the Centers for Disease Control and Prevention (CDC). The leading cause of death was heart diseases while stoke ranked 5th. Some of the causes of death had the same thing in common, they were quite unpredictable.

1.2. Motivations and Challenges

If we want to complete this project, it will be desirable to learn some programming languages and go into skilled with these programming languages, so it will necessary to study online and research on it to make this project complete successfully.

Time is also the major challenge in order to complete this project, because only few months are available for us to complete this project. But trust of our teachers always motivate us.

1.3. Goals and Objectives

1.3.1. To provide connectivity and guidance to Smart Scout to be a powerful supporter for services that work for patients.

1.3.2. Bring the public's opinions to the heart of national choices about the NHS and the social care.

1.3.3. To build and develop an operative learning and values those are based on Smart Scout.

1.4. Literature Review/Existing Solutions

We are pioneer in this technology as commercial product in Pakistan, no one is doing. Even there is no direct competitor in all over the Pakistan. But some similar products are using to solve this problem.

Sr. #	Product Name	Brief Description	Price
1	Oregon scientific elite heart rate monitor (Sh201)	It is a watch just take heart rate	15,849
2	Beurer heart rate measurement	It is a watch that takes heart rate	7,099
3	Omron M6 comfort digital blood pressure monitor	A digital machine that measure your blood pressure	11,999

1.5. Gap Analysis

1. Maintenance of the system is very tough.
2. There is probability for getting erroneous results.
3. Responsiveness of the user is very less.
4. It takes much time for processing the actions.

1.6. Proposed Solution

First of all, we will develop the band to sense the subject's physical parameters (like heart-rate and SPO2). This band will send the data to the mobile app using Bluetooth connectivity. Mobile app Receive data from band and display on the App screen and App send sensors data to Cloud hosting (Google Firebase) and also fetch data from Cloud Hosting within the App.

Machine Learning (both Regression, Classification and SVDD) to analyze subject parameter and hence determine whether subject is in normal or critical condition and prompt the physician or close relatives of the subject (specified in the app at start) if user is in the danger.

Second main feature of our app will be to use ensemble of sensor readings for anomaly detection of a faulty reading from any sensor of the two (whether it's through interference, attenuation or some other factor)

Mobile App Features:

- Registration
- Login
- Notification(SMS/Call)
- Cloud Connectivity(Google Firebase Real Time Database)
- Bluetooth Connectivity

Device Features:

- Bluetooth Module (HC-05)
- Sensor(Heart-Rate, Spo2)
- Arduino Nano(Micro Controller)

Future aspects:

- Blood Pressure Measurement
- Increased Accuracy
- Making user-friendly product's prototype
- ICU/CU Monitoring Facility

1.7. Project Plan

Device Development Phases

1. Configuration of Arduino Nano(Micro Controller)
2. Arduino Connect with Sensor (MAX30100)
3. Arduino Connect with Bluetooth Module(HC-05)
4. Band sense the subject's physical parameters (Heart-Rate, SPO2).
5. Band will send the data to the mobile app.

Mobile Application Development Phases

1. Splash Screen
2. Registration System
3. Login System
4. Google Firebase Connectivity
5. Bluetooth Connectivity

Machine Learning (Deep Learning Implementation) Phase

Machine Learning (Classification and SVDD) to analyze subject parameter and hence determine whether subject is in normal or critical condition and prompt the physician or close relatives of the subject (specified in the app at start) if user is in the danger.

1.7.1. Work Breakdown Structure

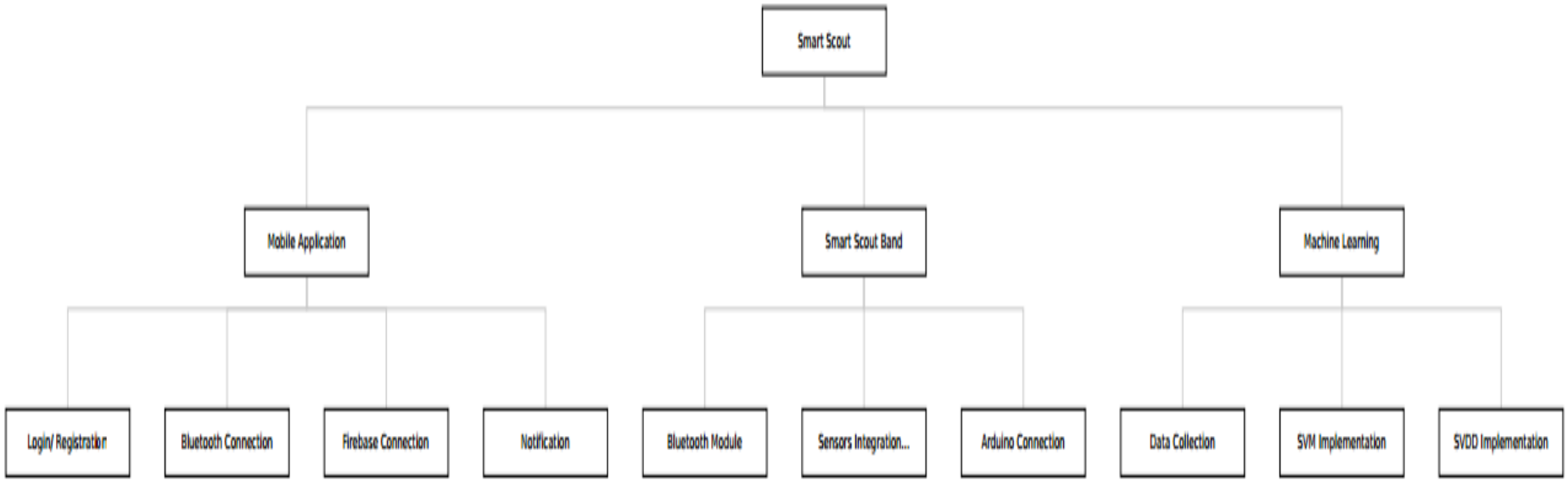

Figure (1.1) Work Breakdown Structure

1.7.2. Roles & Responsibility Matrix

The purpose of roles & responsibility matrix is to identify who will do what.

WBS #	WBS Deliverable	Activity #	Activity to Complete the Deliverable	Duration (# of Days)	Responsible Team Member(s) & Role(s)
001	Mobile Application	001	Login/Registration	1 week	Zeewaqar
002	Mobile Application	002	Bluetooth Connectivity	2 weeks	Zeewaqar
003	Mobile Application	003	Firebase Connectivity	2 weeks	Zeewaqar
004	Mobile Application	004	Notification	1 week	Zeewaqar
005	Smart Scout Band	001	Arduino Configuration	1 week	Nadeem
006	Band	002	Sensor Integration	1 week	Nadeem
007	Band	003	Bluetooth Module	1 week	Nadeem
008	Machine Learning	001	Data Collection	2 weeks	Abdullah
009	Machine Learning	002	SVM	3 weeks	Abdullah
010	Machine Learning	003	SVDD	3 weeks	Abdullah

1.7.3. Gantt chart

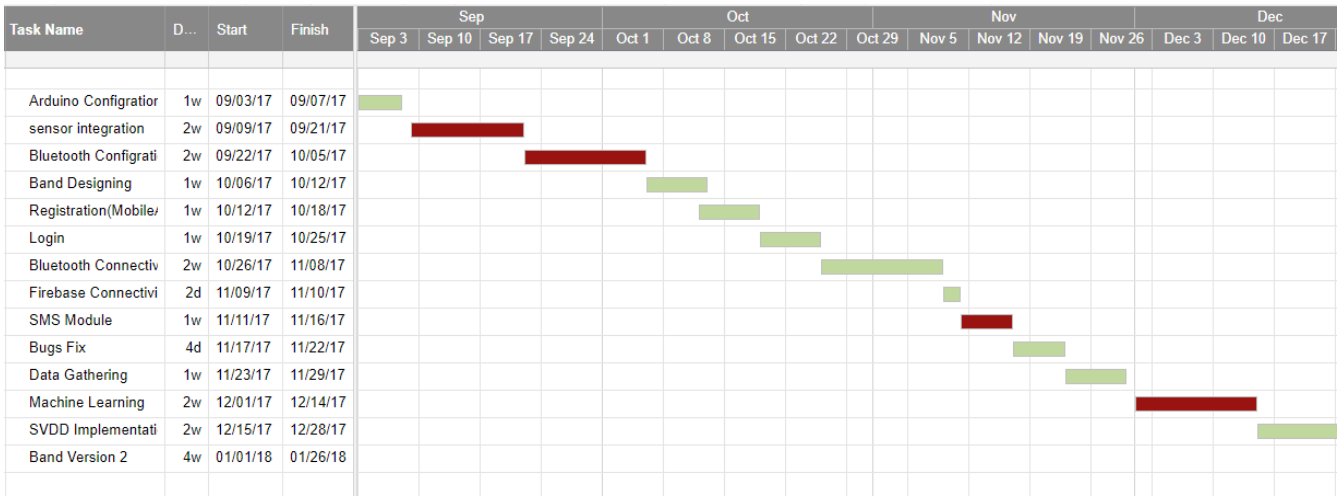

Figure (1.1) Work Breakdown Structure

Chapter 2

Software Requirement Specifications

Chapter 2: Software Requirement Specifications

2.1. Introduction

The Software Requirements Specification is designed to document and describe the agreement between the client and the developer regarding the specification of the software product. Its primary purpose is to provide a clear and descriptive "statement of user requirements" that can be used as a reference in further development of the software system. This document is broken into a number of sections used to logically separate the software requirements into easily referenced chunks. This Software Requirements Specification aims to describe the Functions, interfaces, Attributes and Design Constraints imposed on Implementation of the software system described throughout the rest of the document. Throughout the description of the software system, the language and terminology used should unmistakable and constant through the document.

2.1.1. Purpose

The purpose of this document is to present a detailed description of the application. It will explain the importance and features of the application, the interfaces of the application, what the application will do, the constraints under which it must operate.

2.1.2. Document Conventions

This document uses the following:

DB	Database
ER	Entity relationship
DDB	Distributed Database

2.1.3. Intended Audience and Reading Suggestions

Audience of the SRS is Project manager which use SRS to evaluate the project in all phases of SDLC to evaluate, either project progress going according to System requirements. SRS also used by the designer to make appropriate design flow of the product according to SRS.

