
CSE-360 : Integrated Design Project

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# Software Requirement Specification

## PREDICTIS

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# Preface

Heart attack is called as myocardial infarction in medical terminology. Heart is supplied by right and left coronary arteries. Whenever these arteries are blocked, blood supply to heart stops and wall of heart damages, resulting in heart attack.

Coronary heart disease is epidemic in Bangladesh and one of the major causes of disease burden and deaths. Data from registrar general of Bangladesh shows that heart attacks are major cause of death in Bangladesh. World health organization in the year 2019 reported that 29.2% of total global deaths are due to Cardio Vascular Disease (CVD). Cardio vascular disease is expected to be leading cause of deaths in developing countries due to change in life style, work culture and food habits. Hence more careful and efficient methods of cardiac diseases and periodic examination are of high importance. According to the latest WHO data published in 2019 Coronary Heart Disease Deaths in Bangladesh reached 118,287 or 15.23% of total deaths. The age adjusted Death Rate is 109.32 per 100,000 of population ranks Bangladesh 115 in the world. In our days the health industry has collected vast amounts of patient data. Which, unfortunately, is not “produced” in order to give some hidden information. Thus to make effective decisions, which are connected with the base of the patient's data and are subject to data mining and data analytics.

# 2. Introduction

## 2.1 Purpose

Predictis is an Application which enables its users to foresee their risks of having Cardio-vascular diseases. In our country people usually don't get a medical check-up until they face some major health-issues. Most of the people don't have regular heart-checkups, because the manual ways to get these checkups are time-consuming and inconvenient. The aftermath of not knowing their present heart-condition causes serious health injuries and in worst case accidental deaths. Using this application user can get acquainted with their heart-condition on time and will be able to improve their heart-conditions both conveniently and efficiently.

## 2.2 Intended Audience

This Application is mainly developed for aged and obese people. Because people aged over 40 and obese people have higher risk of suffering from clinical heart diseases. Doctors and family members can be helpful to get some important insights about patient's heart-condition through this Application. Health-conscious people who want to check their heart condition can also use this.

## 2.3 Scope

This product is for people who have high risk of ischemic heart disease and health-conscious people who want to have a better cardiac health. It will predict the present heart-condition of user rather than detecting. This product will target ischemic heart disease only, other cardiac diseases will not be included . It will have an application version for android and will not have web version for browsers. It will not be suitable for people who has already faced Myocardial infarction (MI), also known as heart attack.

# 3. Glossary

**Wearable Wireless ECG Monitor** : The Wearable Wireless ECG monitor is designed to provide continuous medical grade data. In addition to continuously recording ECG data, it also monitors heart rate and heart rate variability, skin temperature, respiratory rate and activity tracking.

**Real-Time Data :** Real-time data (RTD) is information that is delivered immediately after collection. There is no delay in the timeliness of the information provided. Real-time data is often used for navigation or tracking.

**ECG/EKG :** An electrocardiogram(ECG/EKG) records the electrical signals in your heart. It's a common and painless test used to quickly detect heart problems and monitor your heart's health.

**CVD :** Cardiovascular disease (CVD) is a general term for conditions affecting the heart or blood vessels. It's usually associated with a build-up of fatty deposits inside the arteries(atherosclerosis) and an increased risk of blood clots.

**Ischemic heart disease :** Ischemic Heart Disease, also known as coronary heart disease, occurs when the blood flow to the heart muscle is reduced because of a partial or complete blockage of the arteries supplying it with blood.

If we consider the coronary arteries to be a system of tubes, as they progressively become blocked it means that the liquid flowing through them, in this case blood, does not reach its destination, the heart, correctly.

**API :** An API (Application Programming Interface) is a set of functions that allows applications to access data and interact with external software components, operating systems, or microservices.

**Data Science and Data Analytics :** Data analytics is the science of analyzing raw data in order to make conclusions about that information. Many of the techniques and processes of data analytics have been automated into mechanical processes and algorithms that work over raw data for human consumption.

**BMI :** Body mass index (BMI) is a value derived from the mass (weight) and height of a person. The BMI is defined as the body mass divided by the square of the body height, and is universally expressed in units of kg/m2, resulting from mass in kilograms and height in meters.

# 4. Requirement Discovery

## 4.1 Interview

An Interview was conducted with a doctor who is expert in medicine to get acquainted with the requirements of this product. Some important points were noted down during this interview. Some of the doctor's insights are given below:

- Medical Surveying will play a significant role while developing this product.
- BMI (Body Mass Index), Family History of heart disease, Alcohol consumption etc. are important parameters while giving a prediction about ischemic heart disease.
- Intended user of this product should be people aged more than 40 who hasn't been diagnosed with heart disease yet.

## 4.2 Survey

An online survey was completed using a google form to know user's perspective about the system. some important points were collected from the survey.

- Most of the people are willing to use a prediction system to avoid heart attack.
- Most of them are willing to have a continuous monitoring system using wearable devices.
- Mobile application was preferred over web application for this system.
- Steps should be taken during emergency.

## 4.3 Literature Review

We have read some articles and research papers and found out some important perspectives/information, which are given below.

- Using mobile devices to collect Electrocardiography (ECG), Seism cardiography (SCG) data from sensors and efficient analysis of those data can monitor a patient's cardiac activities for early warning.
- A heart attack self-test application for a mobile phone allows potential victims, to quickly assess whether they are having a heart attack, without the intervention of a medical specialist. If the application assesses that the user is at risk, it will automatically determine the current location of the user and alert the ambulance services and others to the person's location.
- The stratification of patients into subpopulations is at the core of clinical decision-making and clinical trial design in medicine. Machine learning algorithms is used in analyzing a user's medical data and clustering him into different zones so that the clinical decision can be given about the health condition of user.

# 5. User Requirements

**5.1** The user shall be observed thoroughly before giving the prediction.

**5.2** The application shall inform user about their risk of having heart disease.

**5.3** The user shall be informed in case of any abnormality arises.

**5.4** The application shall be able to contact concerned people in case of any emergency.

**5.5** The user shall be able to visualize their history of heart condition.

# 6. System Architecture

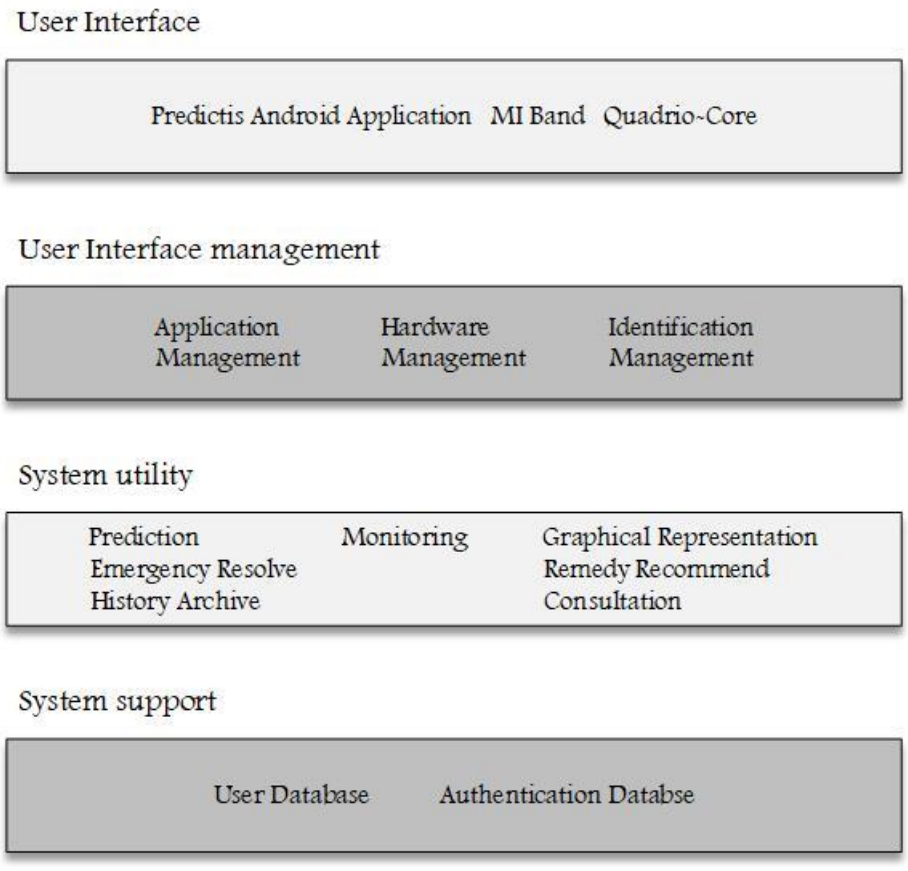



Figure 1.1 System Architecture

# 7. System Requirement Specification

## 7.1 System Requirements

### 1. Observing user for prediction

**1.1** Some profile data will be collected from user manually. E.g. Existing disease, BMI, Smoking Habit etc.

**1.2** Some Real-time data will be collected from user using Wearable Wireless ECG Monitor and MI band.

### 2. Classifying into risk-zones

**2.1** The system will classify the users into three different risk zones using collected data.

**2.2** Three different zones are Red, Green and Yellow where :

-Red zone denotes maximum risk of having a heart disease.
-Yellow zone denotes moderate risk of having a heart disease.
-Green zone denotes least risk of having a heart disease.

### 3. Informing abnormality

**3.1** The application will notify user with a pop-up message if the pulse-rate crosses a certain threshold point multiple times during a day.

**3.2** The threshold point will be set while observing the user which may vary from user to user.

### 4. Contact Concerned people during any crisis

**4.1** The application will ask for user permission to inform concerned people during any abnormality.

**4.2** The user will press a button and SMS will be sent to the concerned people or emergency ambulance service.

**4.3** The application will provide medical consultation during any crisis.

**5. Visualizing previous Heart-condition**

**5.1** User can visualize if their heart-condition got better comparing with their previous results.

**5.2** the application will show the graphical view of parameters for comparison.

## 7.2 Requirement Classification

| Stated Requirements | Types of Requirements | | Remarks |
|---|---|---|---|
| | Functional | Non-functional | |
| **1. Observing users** | | | |
| 1.1 Profile-data collection | | ✓ | |
| 1.2 Real-time data collection | ✓ | | [It can be both, but user prefers to be observed for better result, so functional is chosen.] |
| **2. Classifying risk-zones** | | | |
| 2.1 Classify risk-zone | ✓ | | |
| 2.2 Red, Yellow, Green zones | | ✓ | [There are many ways to represent risk-zones, that's why non-functional is chosen.] |

| Stated Requirements | Types of Requirements | | Remarks |
|---|---|---|---|
| | Functional | Non-functional | |
| **3. Informing Abnormality** | | | |
| 3.1 Pop-up notification | ✓ | | |
| 3.2 Set Threshold point | | ✓ | |
| **4. Contact during crisis** | | | |
| 4.1 Ask user permission | | ✓ | |
| 4.2 Send urgent message | ✓ | | |
| 4.3 Provide medical Consultation | | ✓ | [This feature is subsidiary thus chosen as non-functional.] |
| **5. Visualizing previous heart-condition** | | | |
| 5.1 Storing previous records | | ✓ | |
| 5.2 Comparing with previous heart-conditions | ✓ | | |
| 5.3 Show graphical representation of user data | | ✓ | |

# 8. System Model

## 8.1 Context diagram

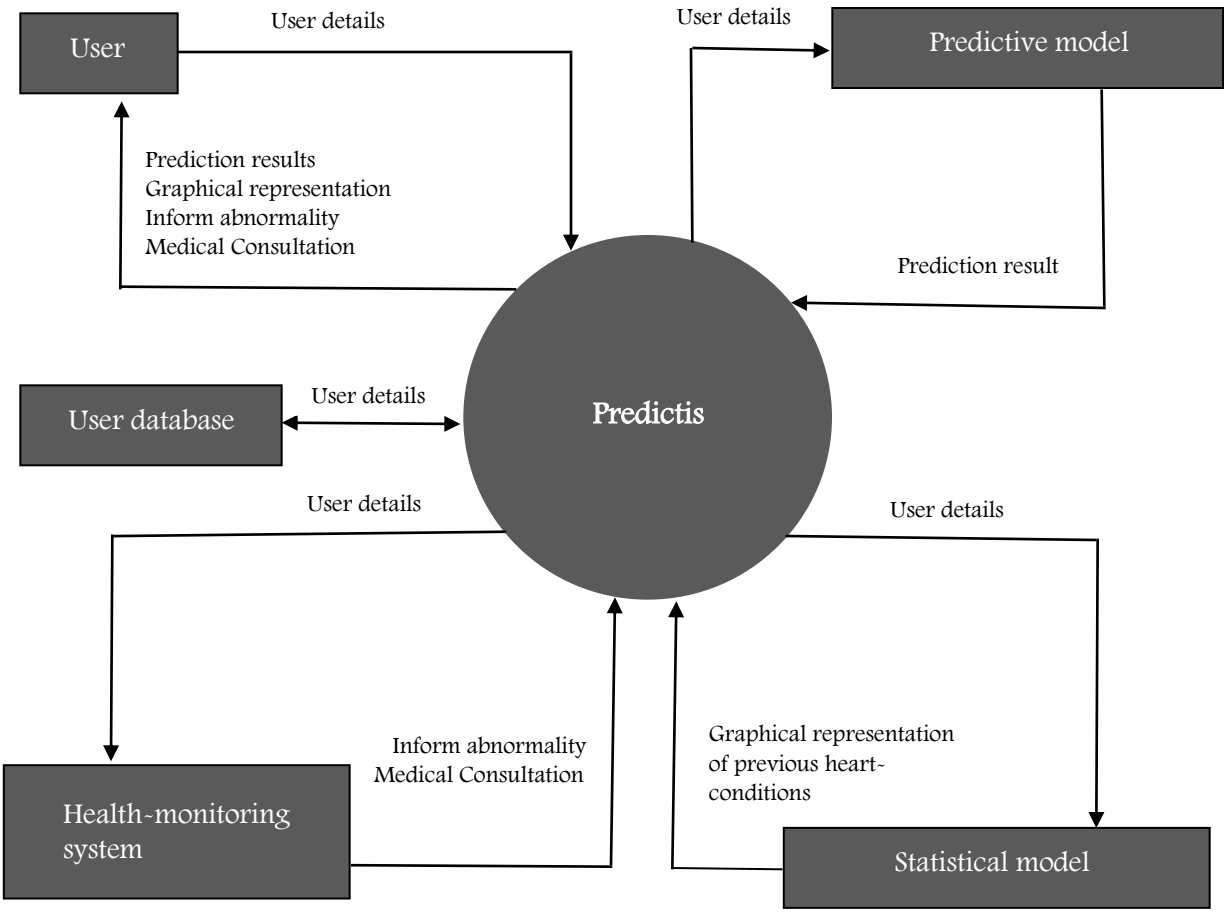



Figure 1.1 Context model

## Description

**1.** There are 4 different subsystems in the context diagram. User database, where all the user information and results will be stored.

