Health AI: A Personal Healthcare Companion

Software Requirements Specification

Course Name: I.D.P./ Capstone Project

Course Code: CSE-360

Program: CSE-20

Group No: B3

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Table of Contents

1. Preface

Healthcare is considered one of the fundamental human rights. But still, it is seen that healthcare is not always available for everyone. Most of the time it is hard to find suitable doctor's contact information for a particular illness. Sometimes it is hard to detect if a person is seriously ill or if it's just a casual illness. Knowing the seriousness of the illness is very significant. Most times people neglect their medical situation and then suffer from major illnesses. Some people don't like to visit doctors/medical checkups as they find it a waste of time and energy. For some people, it is too costly to visit a doctor for a simple illness. This is where an AI-based healthcare system can help. AI can detect illness by analyzing a few health metrics and symptoms. Based on the detected illness, AI can suggest basic instructions for the cure and the appropriate doctor's contact information.

Moreover, most people don't have emergency ambulance numbers saved in their contacts. In case of an emergency, people get panicked. A smart application system can help people to find the closest hospital for an ambulance in this scenario.

2. Introduction

2.1 Purpose

"Health AI" is a personal healthcare companion application system. There will also be a hardware device for collecting real-time health metrics. This app will be able to analyze these data and it will talk with the patient to understand the symptoms. By analyzing, it will predict the illness type. According to WHO (2010), only about 3% of the total GDP is spent on healthcare in Bangladesh. Thus, many people cannot afford to go to doctors for help. This app will be able to suggest basic instructions for the cure based on the detected illness. It will also suggest contact information for relevant doctors. For emergencies, this app will have a built-in emergency SOS button. The SOS button will send messages to the closest contacts and the nearest hospital for the ambulance.

2.2 Intended Audience

This application system is intended for almost everyone. Mostly it will be helpful for the people living in remote areas who don't have access to fundamental healthcare. Also, this app will be beneficial for middle-class people as this app will provide them with free healthcare support. This app will help a patient to find suitable doctors. So, doctors are also benefited.

2.3 Scope

This healthcare system is mainly a cloud-based mobile application. An Internet connection is required for this app. There will be a hardware device along with various sensors to collect various health metrics such as blood pressure, heart rate, oxygen level, and temperature. Based on the input data and talking with the patient, the app will be able to detect the type and seriousness of some common illnesses. It will provide some general instructions for the cure and suggest relevant doctors in that field. The SOS service will send auto messages to the nearest hospital and to close contacts.

3. Glossary

A.I.: Artificial Intelligence refers to systems that mimic human intelligence to perform a task and iteratively improve themselves.

Arduino: Arduino is an open-source electronics platform based on hardware and software.

Cloud-based application: Cloud-based applications refers to applications that run on shared computing resources via the internet.

Database: A database is a structured set of data held in a computer.

Healthcare: Healthcare is the collection of efforts made to maintain physical, mental, and emotional well-being.

ML: Machine learning is a branch of AI and computer science that focuses on the use of data and algorithms to imitate humans.

N.L.P.: Natural language processing is a branch of AI that helps computers to understand human text and speech.

Oximeter: An oximeter is a device to measure oxygen level of human body.

SOS: SOS is used to call for help during an emergency.

4. Requirements discovery

4.1 Literature Review:

A good number of articles, journals, conferences, and research papers were recited, and some important viewpoints were observed. Based on health, there is a lot of research, projects, documents & applications. But there are only a few such documents or applications which can act like a personal doctor or a healthcare assistant. The existing applications have a lot of limitations too. One of these apps is "Health Mug" which is based on AI analysis of a patient's symptoms which suggests doctors. But this app cannot suggest any physical activities to the patient. Another app is "Life Plus Bangladesh" which is an online doctor appointment booking app and a medicine shop giving telemedicine & ambulance services. There is no app on the market that can talk with the patient to analyze the symptoms and give predictions on the patient's health problems along with giving valuable suggestions. There is no existing system that takes real-time diagnostic values for analysis purposes. So, it is found from the reviews that users need a fully functional medical one-stop solution that can do all these jobs easily.

Some important articles:

Reference	**Objectives**	**Outcomes**	**Methodology**
[10.1]	To make a system that can preserve patients' previous medical records with a view to helping doctors to get an overview of the patient.	An android application that can store the medical record history of a user so that it can be analyzed in the future.	• Patient and doctor both will register with personal details. • A unique id will be generated for a patient. • This id will be used in the future by doctors to study the medical history of the patient within the app.
[10.2]	To describe an	A chat-bot	• User message is processed

	AI-based chat-bot application that delivers instructions and support to women and mothers.	system that can interact with pregnant women and mothers to provide help and support.	through two modules. • Intent classification module checks the user input message and identifies the purpose. • Entity recognition module recognizes the user message structure and extracts main keywords. • Response generator module provides a useful response.
[10.3]	To make a healthcare chat-bot using AI that will be able to detect illness and provide information on that basis.	A chat-bot that can detect illness and provide information regarding the detected illness.	• Chat-bot processes input data using algorithms. • It understands the input using the previous database of symptoms and algorithms. • Suggests necessary measures and doctors' details near the user.
[10.4]	To build a chatbot that communicates with the user and can give treatments for various common diseases based on the symptoms using the appropriate algorithm and Recurrent Neural Network algorithm.	Brings healthcare available to everyone and endure early detection of diseases at home.	• The voice from the user is recorded using a microphone and the voice is converted to text using Google API. • The unstructured output of Google API will be taken as input and info is extracted using the Bag of Words method. • Two types of response systems are developed. • General Response is created by training the chatbot using Seq2Seq model. • Medical Assistant: Apriori algorithm is used to predict the disease. • Google text to Speech API is used to convert the response text to speech.
[10.5]	To create an alternative to traditional medical	A platform where the users can interact and track their health	• At first while registering, the user must provide some personal details which will be kept confidential.

	checkups in hospitals with a medical chat-bot companion	status and get encouraged to remain healthy.	• The admin can view all the user details and monitor users. • User can communicate and the words are identified to detect symptoms using NLP. • The chat-bot is trained with the symptoms dataset and can identify the disease using the KNN algorithm. • Finally, the chat-bot recommends the required treatment for the identified disease.

4.2 Interview:

Two interviews regarding healthcare availability were conducted. From conductions of these interviews, it is obvious that healthcare is still not easily accessible for all people. It's hard to find relevant doctor's contact info for a particular illness most of the time.

Moreover, it is even harder to figure out which disease a person is suffering from without going for a formal checkup. Many people don't want to go for a formal checkup as they see it as a waste of energy. Instead, they ask their friends/family for suggestions which is quite risky as healthcare is a sensitive issue.

4.3 Survey:

Google form was used to interact directly with the targeted users to know their requirements. The results of this survey helped to detect and discover requirements. The questions can be found from the appendix section.

From the results of the survey, it is noticed that some healthcare-based problems of the participants can be solved by our system. These important points are given bellow

- About half of the participants think healthcare services are not always available to them and about 25% think that healthcare services are never available to them any time they want. So, an AI-based healthcare and consultancy app is helpful for our participants.
- About 75% of the participants search on the internet for finding the solution to their medical problems. 60% of people think the results from the internet are somehow (50%) acceptable. So, an ai based system can be a solution for them to find their queries.
- Only 1% of the participants check their blood pressure, heart rate, or oxygen level regularly whereas above 90% of participants agree that it is important to track these

records continuously. This proposed system will be handy for keeping track of these records easily anywhere.

- In case of emergency, about 40% of people cannot remain calm, and, they do not have any doctor's or ambulance's contact number saved. This requirement can be fulfilled by the proposed system's SOS feature.
- About 40% of our participants are familiar with fitness or medical apps. So, it will not be harder for people to get used to our system. Most of the available systems don't fulfill all the requirements of participants. This proposed app can solve this problem for them by being a one-stop solution.

5. User Requirements

5.1 The system shall understand human language and various health metrics.
5.2 The system shall detect illness/disease.
5.3 The system shall suggest relevant general instructions for the cure.
5.4 The system shall suggest relevant doctors.
5.5 The system shall have an emergency ambulance/contact system.

6. System Architecture

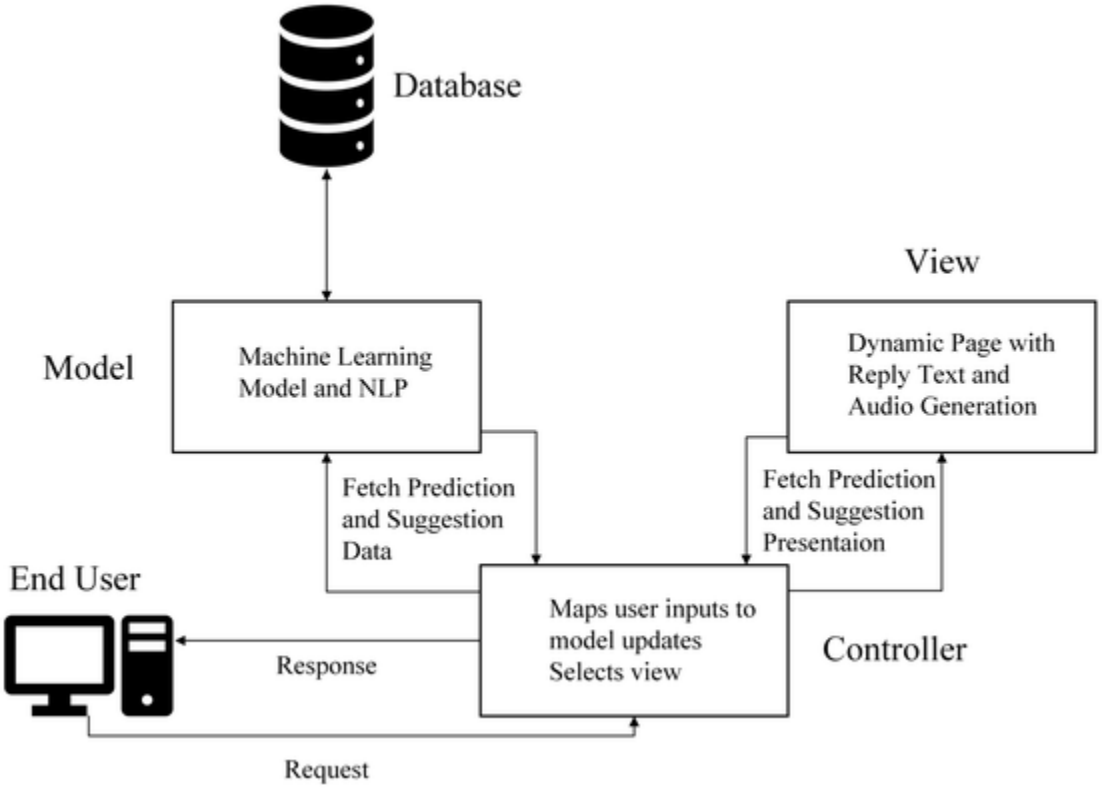


Figure 1: System Architecture

Description:

An android application will be used as a user interface and an integrated handheld device will be used to take various health metrics.

There will be an identity management system to identify a particular user. Also, a hardware and an application management system will be used to coordinate the handheld device and the android application.

The main application functionalities will be illness prediction, doctor suggestion, cure suggestion and emergency message system.

The app will run on a cloud service and a database will be maintained.

7. System Requirement Specification

7.1 System Requirements:

7.1.1 Understanding human language and health metrics

7.1.1.1 The system shall take human voice/text as input via mobile phone to interpret the meaning and understand the symptoms.

7.1.1.2 The system shall use a blood pressure machine to measure blood pressure and interpret the significance of the received value.

7.1.1.3 The system shall use a finger oximeter heart rate module to measure oxygen level along with heart rate and interpret the significance of the received value.

7.1.1.4 The system shall use a contactless temperature sensor module for Arduino to measure temperature and interpret the significance of the received value.

7.1.2 Detecting sickness/illness

7.1.2.1 The system shall process all the provided information using machine learning and the database.

7.1.2.2 The system shall give a prediction about the illness/disease type with 99% accuracy.

7.1.2.3 The system shall give predictions via text as well as voice output.

7.1.3 Suggesting Cure

7.1.3.1 The system shall suggest various general instructions for the cure based on the predicted disease/illness by processing the database and machine learning model.

7.1.3.2 Instructions shall be given via text as well as voice output.

7.1.4 Suggesting Doctors

7.1.4.1 The system shall have a database of available doctors' contact information.

7.1.4.2 Based on predicted disease and doctors' expertise, the system shall suggest various doctors with contact information.

7.1.5 Emergency Contact

7.1.5.1 The system shall have an emergency button.

7.1.5.2 If the button is pressed, an emergency message is sent to the nearest ambulance.

7.1.5.3 Also, an emergency help message will be sent to predetermined close contacts.

7.2 Requirements Classification

System Requirements	Functional	Non-Functional
Voice/text input	✓	✘
Real-time data collection	✓	✘
Accuracy of interpreting the significance of the received data	✘	✓
Processing data using ML	✓	✘
Prediction Accuracy	✘	✓
Text and Voice Output	✓	✘
Suggesting Cure	✓	✘
Suggesting Doctors	✓	✘
Emergency message	✓	✘
Emergency ambulance service	✓	✘

8. System Model

8.1 Context Diagram

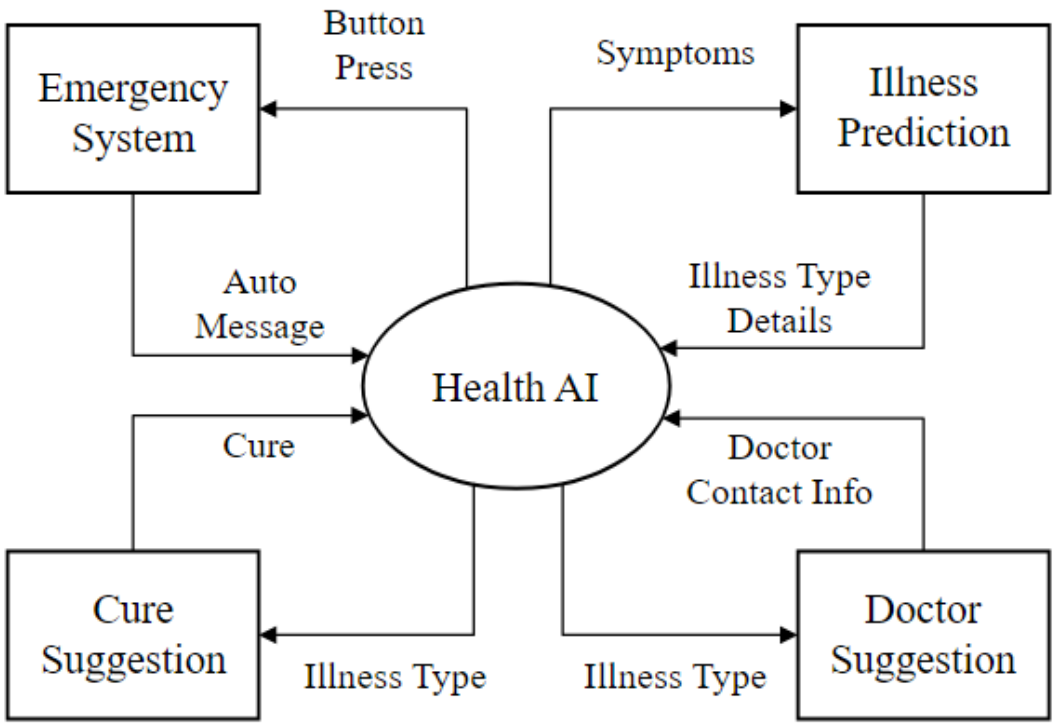


Figure 2: Context Diagram

Description:

There are 4 different subsystems in the context diagram.

1. Illness prediction module will take symptoms as input and provide information about illness type.
2. Cure suggestion module will take illness type as input and provide information about the cure.
3. Doctor suggestion module will take illness type as input and provide contact information of relevant doctors.
4. Emergency system module will be triggered by an SOS button press and it will send automated messages/signals to predetermine contacts and the nearest ambulance service.

8.2 Activity Diagram

8.2.1 Activity Diagram for Disease Detection

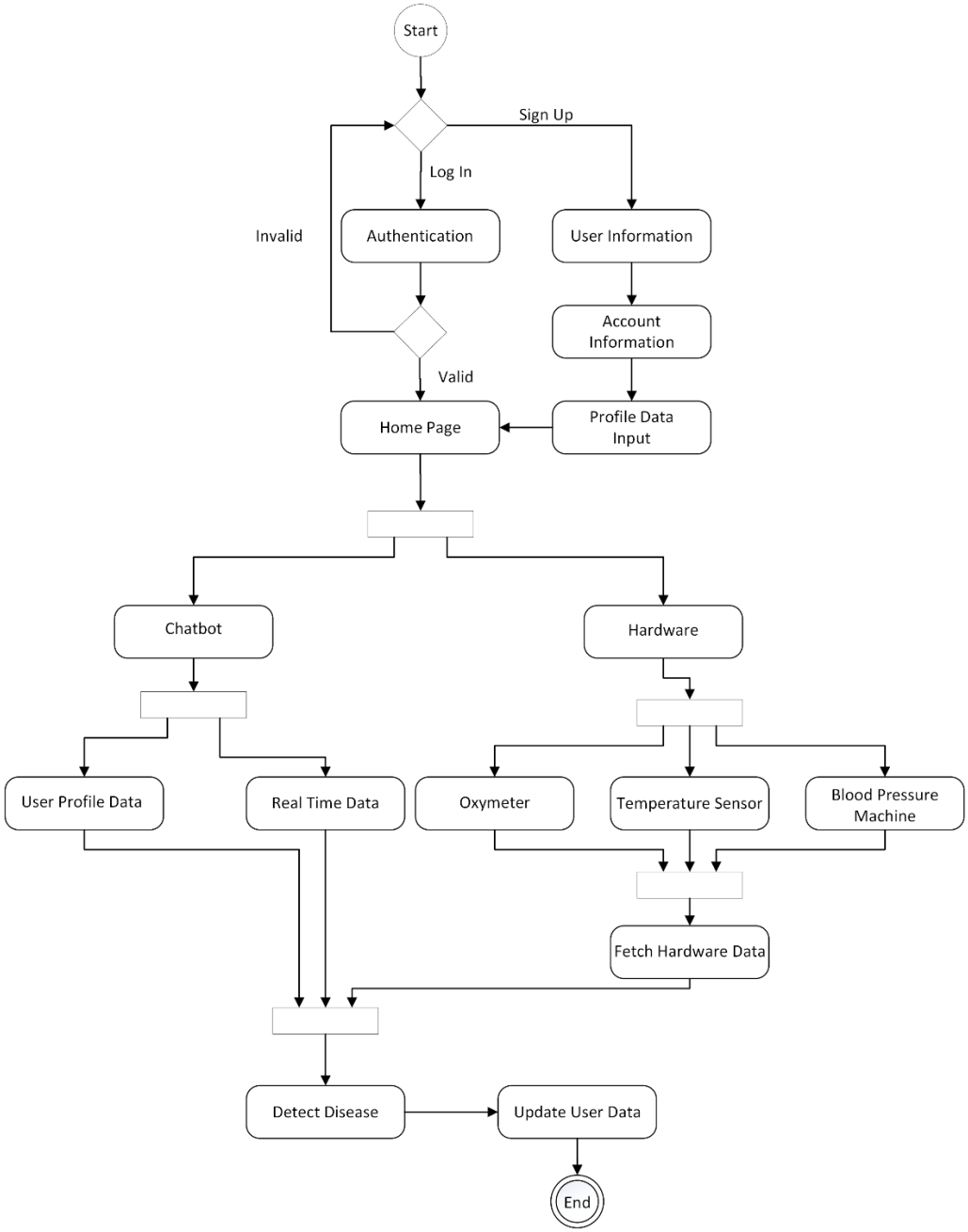


Figure 3: Activity Diagram for Disease Detection

Description:
In the disease detection module real time data collected from user chat combined with user profile and sensor data to identify the disease. User profile is also updated with the latest data to keep the user profile up to date.