Developer uses the SRS to check either the implementation fulfill the functionalities of the product which are defined in SRS.

Testers use the SRS to check functionality of product at different testing stages either product functionality is according to System requirements or not.

Quality assurance team uses the SRS to check the quality of the product like reliability, product response, also check the functional requirements.

2.1.4. Product Scope

Our Product has huge scope in the market since there are a number of heart patients (while doctor to patient ratio is pretty low) as well as disabled or senior citizen who are in need of a 24/7 monitoring but resources (either relatives don't have time or even paramedical staff is not available all the time) are unavailable for close monitoring all the time.

2.2. Overall Description

2.2.1. Product Perspective

Smart Scout is an innovative solution for detecting a person whose health in danger and informing concerned persons about that danger. It is a smart device application system that provide patient care and health monitoring 24/7. This Smart Scout band capable of reading a human's Pulse Rate and SpO_2. First of all, we will develop the band to sense the subject's physical parameters (like pulse-rate, SPO2). This band will send the data to the mobile app.

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Second main feature of our app will be to use ensemble of sensor readings for anomaly detection of a faulty reading from any sensor of the two (whether it's through interference, attenuation or some other factor).

2.2.2. Product Functions

Smart Scout Device

- Band sense the subject's physical parameters (Heart-Rate, SPO2).
- Band will send the data to the mobile app.

Mobile Application Development

- Registration System
- Login System
- Google Firebase Connectivity
- Bluetooth Connectivity

Machine Learning (Deep Learning Implementation) Phase

Machine Learning (both Regression and Classification) to analyze subject parameter and hence determine whether subject is in normal or critical condition and prompt the physician or close relatives of the subject (specified in the app at start) if user is in the danger. Anomaly detection of a faulty reading from any sensor of the two (whether it's through interference, attenuation or some other factor).

2.2.3. User Classes and Characteristics

There are three types of users that interact with the system:

- users of the mobile application
- Doctors
- Pharmacist

Each of these three types of users has different use of the system so each of them has their own requirements

2.2.4. Operating Environment

The application will only be available for the Android operating systems. The application shall only be used with compatible android devices

2.2.5. Design and Implementation Constraints

There are few constraints that the system should follow. They are:

- All the inputs should be checked for validation and messages should be given for the improper data. The invalid data are to be ignored and error messages should be given.
- Application will be developed for android OS only and will not run on IOS or any other OS.
- Application will not work without internet.

2.2.6. User Documentation

SRS document

2.2.7. Assumptions and Dependencies

One assumption about the product is that it will always be used on mobile phones that have enough performance. If the phone does not have enough hardware resources available for the application and user does not have band then application does not work

2.3. External Interface Requirements

2.3.1. User Interfaces

The interface will meet the following requirements to conform to the user's needs. It will be simple and easy to understand. Controls which allow the user to interact with the application will be clear and imply their functionality within the application. The interface will include user inputs as well as

2.3.2. Hardware Interfaces

- Arduino(Microcontroller)
- Bluetooth Module
- Heart Rate Sensor
- SpO_2 Sensor

2.3.3. Software Interfaces

- Android Studio
- Arduino IDE
- Google Firebase
- SVM
- SVDD

2.3.4. Communications Interfaces

The communication between the different parts of the system is important since they depend on each other. However, in what way the communication is achieved is not important for the system and is therefore handled by the underlying operating systems for both the mobile application and the band

2.4. System Features

The App helps you stay connected to the doctors. You will have access to features that make your experience more effective and more efficient.

Features include:

2.4.1. System Feature 1 (Mobile App Features)

- Registration
- Login
- Bluetooth Connectivity
- Google Firebase Connectivity
- Notification

2.4.2. System Feature 2 (Device Features)

- Real time readings
- Measure heart rate
- Measure Spo2
- Send Reading to Mobile App(Using Bluetooth)

2.4.3. System feature 3 (Machine Learning)

- Predict patients health using deep learning
- Save previous record of patient

2.5. Other Nonfunctional Requirements

2.5.1. Performance Requirements

Performance is measured in terms of system's output. Requirement specification plays an important role in the analysis of the system.

- System should be accurate
- System should be better than the existing system

2.5.2. Safety Requirements

The user in the application is provided with user name and password for authenticating before the login process. Invalid users are blocked from logging in. As the application is deployed in user machine each user can be provided with a login facility authenticates with the set of username and password for restricting the unauthorized users from logging in to increase the strength of the passwords the process of encryption and decryption can also be applied

2.5.3. Security Requirements

As the source code or software is deployed under the user machine. No security is provided to the user code

2.5.4. Software Quality Attributes

5. Reliability

   The application will meet all of the functional requirements without any unexpected behavior. At no time should the gauge output display incorrect or outdated information without alerting the user to potential errors.

6. Availability

   The application will be available at all times on the user's Android device, as long as the device is in proper working order. The functionality of the application will depend on any external services such as internet access that are required. If those services are unavailable, the user should be alerted.

7. Security

   The software should never disclose any personal information of any users, and should collect no personal information from its own users.

8. Maintainability

   The application can maintained easily.

9. Portability

This software will be designed to run on any Android operating system version 2.3 or higher. The software will be forward compatible for all currently released Android operating system versions.

2.5.5. Business Rules

Currently in Pakistan pharmacy chain trend is increasing due to which we got opportunity to sell our product through them to save our distribution cost. So we are targeting main pharmacy chains.

Chapter 3

Use Case Analysis

Chapter 3: System Analysis

Following use case model shows how a mobile phone use will interact with mobile application system.

3.1. Use Case Model

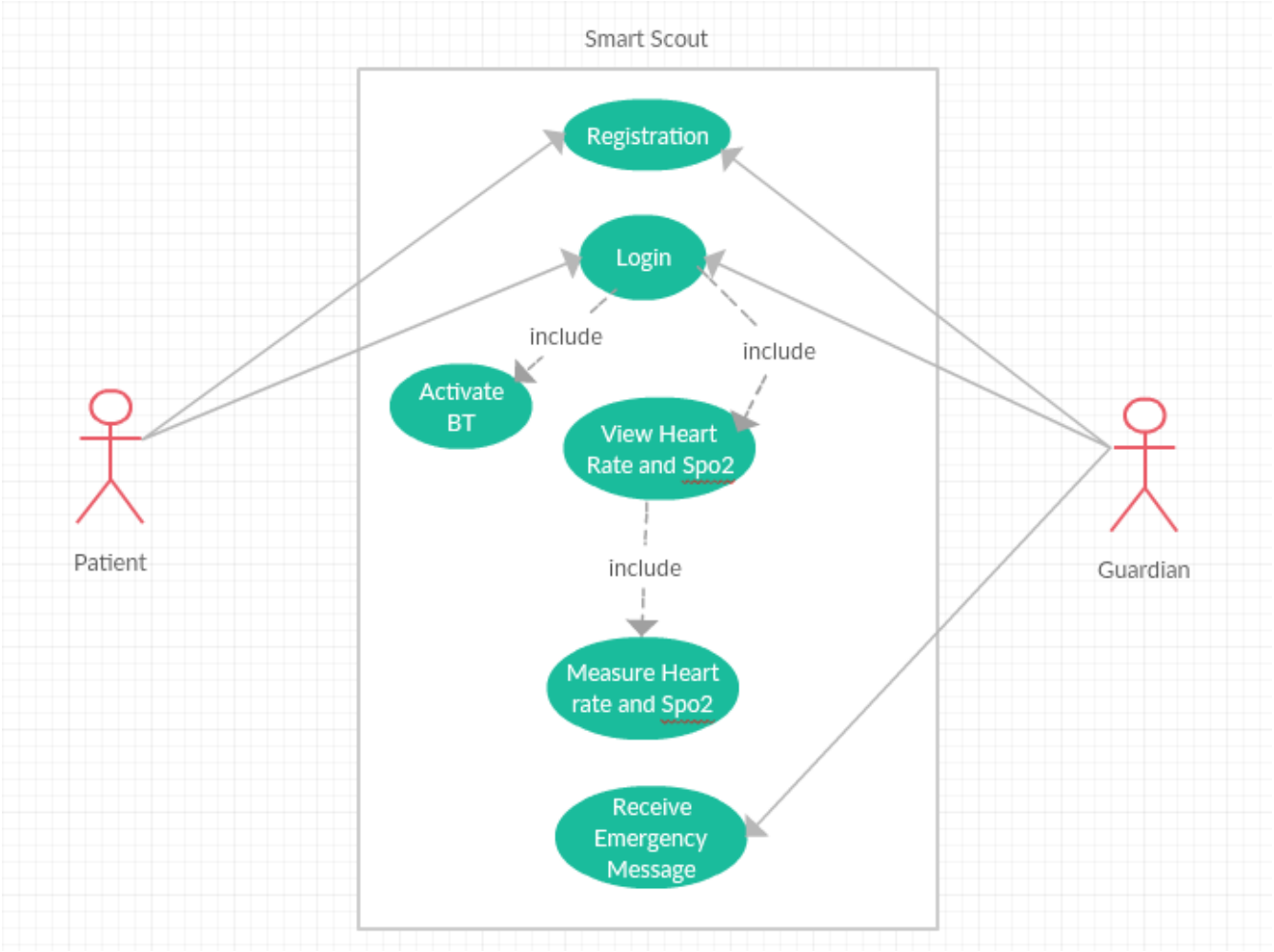
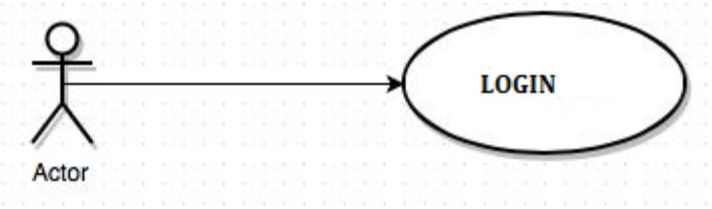