2. Predictive model is another sub-system which will classify the users into different risk zones (red, yellow, green).

3. Statistical model, will give the graphical representation of the user-data and will show the comparison among old results.

4. Health monitoring system will monitor the user and inform them if any abnormality is detected. MI band and wireless ECG must be connected to the system to use this sub-system.

## 8.2 Use Case diagram

### 8.2.1 User Sign-up Use Case

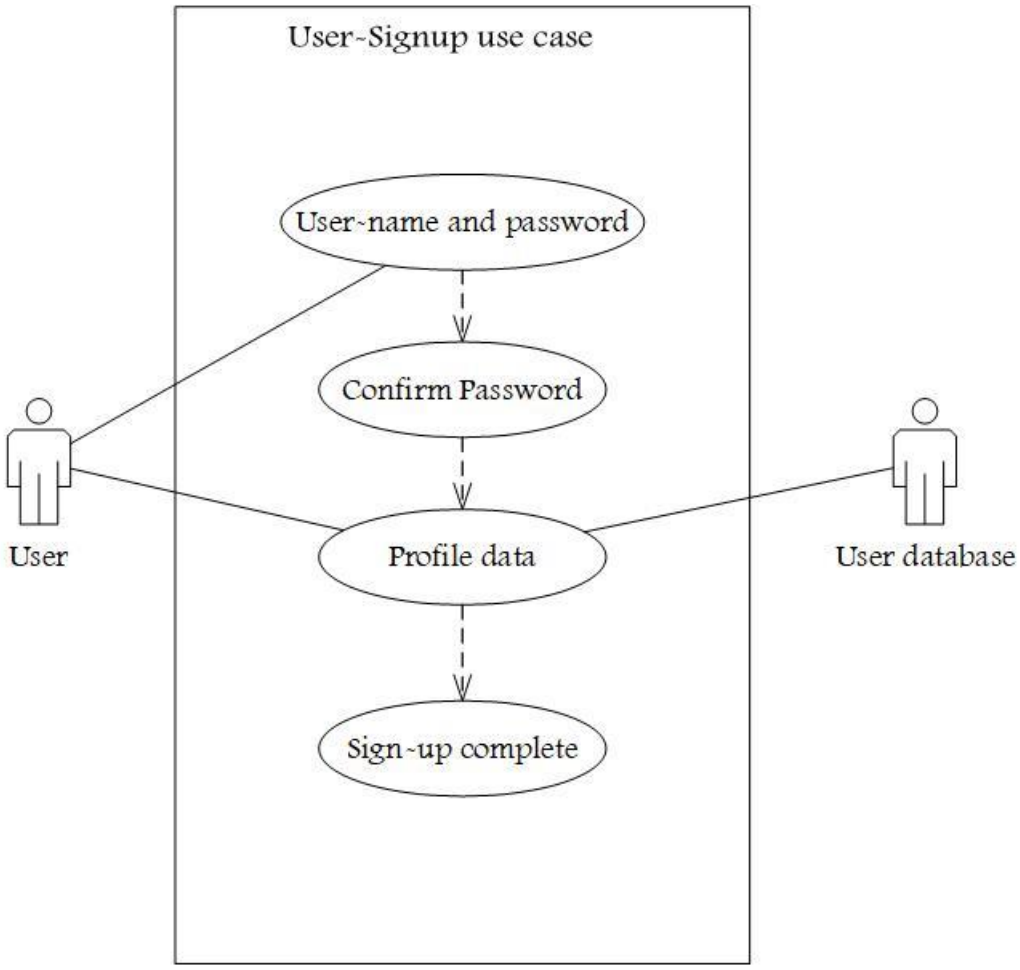



Figure 2.1 : User sign-up

## Tabular description

| User sign-up use case | | |
|---|---|---|
| **Actors** | | User, user database |
| **Description** | | The user may use this application for the first time, so user may need to sign up first. Username and password is required for signing up and by confirming password, the user may be able to insert his profile data. The user database may store the profile data (Age, sex, weight) collected from the user. |
| **Data** | | Username, password, Profile data |
| **Stimulus** | | Signup option selected by the user |
| **Response** | | Successfully signed up |
| **Comments** | | The user has to use the application for the first time. |

### 8.2.2 User login use-case

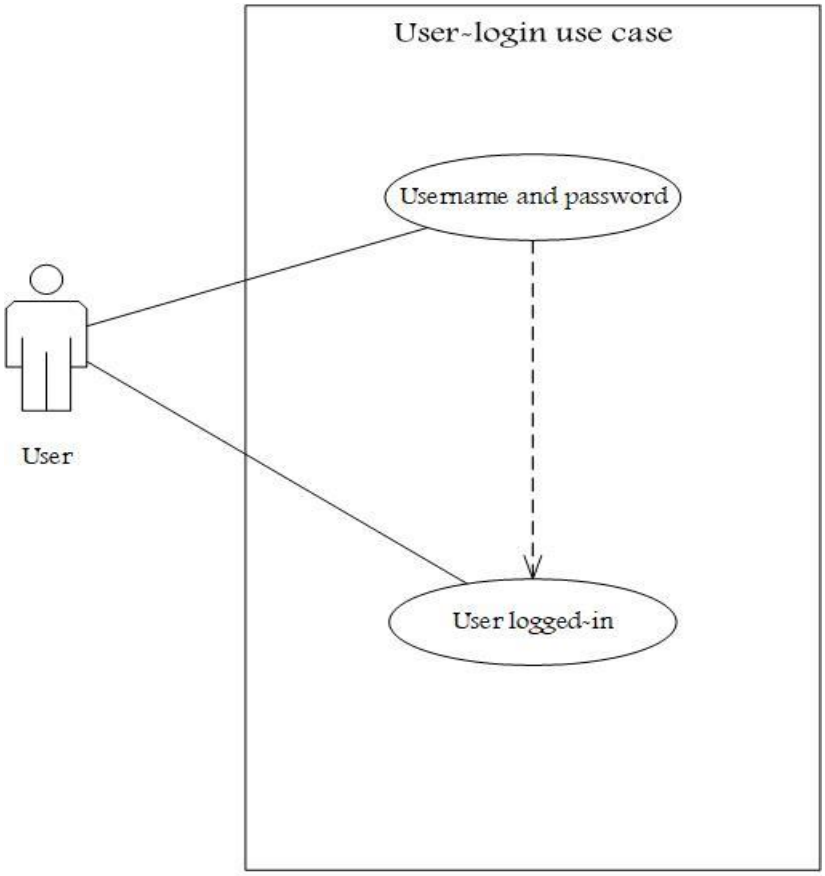



Figure 2.3 : User-login

## Tabular description

| User login use case | | |
|---|---|---|
| **Actors** | | User |
| **Description** | | The user may use this application before and may not need to sign up this time. In this case, user can login by providing username and password. |
| **Data** | | Username, password |
| **Stimulus** | | Login option selected by the user |
| **Response** | | Successfully logged in |
| **Comments** | | This option is for existing user. |

### 8.2.3 Interfacing hardware use-case:

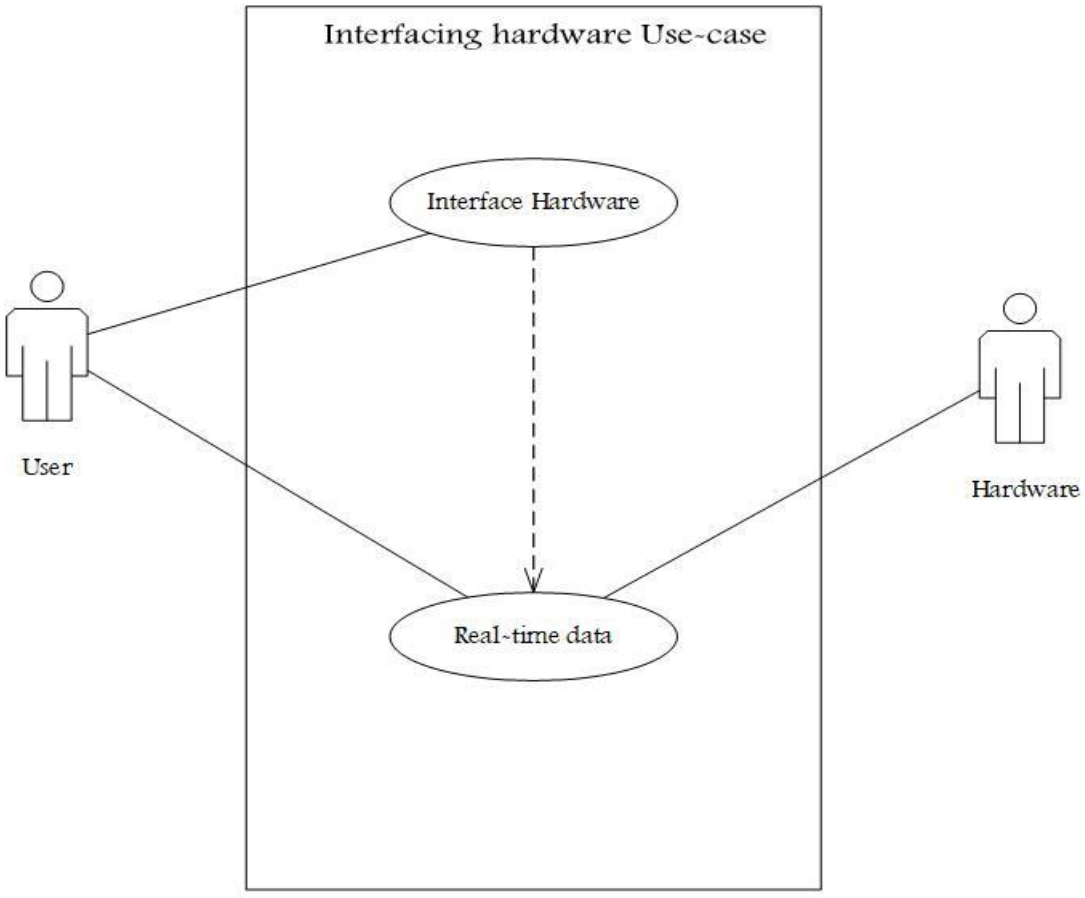



Figure 2.3 : Hardware Interfacing

## Tabular description

| Interfacing hardware use-case | | |
|---|---|---|
| **Actors** | | User, hardware |
| **Description** | | The user may need to interface with the hardware to measure some real-time data (blood pressure, heart rate etc.). |
| **Data** | | Real-time data. |
| **Stimulus** | | Interfacing with hardware |
| **Response** | | Interface confirmation |
| **Comments** | | Bluetooth or Wi-Fi connecting is needed to interface. |