8.2.2 Activity Diagram for Taken Actions

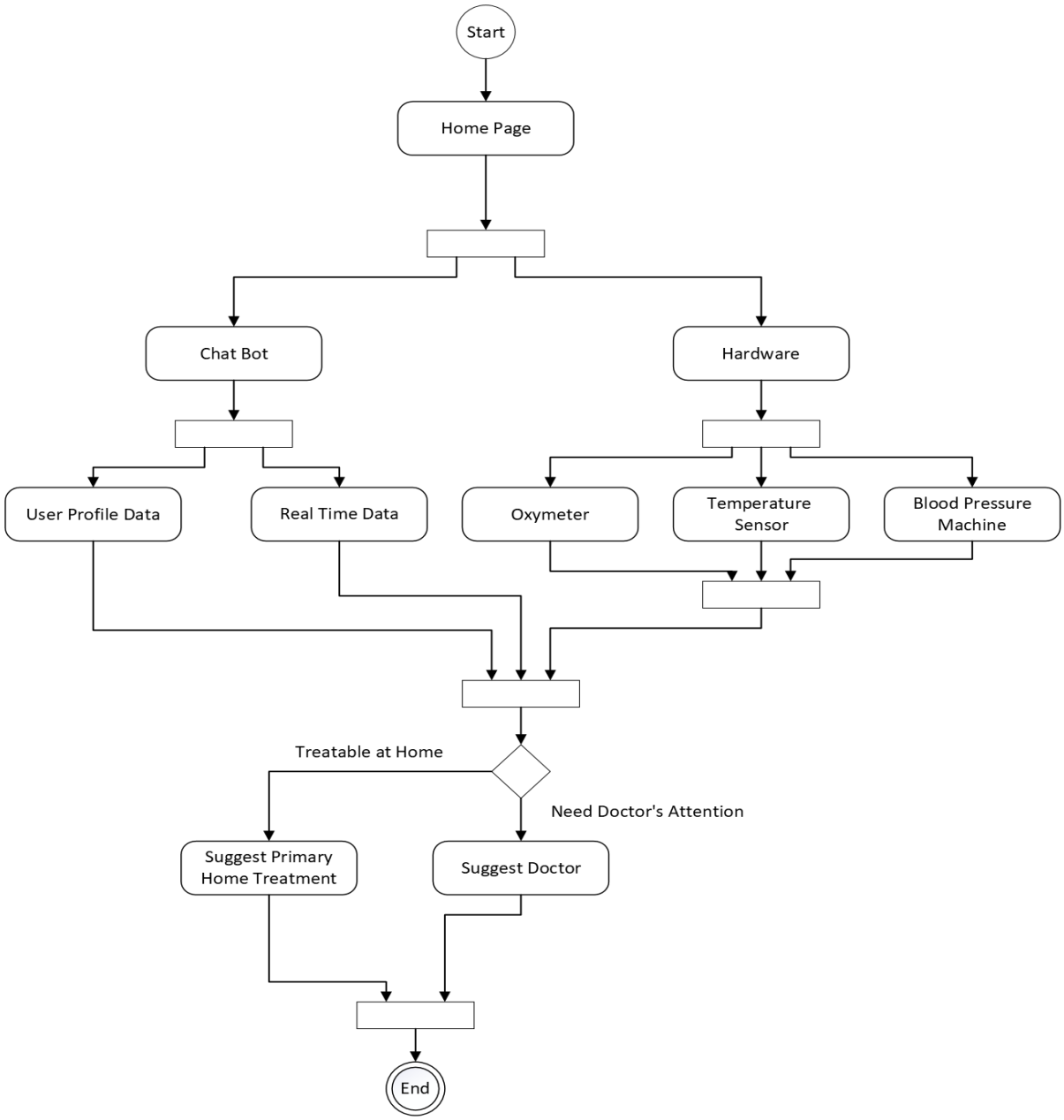


Figure 4: Activity Diagram for Taken Action

Description:

From user profile data, user chat and hardware data the machine learning algorithm will judge user's condition. If the condition is treatable at home than primary home treatment will be suggested. Otherwise, the system will suggest nearby doctors.

8.2.3 Activity Diagram for Emergency System

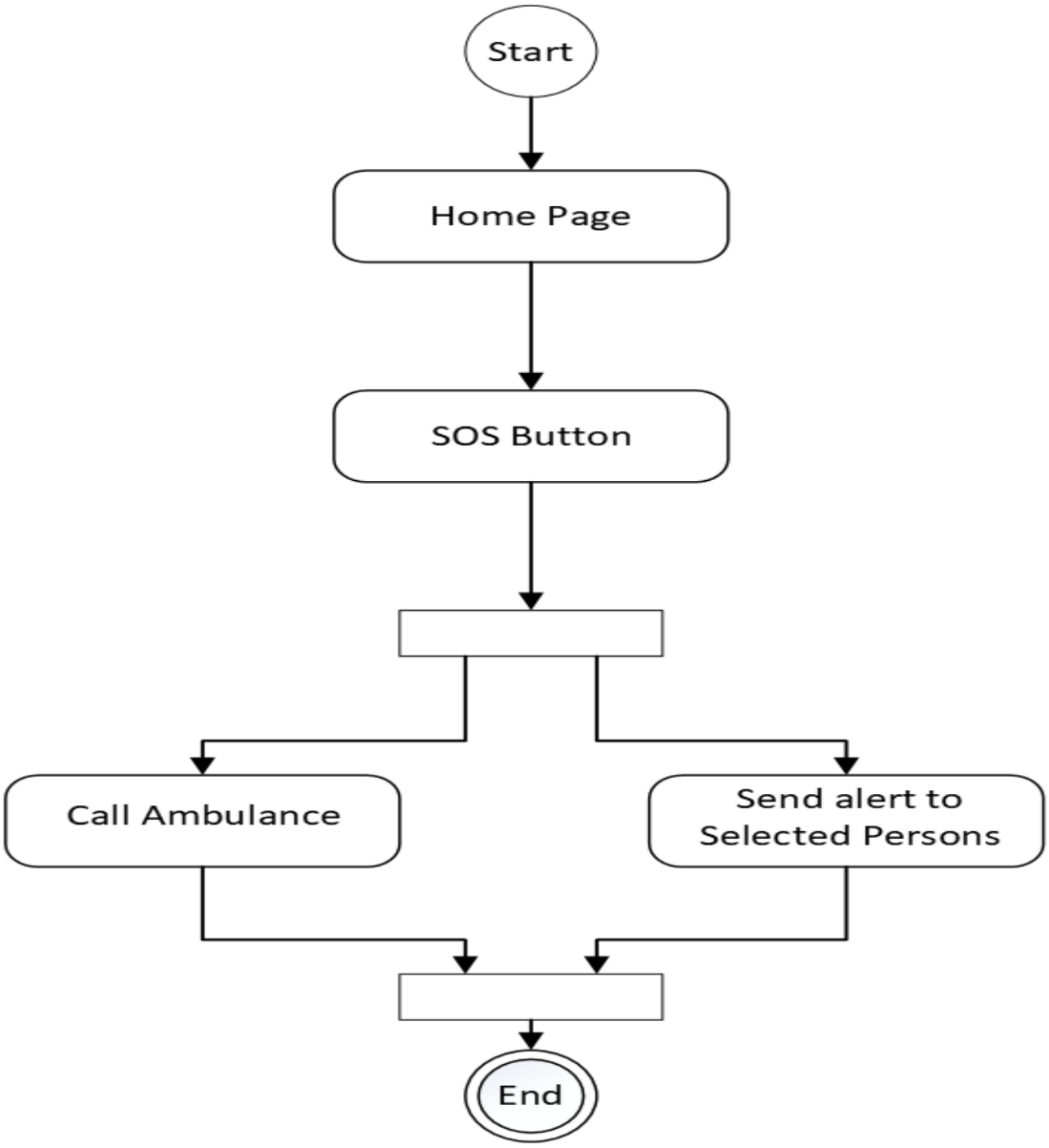


Figure 5: Activity Diagram for Emergency System

Description:

This activity diagram shows the work of SOS button. User will use this in case of emergency. If the button is pressed, previously selected persons by the users will be notified and an ambulance will be called if wanted.