Figure (3.1) Use Case Model

3.2. Use Case Descriptions

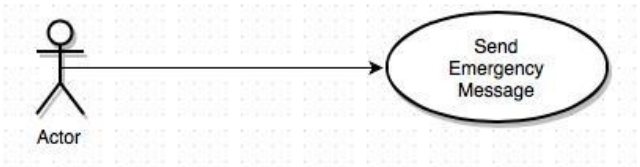
Actors	Actions	Description
User	login	The user will enter login in order to access the application. In case of wrong password or wrong email ,user will not login
	Registration	New user will sign up by filling the requirements
	Activate Bluetooth	User will activate device by using band to measure heart rate or SPO2
	Send Emergency Message	The Guardian will receive the message
	View heart Rate and SPO2	User will view heart rate or SPO2 on mobile screen
	Measure heart rate OR SPO2	User will measure heart rate or SPO2 using band

Use case 1: login



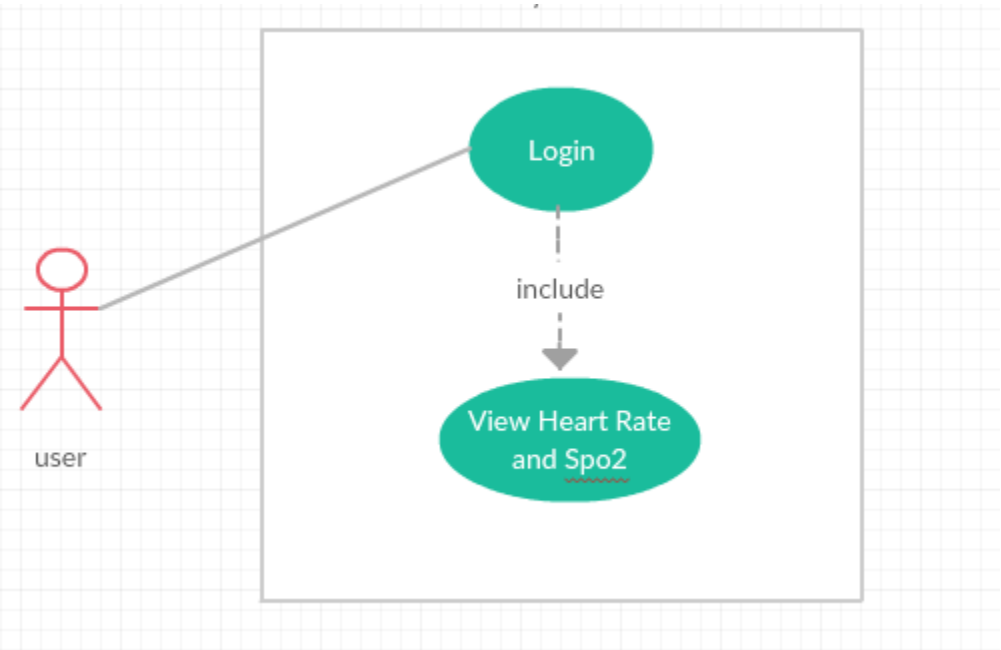
LOGIN	
Req-no:	1
Use case id:	1001
Description:	The user will enter password and email in order to access the Application. In case of wrong password or email user will not login

Use Case 2: Send Emergency Message



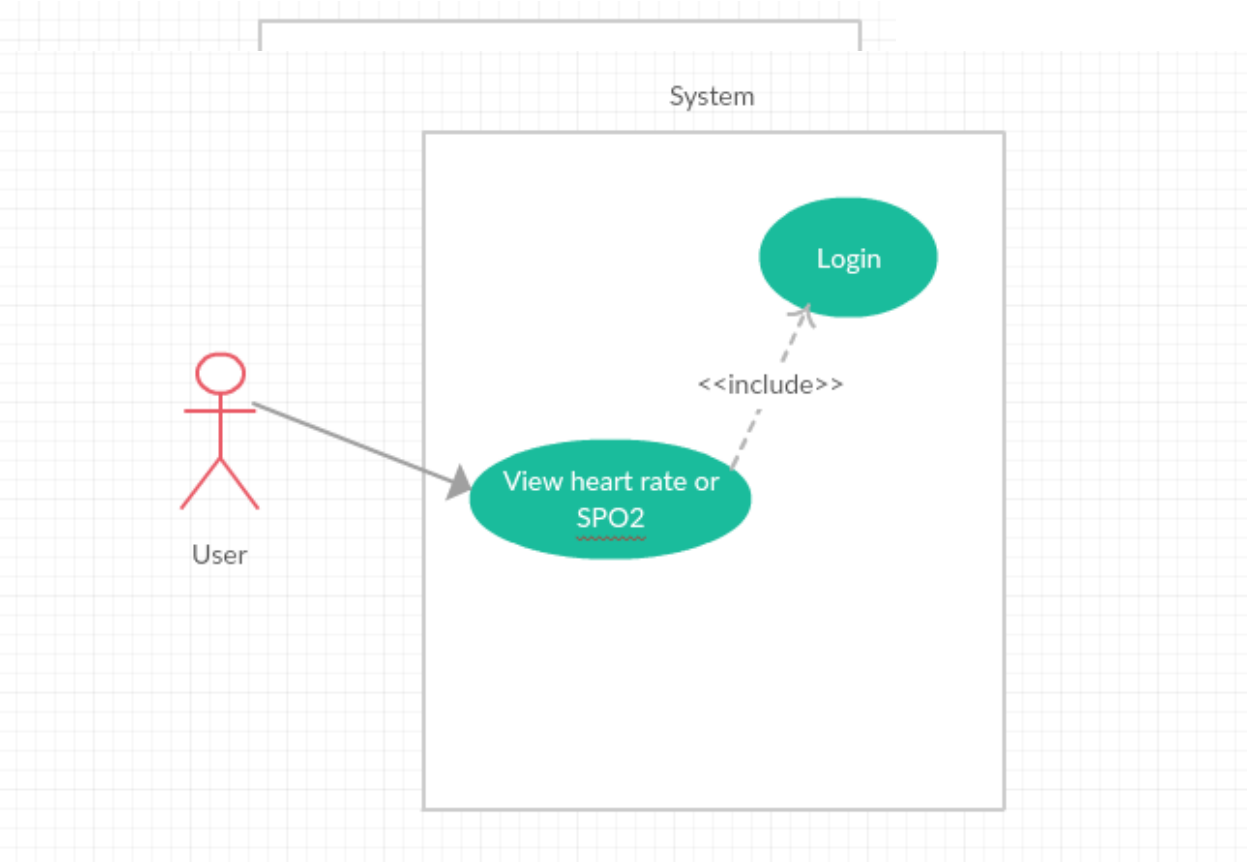
Send Emergency Message	
Req-no:	2
Use case id:	1002
Description:	Prewritten emergency message will be send to the pre saved contact of the guardian. The receiver will receive the message.

Use Case 3: View heart rate or SPO2



View heart rate or SPO2	
Req-no:	3
Use case id:	1003
Description:	User will view the heart rate and spo2 on mobile screen received from the device

Use Case 4: Measure heart rate and SPO2



Send Emergency Message	
Req-no:	4
Use case id:	1004
Description:	User will measure heart rate or SPO2 using device.