### 8.2.4 User data accumulation use-case:

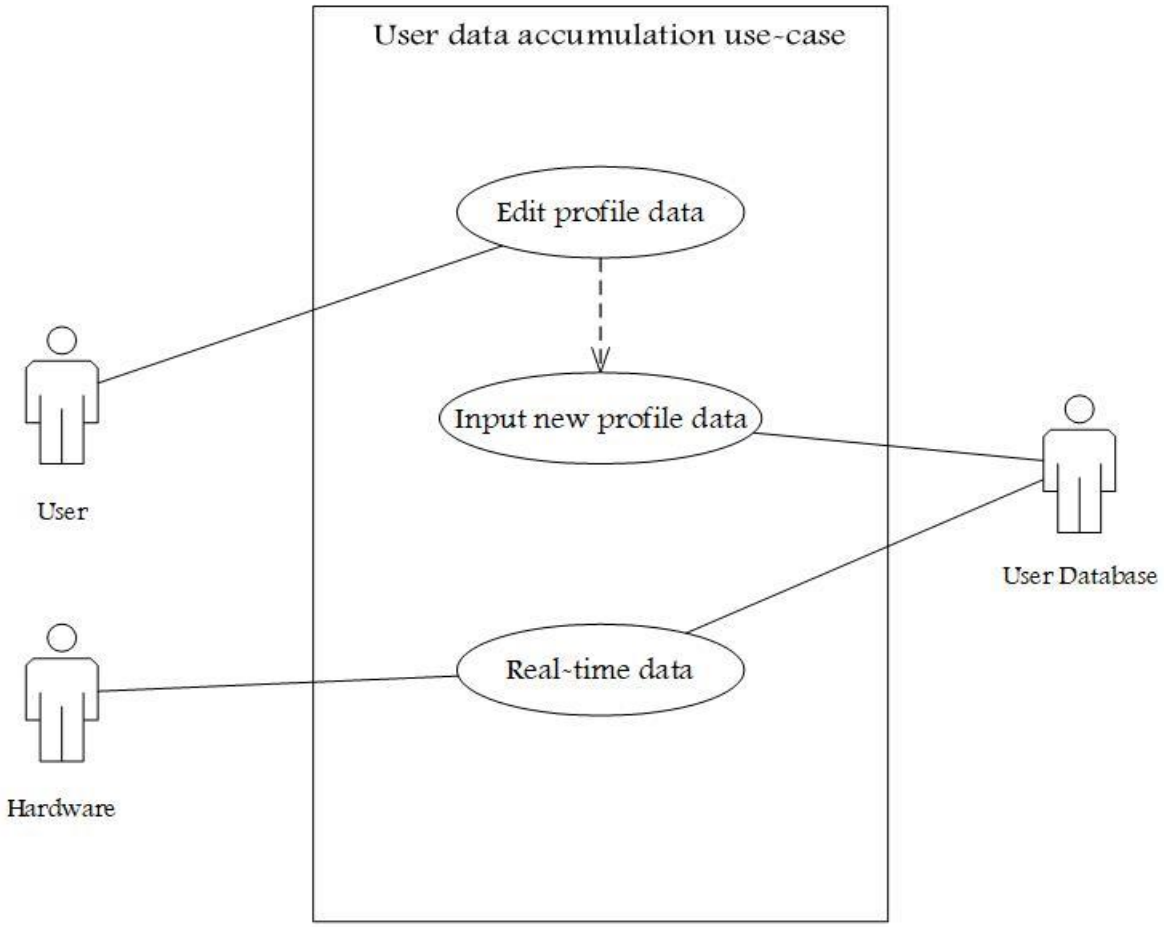



Figure 2.4 : Data accumulation

## Tabular description

| User data accumulation use-case | | |
|---|---|---|
| **Actors** | | User, user database, hardware |
| **Description** | | The user may be an old user and in that case he may need to update his changeable profile data (Cholesterol, weight etc.). |
| **Data** | | Real-time data. |
| **Stimulus** | | Interfacing with hardware |
| **Response** | | Interface confirmation |
| **Comments** | | Bluetooth or Wi-Fi connecting is needed to interface. |

## 2.5 Predicting heart condition use-case:

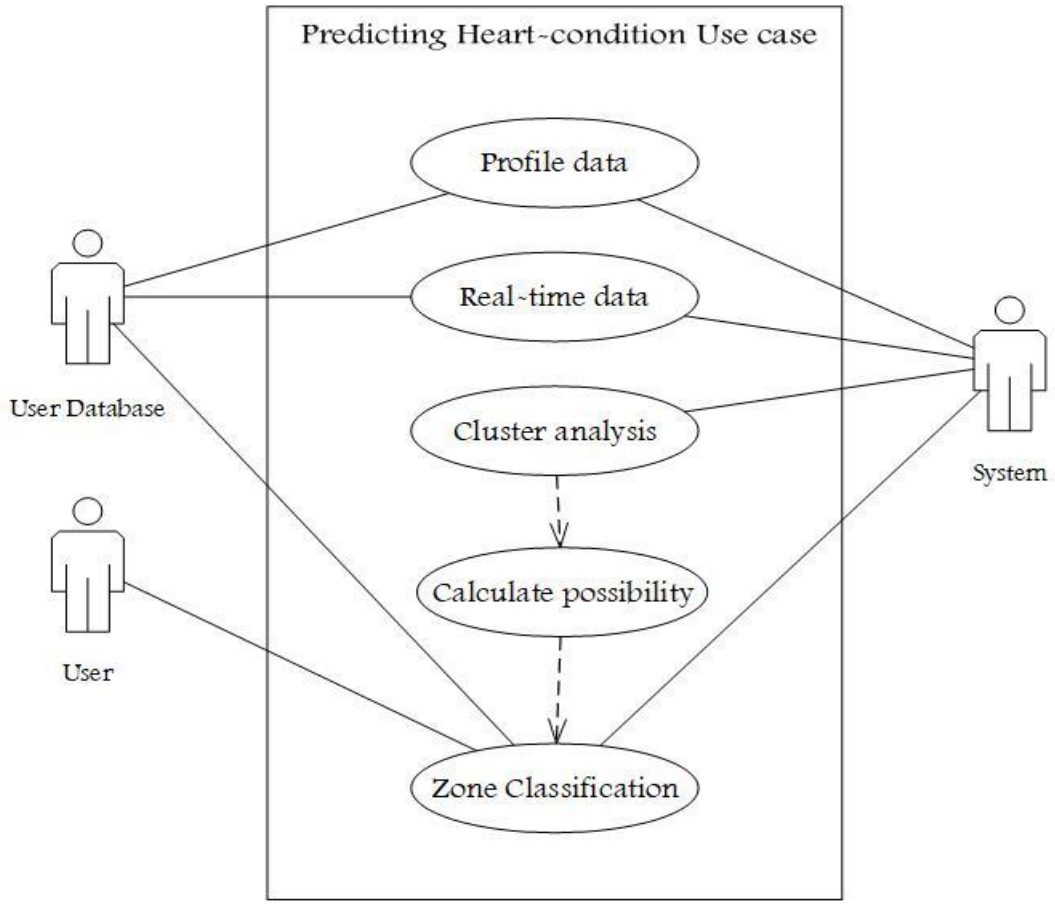



Figure 2.5 : Prediction

## Tabular description

| Predicting heart condition use-case | | |
|---|---|---|
| **Actors** | | User, user database, system. |
| **Description** | | Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups. The system may take profile data and real-time data from the user database and use cluster analysis for dividing them into different cluster. Possibilities of cluster will be calculated and users will be classified into zones (red, green, yellow). |
| **Data** | | Profile data, real-time data. |
| **Stimulus** | | Selecting predict option. |
| **Response** | | Showing zones. |
| **Comments** | | Profile data should be updated before every prediction. |

## 2.6 Heart monitoring use-case:

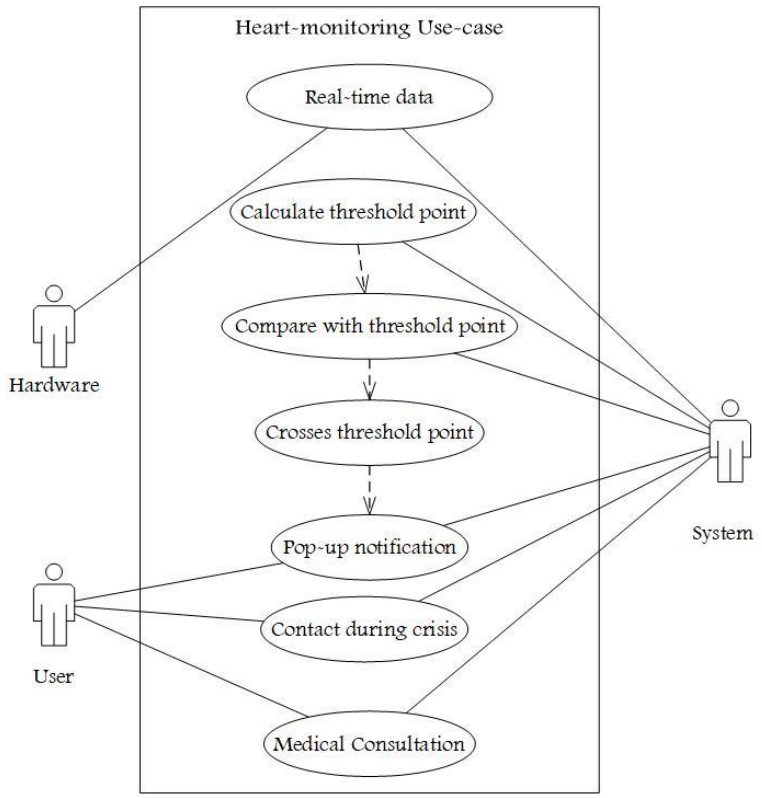



Figure 2.6 : Monitoring User

## Tabular description

| Heart-monitoring use-case | | |
|---|---|---|
| **Actors** | | User, hardware, system. |
| **Description** | | The system may need to monitor patient using the real-time data. The system will compare the real-time data with the threshold point. It may cross the threshold point; in that case a notification will pop up. The user can contact people during emergencies using the system. And in case of any emergency medical consultation will be provided to the user by the system. |
| **Data** | | Realtime data, pop up notification, contact during crisis, medical consultation. |
| **Stimulus** | | Selecting monitoring option. |
| **Response** | | Consultation, pop up notification. |
| **Comments** | | MI band and wireless ECG should be connected with the system. |

## 2.7 Graphical representation use-case:

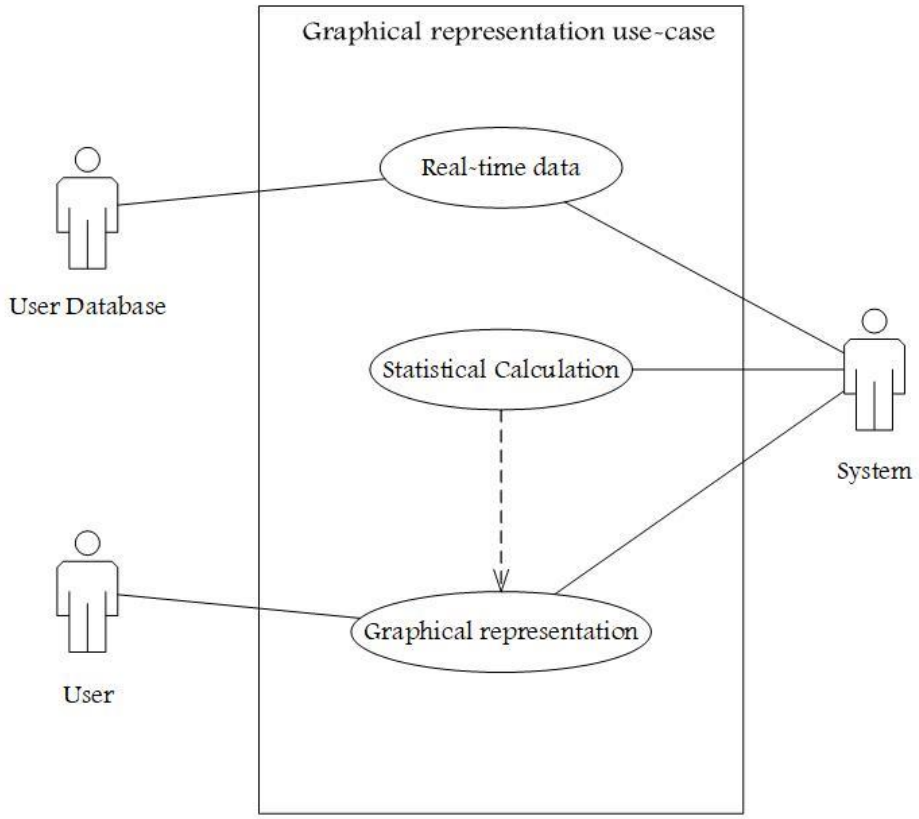



Figure 2.7 : Graphical representation

## Tabular description

| Graphical representation use-case | | |
|---|---|---|
| **Actors** | | User, user database, system. |
| **Description** | | The System may use real-time data from the user database and may represent the graphical view of the data using statistical calculation. |
| **Data** | | Realtime data, graphical representation. |
| **Stimulus** | | Selecting Graphical representation. |
| **Response** | | Graphical view. |
| **Comments** | | The graphical view is about the patient's history. |