8.3 Use Case Diagram

8.3.1 Illness prediction

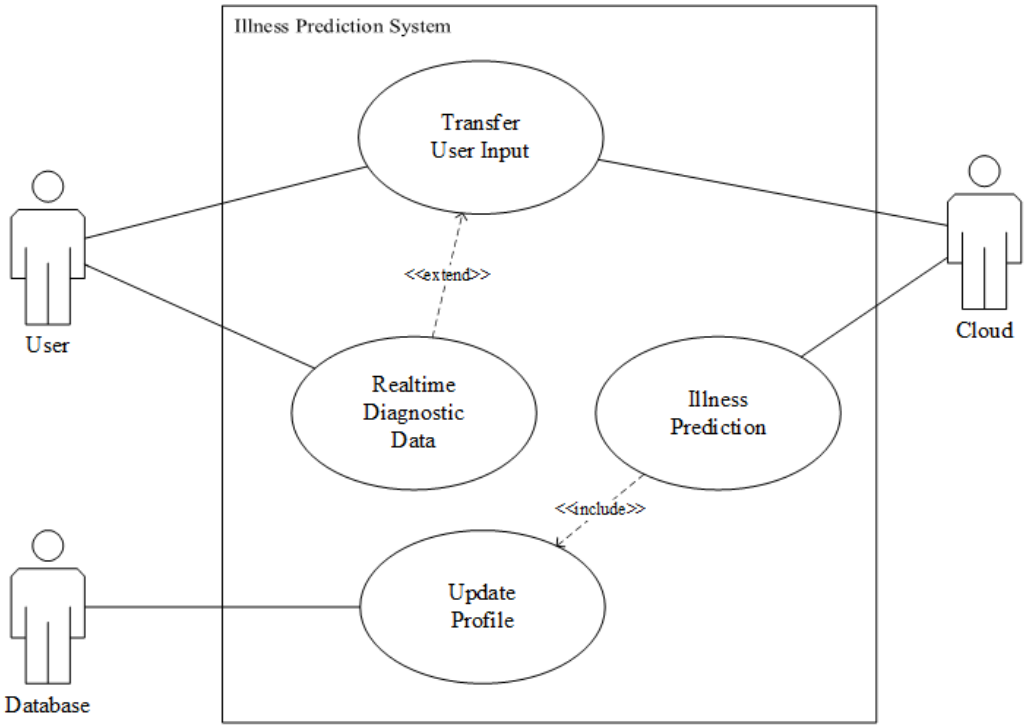


Figure 6: Use case diagram for Illness Prediction System

Tabular Description:

Transfer user data	
Actors	User, Cloud.
Description	A registered user gives his or her problems as input which may be in voice or text format. On the other hand, user can measure his or her heart rate, blood pressure, oxygen level and give them as input also. This real time diagnostic data input is optional. Then all these user inputs are transferred to cloud. Predicated illness is then transferred to the user.
Data	Users' problems, users' real time diagnostic data.
Stimulus	Chatbot and diagnostic hardware enabled by user
Response	Uploads users' problems and diagnostic data to cloud for analysis and returns the predicted illness to the user.
Comments	User must be registered. Real time data in not compulsory.

Real time diagnostic data	
Actors	User.
Description	User wears a handheld device and measures his or her heart rate, blood pressure, oxygen level which is transferred to the app then to the cloud.
Data	Users' real time diagnostic data which are heart rate, blood pressure and oxygen level.
Stimulus	User activates handheld diagnostic device.
Response	Sends the diagnostic data to the mobile application.
Comments	User must wear the handheld device and fully finish the measurements.

Illness Prediction	
Actors	Cloud
Description	With the data which are uploaded into cloud by the user all the analysis are done, and predicted disease or problem of the user is then is figured out. Also, the current states and illness of the user is saved in the database
Data	Users inputted data, predicted illness.
Stimulus	User uploads his or her problems and diagnostic data
Response	Predicts the users' problem
Comments	User must upload valid problems

Update Profile	
Actors	Database
Description	User's problems, diagnostic data and predicted illness is stored in the database for future usage.
Data	User's problems, diagnostic data, and predicted illness.
Stimulus	Illness prediction predicts the problem successfully.
Response	All the data are saved in the users' profile database
Comments	User must give permission to store his or her personal data.

8.3.2 Cure Suggestions

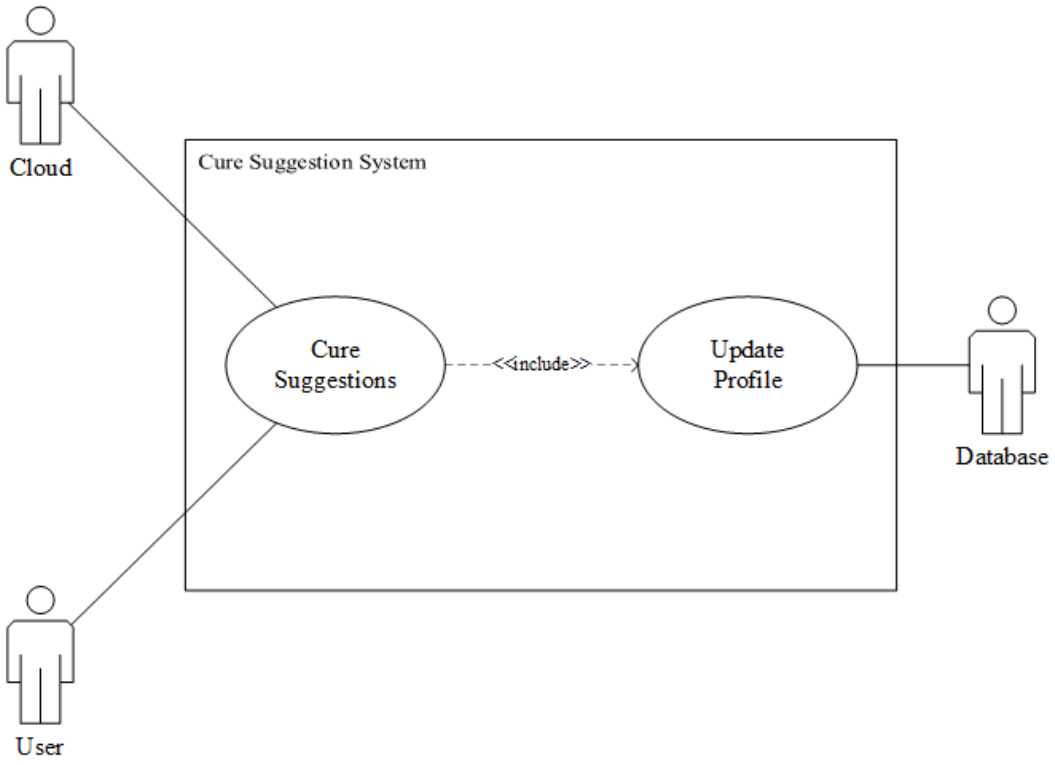


Figure 7: Use case diagram for Cure Suggestions System

Tabular Description:

Cure Suggestions	
Actors	User, Cloud.
Description	From the cloud the predicted illness is taken, and cure of the corresponding problem is given if the problem can be solved in home.
Data	Predicted Illness.
Stimulus	Illness prediction system gives predicated illness.
Response	Home remedies for the illness is given to the user
Comments	User may follow the cure suggestion if it has no side effect for him or her.

Update profile	
Actors	Database.
Description	Cures suggestions are saved in the database for future usage.
Data	Cure suggestions.
Stimulus	Cure suggestions gives any kind of suggestions.
Response	Saves data into the user's profile database.
Comments	User must give permission to store his or her personal data.

8.3.3 Doctor Suggestions

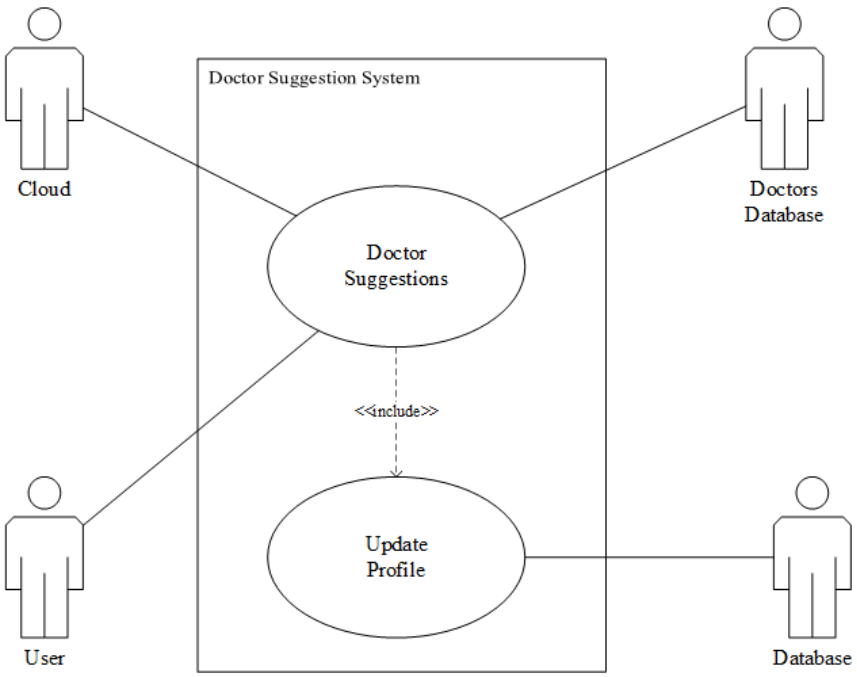


Figure 8: Use case diagram for Doctor Suggestions System

Tabular Description:

Doctor Suggestions	
Actors	User, Cloud, Doctors database
Description	From the cloud predicted illness is taken and the specialist doctor on that problem is searched from the doctor's database. Nearest specialist doctor is then suggested to the user.
Data	Predicted illness, doctor's database.
Stimulus	Illness is predicted which needs specialist doctors to resolve.
Response	Gives a list of nearest specialist doctors on the predicted illness.
Comments	User must give permission to access his or her location.