Chapter 4

System Design

Chapter 4: System Design

4.1. Architecture Diagram

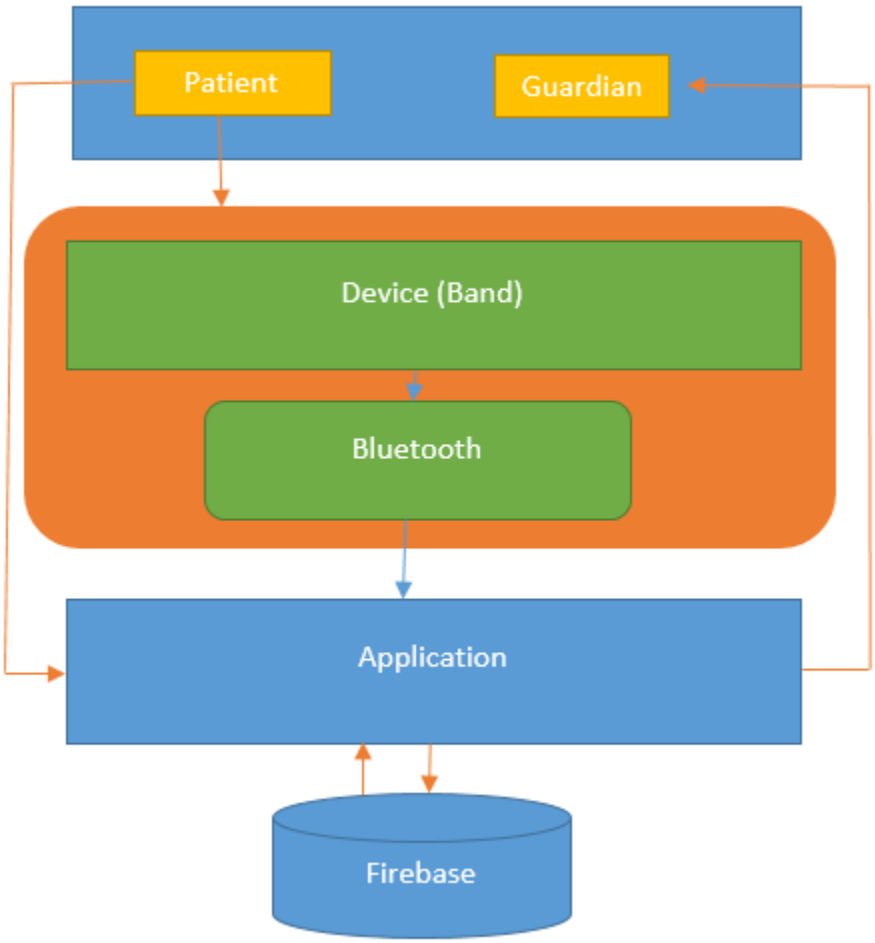


Figure (4.1) Architecture Diagram

4.2. Domain Model

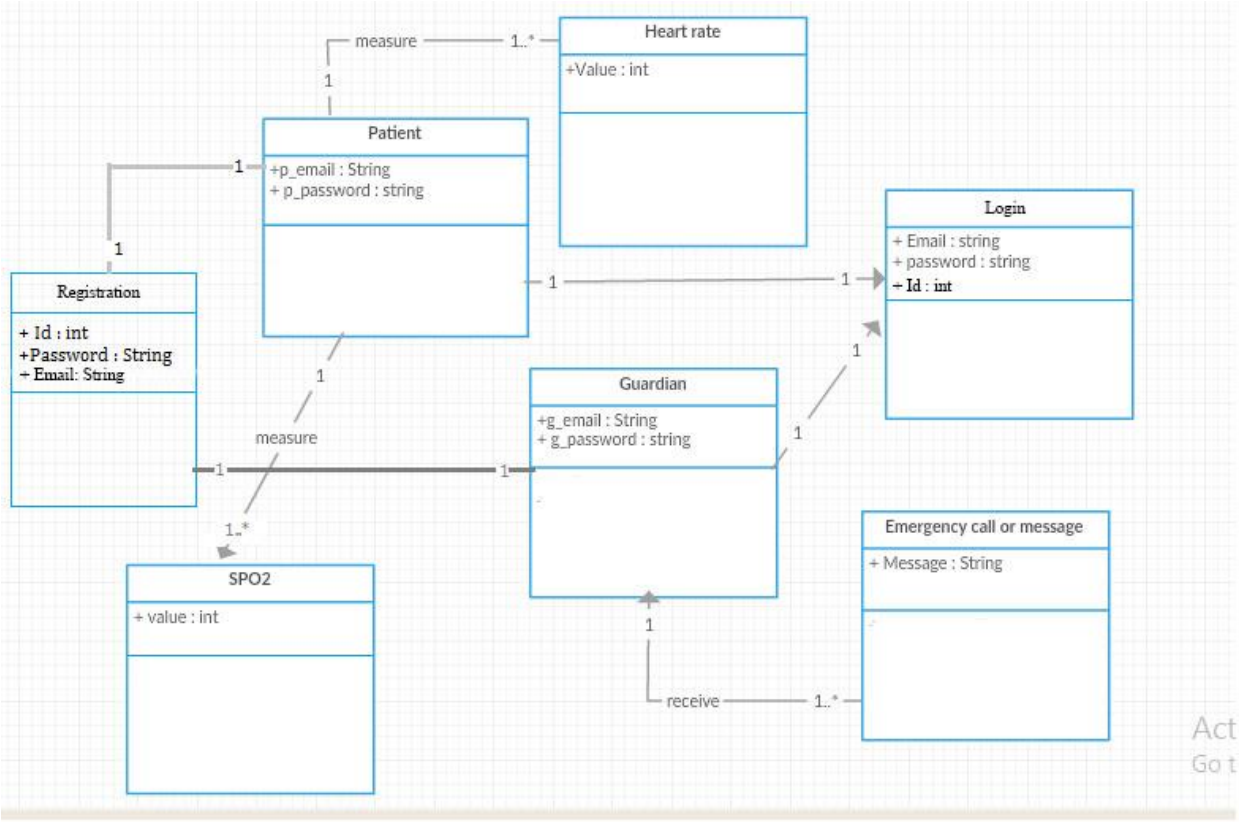


Figure (4.2) Domain Model

4.3. Entity Relationship Diagram with data dictionary

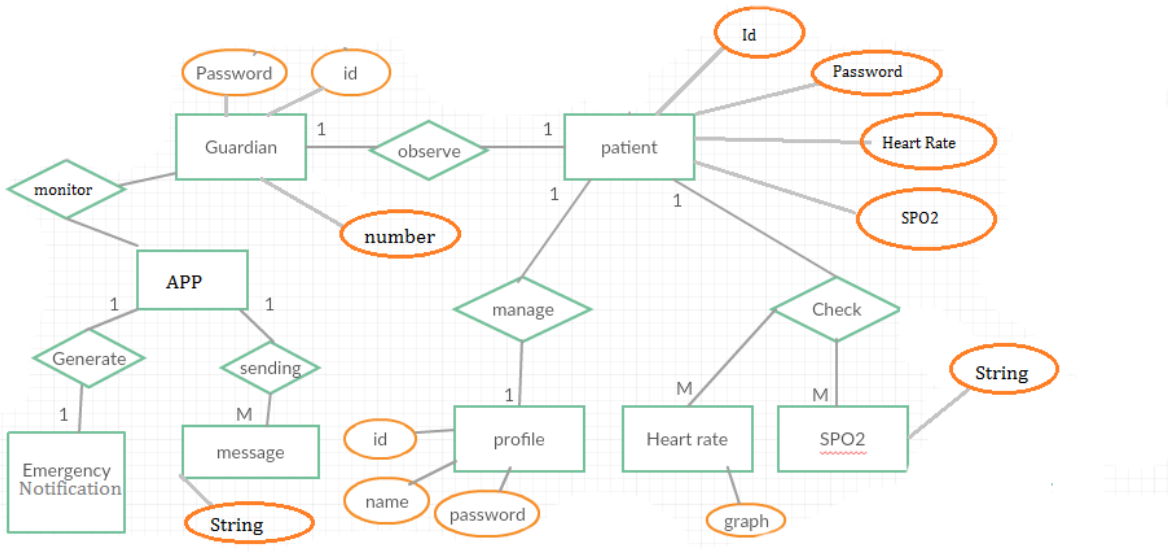


Figure (4.3) Entity Relationship Diagram with data dictionary

4.4. Class Diagram

