QUAID-I-AZAM UNIVERSITY ISLAMABAD

DEPARTMENT OF COMPUTER SCIENCE

IOT BASED MOTHER AND FETUS HEALTH MONITORING

SOFTWARE PROJECT TECHNICAL DOCUMENTATION

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Chapter No 1

<u>Software Project Management Plan</u>

1 Introduction

1.1 Project Overview

- **Purpose**: To develop an **IoT-based real-time Mother and Fetus Health Care Monitoring System** that enables pregnant women to track vital health parameters at scheduled intervals, facilitating early detection of potential pregnancy-related risks.

- **Objectives**:

  - Design and implement a wearable device capable of measuring

    1. Blood pressure,

    2. Pulse Rate

    3. Body temperature,

    4. Blood sugar levels,

    5. Fetal movement.

  - Store the measured data on an online database for risk analysis.

  - Design a mobile application that will:

    1. Check patient data to detect pregnancy risks related to the above parameters & generate alerts for both patient and doctor if there is any risk.

    2. Connect Doctors with their patients. The doctor can mark the risk as accurate or non-accurate after a detailed medical checkup and doctors can prescribe personalized diet plans and medicine if applicable.

- **Scope:**

  - Development of hardware (smart wristband) and software (mobile application) components.

  - Implementation of data collection at scheduled intervals, transmission, and analysis functionalities.

  - User interface design for both patients and healthcare professionals.

  - This app will not suggest any medicine to the patient because it is illegal to do so without a license.

1.2 Project Deliverables

Project deliverable includes:

1. **Technical Documentation:**
   a. Software Project Management Plan
   b. Software Requirement Specification
   c. Software Design Description
   d. Software Test Documentation
2. **Mobile Application**
3. **Wearable Wristband:**
   a. Arduino Uno Micro-controller

  b. Arduino ESP8266 Micro-controller
  c. Sensor
    i. Blood Pressure and Pulse Monitor
    ii. Body Temperature Sensor
    iii. Blood Glucose Sensor
    iv. Heart Rate Sensor
    v. Fetal Movement Buttons

2 Project Organization

2.1 Software Process Model

For the development of IoT Based Mother and Fetus Health Care Monitoring System, An **Agile Software Development Model** is chosen.
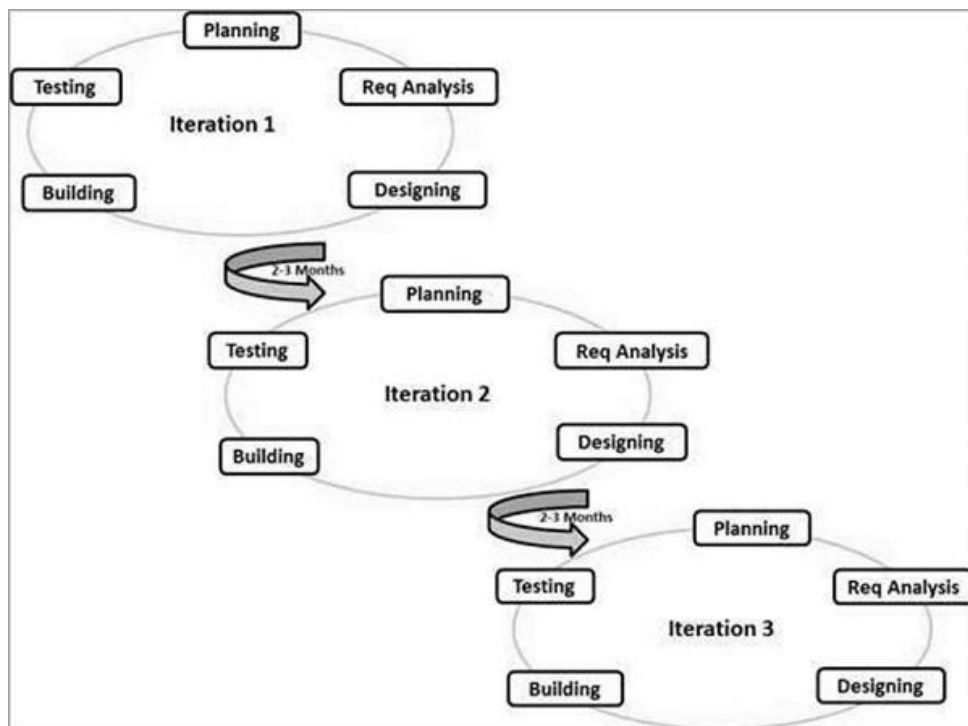
Figure 1: Agile Software Development Model

Agile methodologies are iterative and incremental, which means they are known for dividing the project into smaller parts and adjusting to changing requirements. It prioritizes flexibility, collaboration, and customer satisfaction.

2.2 Roles and Responsibilities

  1. **Student (Khurram Shahzad):**
    a. System Analyst
    b. Software Architect
    c. Database Designer
    d. UI / UX Designer
    e. Front-end Developer
    f. Software Developer
    g. Quality Assurance Engineer
  2. **Project Supervisor (Prof. Dr. Muazzam Ali Khan Khattak)**
    a. Mentor, Reviewer, Technical Guidance.

2.3 Tools and Techniques

Tools / Technique	Purpose
Project Libre	For creating Project Timeline & Gantt Charts & tracking milestones.
Microsoft Word	For creating technical project documentation.
Draw.io	For designing UML diagrams.
Android Studio	As an IDE for Mobile Application Development for Mother and Doctor.
Vs Code	A lightweight code editor for NodeJS, ExpressJS programming.
Database	For storing data by syncing real time health data from sensor to the cloud.
NodeJS & Express.JS	NodeJS & Express JS for Backend Development.
Dart	Backend Programming Language for Mobile Application development.
Flutter	For cross platform Mobile Application's Front end.
Git GitHub	For version control and collaboration.
Postman	For API Testing.
Figma	For creating UI design.
Arduino IDE	As an IDE for writing the code to program Arduino/ESP32 micro-controllers to read sensor data and transmit it.
C++	Language supported by Arduino Micro-controller.

3 Project Management Plan

The Project Management Plan describes how time and resources are managed throughout the project life cycle.

3.1 Tasks

These are the task that will be carried out through the software development life cycle.

3.1.1 Requirement Analysis Phase

3.1.1.1 Requirements Identification

Task Description	The initial step of this project is the identification of requirements which are functional and non-functional.	
Deliverables	Requirements are collected and reviewed	
Resource Needed	People	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word
	Hardware	Laptop
Dependencies and Constraints	None	
Risks	None	

3.1.1.2 Defining Use Cases

Task Description	After finalizing all **Software** requirements, Use Case Description and Diagrams will be created.	
Deliverables	Use Case Description, Use Case Diagram	
Resource Needed	People	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word, Draw.io
	Hardware	Laptop
Dependencies and Constraints	All functional requirements should be clear.	
Risks	Requirements may change frequently.	

3.1.1.3 Develop Domain Model

Task Description	After finalizing the Use Case description and diagrams, Domain Model will be created.	
Deliverables	Domain Model	
Resource Needed	People	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word, Draw.io
	Hardware	Laptop
Dependencies and Constraints	We must know all the Use Case before developing domain model.	
Risks	Addition of new use cases may affect the domain model.	

3.1.1.4 ERD Design

Task Description	This task includes creating of entity relationship diagram.	
Deliverables	ERD Diagram.	
Resource Needed	People	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word, Draw.io
	Hardware	Laptop
Dependencies and Constraints	We must know the Domain Model Design in order to know the flow of data and what data we will need in this step.	
Risks	An update in the domain model will also require change in ERD Diagram.	

3.1.1.5 Software Requirements Specification Completion

Task Description	This task includes making **Software** Requirement Specification document.	
Deliverables	Complete SRS Document.	
Resource Needed	People	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word
	Hardware	Laptop
Dependencies and Constraints	None	
Risks	None	

3.1.2 Design Phase

3.1.2.1 Develop Design

Task Description	Development of Architectural Design	
Deliverables	Architectural Diagram	
Resource Needed	People	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word
	Hardware	Laptop
Dependencies and Constraints	Requirement Analysis must be completed.	
Risks	None	

3.1.2.2 Developing Interfaces

Task Description	This task includes how each screen will look like and which feature would come on which screen.	
Deliverables	Figma Design	
Resource Needed	**People**	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word, Figma
	Hardware	Laptop
Dependencies and Constraints	Requirement Analysis must be completed.	
Risks	None	

3.1.2.3 Class Diagram Designing

Task Description	This task includes creation of Class Diagram. It shows the flow of data and how they are related to each other.	
Deliverables	Class Diagram.	
Resource Needed	**People**	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word, Draw.io
	Hardware	Laptop
Dependencies and Constraints	Architectural Design must be completed.	
Risks	If architectural design and domain model are not well defined, it may cause problems.	

3.1.2.4 Sequence Diagram Design

Task Description	In this step we will create Sequence Diagrams to show the flow of data between user and system classes.	
Deliverables	Sequence Diagrams	
Resource Needed	**People**	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word, Figma
	Hardware	Laptop
Dependencies and Constraints	Architectural Design must be completed.	
Risks	If architectural design and domain model is not well defined, it may cause problems.	

3.1.2.5 Design Phase Verification

Task Description	In this step we will verify all the previous steps of this phase.	
Deliverables	Design Phase is completed and it's document will be reviewed.	
Resource Needed	**People**	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word, Figma
	Hardware	Laptop
Dependencies and Constraints	The whole Design Phase must be completed.	
Risks	If architectural design and domain model is not well defined, it may cause problems.	

3.1.2.6 Software Test Documentation

Task Description	In this step we will define the test cases.	
Deliverables	Tests are reviewed. Design Phase is complete.	
Resource Needed	People	Khurram Shahzad, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word
	Hardware	Laptop
Dependencies and Constraints	Design Phase should be completed.	
Risks	None.	

3.1.3 Implementation Phase

3.1.3.1 System Implementation

Task Description	In this step we will connect the sensors to Arduino microcontroller, send data to Database, create the web server, write code for mobile application.	
Deliverables	Mobile App, Wristband	
Resource Needed	People	Khurram Shahzad, Electronics Expert, Prof. Dr. Muazzam Ali Khan Khattak
	Software	Microsoft Word, VsCode, Android Studio, Database
	Hardware	Laptop, Arduino ESP8266, Sensors, Wires,
Dependencies and Constraints	Would need to learn technologies such as Dart, Flutter.	
Risks	None.	