Update profile	
Actors	Database
Description	Doctor suggestion data is saved in the database for future usage.
Data	Doctor suggestion list.
Stimulus	Doctor suggestions gives any kind of suggestions.
Response	Saves data into the user's profile database.
Comments	User must give permission to store his or her personal data.

8.3.4 SOS/Emergency System

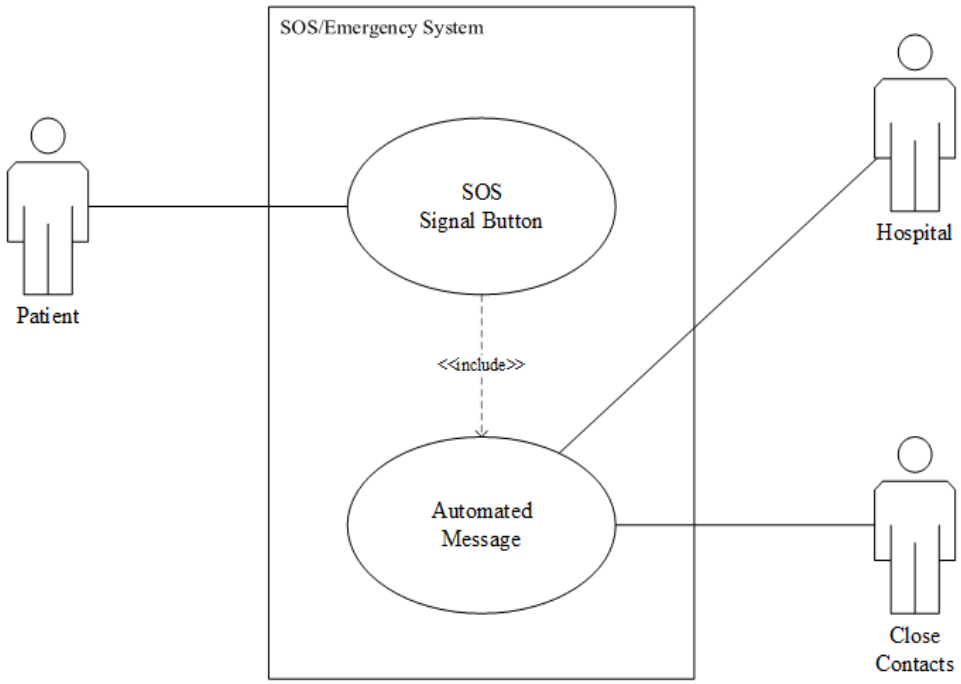


Figure 9: Use case diagram for SOS/Emergency System

Tabular Description:

SOS Signal Button	
Actors	Patients.
Description	Patients may press the SOS button in case of emergencies which will trigger an SOS automated message.
Data	User's location and help wanted message text.
Stimulus	Button-press by user.
Response	Help wanted message.
Comments	Users must manually press the SOS button and give permission to use his or her location.

Automated Messages	
Actors	Hospital and close contacts.
Description	Patients may press the SOS button which will lead to send help wanted messages to hospitals and pre saved close contacts.
Data	User's location and help wanted message text.
Stimulus	SOS button trigger.
Response	SMS to contacts and hospital.
Comments	If no contacts are saved, then the message will only be sent to the closest hospital.