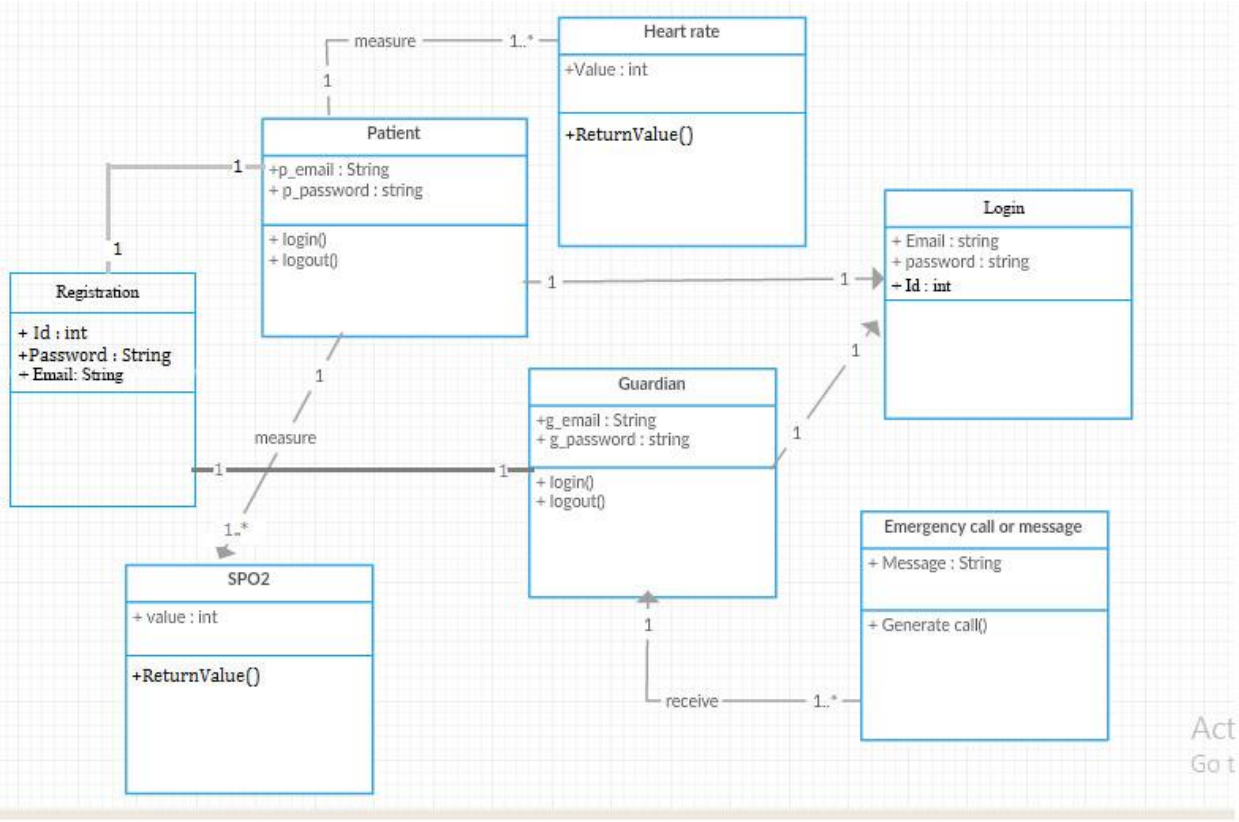


Figure (4.4) Class Diagram

4.5. Sequence / Collaboration Diagram

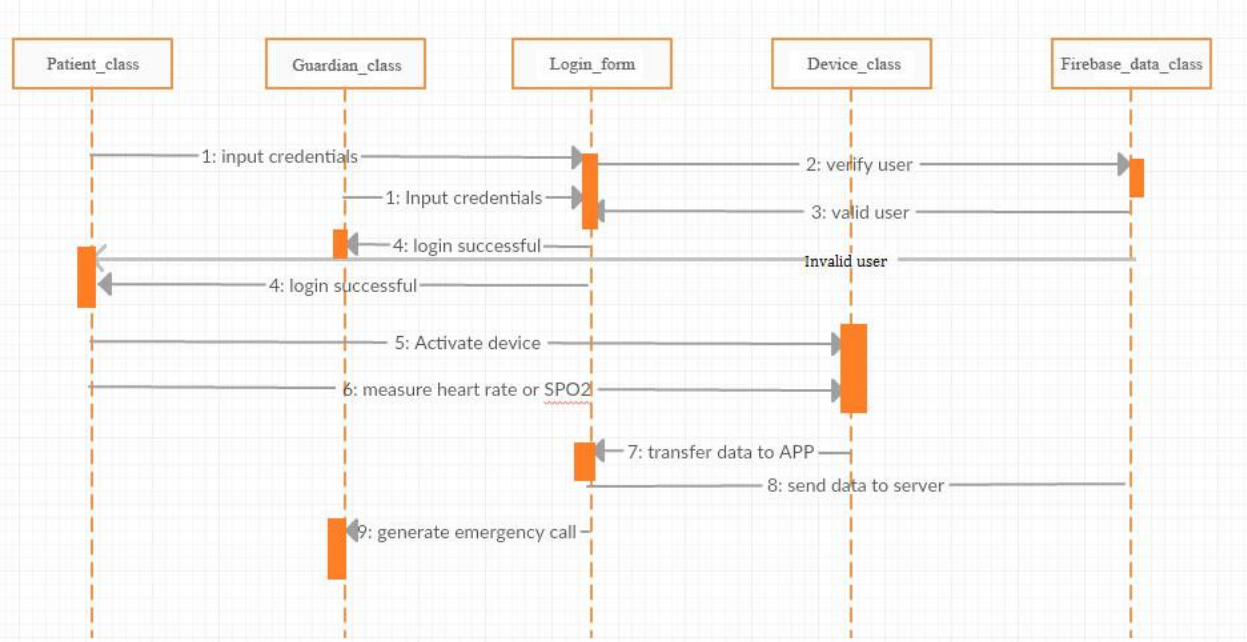


Figure (4.5) Sequence / Collaboration Diagram

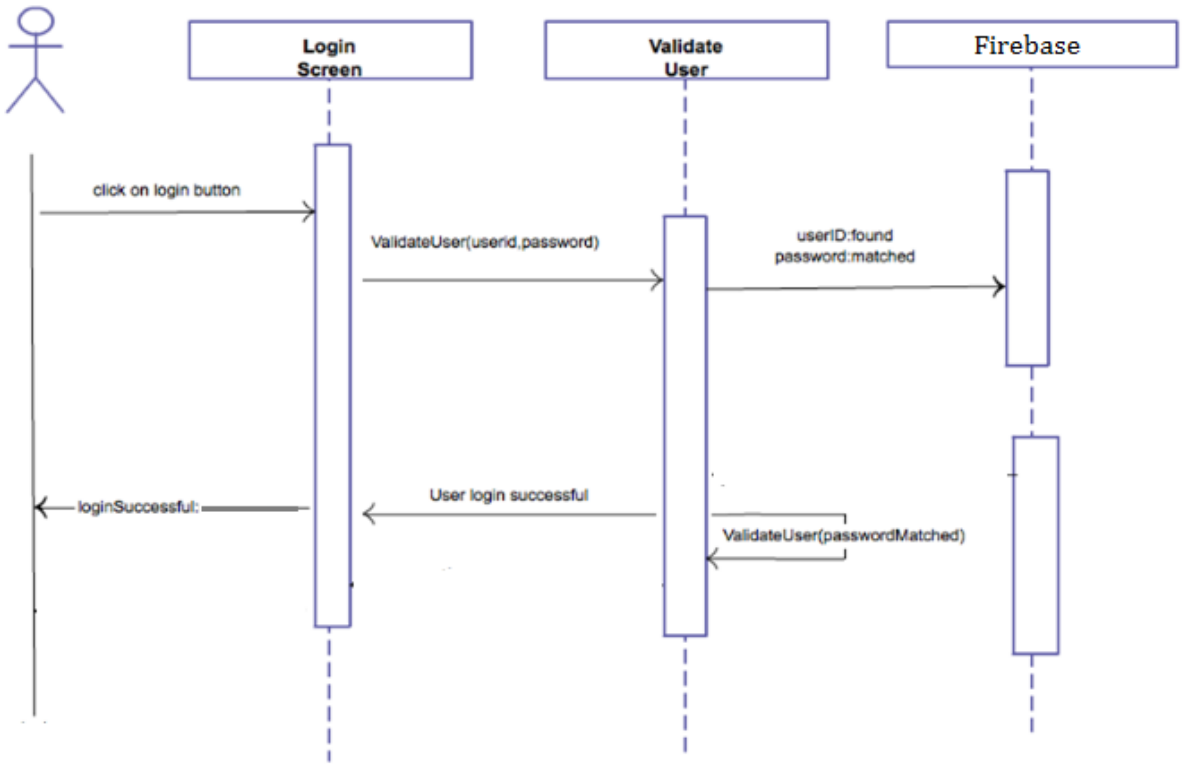


Figure (4.6) Sequence / Collaboration Diagram

4.6. Activity Diagram

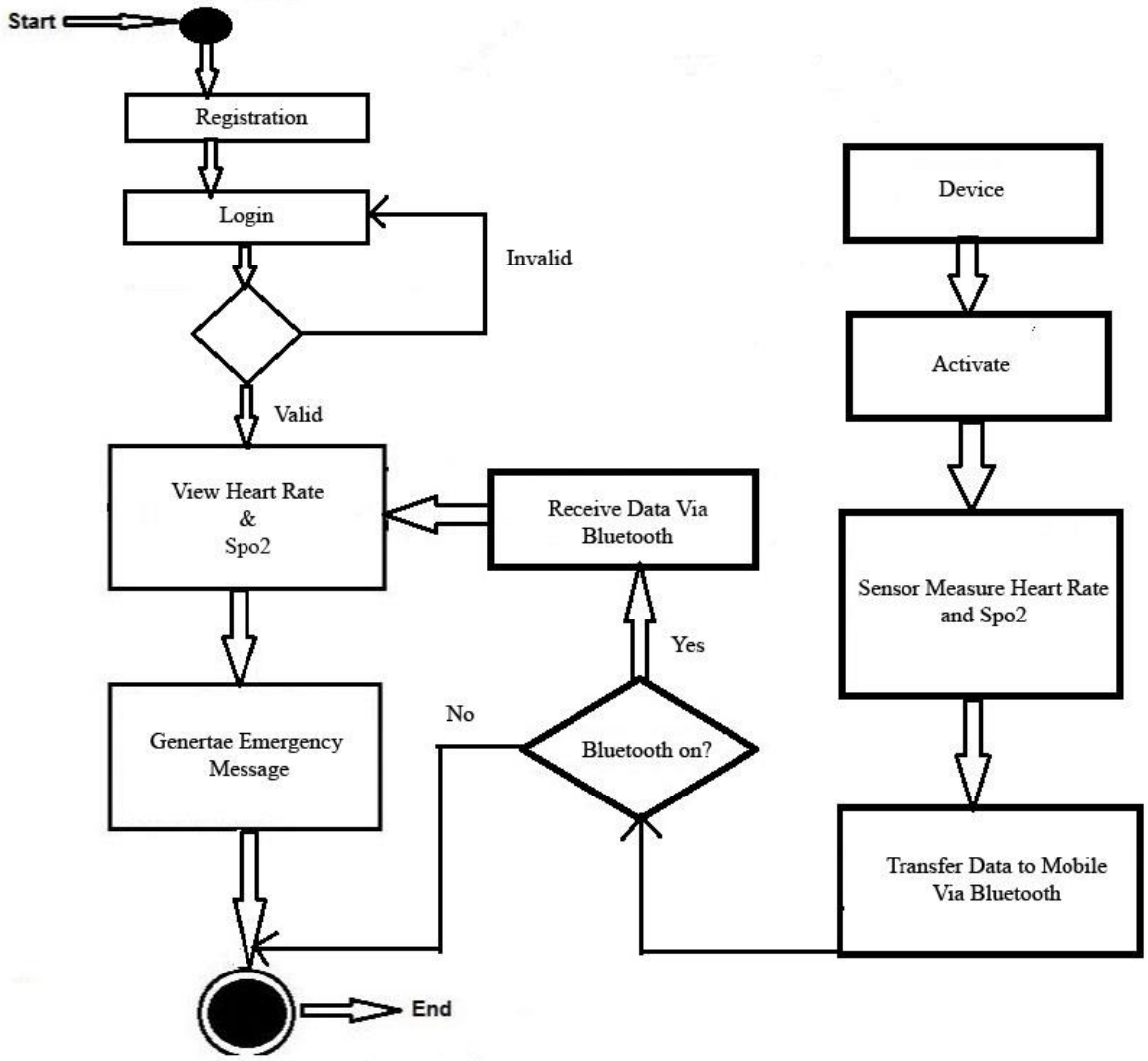


Figure (4.7) Activity Diagram

4.7. Component Diagram