## 2.8 Heart condition history use-case:

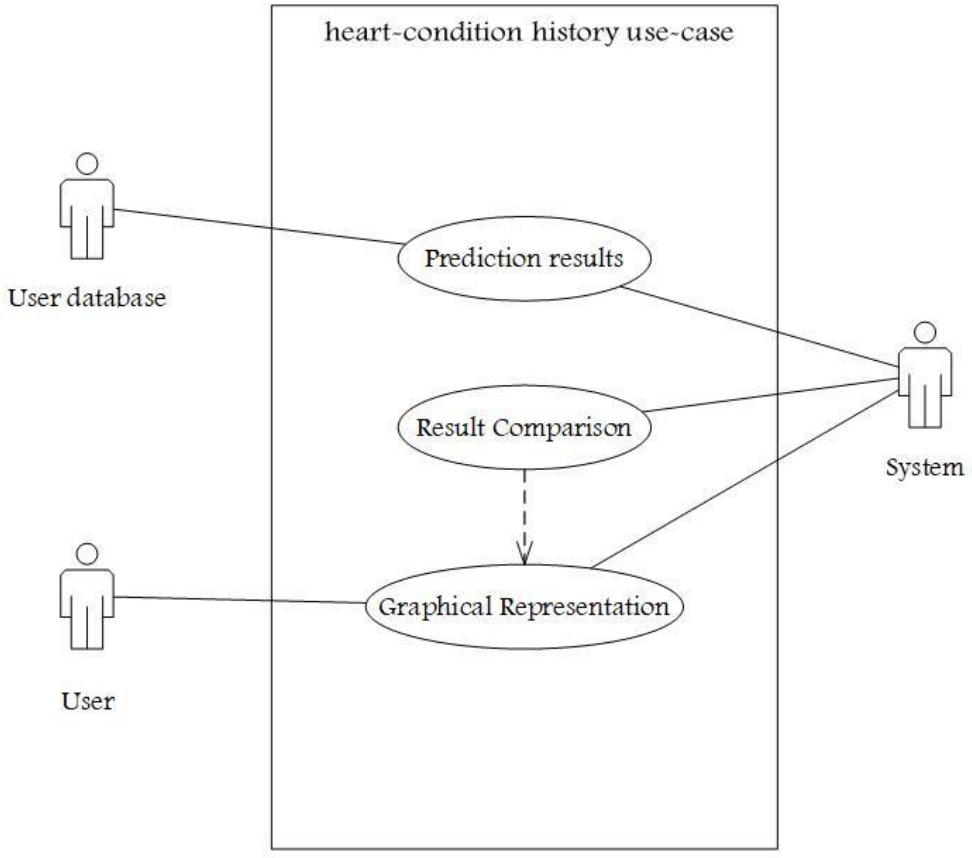



Figure 2.8 : Heart-condition comparison

## Tabular description

| Heart condition history use-case | | |
|---|---|---|
| **Actors** | | User, user database, system. |
| **Description** | | The user may have previous prediction results stored in the database. The user may want to compare the recent prediction result with the previous ones. Result comparison may provide with graphical representation. |
| **Data** | | Prediction result, Graphical representation. |
| **Stimulus** | | Selecting history option. |
| **Response** | | Compared graphical representation. |
| **Comments** | | User should predict their heart-condition at-least twice before using this feature. |