3.2 Assignments

Task	Assignee	Role
Requirement Identification		System Analyst
Defining Use Cases		System Analyst
Develop Domain Model		System Analyst, Software Architect
ERD Design		Database Designer, System Analyst
Software Requirement Specification		Technical Writer
Develop Design		Software Architect, System Designer
Develop Interfaces	Khurram Shahzad	UI/UX Designer, Front-End Developer
Class Diagram Designing		Software Architect, System Analyst
Sequence Diagrams		System Analyst, Software Architect
Design Phase Verification		Quality Assurance Engineer, Software Architect
Software Test Documentation		QA Engineer, Test Analyst
Implementation Phase		Software Developer

3.3 Timetable

|		Name	Duration	Start	Finish	Predecessors
1		Requirement Identification	3 days	5/21/25, 8:00AM	5/23/25, 5:00PM	
2		Defining Use Cases	4 days	5/26/25, 8:00AM	5/29/25, 5:00PM	1
3		Develop Domain Model	4 days	5/30/25, 8:00AM	6/4/25, 5:00PM	2
4		ERD Design	4 days	5/26/25, 8:00AM	5/29/25, 5:00PM	1
5		Software Requirements Specification	3 days	5/30/25, 8:00AM	6/3/25, 5:00PM	1;2;4
6		Develop Design	8 days	6/4/25, 8:00AM	6/13/25, 5:00PM	5
7		Develop Interfaces	6 days	6/16/25, 8:00AM	6/23/25, 5:00PM	6
8		Class Diagram Designing	6 days	6/16/25, 8:00AM	6/23/25, 5:00PM	6
9		Sequence Diagrams	4 days	6/24/25, 8:00AM	6/27/25, 5:00PM	8
10		Design Phase Verfication	4 days	6/30/25, 8:00AM	7/3/25, 5:00PM	7;8;9
11		Software Test Documentation	1 day	7/4/25, 8:00AM	7/4/25, 5:00PM	10
12		Implementation Phase	60 days	7/7/25, 8:00AM	9/26/25, 5:00PM	10;11

Figure 2 Timetable

3.4 Gantt Chart
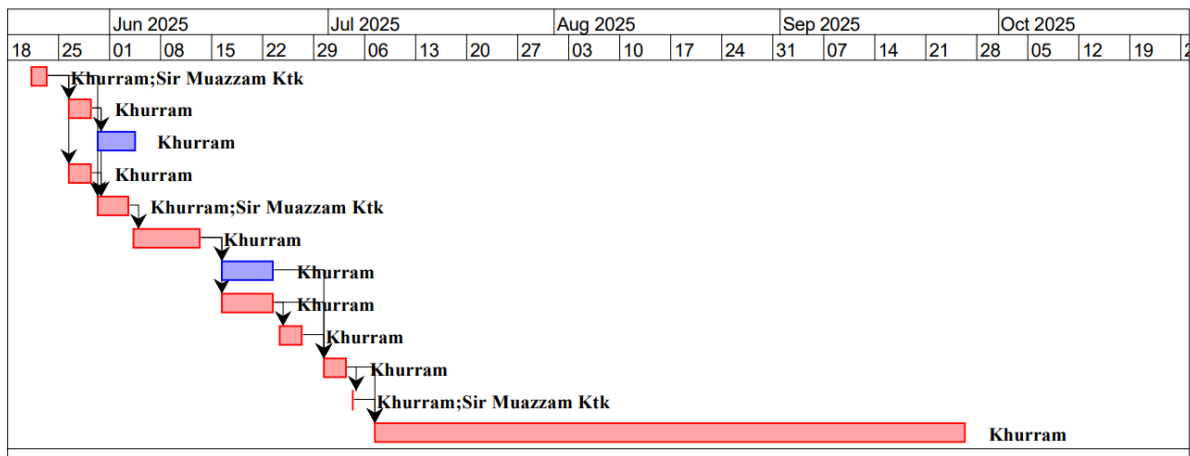
Figure 3 Gantt Chart

Chapter 2

<u>Software Requirement Specification</u>

2.1 Introduction

This document describes the expected software features, constraints, interfaces and other attributes. In this document we will define cases, sequence diagrams, domain model and database design of the project.

2.2 Functional Requirements

The functional requirements for the IoT Based Mother and Fetus Health Monitoring System wearable device are:
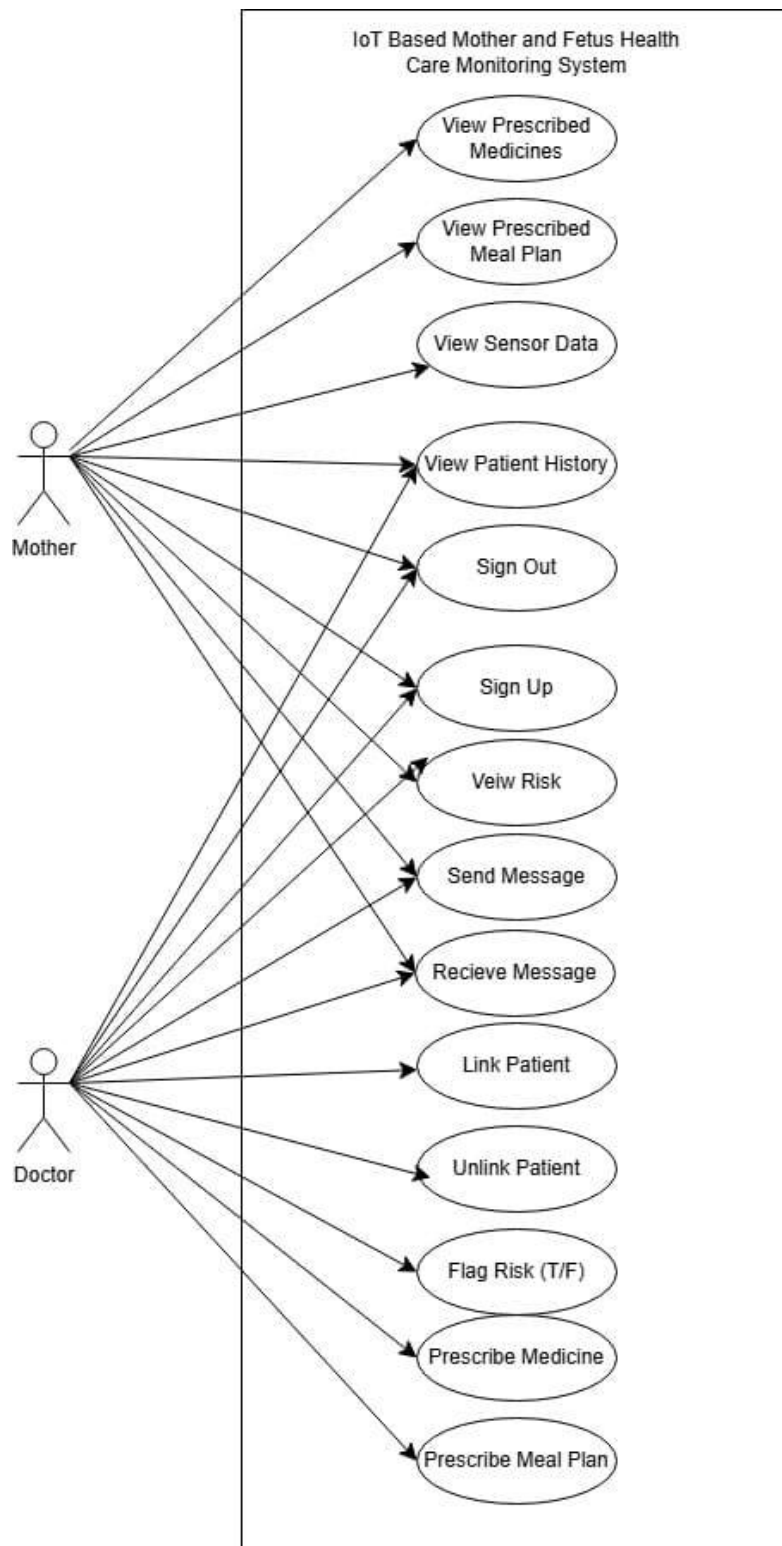
1. The wearable device should be capable of measuring:
    a. Body Temperature.
    b. Heart Rate.
    c. Blood Pressure.
    d. Pulse Rate.
    e. Fetus Movement
    f. Blood Sugar Level.
2. The wearable device should save data on an online database.
3. The device should provide a set of buttons that will help the mother to count kicks, flutter, roll, jabs etc.

The functional requirements of Mobile App are:

1. It should allow the patient and doctor to sign up on the app.
2. It should allow the doctors and patients to sign in to the app.
3. It should allow the patient and doctor to link with each other.
4. It should allow the patient and doctor to unlink once delivery is successful or ends
5. It should allow text messages between a patient and her doctor.
6. It should display the live sensors output to the patient and her doctor.
7. It should send push notifications to patients and doctors if there are any risks.
8. Clicking on the push notifications should show an interface to the patient and doctor displaying the reason why alert was generated and what is the risk?
9. It should allow the doctor to mark the risk as true or false.
10. It should allow the doctor to see the patient's history if it is her second pregnancy and the patient is using the app for her second pregnancy as well.
11. It should allow the doctor to prescribe medicine and meal plans.
12. It should allow the doctor to update the prescribed meal plan and medicines.
13. It should allow the patient to view prescribed meal plans and medicines.
14. The body temperature should be measured continuously to check fever.
    a. If the mother's body temperature is between 36.1°C to 37.3°C (97°F to 99.1°F) then it's normal temperature.
    b. If the mother's body temperature is greater than 38°C (100.4°F) then it is fever and there is risk of infection, preterm labor or birth defects (especially in early pregnancy).
    c. If the mother's body temperature is less than 35°C (95°F) then it is Hypothermia and there is risk of slow metabolism, fetal distress or poor circulation.
15. The blood pressure should be checked every 4 hours a day after 20 weeks of pregnancy.
    a. If blood pressure is around 120/80 mmHg, then the blood pressure is normal.
    b. If blood pressure is greater than or equals to 140 / 90 mmHg on 2 occasions in 4 hours apart in pregnancy, and blood pressure was normal before pregnancy then the patient is suffering from Pregnancy Induced Hypertension. This problem is resolved within 12 weeks of postpartum.

c. If blood pressure is greater than or equals 140 / 90 mmHg after 20 weeks of pregnancy, then this type of hypertension is known as Gestational Hypertension. In this case there is no proteinuria or end organ damage.

d. If blood pressure is greater than or equals 140 / 90 mmHg but less than 160 / 110 mmHg, then this type of hypertension is known as mild Preeclampsia.

e. If blood pressure is greater than or equals 160 / 110 mmHg after 20 weeks of pregnancy, then this type of hypertension is known as severe preeclampsia. In this case there are signs of end organ damage.

f. If blood pressure is greater than or equals 160 / 110 mmHg with generalized tonic seizures after 20 weeks of pregnancy, then this type of hypertension is known as eclampsia.