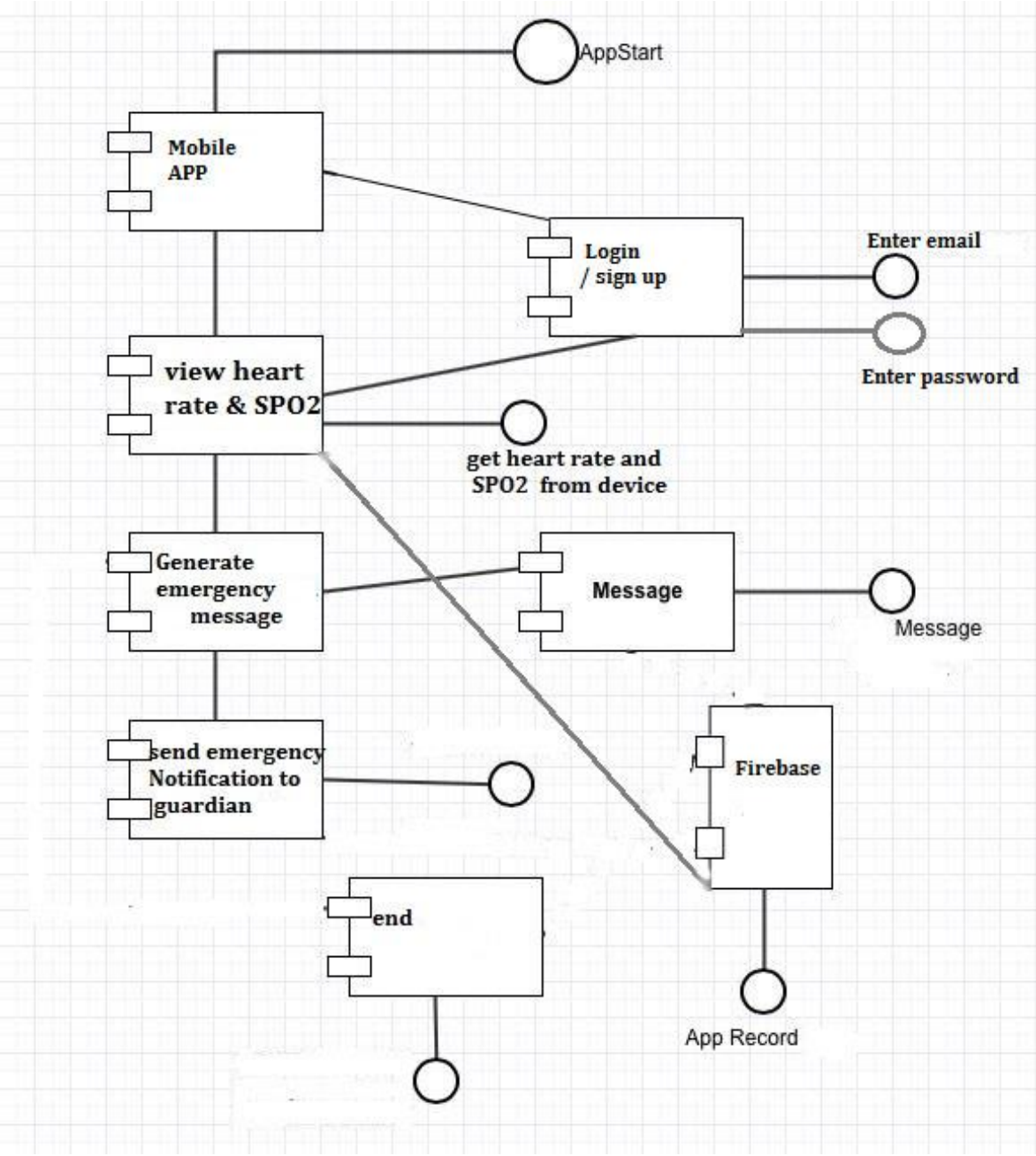


Figure (4.8) Component Diagram

4.8. Deployment Diagram

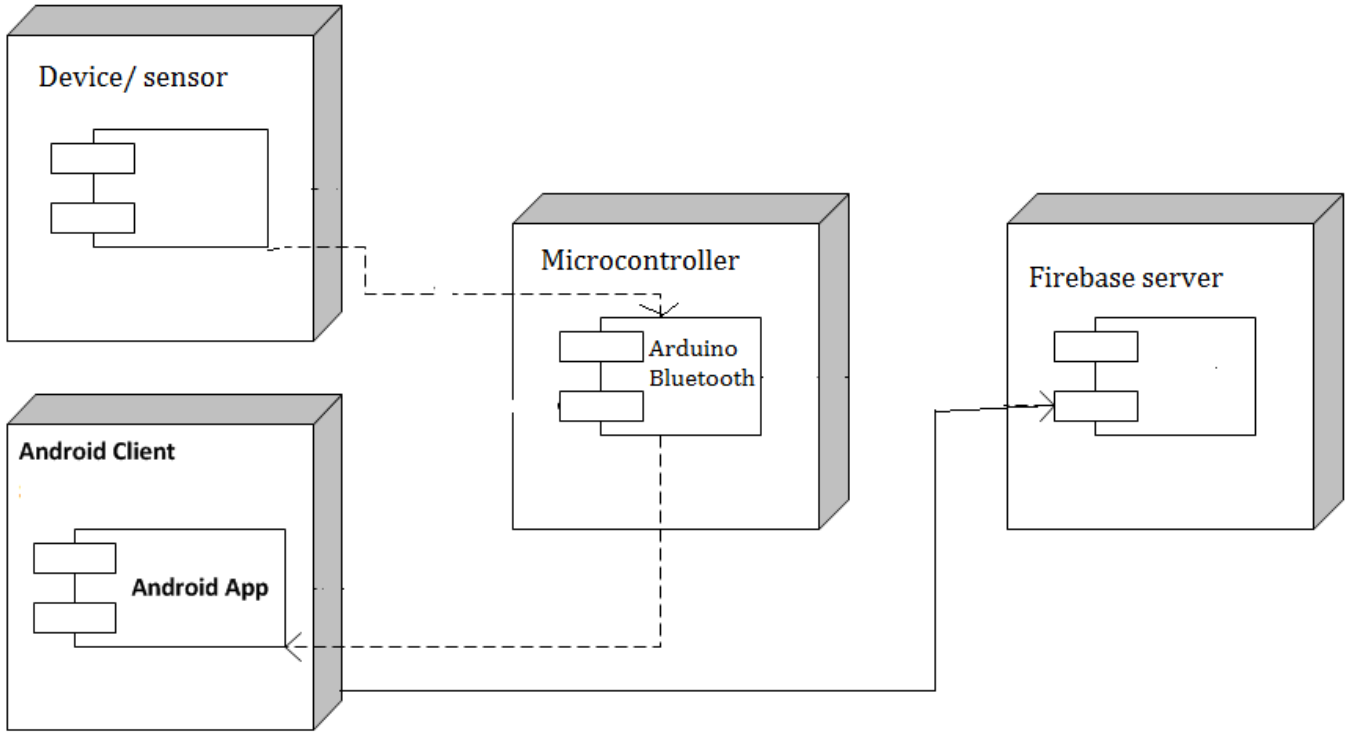


Figure (4.9) Deployment Diagram

4.9. Data Flow diagram [Level 0 and level 1]

Level 0:

This is the data flow diagram (level 0) of application.

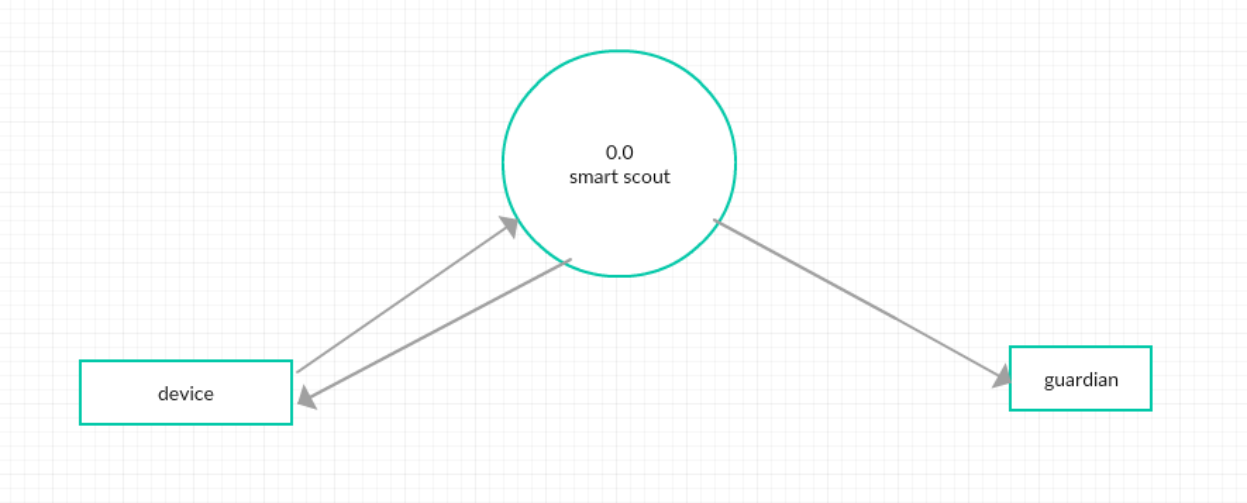


Figure (4.10.1) Deployment Diagram

Level 1:

This is the data flow diagram (level 1) of application.