## 8.3 Activity diagram

### 8.3.1 Activity diagram for predictive model

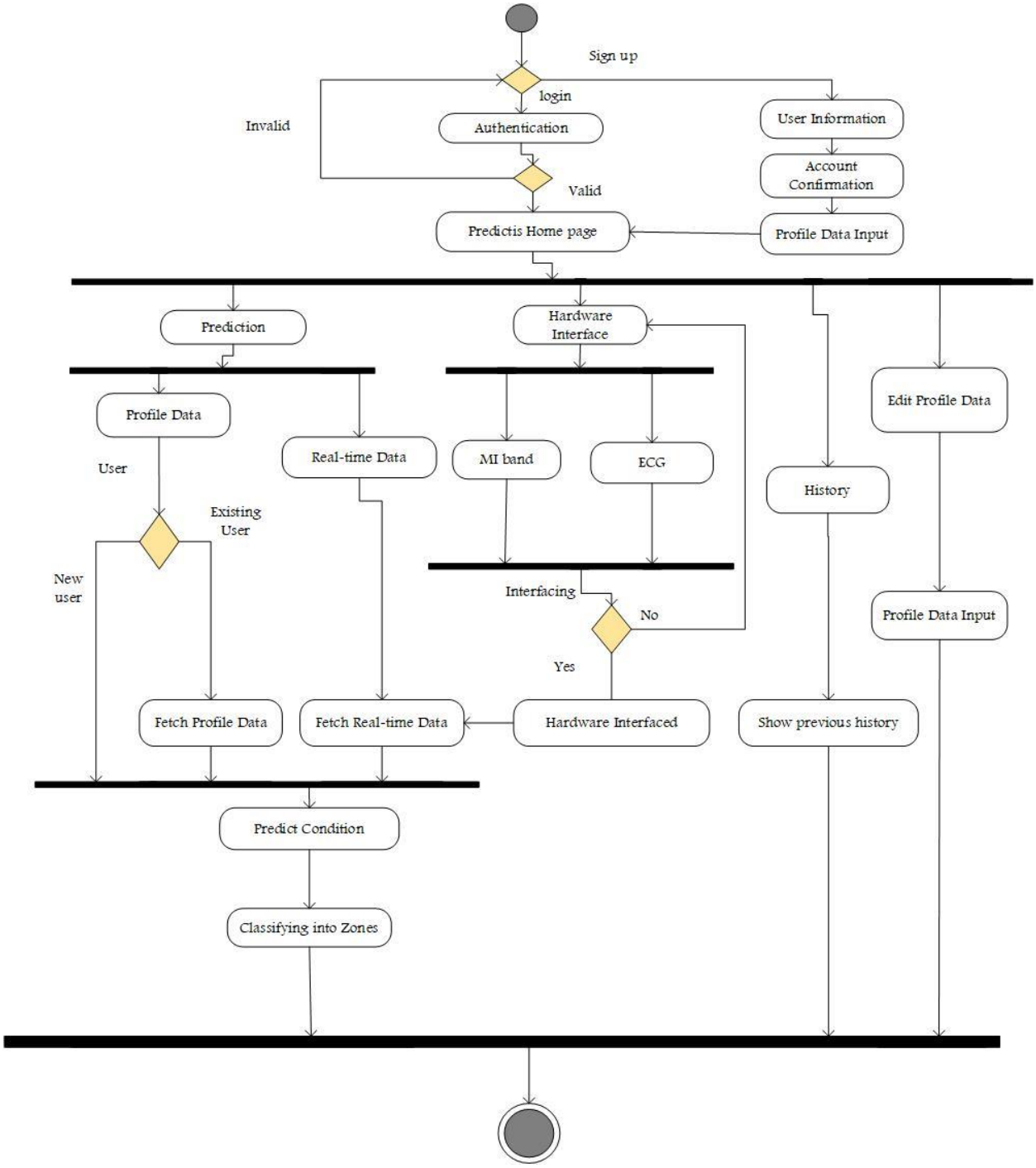



Figure 3.1: predictive model

## 8.3.2 Activity diagram for monitoring system

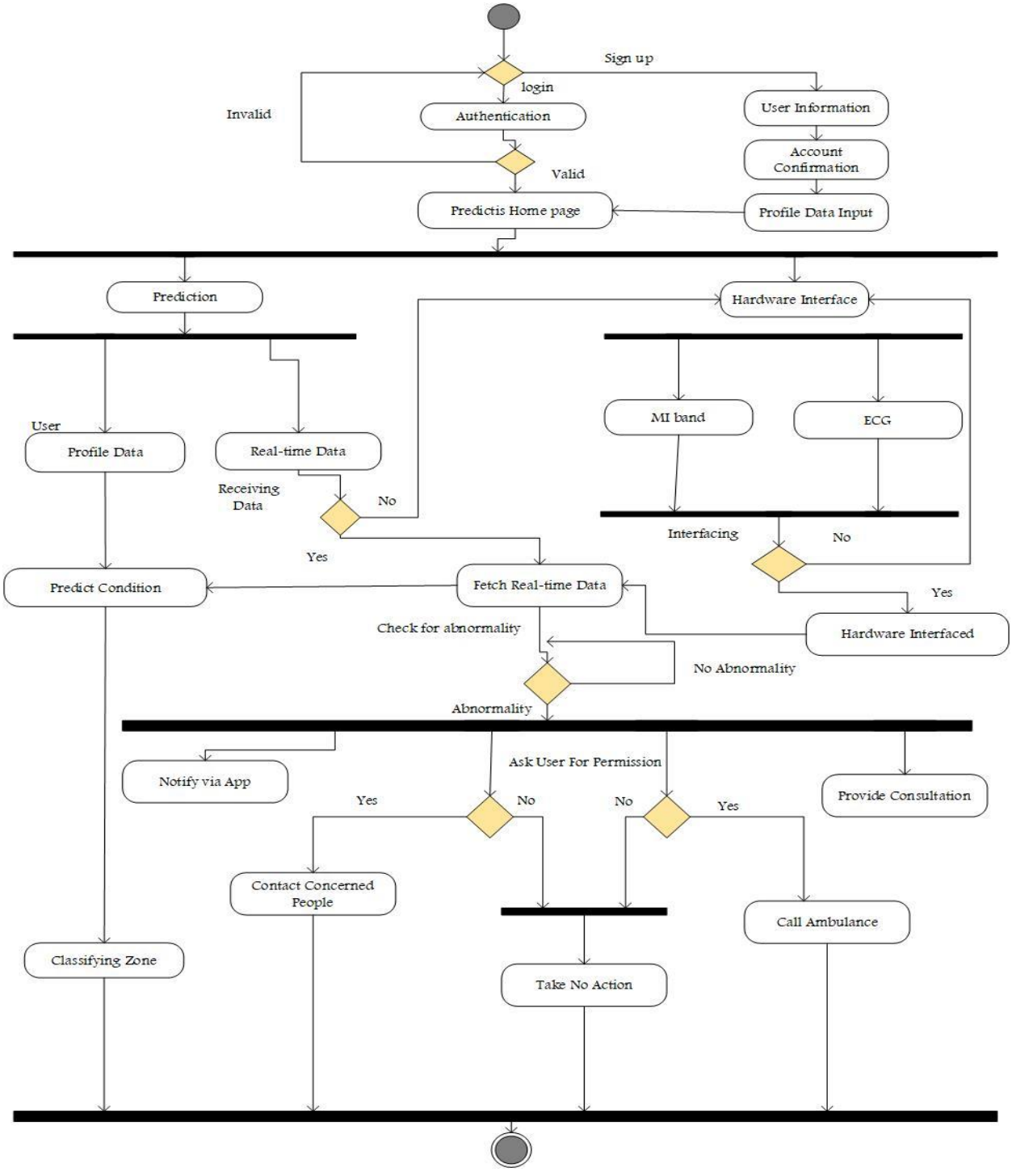



Figure 3.2: Monitoring system

## 8.4 Sequence diagram

### 8.4.1 User-Authentication sequence diagram

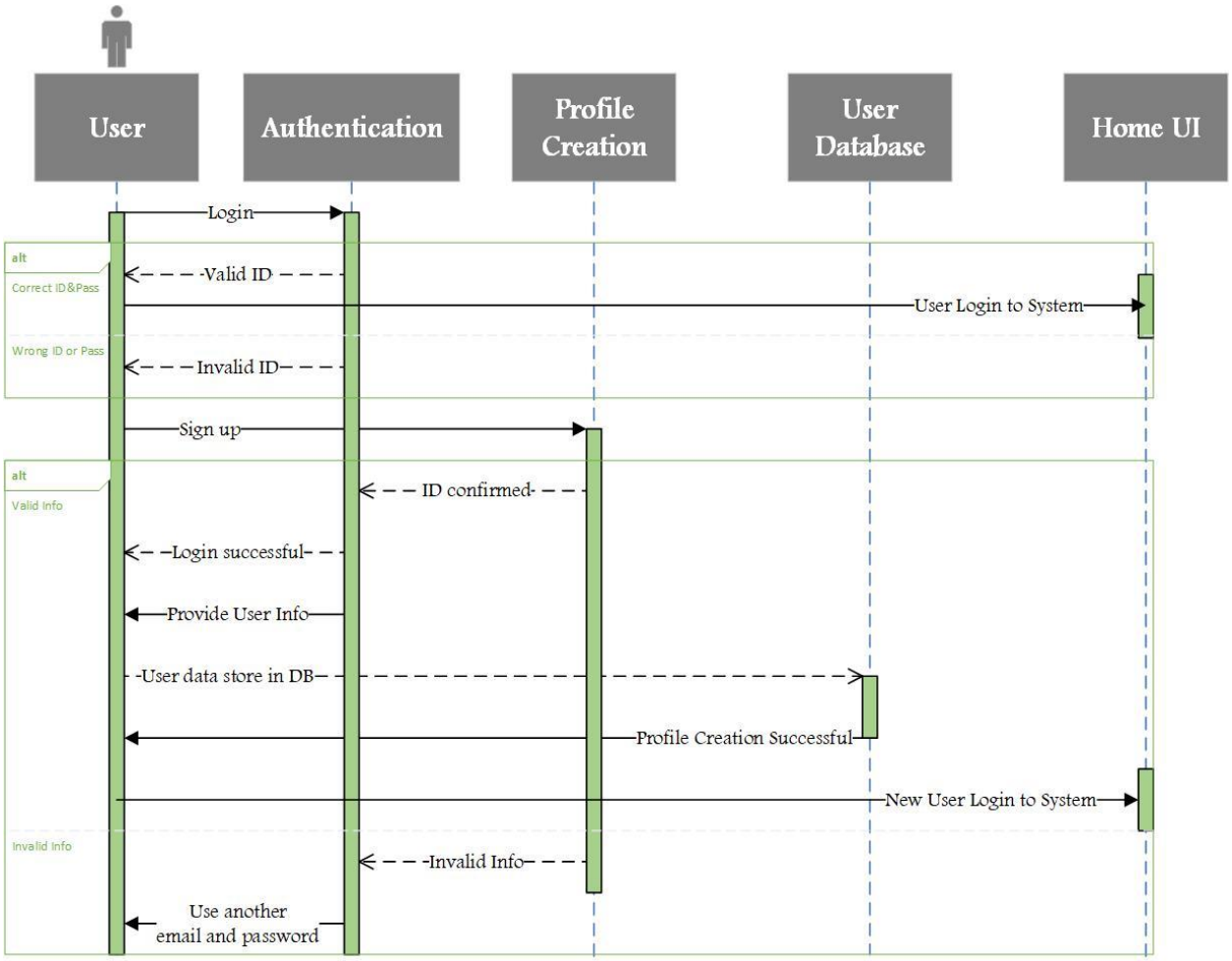



Figure 4.1: User-Authentication

### 8.4.2 Predictive-model sequence diagram

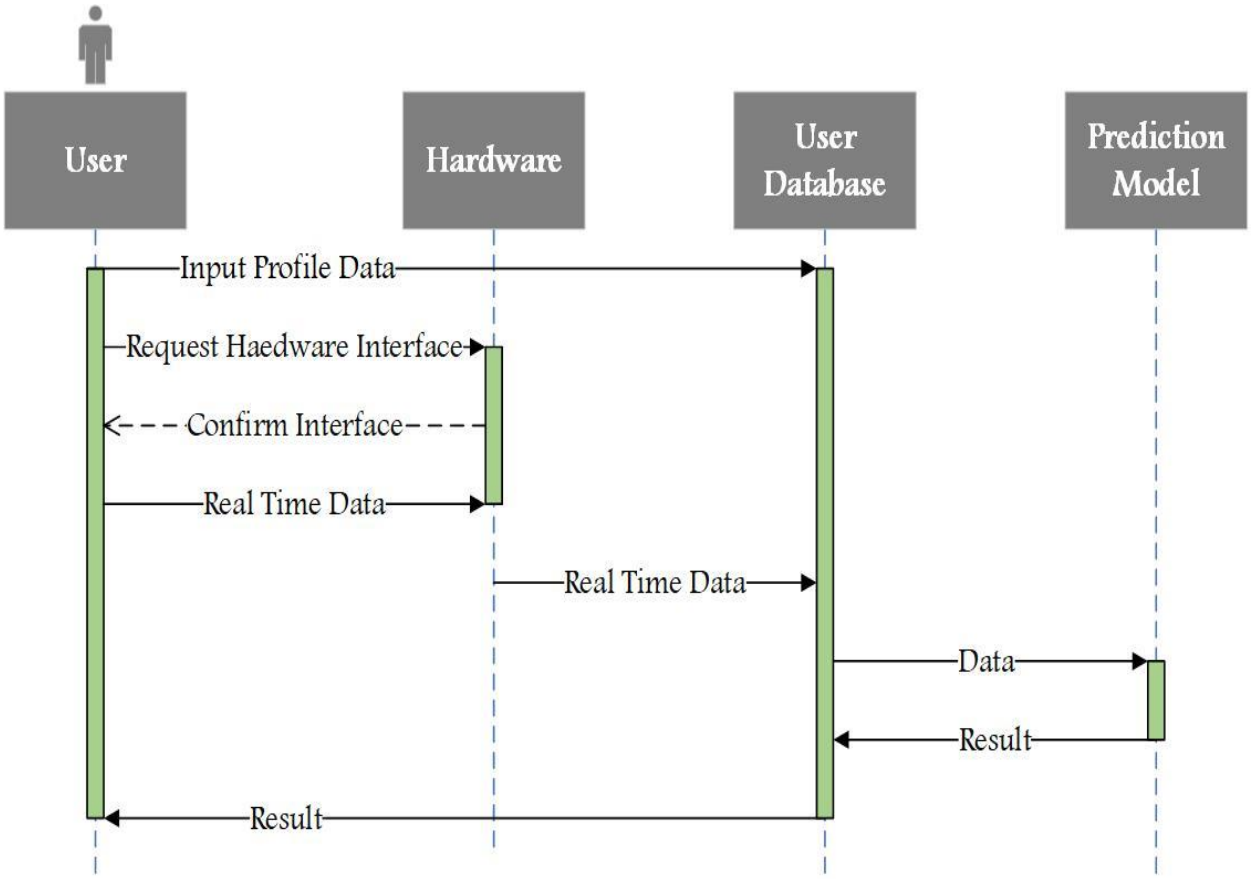



Figure 4.2 : Prediction

## 8.4.3 Heart-monitoring system sequence diagram

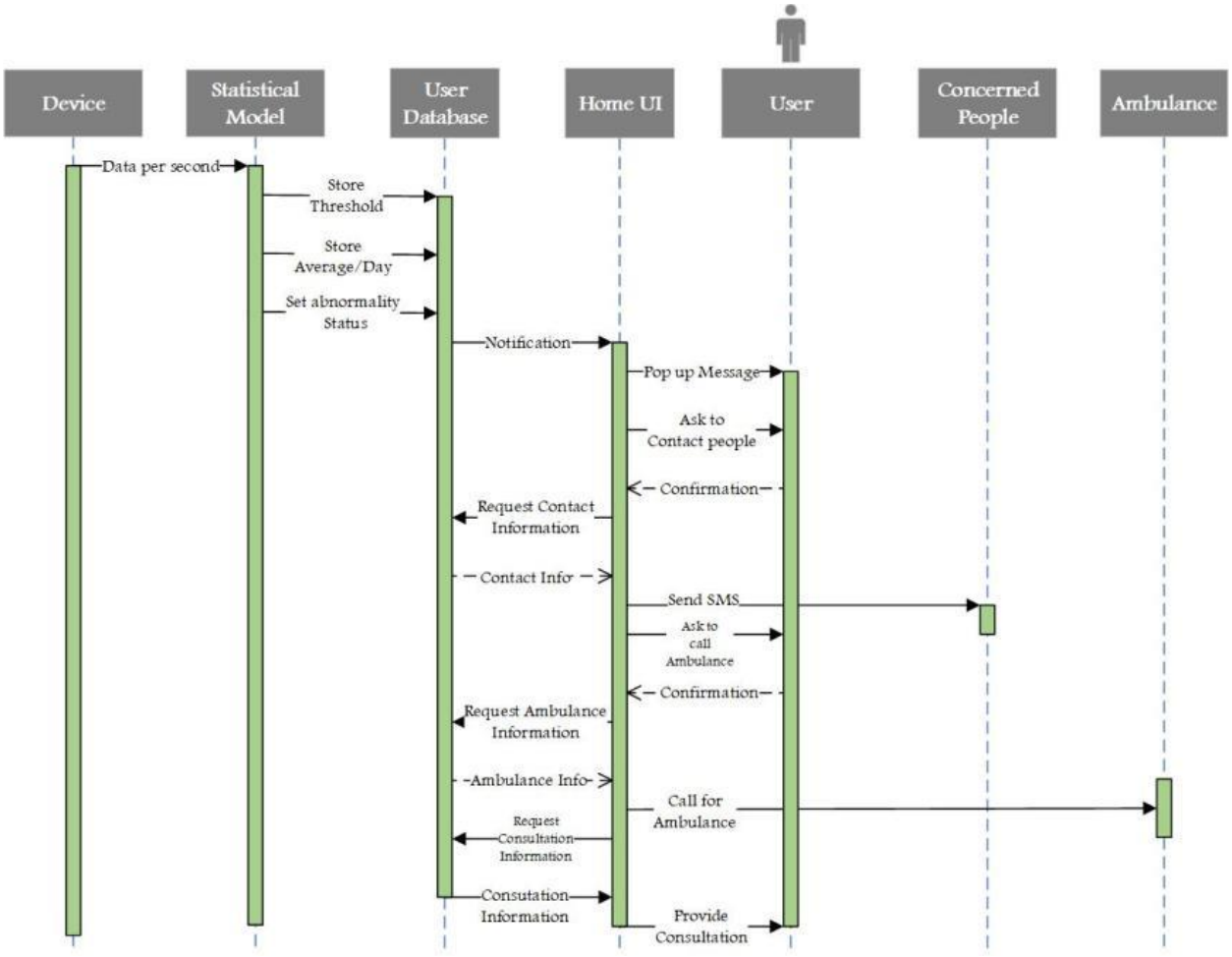



Figure 4.3 : Heart-monitoring

# 8.5 Data Flow Diagram

## 8.5.1 Zone Classification DFD

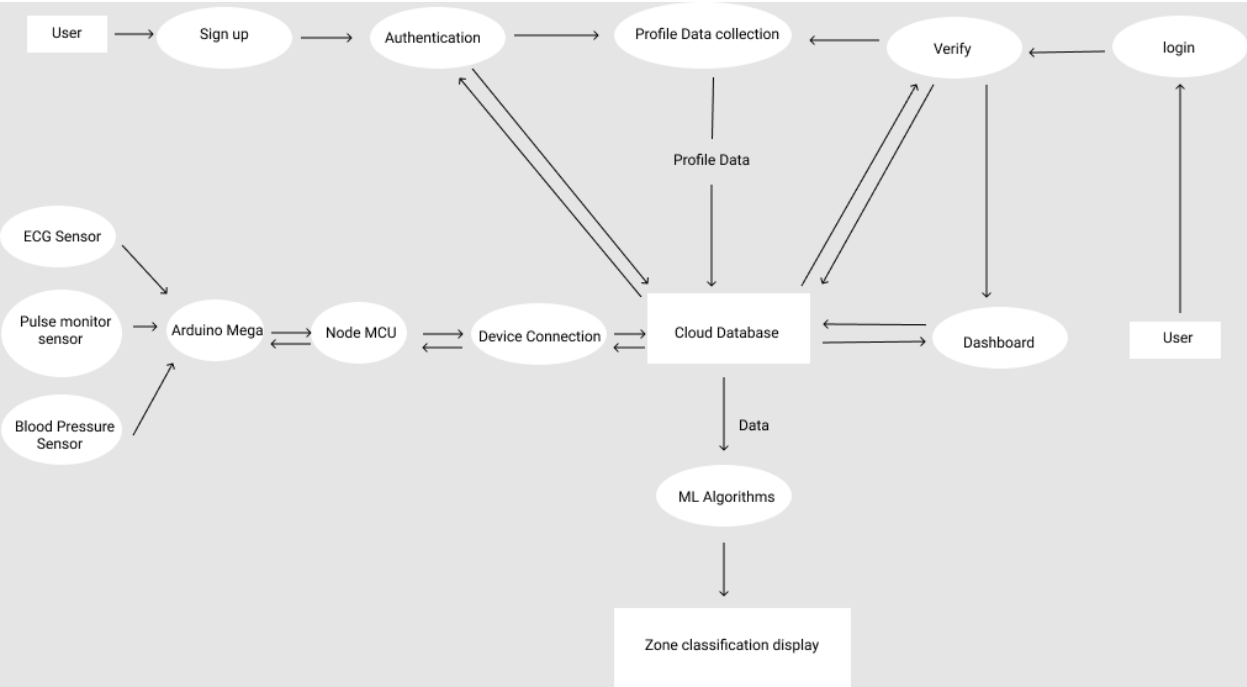



Figure 4.3 : Zone Classification DFD

### 8.5.2 Medical Consultaion DFD

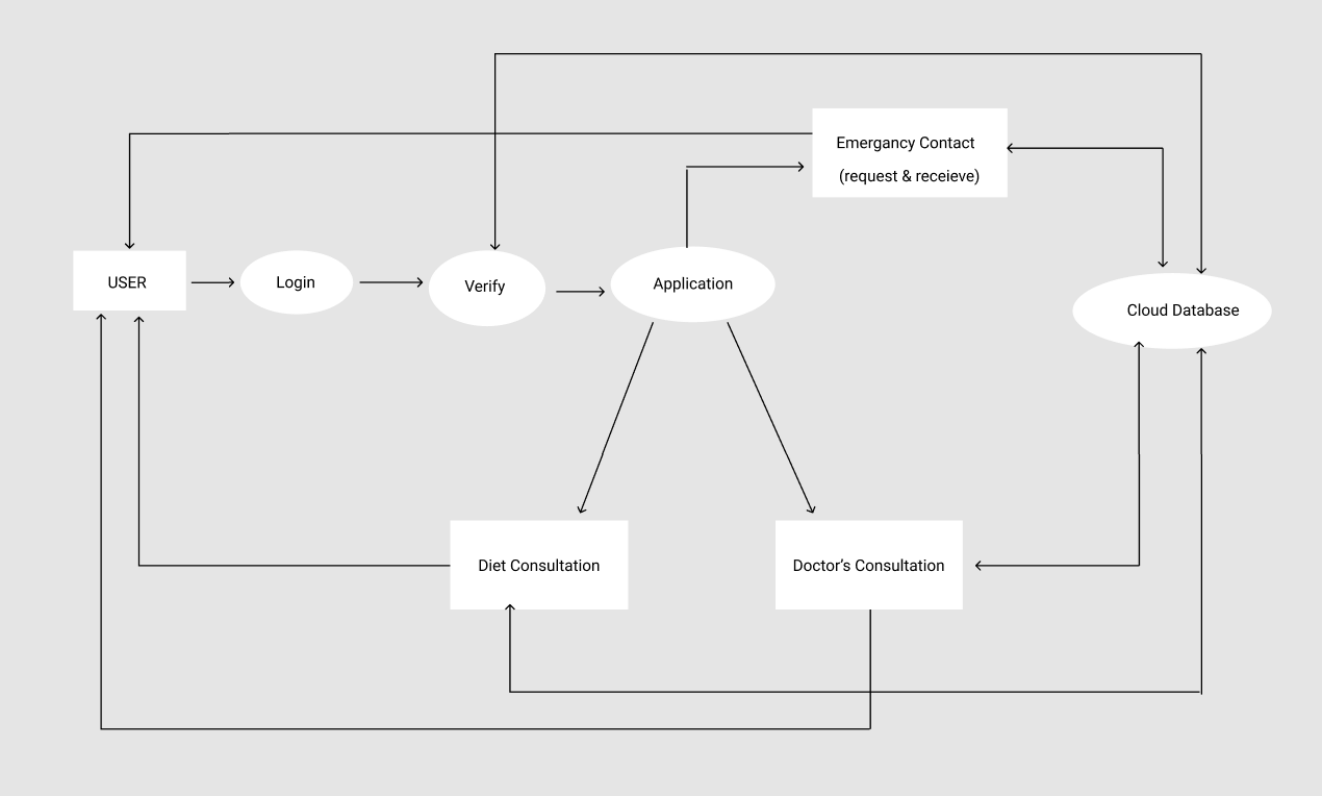



Figure 4.3: Medical Consultation DFD

## 9. User Characteristics

1. CVD conscious people: These are mainly the people who have potential risk of cardiovascular diseases or people with health consciousness. They are basically the users of our system. They interact with the system through providing some profile and Realtime data Using these data predictis provide all its features to them.