16. The heart rate should be measured continuously.
    a. If heart rate is between 60 to 100 bpm the heart rate is normal.
    b. If the heart rate is greater than 100 bpm then it is a risk known as Tachycardia.
    c. If the heart rate is less than 60 bpm then it is a risk known as Bradycardia.

17. The blood sugar should be checked
    a. In the first trimester if patient is overweight or has a family history of diabetes to diagnose gestational diabetes. If gestational diabetes is diagnosed, then sugar should be checked daily before breakfast and 1-2 hours after meals.
    b. If gestational diabetes is diagnosed between 24 to 28 weeks of pregnancy, then sugar should be checked daily before breakfast and 1-2 hours after meals.
    c. If blood sugar is 75 -95 mg /dL before meal or less than 140 mg/dL but greater than 120 mg/dL after 1 hour meal or less than 120 mg/dL after 2-hour meal, then it is normal blood sugar in pregnant women.
    d. If blood sugar is greater than 92 mg /dL before meal or greater than 180 mg/dL after 1 hour meal or greater than 153 mg/dL after 2-hour meal, then this risk in pregnant women is known as Gestational Diabetes Mellitus.

18. The mother should be counting the baby kicks in the third trimester.
    a. The mother should choose a time in which the baby moves well.
    b. 10 movements in 1 hour are considered typically normal.
    c. If a mother feels less than 10 movements in the 1st hour, then it does not mean that something is wrong. In this case the machine should help the mother to count the time until it reaches 10 kicks. After 2-3 days, mother will know what the normal time for her baby is to reach movements. This technique is known as Cardiff count technique.
    d. If there is an enormous amount of change in movement patterns or no movement for i.e yesterday it took 1.3hrs to complete 10 movements and today it took 3-4 hrs., then the patients should inform the doctor. It can be a sign of fetal distress.
    e. If mothers are troubled to count kicks than others in case, they are higher BMI (overweight) or in case placenta is in the front side of the moves.

19. Pregnancy falls into a high-risk category if mother has gestational diabetes, high blood pressure or fetal growth retaliation or cholestasis this calls for a stricter kick count. In case this going to hospital necessary for ultrasound.

Use Case Diagram

IoT Based Mother and Fetus Health Care Monitoring System

- View Prescribed Medicines
- View Prescribed Meal Plan
- View Sensor Data
- View Patient History
- Sign Out
- Sign Up
- Veiw Risk
- Send Message
- Recieve Message
- Link Patient
- Unlink Patient
- Flag Risk (T/F)
- Prescribe Medicine
- Prescribe Meal Plan

Mother

Doctor

Use Case Descriptions

UC-1 Sign Up

USE CASE ID	UC-1
USE CASE NAME	Sign Up
PRIMARY ACTORS	1. Doctor 2. Mother
SECONDARY ACTORS	1. Database
STAKE HOLDERS AND INTEREST	**Doctor:** Create an account to monitor patients. **Mother:** Create an account to track health data.
PRE CONDITION	1. The user has installed the Mobile App. 2. The user account does not exist on the system.
POST CONDITION	1. A new user account is created and stored in Database. 2. The user is redirected to the Sign In screen.
MAIN SUCCESS SCENARIO	1. The user opens the mobile application. 2. The system displays the Sign-up Screen. 3. The user enters credentials (email, name, password, confirm password role: Doctor or Mother). 4. The system validates the credentials (i.e valid email format, password strength). 5. The system stores the account in Database. 6. The system displays a confirmation message and redirects to the Sign In screen.
EXTENSION (ALTERNATIVE FLOW)	**4a. Invalid email format:** System displays "Invalid email format" and prompts re-entry. **4b. Password mismatch:** System displays "Passwords do not match" and prompts re-entry. **4c. Account already exists:** System displays "Account exists" and prompts to sign in or use another email.
SPECIAL REQUIREMENT	Email should be a valid email. Minimum password length: 8 characters, including one uppercase, one number, and one special character.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone, Database (JSON data format).
FREQUENCY OF USE	Low.
SPECIAL ISSUES	None

UC-2 Sign in

USE CASE ID	UC-2
USE CASE NAME	Sign in
PRIMARY ACTORS	1. Doctor 2. Mother
SECONDARY ACTORS	1. Database
STAKE HOLDERS AND INTEREST	**Doctor:** Access the patient's data. **Mother:** Monitor health data.
PRE CONDITION	1. The user has installed the Mobile App. 2. The user account exists in Database.
POST CONDITION	1. The user has signed in and redirected it to the home screen. 2. The sign-in fails and the user remains on the login screen.
MAIN SUCCESS SCENARIO	1. The user opens the mobile application. 2. The system displays a Sign in Screen. 3. The user enters email and password. 4. The system validates credentials against Database. 5. The system authenticates the user and redirects to the home screen.
EXTENSION (ALTERNATIVE FLOW)	**3a. Invalid email/password:** System displays "Incorrect email or password" and prompts re-entry. **3b. Account does not exist:** System displays "Account not found" and prompts to sign up.
SPECIAL REQUIREMENT	-
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone, Database (JSON data format).
FREQUENCY OF USE	Low.
SPECIAL ISSUES	None

UC-3 Pair Wristband

USE CASE ID	UC-3
USE CASE NAME	Pair Wristband
PRIMARY ACTORS	1. Mother
SECONDARY ACTORS	1. Wristband 2. Database
STAKE HOLDERS AND INTEREST	**Mother:** Pair wristband to send health data to the app. **Doctor:** Receive accurate health data from paired device
PRE CONDITION	1. The mother has Signed In to the account. 2. The mother has turned the Wristband on. 3. Mother has turned on Bluetooth of phone.
POST CONDITION	1. Device Pairing Success. 2. Failed pairing with device.
MAIN SUCCESS SCENARIO	1. The mother opens the Bluetooth setting on the system. 2. The system displays a list of available Bluetooth devices to the mother. 3. The mother selects the Wristband from the list of available Bluetooth devices to connect it with her phone. 4. The system establishes connection and display connected.
EXTENSION (ALTERNATIVE FLOW)	**3a. Failed Device Pairing:** Mother may see failed to connect. In this scenario she may try again. **4a. No Device Configured:** Mother will be displayed a warning message "No Wristband Paired".
SPECIAL REQUIREMENT	The Wristband should connect to the phone within 30 seconds.
TECHNOLOGY AND DATA VARIATION LIST	Wristband (Bluetooth) Smart Phone.
FREQUENCY OF USE	Low, User will remain signed into the app.
SPECIAL ISSUES	None

UC-4 View Live Sensors Data

USE CASE ID	UC-4
USE CASE NAME	View Live Sensor Data
PRIMARY ACTORS	1. Doctor 2. Mother
SECONDARY ACTORS	1. Wristband 2. Database
STAKE HOLDERS AND INTEREST	**Mother:** View Own Health in real time. **Doctor:** Monitor patient health in real time.
PRE CONDITION	1. The mother is wearing the wristband with all sensors in contact with the skin. 2. Mother has paired the Wristband with the App. 3. The doctor is signed in and linked to the mother.
POST CONDITION	1. Sensor data (e.g. heart rate, blood pressure) is displayed on the app.
MAIN SUCCESS SCENARIO	1. The user (Doctor or Mother) opens the mobile app and navigates to Live Sensor Screen. 2. The system displays the Live Sensor Data screen. 3. The wristband collects and sends data (e.g., heart rate, blood pressure) to the system. 4. The system retrieves and displays real-time sensor data to the user and stores data on the Database. 5. Steps 3 and 4 are repeated until the live sensor screen is active.
EXTENSION (ALTERNATIVE FLOW)	**3a. Wristband disconnected:** System displays "Device disconnected" and prompts to check connection. **3b. The Mother Removes Wristband:** System displays "Please wear the wristband to get real-time data". In this case the system stops transmitting the data. **3c. Sensor Malfunction:** System detects invalid data (e.g. heart rate = 0bpm) and display "Sensor Error". **4a. Poor internet:** System displays "Data uploading failed" and retries when connection is restored at this point system stores data locally.
SPECIAL REQUIREMENT	Real-time data syncing with less than 5 -second latency. Data must be stored on
TECHNOLOGY AND DATA VARIATION LIST	1. Band Wrist 2. Smart Phone 3. Database.
FREQUENCY OF USE	High
SPECIAL ISSUES	All sensors are not continuous sensors. Available continuous sensors are not accurate.