8.4 Sequence Diagram

8.4.1 Login

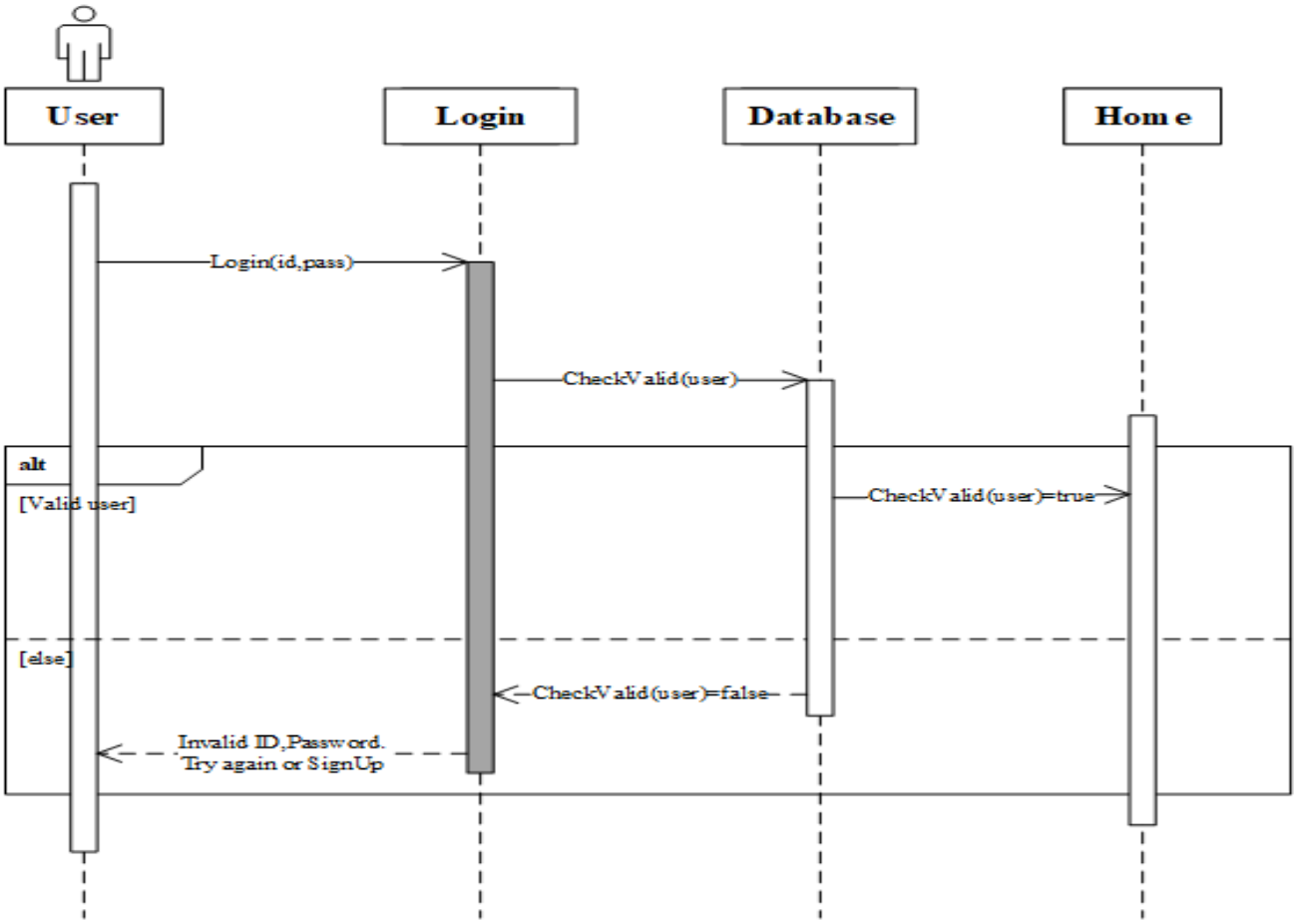


Figure 10: Sequence diagram for Login

8.4.2 Illness prediction

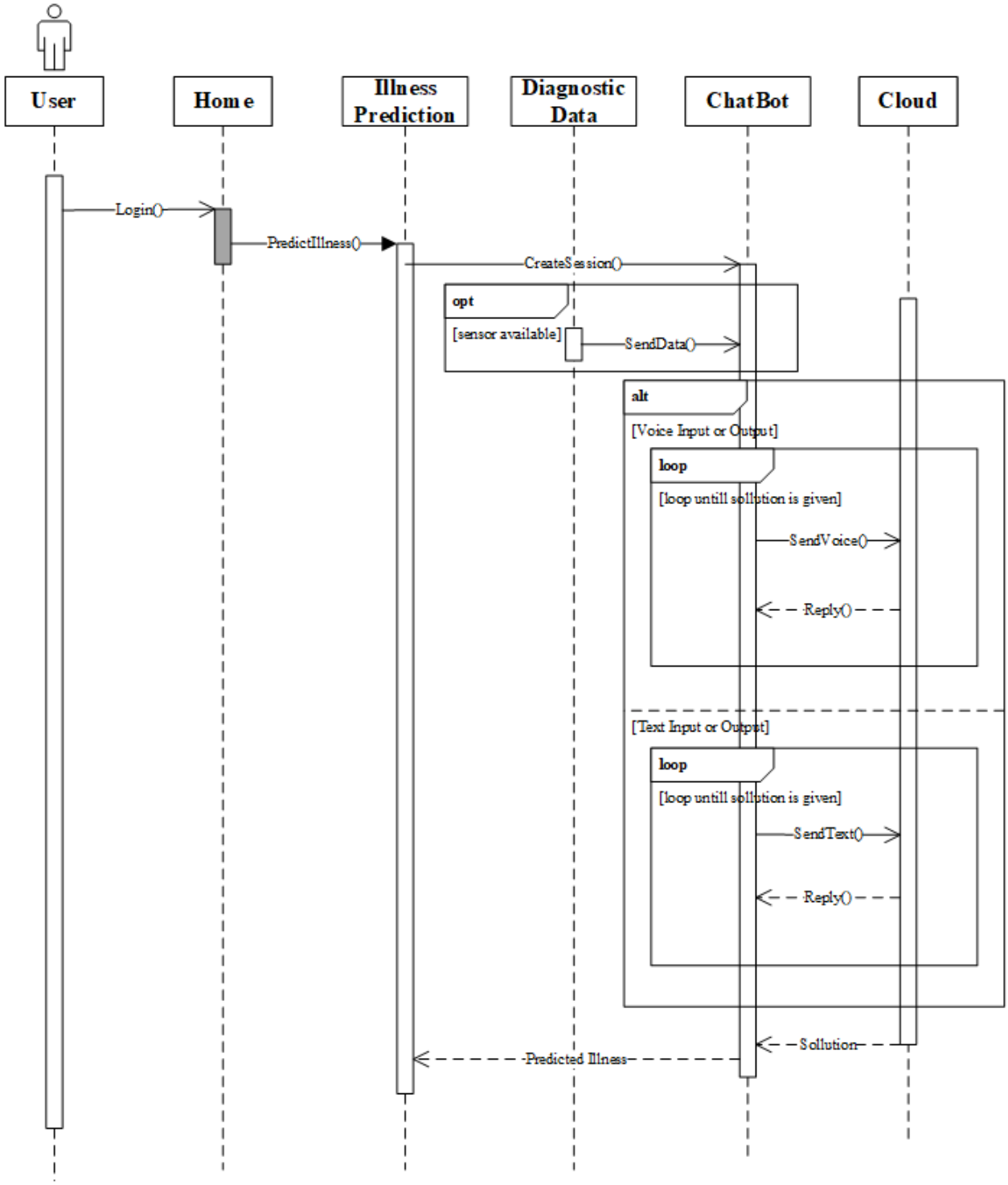


Figure 11: Sequence diagram for Illness Prediction System

8.4.3 Cure Suggestions

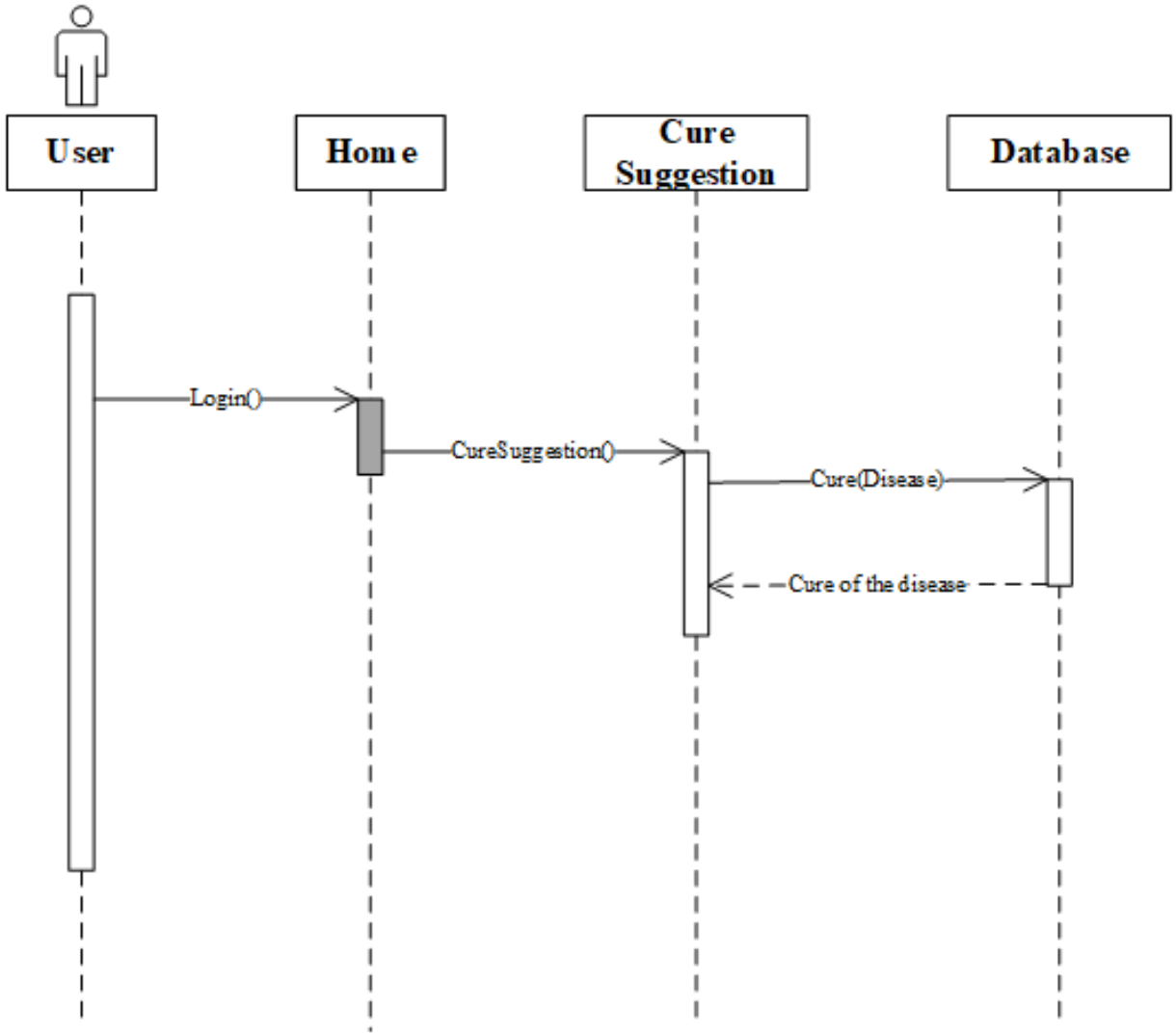


Figure 12: Sequence diagram for Cure Suggestions System

8.4.4 Doctor Suggestions

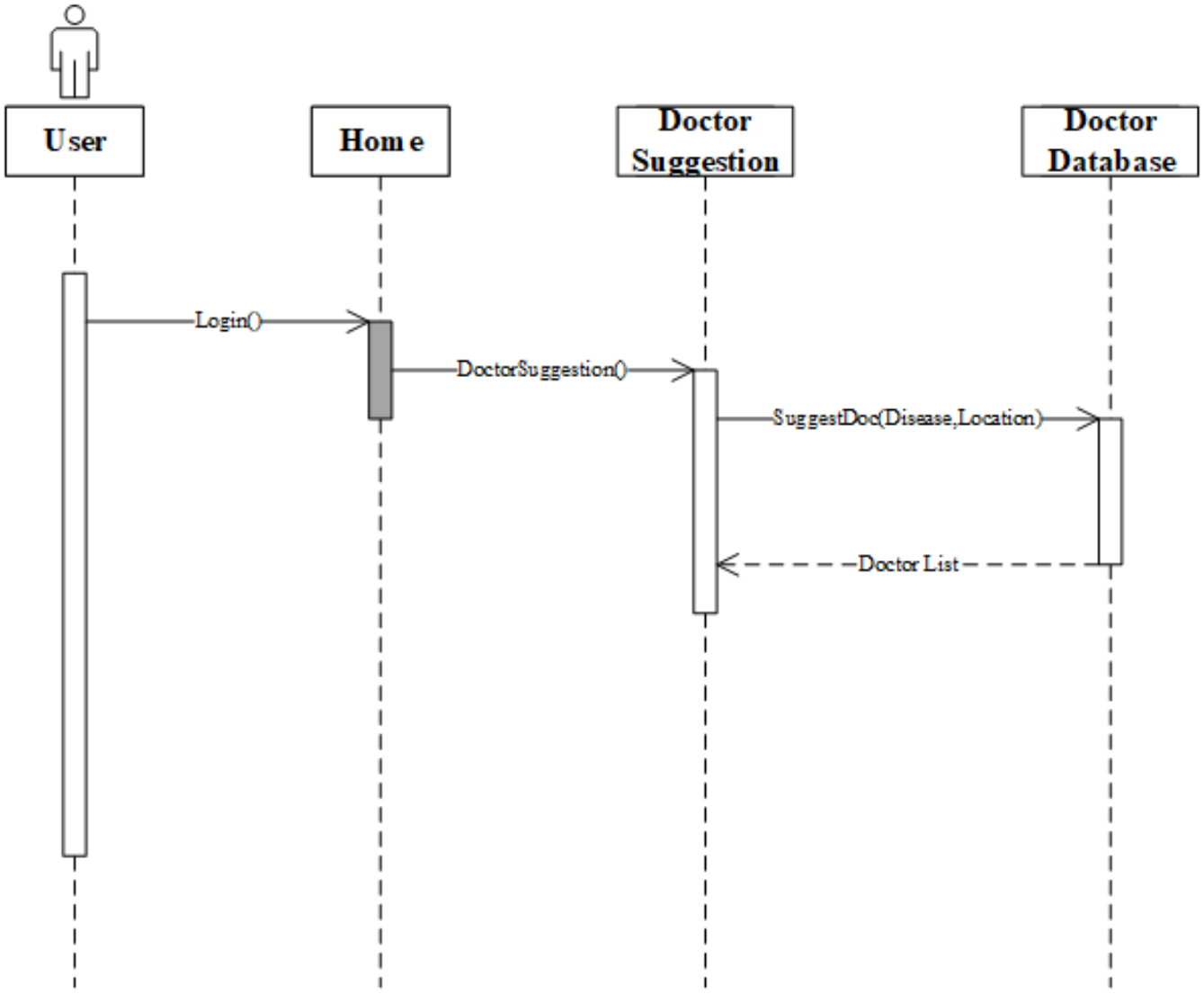


Figure 13: Sequence diagram for Doctor Suggestions System

8.4.5 SOS/Emergency System

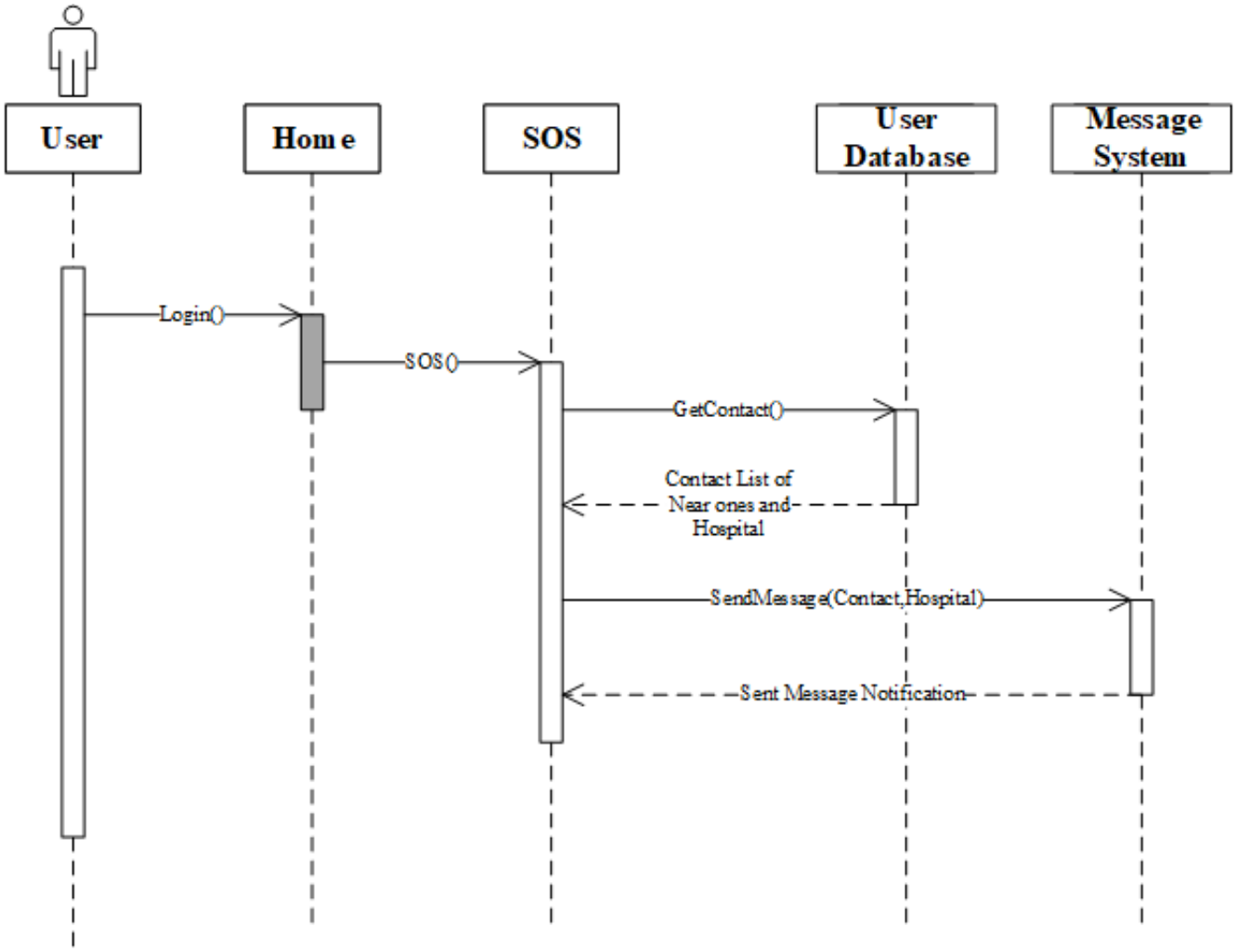


Figure 14: Sequence diagram for SOS/Emergency System

8.5 State Diagram

8.5.1 Doctor Suggestions