2. Doctor: Doctors will provide their consultation based on the risk zone classification of the users. Doctor will also interact with potential CVD patients in case of any emergencies through phone calls.

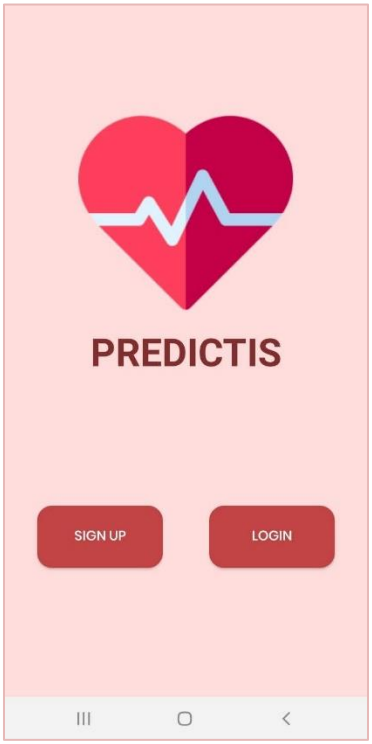
3. Close acquaintance: In case of any medical emergency or abnormal health condition patients can contact with their concerned family member or friend.

# 10. Specific Requirements

## 10.1 External Interfaces

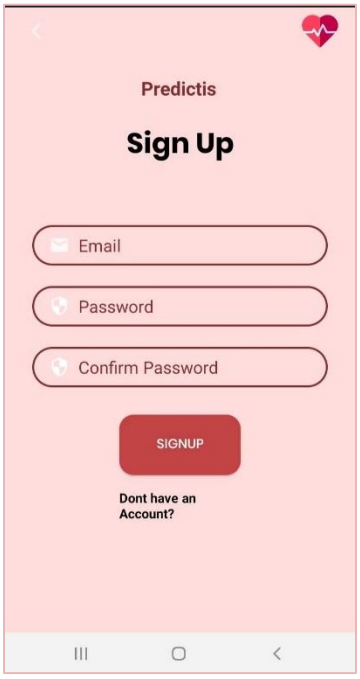
### 10.1.1 User Interface

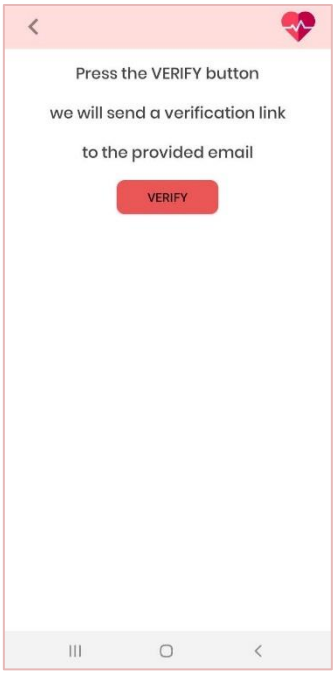
#### 10.1.1.1 Landing Page

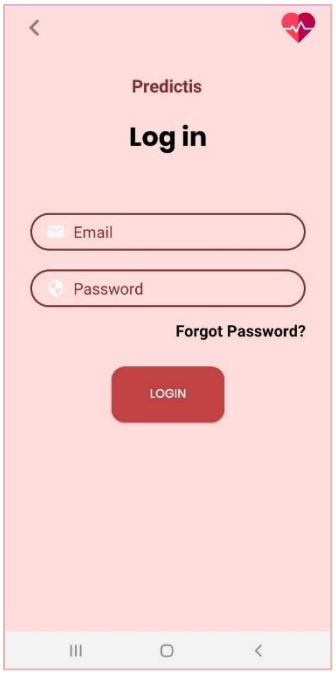



The application starts with a landing page. The user selects an option to either signup or login.

### 10.1.1.2 Authentication

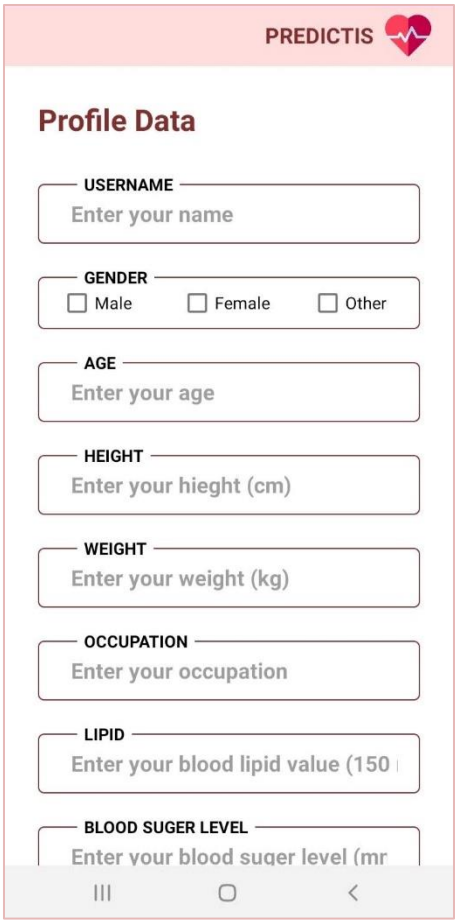


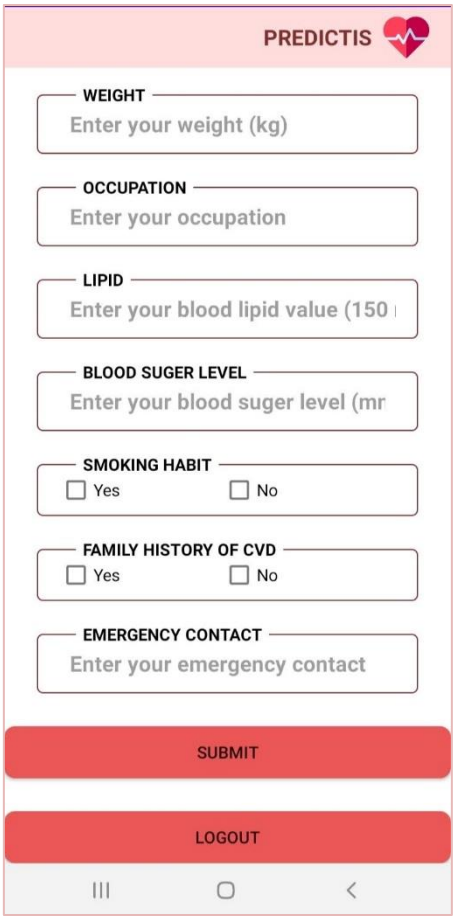




The signup and login pages receive email, password. The username and password is stored in the firebase. Authentication by email verification is done only once when a user creates a new account. User can login anytime in the application using these credentials by the login page.

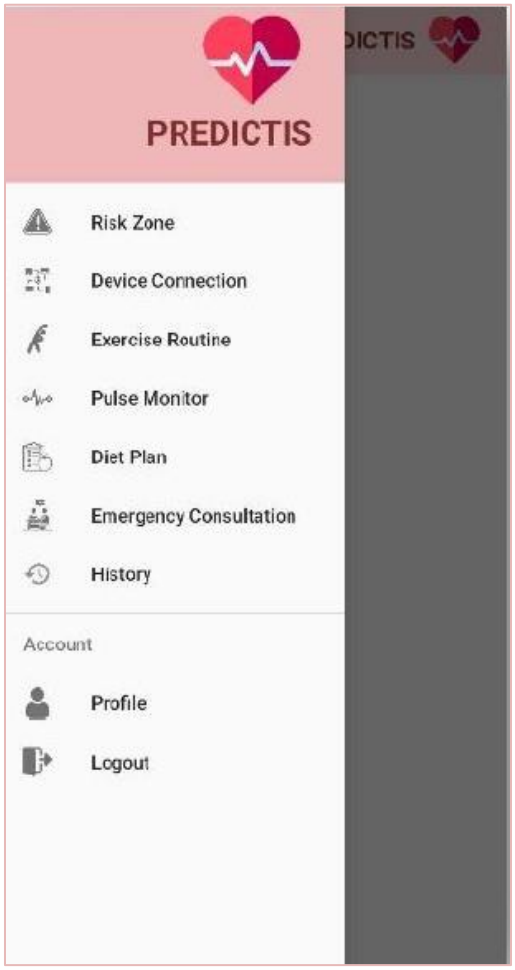
### 10.1.1.2 Profile Data Collection



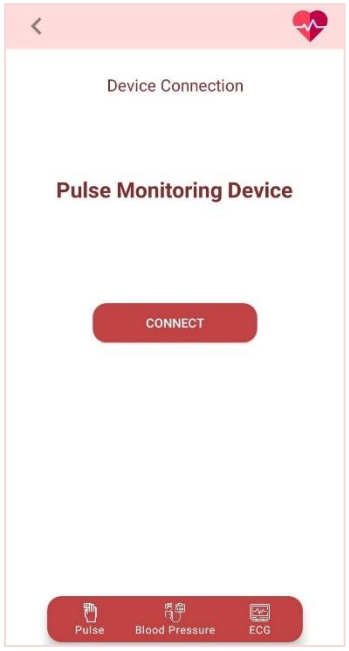

After signing up the user is asked to give some profile data which is stored in profile data database in firebase. These profile data are used to predict zone classification.

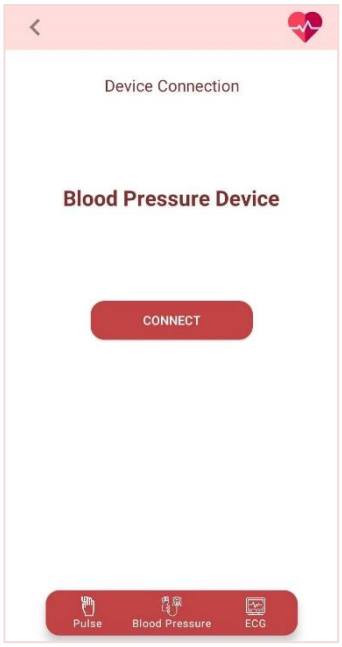
### 10.1.1.3 Menu-bar

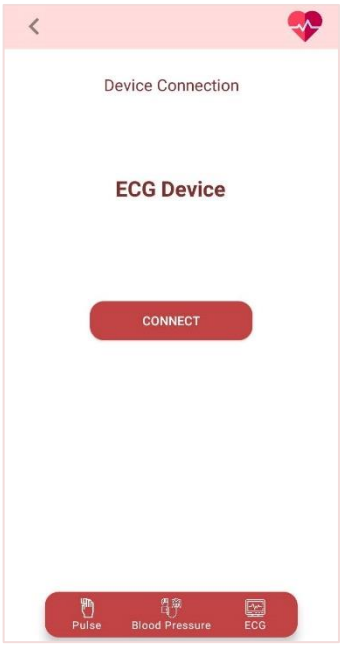



Application has a menu bar where user can select any option as shown in the picture of this page.