UC-5 Prescribe Meal Plan

USE CASE ID	UC-5
USE CASE NAME	Prescribe Meal Plan
PRIMARY ACTORS	1. Doctor
SECONDARY ACTORS	1. Database
STAKE HOLDERS AND INTEREST	**Doctor:** Prescribe dietary recommendations for the patient. **Mother:** Receive meal plan.
PRECONDITION	1. The doctor is signed in and linked to the mother. 2. The mother's profile exists in Database.
POST CONDITION	1. Patient or Doctor or both are preview live sensor readings
MAIN SUCCESS SCENARIO	1. The doctor opens the mobile app, and the home screen is displayed. 2. The system displays the linked patients upon the request of doctor. 3. The doctor selects the patient. 4. The doctor navigates the Meal Plan section. 5. The doctor enters meal details (e.g., food items, frequency). 6. The doctor submits the meal plan. 7. The system sends a notification to the mother after saving data online database.
EXTENSION (ALTERNATIVE FLOW)	**4a. Invalid input (e.g., empty fields):** System displays "Please complete all fields" and prompts re-entry. **5a. Input exceeds character limit:** System displays "Input too long" and prompts editing. **5a. Database error:** System displays "Failed to save" and retries.
SPECIAL REQUIREMENT	Meal plan saving and notification delivery must be completed within 5 seconds under stable network conditions.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone Database
FREQUENCY OF USE	Medium
SPECIAL ISSUES	None

UC-6 Prescribe Medicine

USE CASE ID	UC-6
USE CASE NAME	Prescribe Medicine
PRIMARY ACTORS	1. Doctor
SECONDARY ACTORS	1. Database
STAKE HOLDERS AND INTEREST	**Doctor:** Prescribe medications for the patient. **Mother:** Receive prescription.
PRE CONDITION	1. The doctor is signed in and linked to the mother. 2. The mother's profile exists in Database.
POST CONDITION	1. A prescription is saved in Database and associated with the mother's profile. 2. The mother receives a notification.
MAIN SUCCESS SCENARIO	1. The doctor opens the mobile app. 2. The system displays the list of linked patients. 3. The doctor navigates the Medicine Prescription section. 4. The doctor enters medicine prescription details (e.g., medicine name, dosage, frequency). 5. The system saves the prescription to Database. 6. The system sends a notification to the mother.
EXTENSION (ALTERNATIVE FLOW)	**4a. Invalid input (e.g., empty fields):** System displays "Please complete all fields" and prompts re-entry. **5a. Database error:** System displays "Failed to save" and retries.
SPECIAL REQUIREMENT	None.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone Database
FREQUENCY OF USE	Medium
SPECIAL ISSUES	None

UC-7 View Prescribed Medicine

USE CASE ID	UC-7
USE CASE NAME	View Prescribed Medicine
PRIMARY ACTORS	1. Doctor 2. Mother
SECONDARY ACTORS	1. Database
STAKE HOLDERS AND INTEREST	**Doctor:** Review prescribed medications. **Mother:** View prescribed medications.
PRE CONDITION	1. The user (Doctor or Mother) is signed in. 2. A prescription exists in Database for the mother.
POST CONDITION	1. The user views the prescribed medicine details.
MAIN SUCCESS SCENARIO	**Use Case: Doctor Views Prescriptions** 1. Doctor opens the mobile App. 2. The system displays a home/dashboard. 3. Doctor selects a linked patient. 4. Doctor navigates to "Prescriptions" section. 5. System retrieves and displays full list of prescriptions. 6. The doctor selects a prescription to view full details (e.g., medicine name, dosage, frequency, notes). 7. Doctors may edit or delete the prescription **Use Case: Mother Views Prescriptions** 1. Mother opens the mobile app. 2. The system displays the home screen. 3. Mother navigates to "My Prescriptions." 4. The system fetches only her own prescriptions from the database. 5. System displays each medicine with dosage, frequency, and instructions.
EXTENSION (ALTERNATIVE FLOW)	**4a. No medicine prescriptions found:** System displays "No prescriptions available." **4b. Database error:** System displays "Failed to load data" and retries.
SPECIAL REQUIREMENT	Data must be displayed within 2 seconds.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone. Database
FREQUENCY OF USE	Medium
SPECIAL ISSUES	None

UC-8 View Prescribed Meal Plan

USE CASE ID	UC-8
USE CASE NAME	View Prescribed Meal Plan
PRIMARY ACTORS	1. Doctor 2. Mother
SECONDARY ACTORS	3. Database
STAKE HOLDERS AND INTEREST	**Doctor:** Review prescribed meal plans. **Mother:** View dietary recommendations.
PRECONDITION	1. The user (Doctor or Mother) is signed in. 2. A meal plan exists in Database for the mother.
POST CONDITION	1. The user views the prescribed meal plan details.
MAIN SUCCESS SCENARIO	**Use Case: Doctor Views Meal Plan** 1. Doctor opens the mobile App. 2. The system displays a home/dashboard. 3. Doctor selects a linked patient. 4. Doctor navigates to "Meal Plan" section. 5. System retrieves and displays full list of Meals. 6. Doctors may edit or delete the meal. **Use Case: Mother Views Meal Plan** 1. Mother opens the mobile app. 2. The system displays the home screen. 3. Mother navigates to "My Prescriptions." 4. The system fetches only her own prescriptions from the database. 5. System displays each medicine with dosage, frequency, and instructions.
EXTENSION (ALTERNATIVE FLOW)	**4a. No meal plans found:** System displays "No meal plans available." **4b. Database error:** System displays "Failed to load data" and retries.
SPECIAL REQUIREMENT	Data must be displayed within 2 seconds.
TECHNOLOGY AND DATA VARIATION LIST	
FREQUENCY OF USE	Medium
SPECIAL ISSUES	None

UC-9 Mark Risk (T /F)

USE CASE ID	UC-9
USE CASE NAME	View Prescribed Meal Plan
PRIMARY ACTORS	1. Doctor
SECONDARY ACTORS	1. Database 2. Notification Service
STAKE HOLDERS AND INTEREST	**Doctor:** Validate system-generated health risks. **Mother:** Be informed of validated risks.
PRE CONDITION	1. The doctor is signed in and linked to the mother. 2. A risk alert (e.g. high blood pressure) exists in Database.
POST CONDITION	1. The risk is marked as True or False in Database. 2. The mother receives a notification if the risk is True
MAIN SUCCESS SCENARIO	1. The doctor receives a risk alert notification. 2. The doctor opens the mobile app. 3. The system displays the Risk Details screen displaying patient name and risk. 4. The doctor reviews the risk data (e.g., blood pressure readings). 5. The doctor marks the risk as True or False. 6. The system saves the decision to Database. 7. The system sends a notification to the mother about the validity of risk.
EXTENSION (ALTERNATIVE FLOW)	**4a. Insufficient data:** System prompts the doctor to request additional data. **6a. Database error:** System displays "Failed to save" and retries.
SPECIAL REQUIREMENT	Notification Delivery in less than 5 seconds.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone Database Notification Service
FREQUENCY OF USE	Medium
SPECIAL ISSUES	None

UC-10 Link Patient

USE CASE ID	UC-10
USE CASE NAME	View Prescribed Meal Plan
PRIMARY ACTORS	1. Doctor
SECONDARY ACTORS	1. Database
STAKE HOLDERS AND INTEREST	**Doctor:** Connect with patient for monitoring. **Mother:** Share health data with doctor.
PRE CONDITION	1. Both Doctor and Mother are signed in. 2. The mother's profile exists in Database.
POST CONDITION	1. The doctor and mother are linked in Database. 2. Link request fails or is declined.
MAIN SUCCESS SCENARIO	1. The doctor opens the mobile app and navigates to Link Patient Screen. 2. The system displays the Link Patient screen. 3. The doctor enters the patient's unique ID. 4. The system validates the patient's id and display patient Name and profile picture to confirm doctor connects with the correct patient. 5. The system connects the doctor with the patient and saves this info.
EXTENSION (ALTERNATIVE FLOW)	**3a. Invalid ID:** System displays "Invalid ID" and prompts re-entry. **4a. No matching user:** System displays "User not found" and prompts to check ID. **5a. Database error:** System displays "Failed to link" and retries after 7 seconds.
SPECIAL REQUIREMENT	The link process must be completed within 10 seconds.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone. Database Notification Service
FREQUENCY OF USE	Low.
SPECIAL ISSUES	None

UC-11 Archive Patient

USE CASE ID	UC-11
USE CASE NAME	Archive Patient
PRIMARY ACTORS	1. Doctor
SECONDARY ACTORS	1. Database
STAKE HOLDERS AND INTEREST	**Doctor:** End monitoring after delivery and focus on active patients. **Mother:** Stop sharing health data.
PRE CONDITION	1. Both Doctor and Mother are signed in. 2. The doctor and mother are linked in Database.
POST CONDITION	1. The patient is removed from an active patient list and will be displayed archive patients list. 2. Unlink request fails.
MAIN SUCCESS SCENARIO	1. The doctor opens the mobile app and requests to view **Linked Patients**. 2. The system displays a list of **linked patients**. 3. The doctor selects a patient to **archive** from the active patients list. 4. The system prompts a **confirmation message** to archive the selected patient. 5. The doctor confirms the **archive action**. 6. The system removes the selected patient from the **active list**, moves them to the **archived patients list**, and saves the change in the database.
EXTENSION (ALTERNATIVE FLOW)	**5a. User cancels:** System returns to the Linked Profiles screen. **6a. Database error:** System displays "Failed to unlink" and retries.
SPECIAL REQUIREMENT	Unlink process must be completed within 5 seconds.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone Database.
FREQUENCY OF USE	Low.
SPECIAL ISSUES	None

UC-12 View Risk

USE CASE ID	UC-12
USE CASE NAME	View Risk
PRIMARY ACTORS	1. Doctor 2. Mother
SECONDARY ACTORS	1. Database 2. Notification Service
STAKE HOLDERS AND INTEREST	**Doctor:** Review health risks. **Mother:** Understand health alerts.
PRE CONDITION	1. The doctor or mother is signed in. 2. A risk alert exists in the Database. 3. The doctor and mother are linked.
POST CONDITION	1. The user views risk details and associated data.
MAIN SUCCESS SCENARIO	1. The user receives a risk alert notification and taps over it. 2. The system displays the Risk Details screen. 3. The system retrieves and displays patient name, patient photo and active risk details (e.g., high blood pressure, reason).
EXTENSION (ALTERNATIVE FLOW)	**4a. No risks found:** System displays "No active risks." **4b. Database error:** System displays "Failed to load data" and retries.
SPECIAL REQUIREMENT	Display time: < 2 Seconds.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone, Database Notification Service
FREQUENCY OF USE	Medium.
SPECIAL ISSUES	Risk visualization format (e.g., graphs, text) TBD.