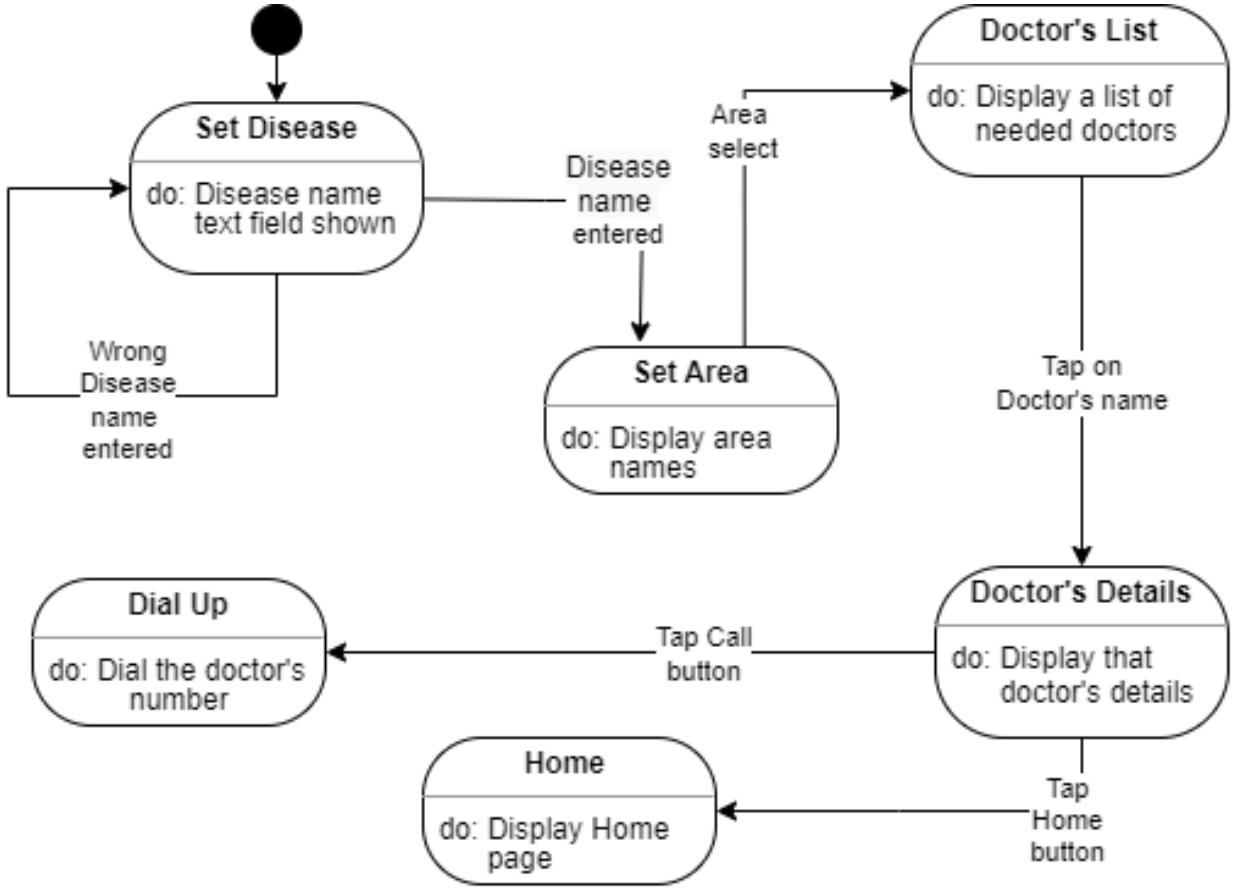


Figure 15: State diagram for Doctor Suggestions System

States	**Description**
Set Disease	A text field where to enter the disease name.
Set area	A drop-down field to take the area name.
Doctor’s list	Display a list of eligible Doctors of that customer.
Dial Up	Display dial-up screen with the doctor’s contact number.
Home	Display system’s home page.

Stimulus	Description
Disease name entered	Entering disease names into the text field.
Area select	Select an area from the dropdown bar.
Tap on Doctor's name	Tap any doctor’s name.
Tap call button	Tap on the call/phone sign button.
Tap Home button	Tap on the Home button.