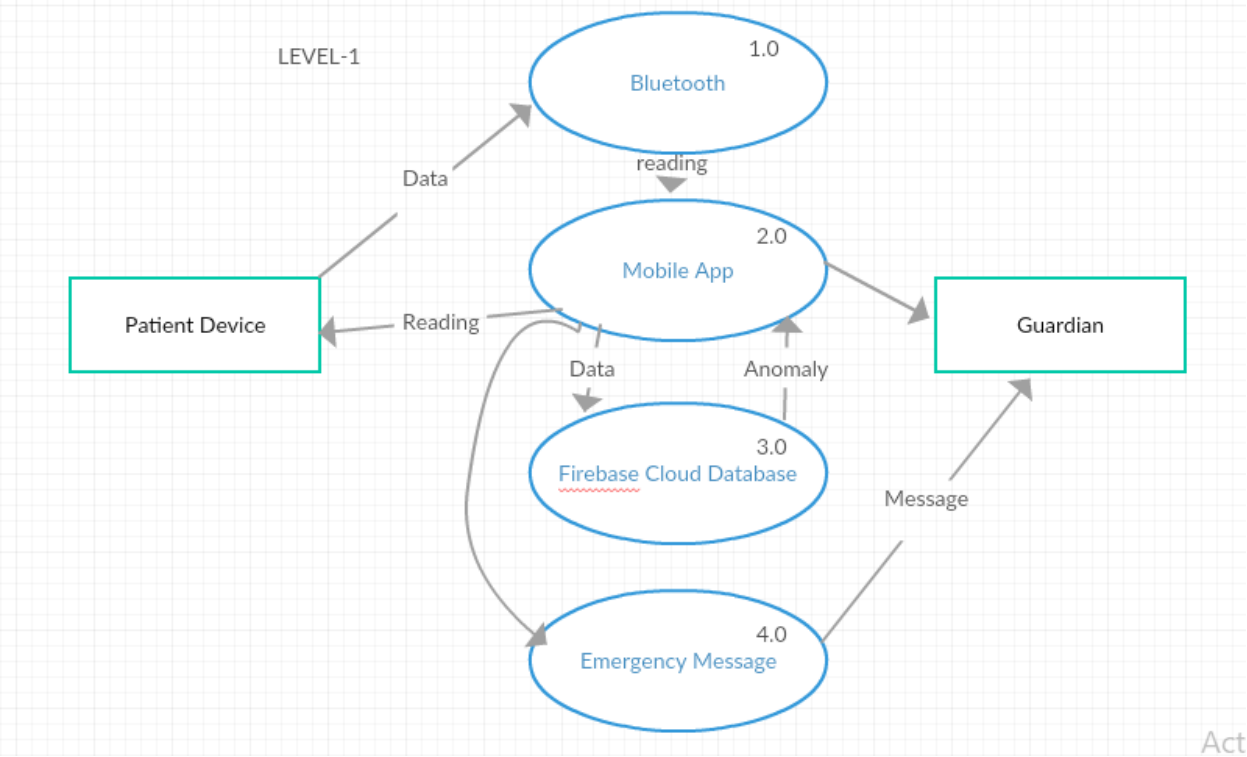


Figure (4.10.2) Deployment Diagram

Chapter 5

Implementation

Chapter 5: Implementation

5.1. Important Flow Control/Pseudo codes

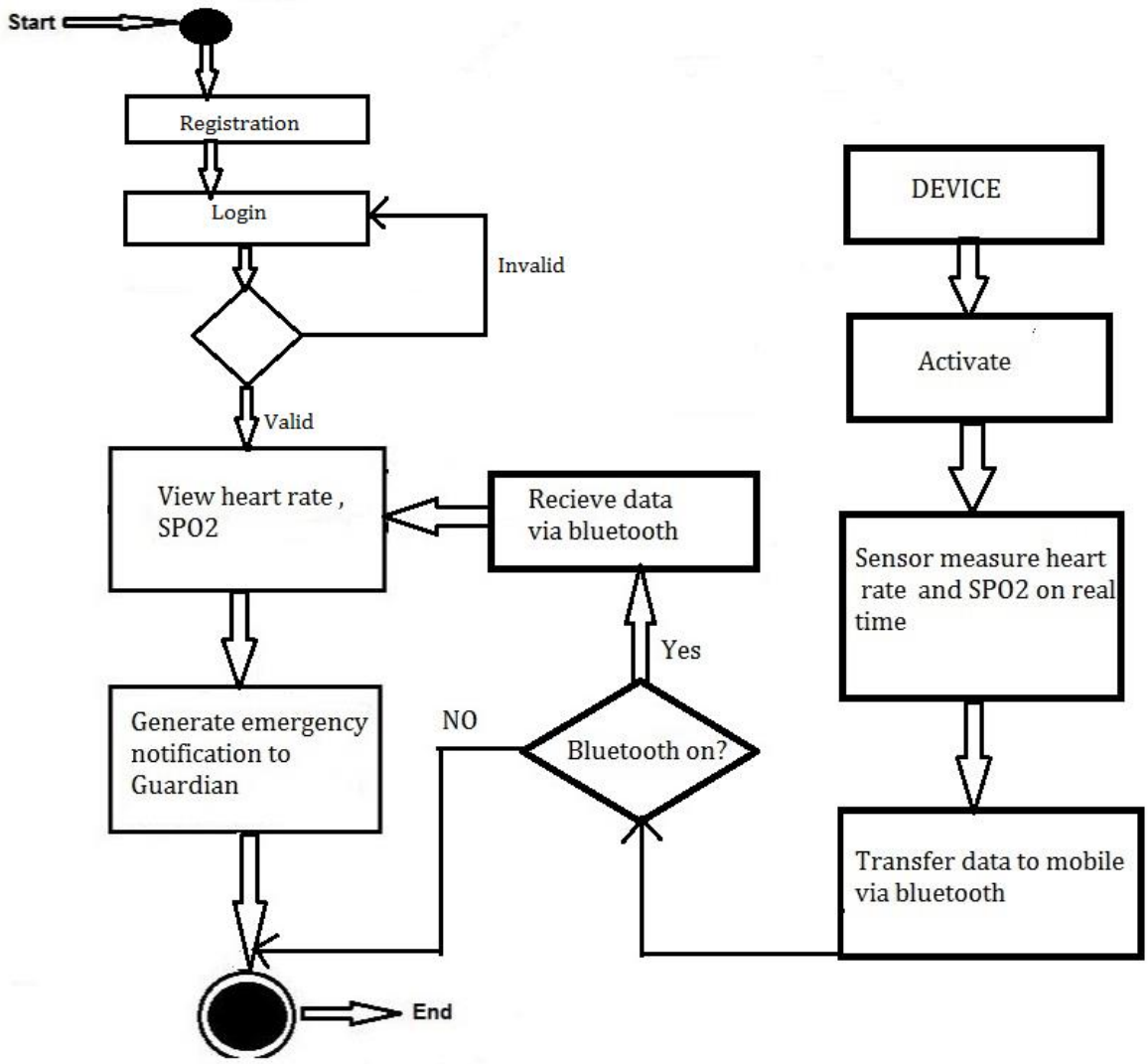


Figure (5.1) Important Flow Control/Pseudo codes

5.2. Components, Libraries, Web Services and stubs

Components

Hardware:

- Arduino Nano(Micro Controller)
- Bluetooth Module(HC-05)
- Heart Rate & Spo2 (MAX30100)

Software:

- Android Studio (Java)
- Arduino IDE(Arduino C)
- Python
- Google Firebase

Libraries

- Python(Tensor Flow)
- Python (Anaconda)
- Google Firebase Database Library
- Max 30100 Library

Web Services

- Google Firebase Real Time Database
- Google Firebase Authentication

5.3. Deployment Environment

There are two deployment environment one is Android OS and cloud base environment where our data will be store. We used android studio to build our App and connected with the Hardware components like Bluetooth module all the data fetch by the Bluetooth module control by an Arduino Nano Microcontroller.

5.4. Tools and Techniques

Hardware

- Arduino(Microcontroller)
- Bluetooth Module
- Heart Rate Sensor
- SpO_2 Sensor

Software

- Android Studio
- Arduino IDE
- Google Firebase
- Anaconda

Programming Language

- Python
- Arduino IDE (C Programming language)
- Android Studio (Java)
- Android App Layout (XML)

Chapter 6

Testing and Evaluation

Chapter 6: Testing and Evaluation

6.1. Equivalence partitioning

6.2.1 Equivalence Partitions (EP) for Enable Password:

Invalid	Valid	valid	Invalid	Valid
< 1	Min – 8	>8	Numeric	Alphanumeric (Special characters)

Test Case Id	Input	Output
01	1554	Incorrect
02	shs223	Incorrect
03	shs22312	Correct
04	Jloiih56	Correct
05	256_885	Incorrect

6.2. Boundary value analysis

Invalid	Valid	valid	Invalid	valid
< 1	Min – 8	>8	Numeric	Alphanumeric (Special characters)

Test Case Id	Input	Output
01	1554	Incorrect
02	shs223	Incorrect
03	shs22312	Correct
04	Jloiih56	Correct
05	256_885	Incorrect

6.3. Unit testing

The primary goal of unit testing is to take the smallest piece of testable part in the application, Isolate it from the remainder of the code, and determine whether it behaves exactly as you Expect. Each unit is tested separately before integrating them into modules to test the interfaces between modules.

6.4. Integration testing

After completion of our module along with testing, modular coding strategy was used. After integrating the module with the complete application, time was given to our team to test their part of module completely and thoroughly. As the whole application is divided into several modules, there were a lot of variable names and function names, which were common to all the modules. There existed a lot of session variables, which we had to incorporate into our module, but as different modules were being developed simultaneously we had to hard code things in place of the session variables in our module. So at the time of integration a lot of hard coded things had to be removed and session variables were replaced.

Chapter 7

Summary, Conclusion and Future Enhancements

Chapter 7: Summary, Conclusion & Future Enhancements

7.1. Project Summary

Smart scout is an innovative solution for providing patient health care facility. Our main focus to develop this project to digitalize our environment and smart solution. This project contribute in the medical industry to easily measure patients physical parameters like Heart-rate and Spo2 using a mobile App and easy carry hand Band.

We used deep learning to measure accuracy, prediction and health condition of a patient. Deep learning also beneficial for detecting anomaly detection of sensor. So at the end Smart Scout contribute to improving a person health condition and predict us on real time of a patient health condition.

7.2. Achievements and Improvements

Throughout this year, we have come across many challenges that we have never met before. This was our first time that we have to be in charge of the whole project, and this was a yearlong project. In addition, it was our first time to deal with programming on Android, Arduino, Machine learning, Python and hardware. We have learnt a lot from machine learning, Hardware integration and android development, which was really valuable and beneficial to our final year project. At the beginning, we were new to Data mining we have to spent massive time on studying the specifications of the platform and trial running the tutorials and sample codes before proposing our project idea to our supervisor. However, those spent time were worthwhile. Technically, the challenge was the Control of number of complains we received from the end users and how we handle and resolve complains. Our complete project is very challenging in which we face challenges one after other. The main challenge was handling Data. Personally, we have to be more self-discipline as besides completing our final year project; we have also courses to take in the semesters. Time management was the most precious thing we have learnt in this project. All in all, we had a great experience and we have learnt a lot.

7.3. Critical Review

Smart Scout is an innovative solution for detecting a person whose health in grave danger and informing concerned persons about that danger. It is a smart device application system that provide patient care and health monitoring 24/7. This Smart Scout band capable of reading a human's Pulse Rate, ECG, SpO_2 and body-temperature. First of all, we will develop the band to sense the subject's physical parameters (like pulse-rate, ECG, SPO2 and body temperature). This band will send the data to the mobile app. Our mobile app will use Machine Learning (both Regression and Classification) to analyze subject parameter and hence determine whether subject is in normal or critical condition and prompt the physician or close relatives of the subject (specified in the app at start) if user is in the danger.

Second main feature of our app will be to use ensemble of sensor readings for anomaly detection of a faulty reading from any sensor of the three (whether it's through interference, attenuation or some other factor)

7.4. Lessons Learnt

There are bundle of things that we learnt throughout this project. We came to know how to interact with physical world through sensors and actuators. Now we came to know how software interacts with hardware. Whole of this world was new to us. We have successfully finished this project with the help of team effort and most importantly with the guidance of our advisor who is very much cooperative.