UC-13 Send / Receive Message

USE CASE ID	UC-13
USE CASE NAME	Send / Receive Messages
PRIMARY ACTORS	1. Doctor 2. Mother
SECONDARY ACTORS	1. Database, 2. Notification Service
STAKE HOLDERS AND INTEREST	**Doctor:** Answers the patient's queries. **Mother:** Communicate with doctor.
PRE CONDITION	1. Both the mother and doctor are signed in and linked. 2. The messaging feature is enabled in the app.
POST CONDITION	1. The message is sent, received, and stored in the Database. 2. The recipient receives a notification.
MAIN SUCCESS SCENARIO	1. The user navigates to the "Messages" section. 2. The user selects the intended recipient from a contact list. 3. The user composes a message. 4. The user sends the message. 5. The system delivers the message to the recipient. 6. The recipient receives a notification. 7. The recipient views the message. 8. The conversation is stored in the message history.
EXTENSION (ALTERNATIVE FLOW)	**3a.** Recipient not found → System displays an error message and prompts to try again. **6a.** Internet unavailable → System shows an error and retries sending when the connection is restored.
SPECIAL REQUIREMENT	Push notifications for new messages.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone.
FREQUENCY OF USE	Low.
SPECIAL ISSUES	None

UC-14 Count Fetal Movements

USE CASE ID	UC-14
USE CASE NAME	Count Fetal Movements
PRIMARY ACTORS	1. Mother
SECONDARY ACTORS	1. Wristband 2. Notification Service 3. Database
STAKE HOLDERS AND INTEREST	**Mother:** Track Fetal movement to monitor baby health. **Doctor:** Receive alerts for abnormal patterns.
PRECONDITION	1. The Mother has signed in and has paired with the wristband. 2. The mother is in third trimester. 3. The wristband has functional fetal movement buttons.
POST CONDITION	1. Fetal Movement Data is recorded in the database. 2. A risk movement is generated if movement patterns are abnormal.
MAIN SUCCESS SCENARIO	1. The mother opens the mobile app and opens the fetal movement Tracking screen. 2. The system displays the Fetal Movement Tracking screen 3. The mother presses the wrist buttons to log 10 movements (e.g., kicks). 4. The system records each press and tracks time to reach 10 movements. 5. The system saves data on a Database. 6. If <10 movements in 2 hours, the system generates a risk alert and notifies doctor and mother.
EXTENSION (ALTERNATIVE FLOW)	**3a. Wristband disconnected:** System displays "Device disconnected" and prompts to reconnect. **6a. Database error:** System displays "Failed to save" and retries. **6b. High-risk pregnancy:** System applies stricter thresholds (e.g.,
SPECIAL REQUIREMENT	Real-time tracking with <1- second response to button presses.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone, Wristband (Bluetooth), Database (JSON data format), Notification Service.
FREQUENCY OF USE	Medium (daily in third trimester)
SPECIAL ISSUES	None

UC-15 Reset Password

USE CASE ID	UC-15
USE CASE NAME	Reset Password
PRIMARY ACTORS	1. Doctor 2. Mother
SECONDARY ACTORS	1. Database
STAKE HOLDERS AND INTEREST	**Doctor:** Reset the password if forgotten. **Mother:** Reset the password if forgotten.
PRECONDITION	1. The user account exists on the system. 2. The user has access to registered email addresses or phone number.
POST CONDITION	1. The user's password is updated successfully, and they can log in with the new password
MAIN SUCCESS SCENARIO	1. The user selects the "Forgot Password". 2. The system prompts the user to enter their registered email address. 3. The user enters the required information and submits the request. 4. The system validates the email/phone number against the user database. 5. The system sends a one-time password to the user's registered email/phone. 6. The user receives the link/code and clicks the link or enters the code in the provided interface. 7. The system verifies the link/code and prompts the user to enter a new password. 8. The user enters and confirms the new password, adhering to security requirements (e.g., minimum length, special characters). 9. The system updates the password in the database and notifies the user of a successful reset. 10. The user can now log in with the new password.
EXTENSION (ALTERNATIVE FLOW)	**5a. Invalid email format:** System displays "Invalid email format" and prompts re-entry. **3b. One Time Password Wrong or Expired:** System displays "Expired One Time Password" and try again. **3c. Account does not exist:** System displays "Account does not exist".
SPECIAL REQUIREMENT	Email should be a valid email. Minimum password length: 8 characters, including one uppercase, one number, and one special character.
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone, Database (JSON data format).
FREQUENCY OF USE	Low.
SPECIAL ISSUES	None

UC-16 Logout

USE CASE ID	UC-16
USE CASE NAME	Logout
PRIMARY ACTORS	1. Doctor 2. Mother
SECONDARY ACTORS	1. Database
STAKE HOLDERS AND INTEREST	**Doctor:** Logout From the App. **Mother:** Logout from the App.
PRE CONDITION	1. The user is logged in.
POST CONDITION	1. The user is Logged out from the system.
MAIN SUCCESS SCENARIO	1. The user selects the "Logout" option from the user interface. 2. The system terminates the user's active session. 3. The system clears any session-related data (e.g., cookies, tokens) from the user's device. 4. The system redirects the user to the login page or a confirmation message indicating successful logout.
EXTENSION (ALTERNATIVE FLOW)	-
SPECIAL REQUIREMENT	-
TECHNOLOGY AND DATA VARIATION LIST	Smart Phone, Database (JSON data format).
FREQUENCY OF USE	Low.
SPECIAL ISSUES	None

System Sequence Diagrams

System Sequence Diagrams illustrate the interactions between external actors and the system, showing the flow of events and data over time
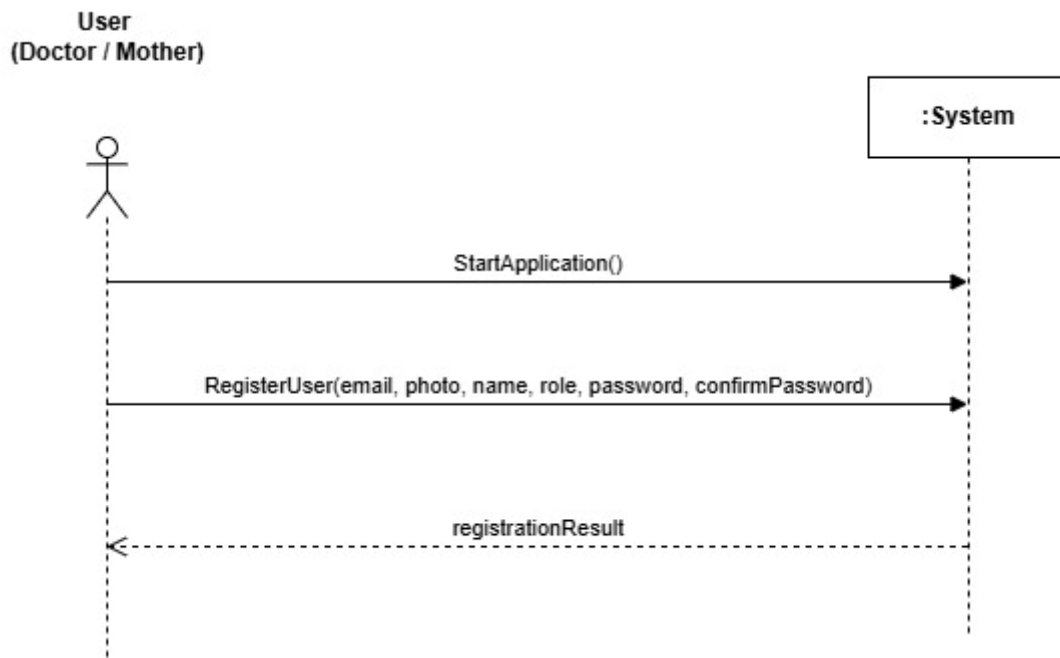
SSD – UC 1 Sign up
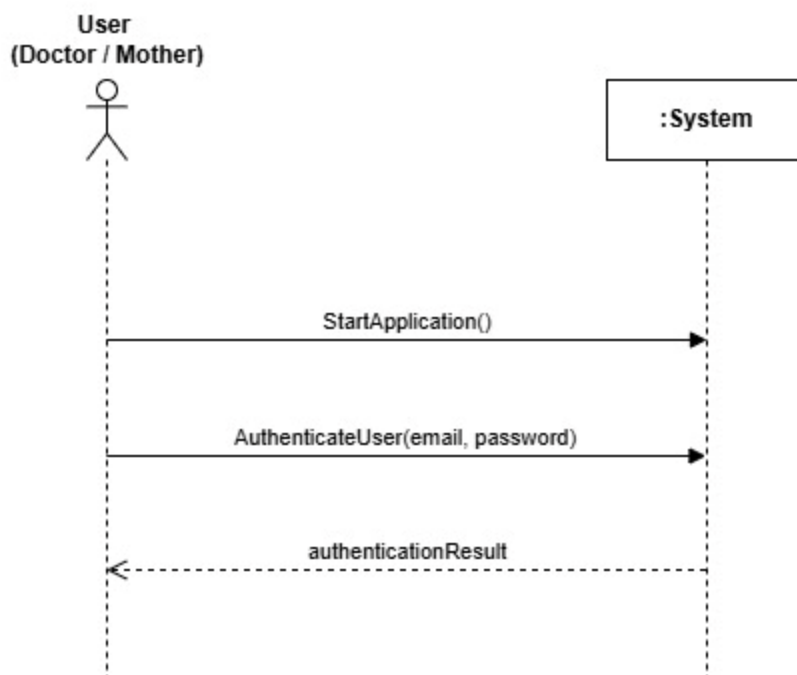