### 10.1.1.4 Device Connection

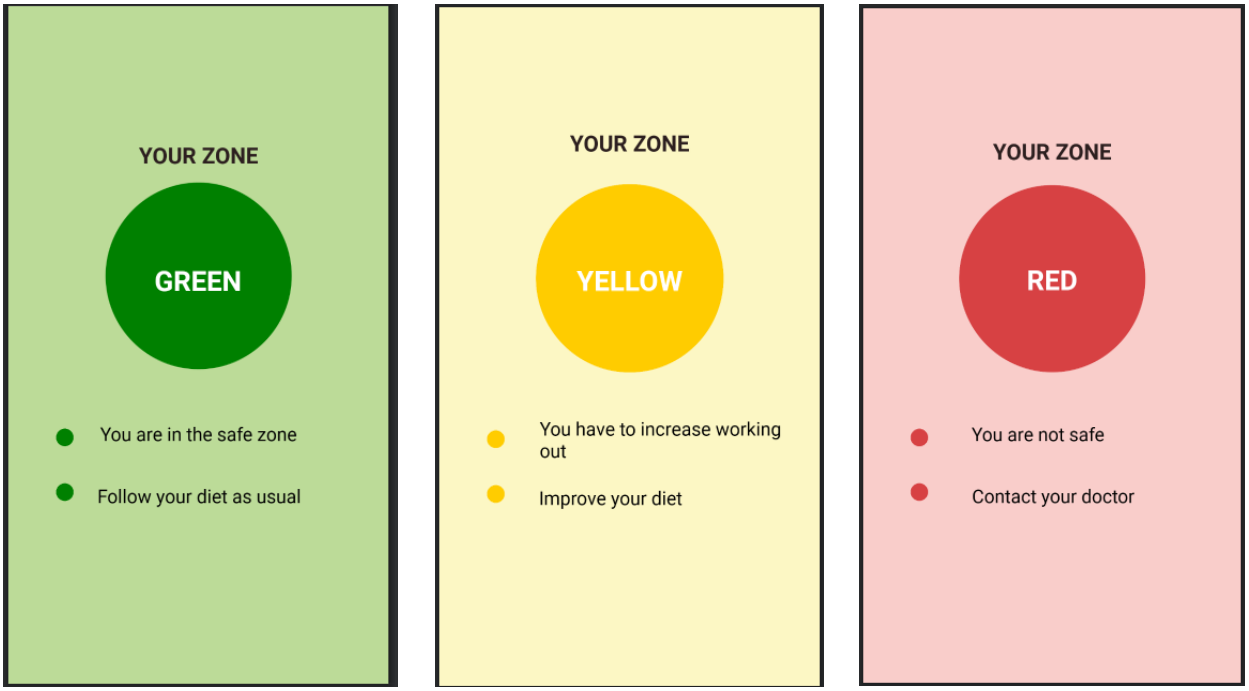


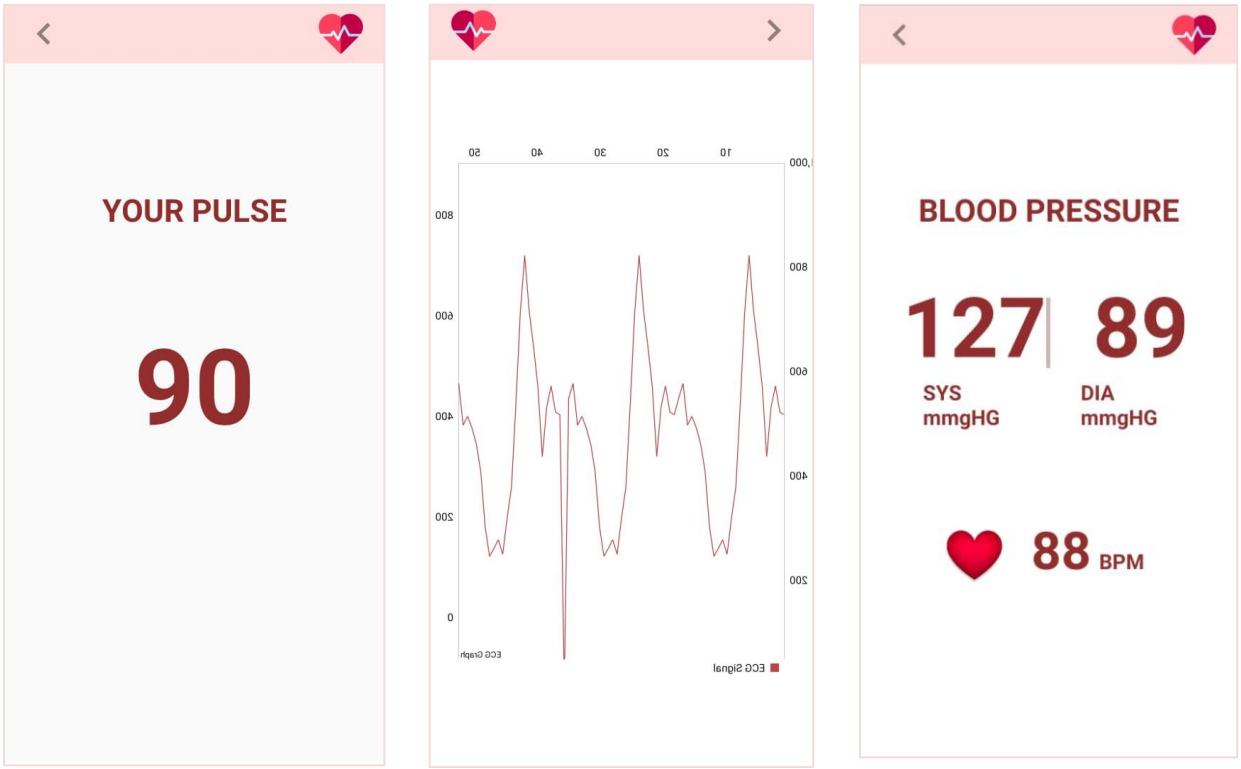

Device connection has three pages for connecting each devices(Pulse, Blood Pressure, ECG).

### 10.1.1.5 Zone Classification



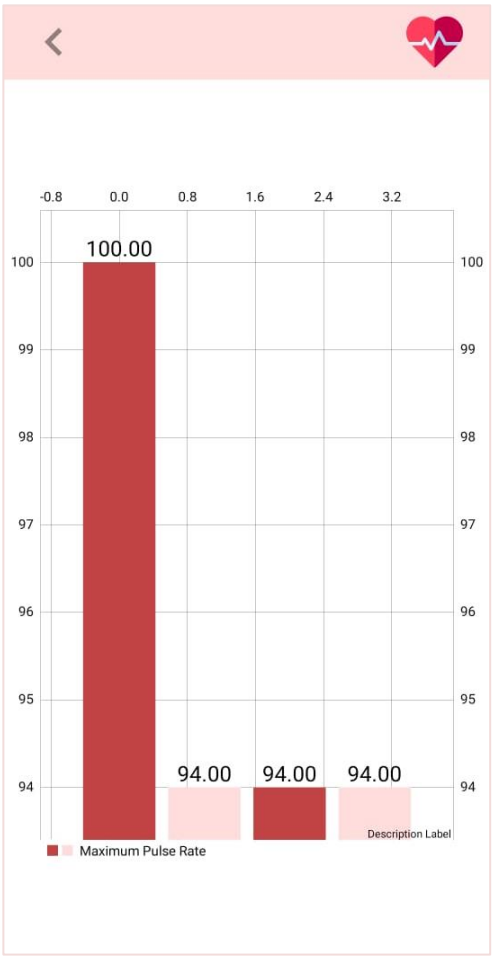

When users select risk zone option, they can see predicted result.

### 10.1.1.6 Health Monitoring



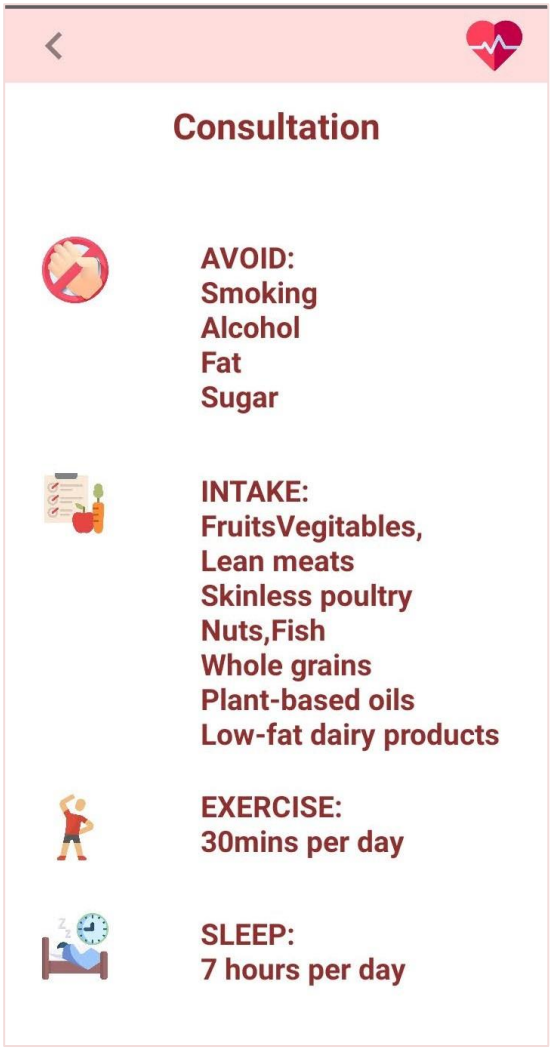

In health monitoring feature of app the user will be able to monitor Realtime pulse, ECG and BP in demonstrated pages.

### 10.1.1.7 Heart History



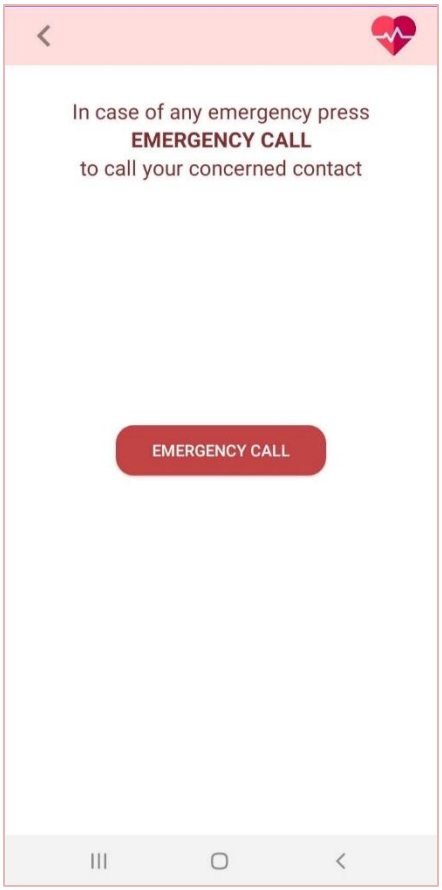

The heart history page will enable user to see the maximum achieved heart rate each time the prediction has been done with graphical representation.

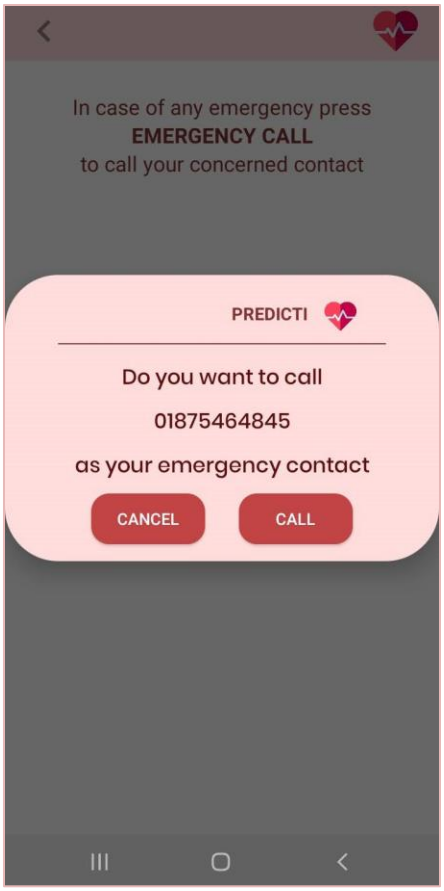
### 10.1.1.8 Medical Consultation




Medical consultation page contains suggestions for a healthy heart.

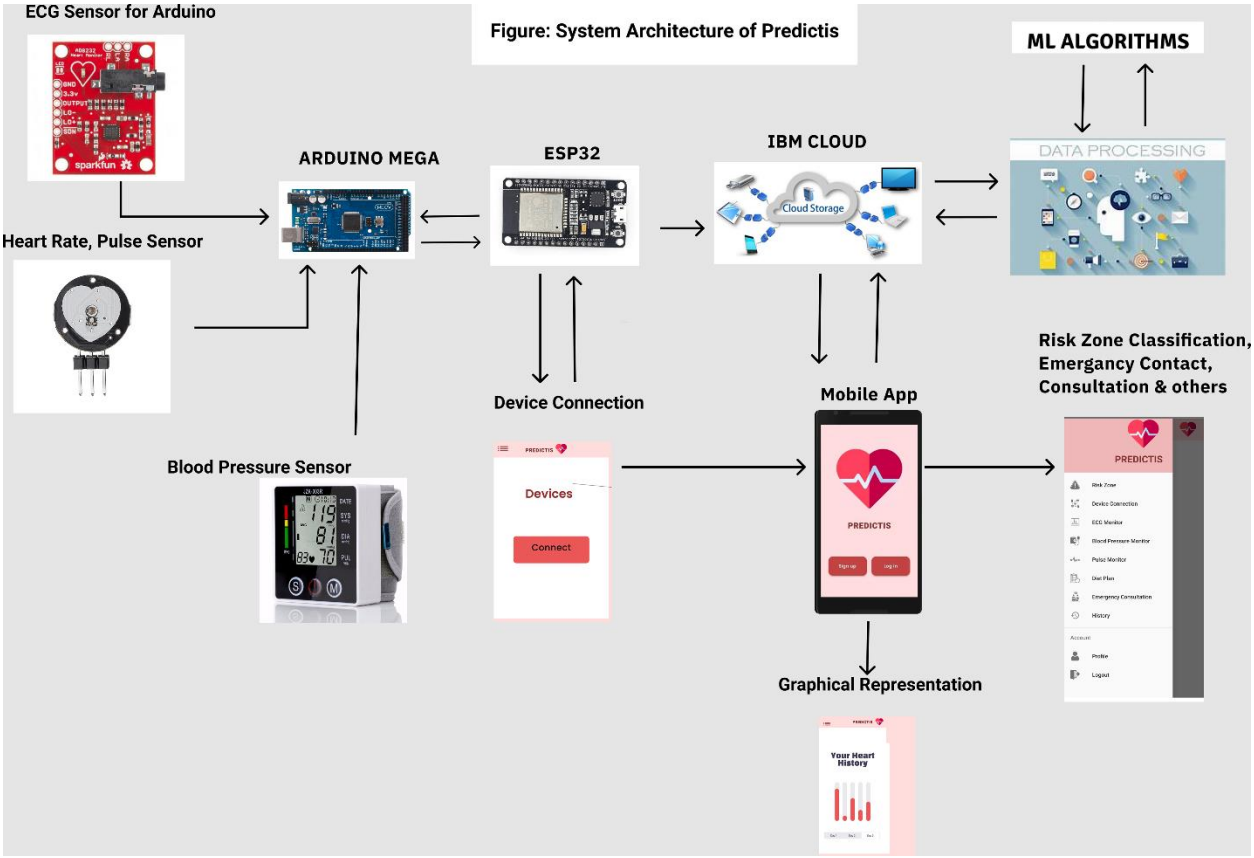
### 10.1.1.9 Emergency Contact




User will see pop up messages if he wats to contact any person or call ambulance when any abnormalities are detected and during monitoring.