8.5.2 Illness Prediction

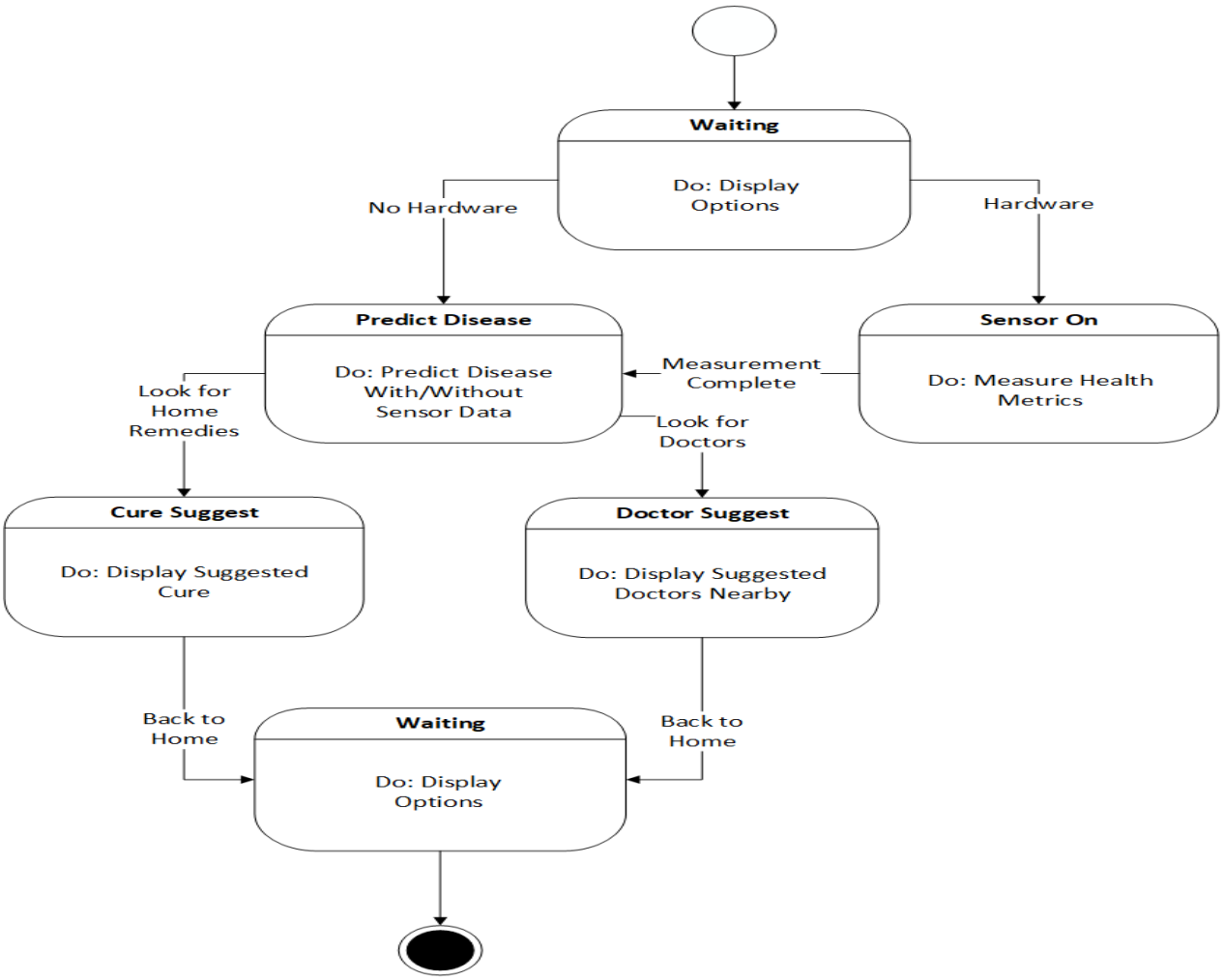


Figure 16: State diagram for Illness Prediction System

State	Description
Waiting	The system is waiting for the user to select an option from the modules.
Sensor On	Sensors are turned on and health metrics are collected.
Predict Disease	Disease is predicted using user profile data and sensor data if there is any.
Cure Suggest	Home remedies are suggested based on the detected disease.
Doctor Suggest	User location is taken, and nearby specialist doctors are suggested for the detected disease.

Stimulus	Description
Hardware	User has connected Hardware
No Hardware	User doesn't have connected hardware
Measurement Complete	Measurement of health metrics complete
Look For Home Remedies	User has selected the cure suggestion module
Look for Doctors	User has selected the doctor suggestion module
Back to Home	User has selected the Home option

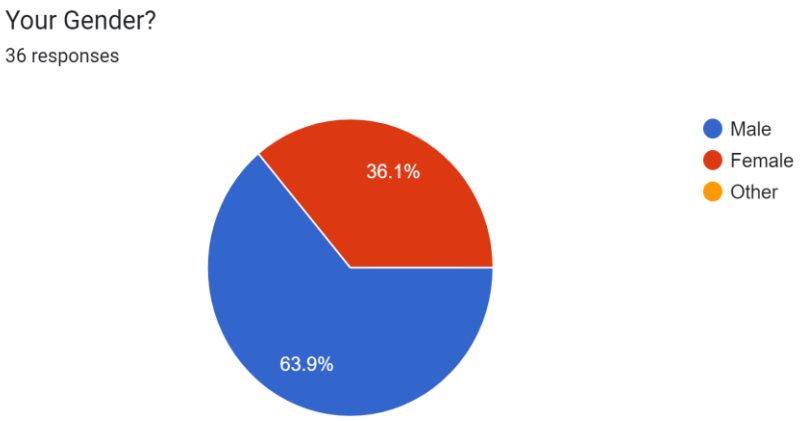
9. Appendix

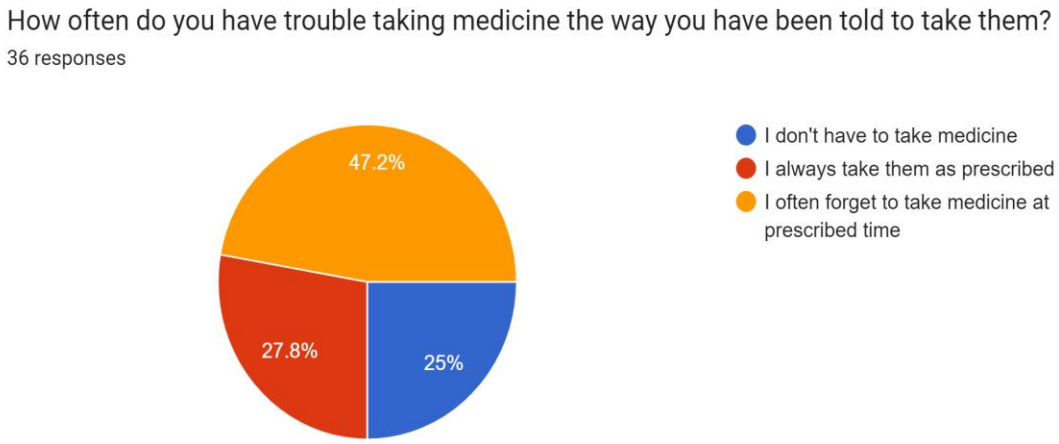
9.1 Questionnaires

- Your Gender?
- Your Age?
- Do you have any chronic disease?
- How often do you visit a doctor?
- How clearly can you express your medical problems to your doctors or to your family?
- Do you have problems talking fluently with your doctor in person?
- Do you think healthcare services are always available to you any time you want?
- How often you take health advice from your relatives?
- How often you search on the internet about medical problem of yours?
- On a scale of 5 how much do you think that the results on the internet about your medical query are accurate?
- How often you check your blood pressure, heart rate, or oxygen level?
- Do you measure these medical records (bp, heart rate, oxygen level) at home or go to the nearest pharmacy (drug shop)?
- Do you think it is necessary to keep a track of these (bp, heart rate, oxygen level) medical records?
- What do you think of following medical advice from a non-medical person?
- Do you think about buying medicine without prescription should be allowed?
- Do you take medicine without a doctor's suggestion?
- How often do you have trouble taking medicine the way you have been told to take them?
- Are you comfortable to discuss your medical problems with your doctor on text, voice, or video call?
- In case of emergency do you prefer texting or talking to someone?
- Do you keep your doctor's contact number on your phone?
- On a scale of 5 how accurately can you identify which specialist doctor you need?
- How you judge your knowledge about the doctors and services of the nearest hospitals around you?

- Have you ever used Google assistant, Siri or Alexa for searching medical queries?
- Are you comfortable to share your location with your close ones in case of any medical emergency?
- Do you have any medical apps on your phone? (If yes then can your write name of any)
- Do you use any healthcare or fitness tracking device or app? (If yes write the names of the device/app)
- In case of a medical emergency, how you judge your ability to remain calm?
- What is the main problem you face in case of medical emergency?

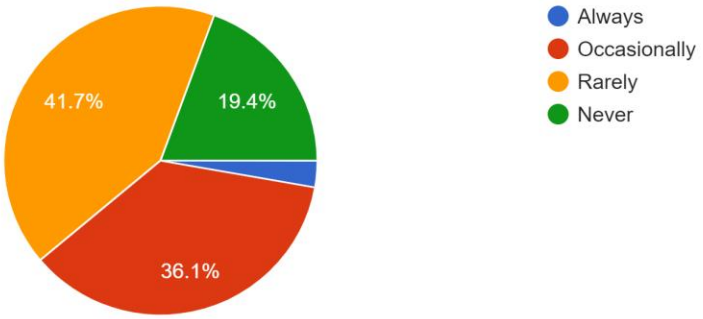
9.2 Some Responses





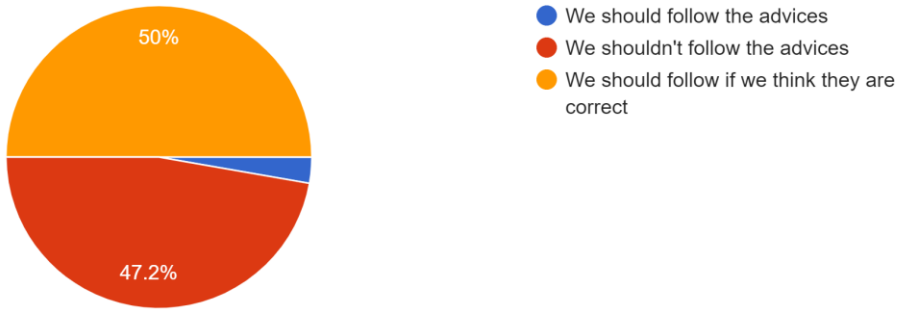
How often you check your blood pressure, heart rate, or oxygen level?

36 responses



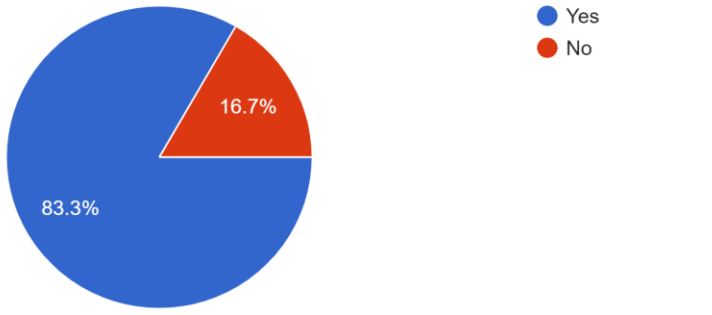
What do you think of following medical advice from a non medical person?

36 responses



Are you comfortable to share your location with your close ones in case of any medical emergency?

36 responses



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