Figure 4 UC-1 Signup

SSD – UC 2 Sign In

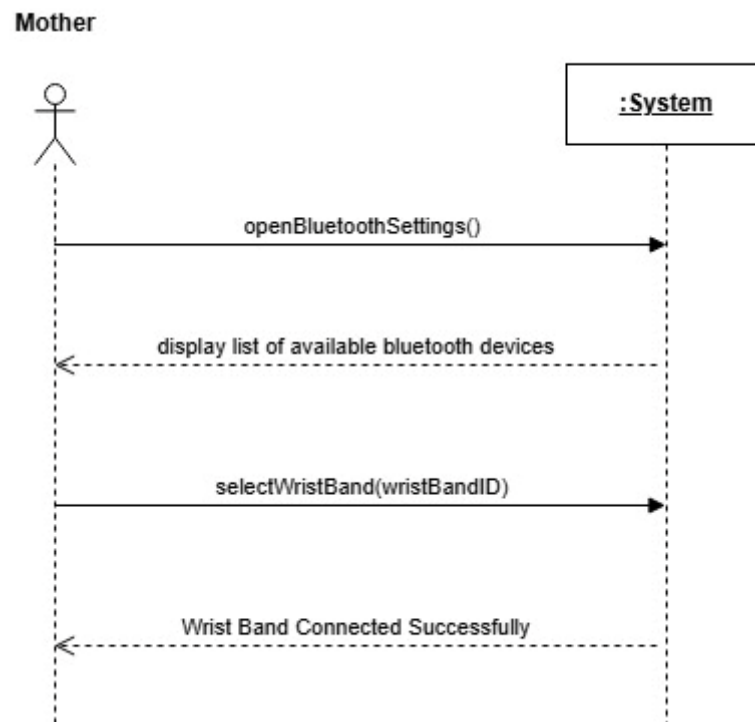*Figure 5 SSD UC-2 Sign in*

SSD UC-3 Pair Wristband

Figure 6 SSD UC-3 Pair Wristband
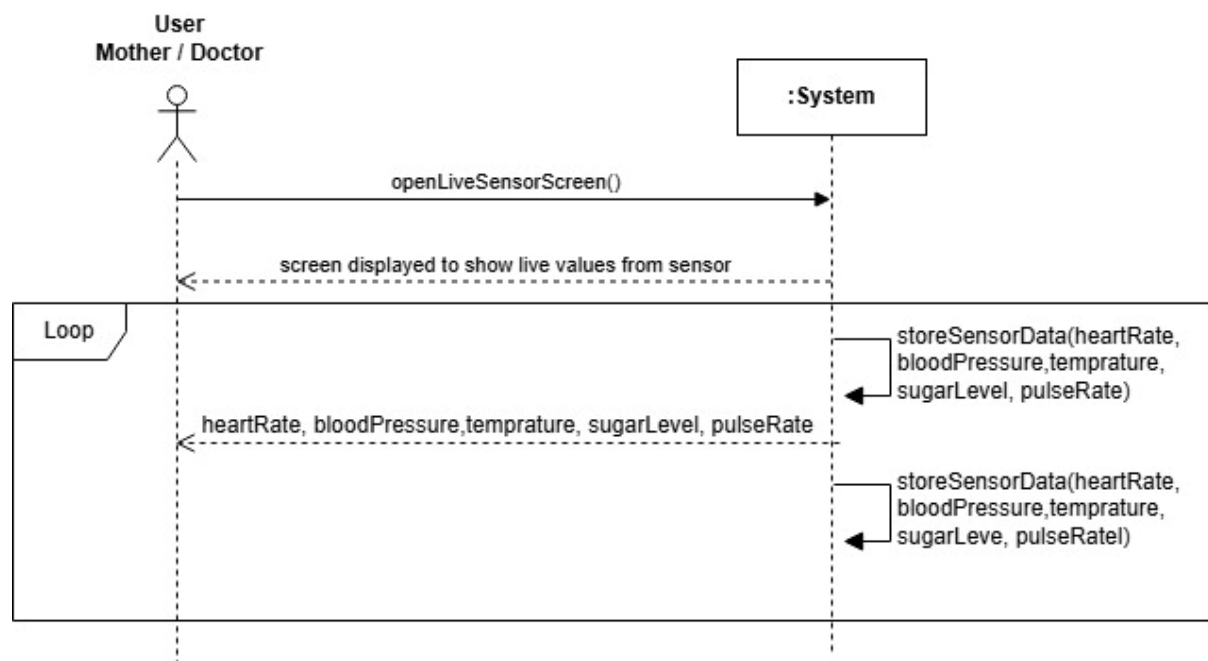
SSD UC-4 View Live Sensor Data

Figure 7 UC-4 View Live Sensor Data
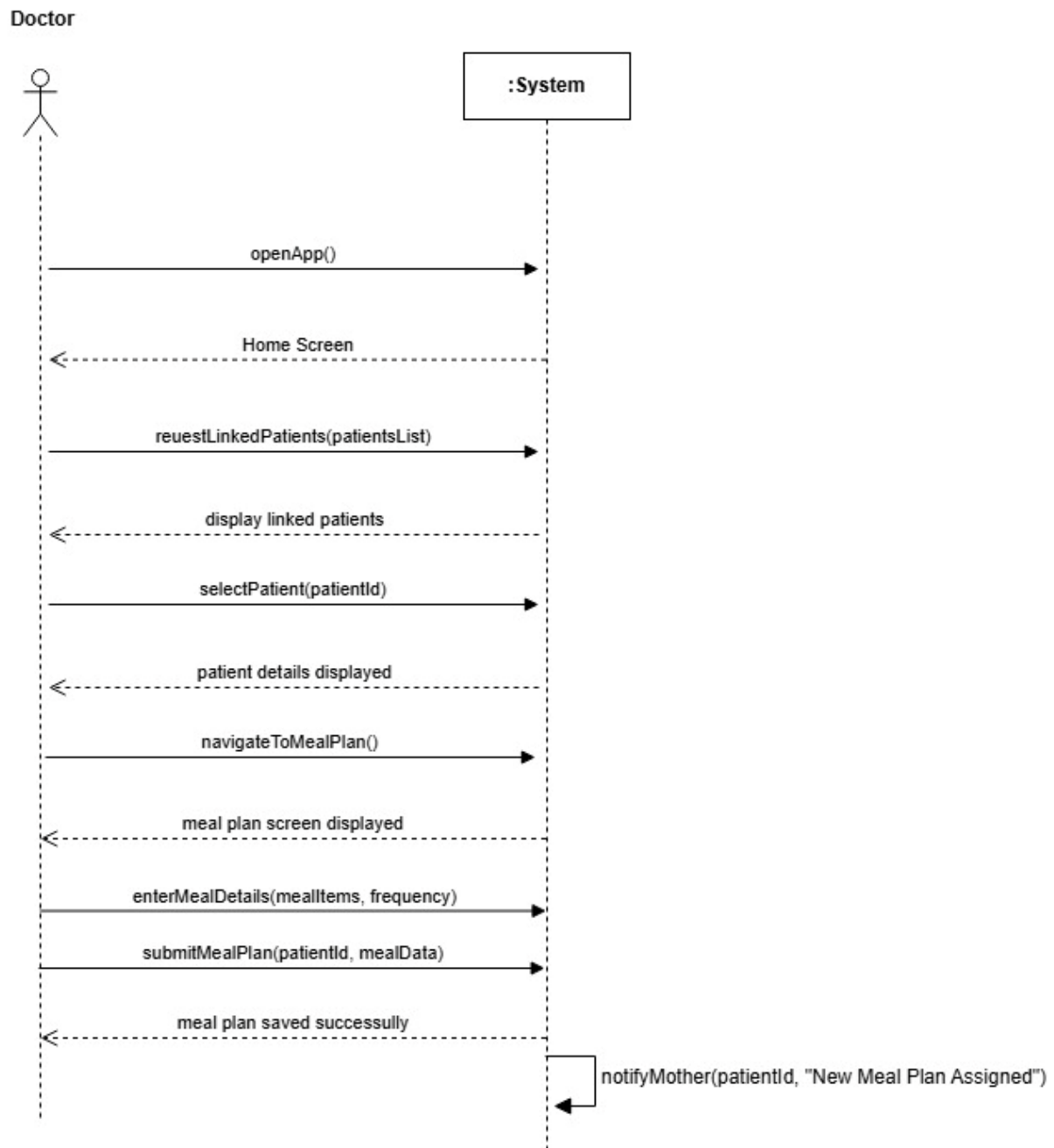
SSD UC-5 Prescribe Meal Plan

Figure 8 UC-5 Prescribe Meal Plan
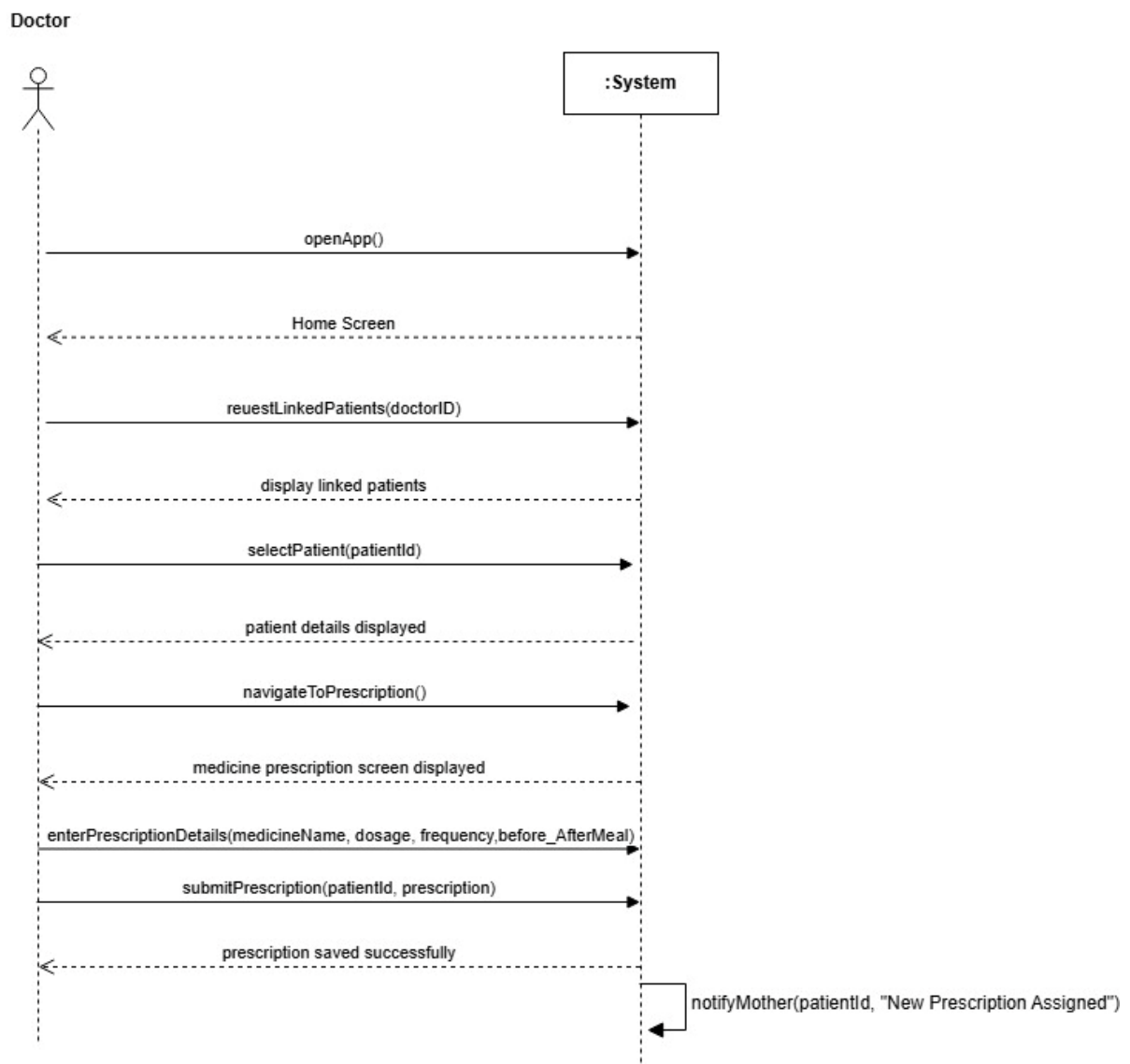
SSD UC-6 Prescribe Medicine