7.5. Future Enhancements/Recommendations

Future aspects:

- Blood Pressure Measurement
- Increased Accuracy
- Making user-friendly product's prototype
- ICU/CU Monitoring Facility

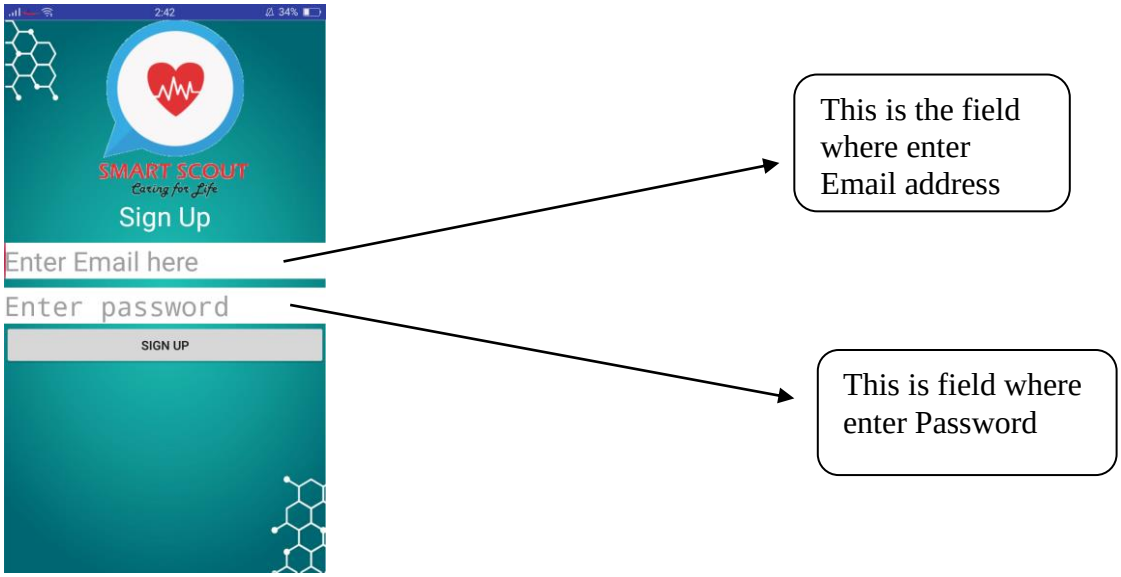
Appendices

Appendix A: User Manual

This is Mobile App title (Splash Screen)

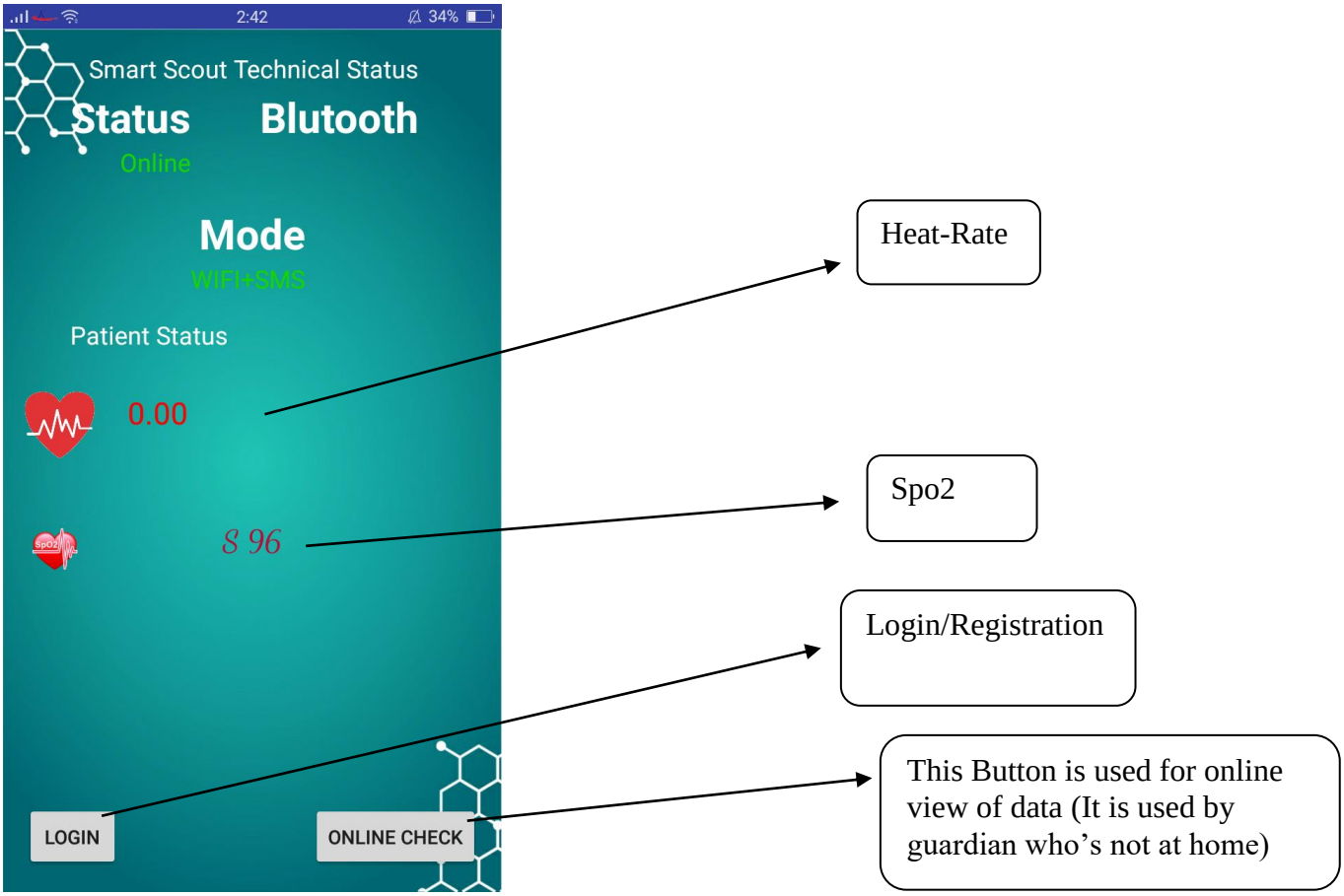
Appendix A: UI Design

This is Registration screen where user Register yourself.



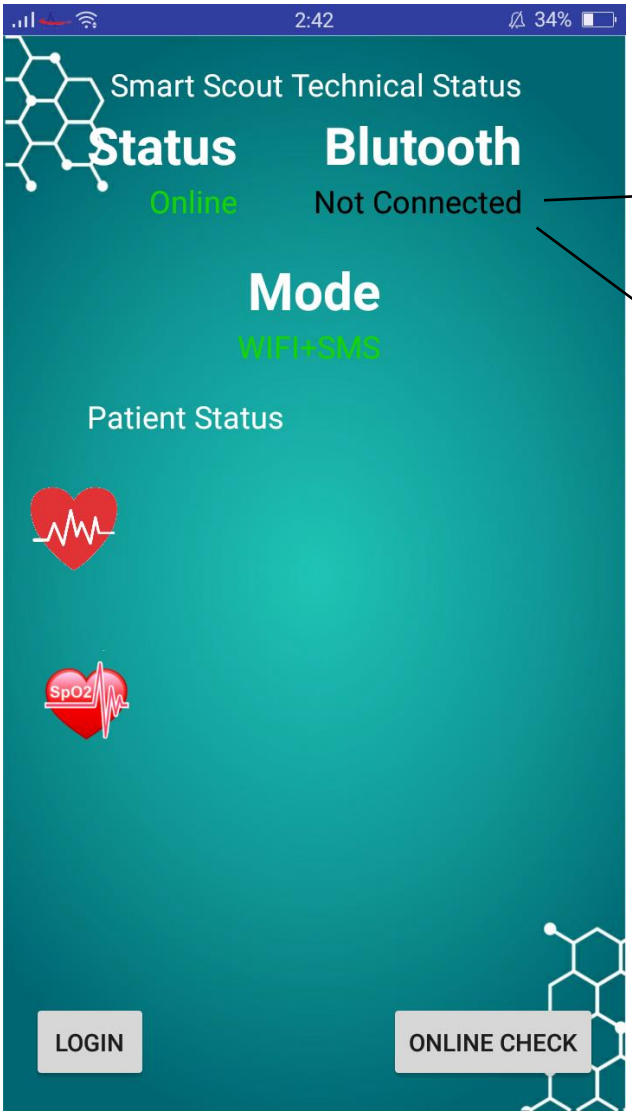
A.1. User Interface

This is user interface where user see the values of heart-rate and Spo2 on real time.



A.1.1. Bluetooth Connectivity and Pairing

This screen shows the Bluetooth connectivity



This Status Show Bluetooth not connected

When connected to Bluetooth module shows the sensor data on screen

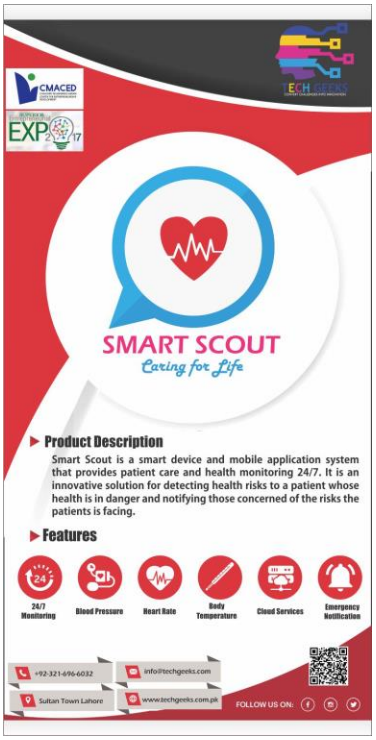
Appendix B: Information / Promotional Material

This is our Product Logo

SMART SCOUT
Caring for Life

C.1. Broacher

C.2. Standee



C.3. Company Logo

This is our company logo

Business Card

This is our Business card sample

Identity Card Company

This is Sample Identity Card of company

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Reference and Bibliography

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http://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm

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https://learn.sparkfun.com/tutorials/ad8232-heart-rate-monitor-hookup-guide

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https://www.aliexpress.com/item/Heart-Rate-Click-MAX30102-Sensor-Blood-Oxygen-Pulseoximetry

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http://www.vogella.com/tutorials/java.html

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