## 10.1.2 Hardware Interface




**NodeMCU**: NodeMCU stands for Node Microcontroller Unit. It is an open-source Lua-based firmware that is designed for IoT (Internet of Things) applications. It can be simply defined as Arduino with built-in Wi-Fi module. With this we collect data from the sensor & send into the backend.

**ECG Sensor (AD8232)**: ECG is a method of collecting electrical signals generated by the heart. This allows us to understand the level of physiological arousal that someone is experiencing. With the help of NodeMCU, this is used to collect generated signals & used to measure the electrical activity of the heart.

**Pulse Sensor**: A pulse wave is the change in the volume of a blood vessel that occurs when the heart pumps blood, and a detector that monitors this volume change is called a pulse sensor. With the help of NodeMCU with this sensor & some calculation, we get the pulse rate data.

### 10.1.3 Software Interface

The whole purpose of front-end development is to make the whole system easily accessible and usable for all the stakeholders. When users sign up by authentication through email, they can log in by giving profile data which is stored in the database. Then they can see the dashboard. Cloud storage and firebase is used to keep the data. ECG and pulse monitor sensors are connected with the database through Wi-Fi module and the application fetches the data. The real-time data is collected from the sensors and it stores in the real- time database. After the system will fetch the real time user profile data and real time data which will be used to predict the zone classification (green for healthy heart, yellow for moderate risk, red for high risk of heart disease).

# 11. System Evolution

Following are some possible changes or requirements due to hardware evolution and changing user needs that may occur in future:

- ✓ It will be able to upgrade its monitoring functionalities. In the future version of Predictis there will be more reliable AI program so that Predictis is able to monitor the patient more effectively. This will make Predictis quite accurate than this version.
- ✓ The security of the network between the hardware devices will be improved. The connection will be done using Bluetooth. Sometimes data breaches happen in the Bluetooth network. Some security algorithms might be applied to prevent this problem.
- ✓ It will be able to detect smoking activities. Some functionalities will be applied to the sensors to detect and control smoking habits of the users.
- ✓ It will be able to detect if the user is doing exercise. Predictis will be able to detect when the user is doing exercise. It may give alarm to notify user about his exercise time if the user does not maintain the routine and minimum exercise time.
- ✓ Predictis will be able to give appointment facilities with doctors. It will be able to provide the list of available doctors in the nearby hospitals. It may also provide available time slot for a particular doctor. So that user will be able to make appointment in times of need.

# 12. Appendix

## 12.1 Appendix A

This section contains the Q&A session with a specialist in medicine.

**Q 1: What type of attributes does a doctor need to diagnose heart disease?**

A 1: “Basically exertional chest pain, BMI, family history of heart disease, smoking or alcohol consumption, lipid profile, blood sugar, variation in heart rate and blood pressure these are the primary factor. But doctors also ask for the information about patients existing history of diseases, occupation, abnormal pulse rate (drop beat).”-he replied.

**Q 2: If a person is predicted to be in red zone, is it possible for him to improve his condition?**

A 2: “Yes”-he answered and also added that “If that person changes his lifestyle in a proper manner, he can improve his heart condition. He has to be careful about his diet plan as well and do regular exercise.”

**Q 3: Is abnormality of BP and heart rate important for heart disease prediction?**

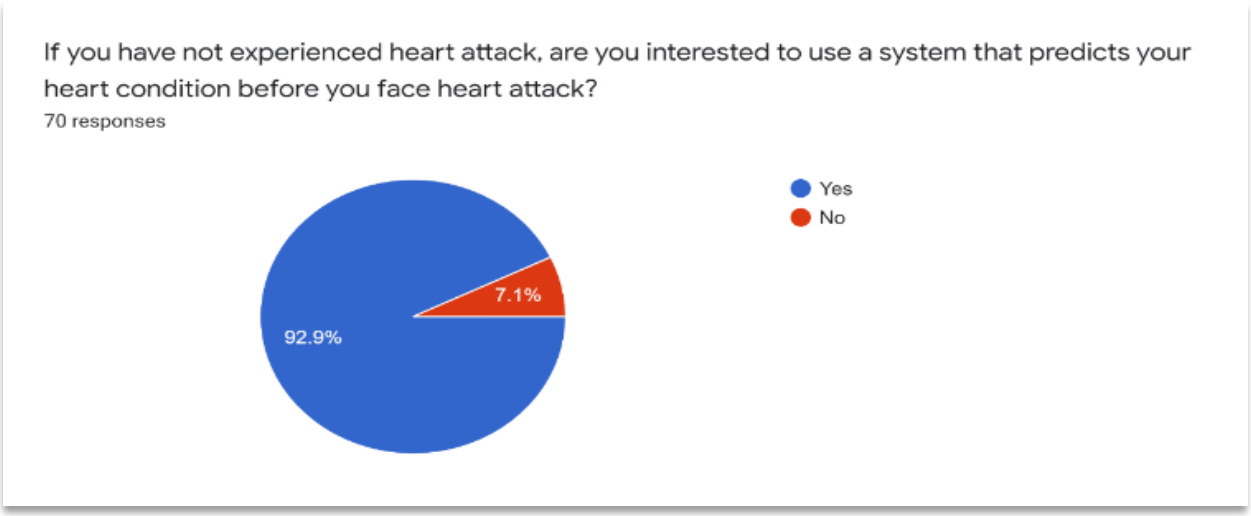
A 3: "Yes."-he answered and added that “Pulse-rate or heart-rate is not as big factor as BP while predicting ischemic heart disease”.

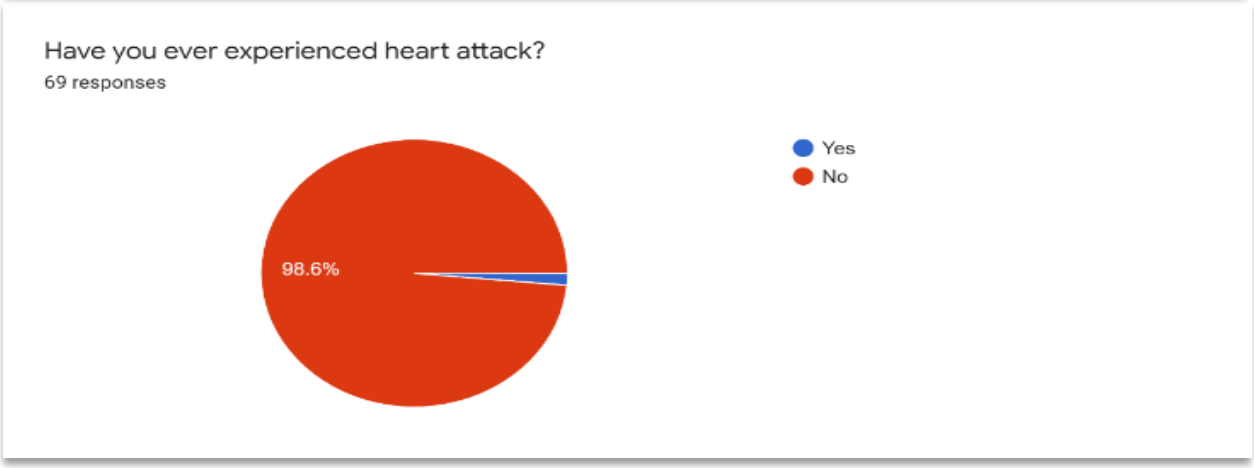
**Q 4: Is our system helpful for a doctor?**

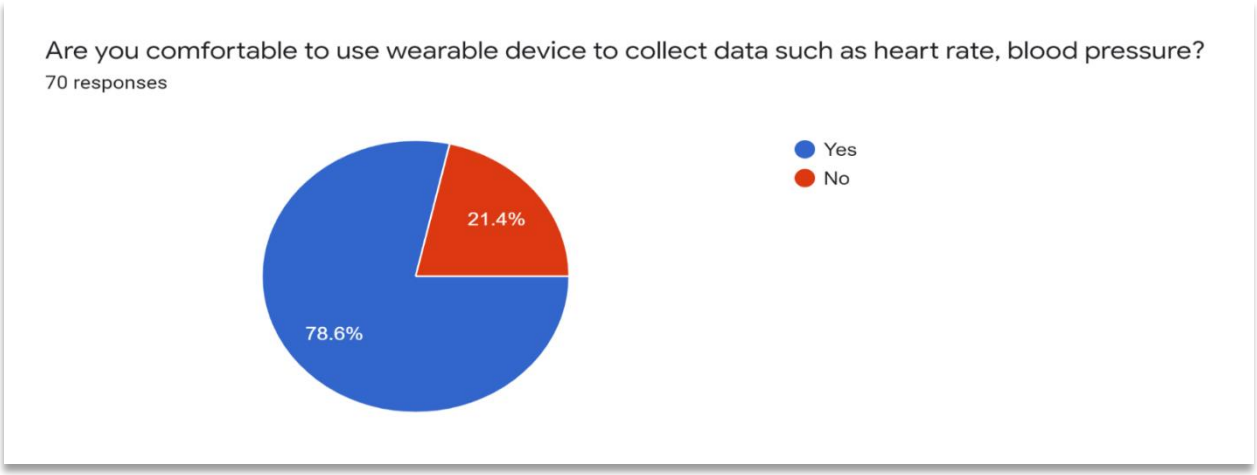
A 4: "Not necessarily”-he said. He further added that “This application will not help the doctors as they can examine the patients and detect if they have heart disease or not but it will help to make people conscious about their heath and encourage them to take doctor's consultation."

## 12.2 Appendix B

### 10.2.1 Questions and responses of the conducted survey

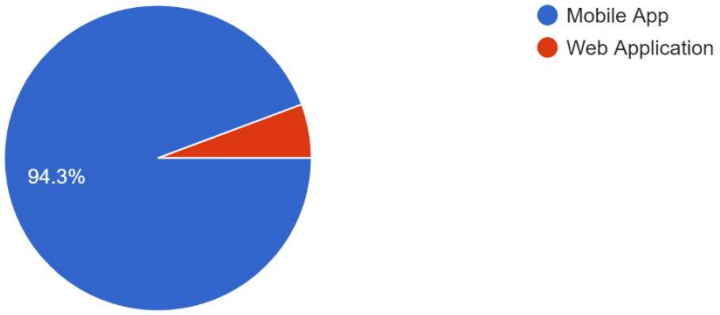


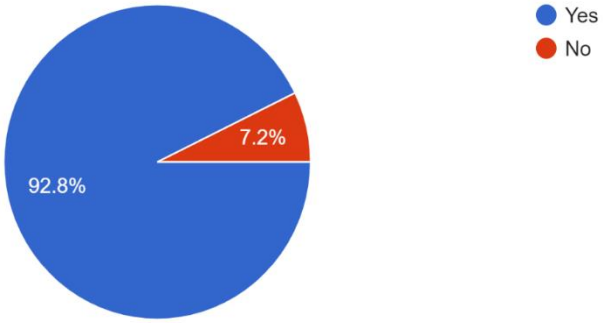
Which platform will be suitable for using such system?

70 responses



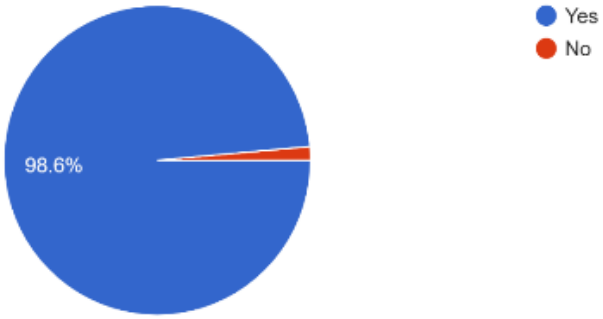

Do you want a continuous monitoring system for your heart?

69 responses




Do you want the system to inform someone in case of emergency?(Sending SMS to relatives, call for an ambulance)

70 responses



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