Figure 9 SSD UC-6 Prescribe Medicine
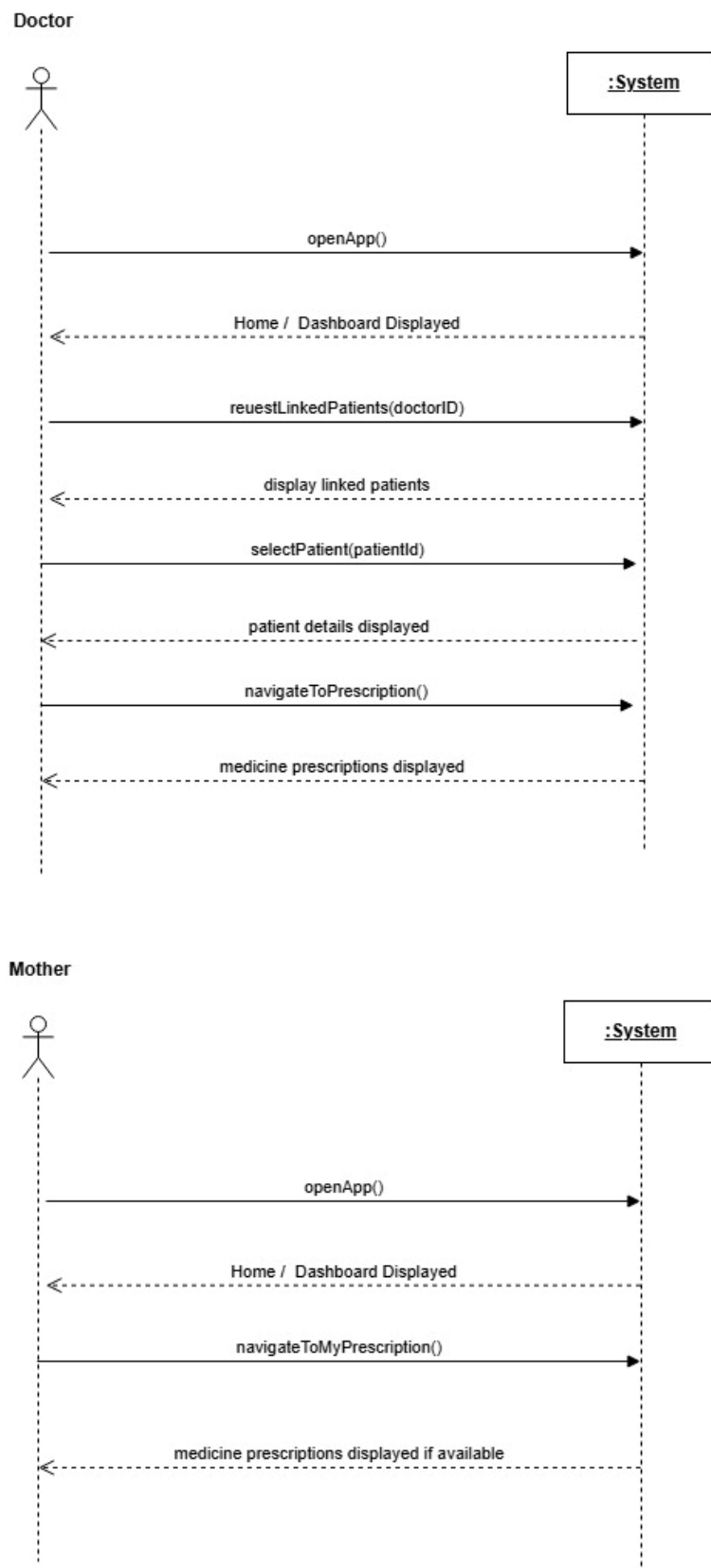
SSD UC-7 View Prescribe Medicine

Figure 10 SSD UC-7 View Prescribed Medicine
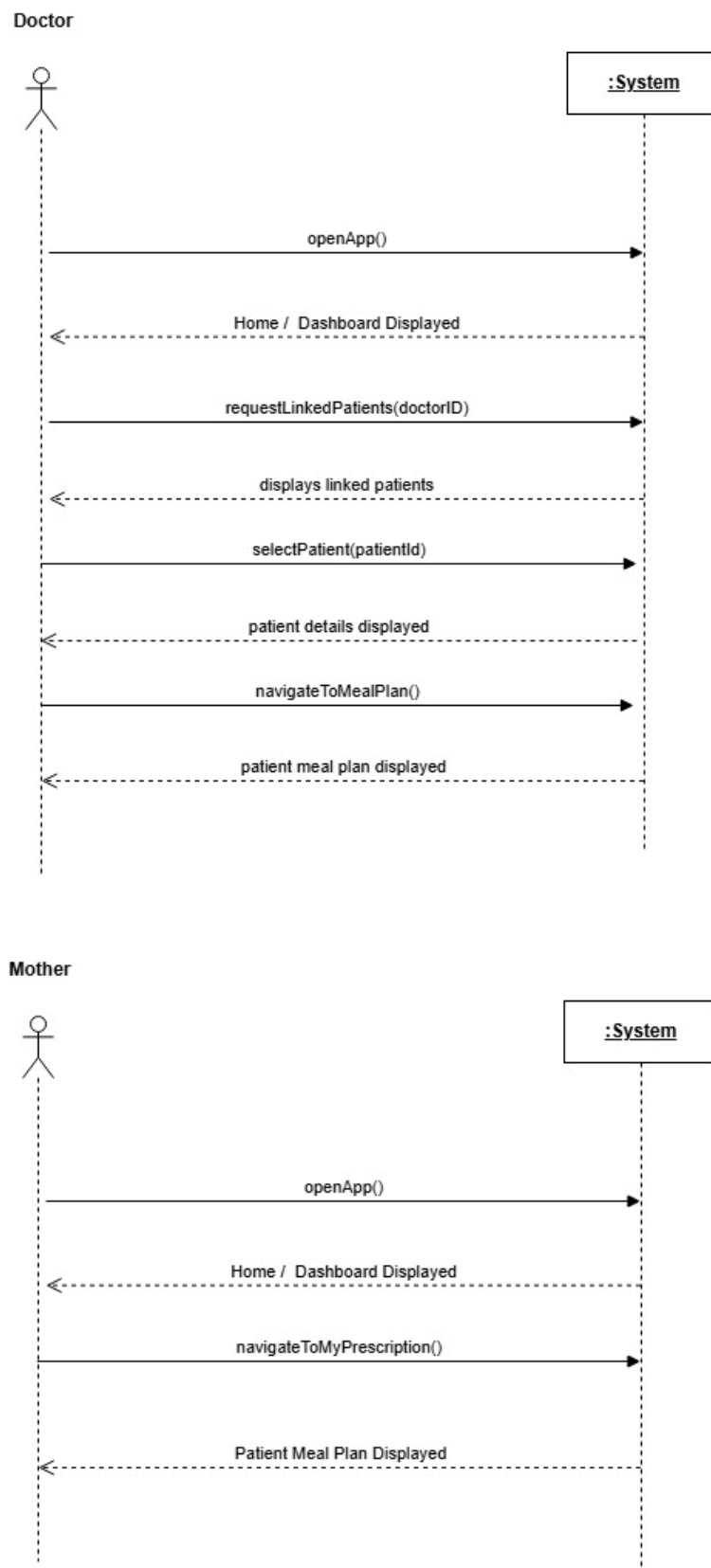
SSD UC-8 View Prescribed Meal Plan

Figure 11 SSD UC-8 View Prescribed Meal Plan
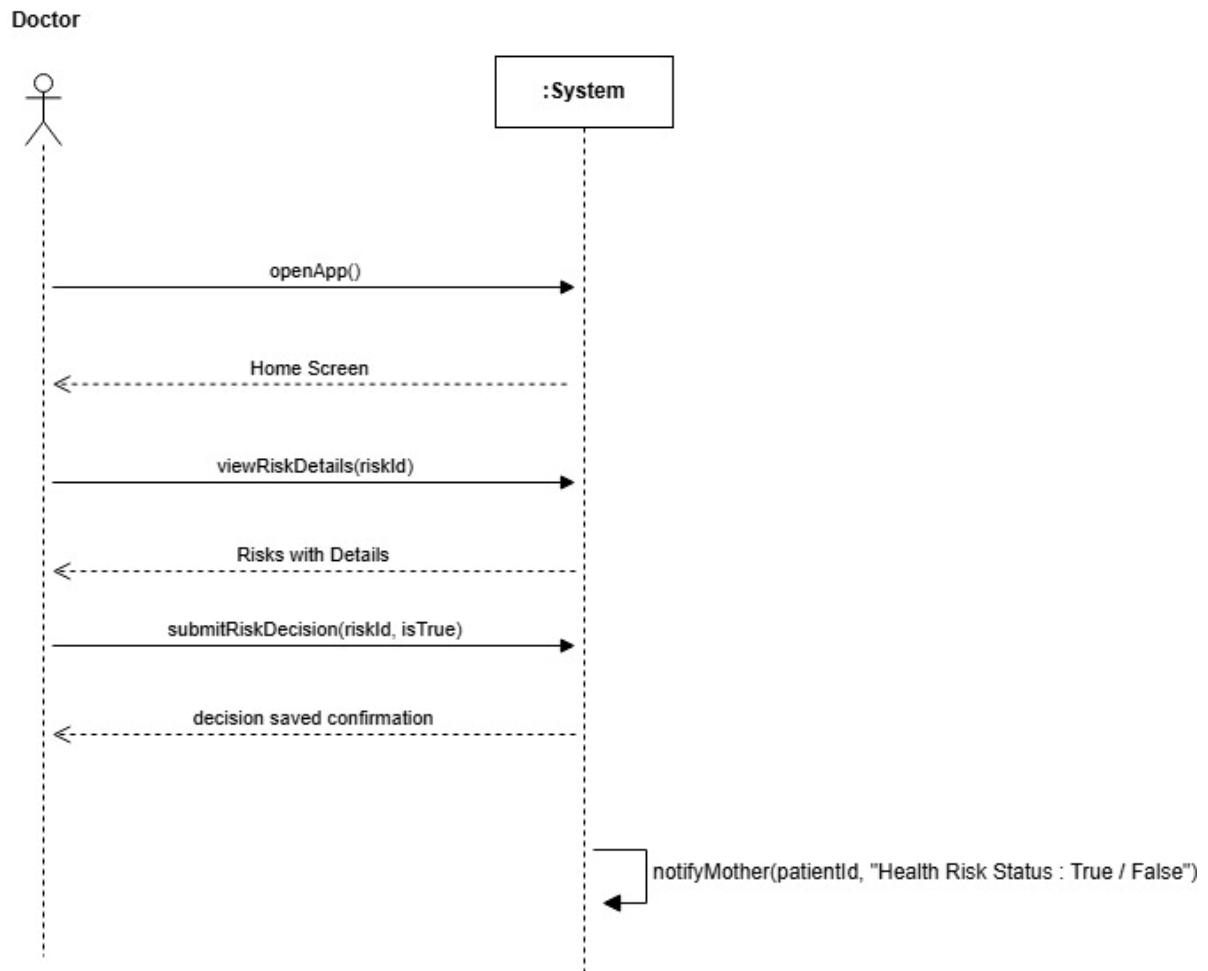
SSD UC-9 Mark Risk (T / F)

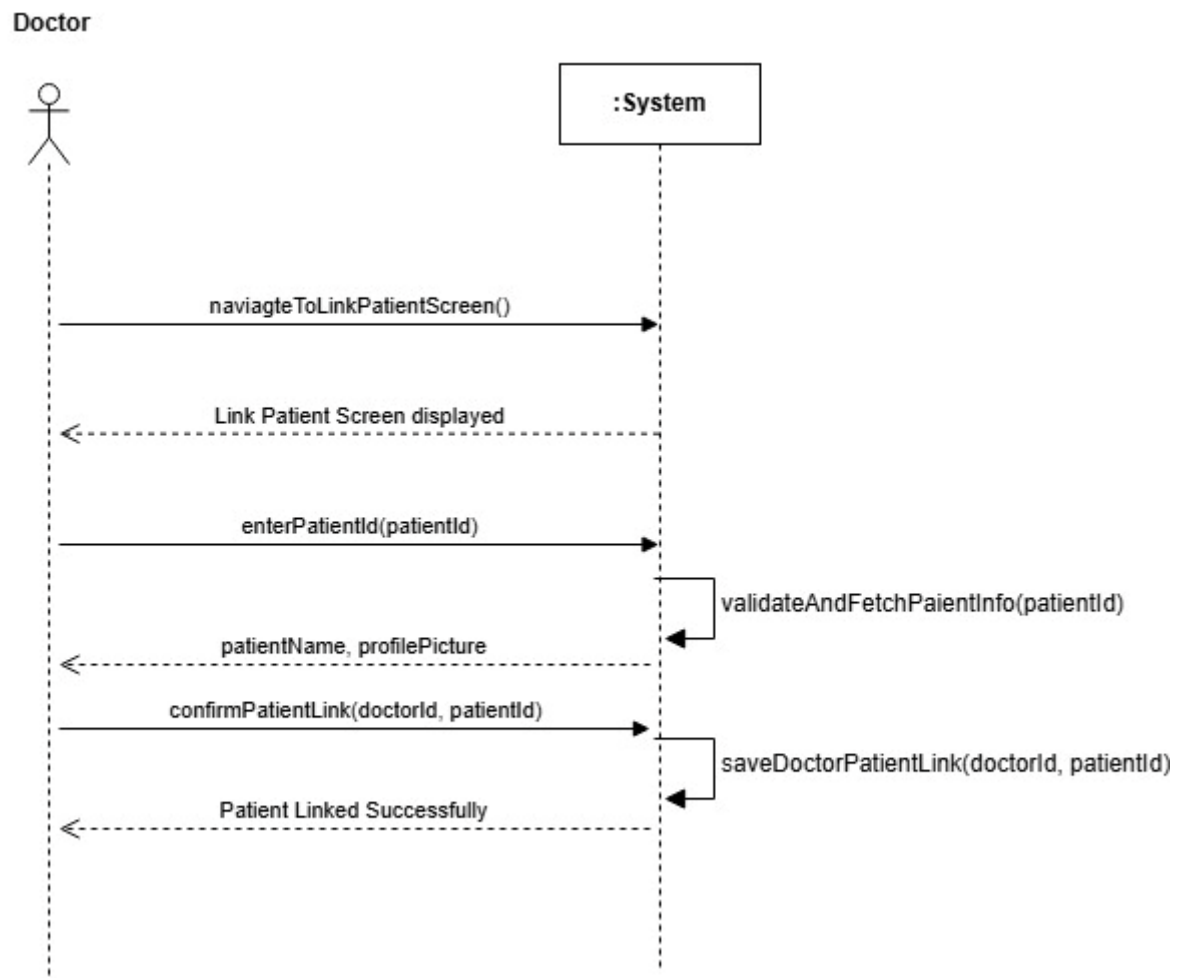*Figure 12 SSD UC-9 Mark Risk (T / F)*

SSD UC -10 Link Patient

SSD UC -11 Unlink Patient
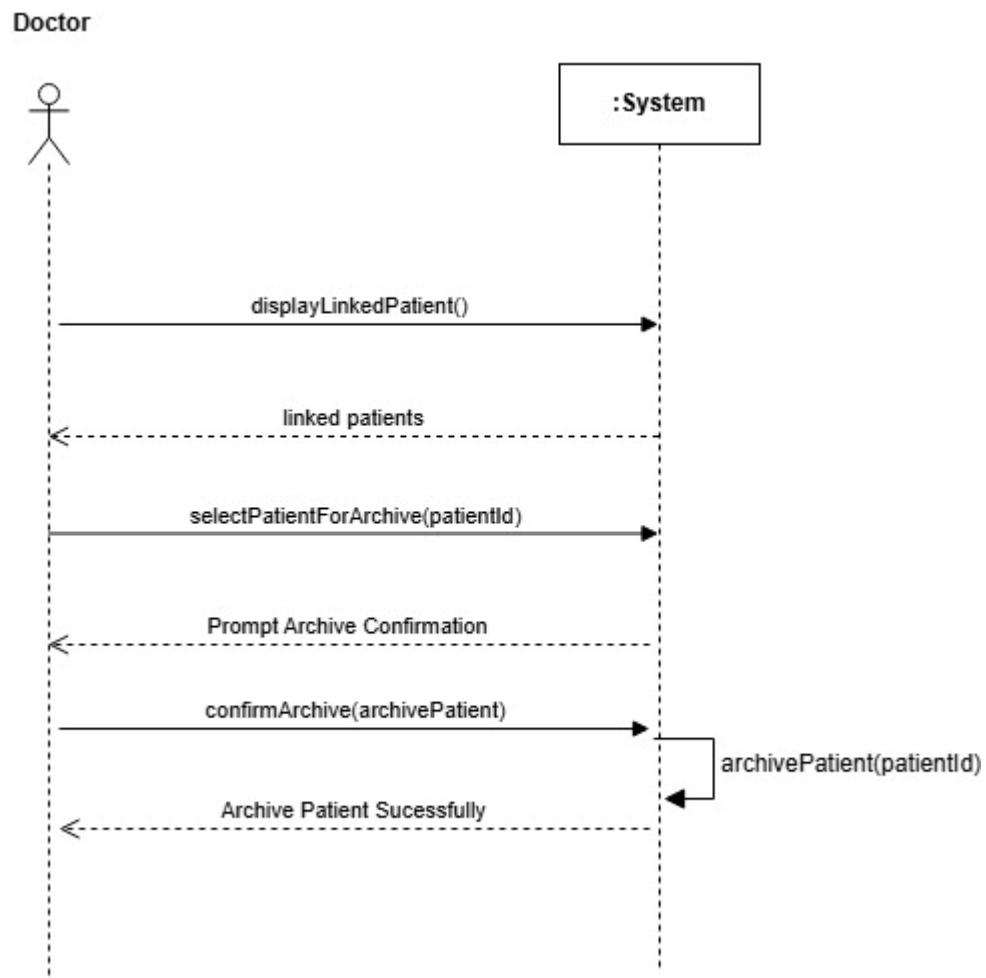
Figure 13 SSD UC -11 Unlink Patient

SSD UC-12 View Risk
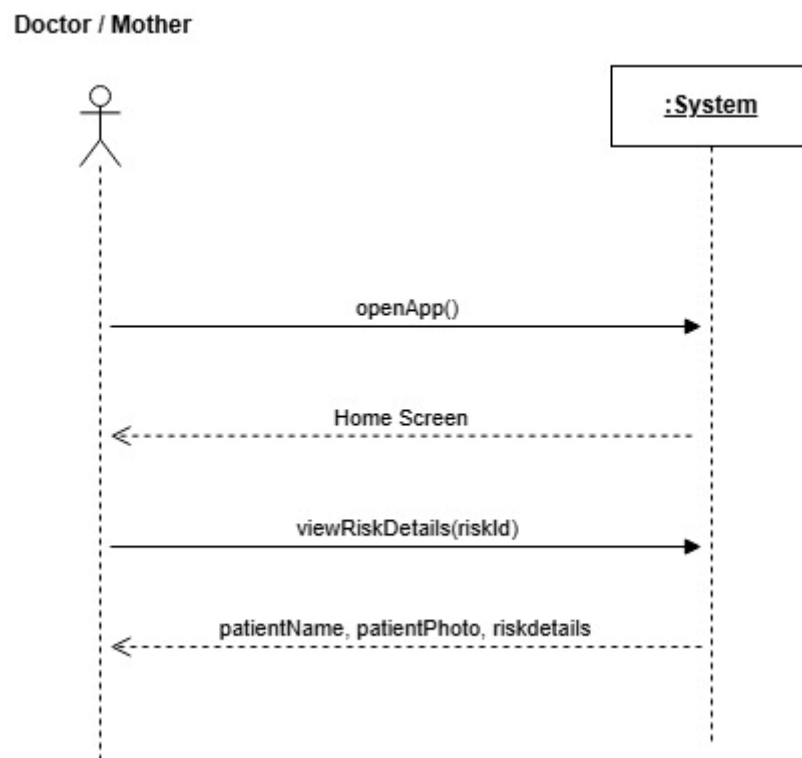
Doctor / Mother

SSD – UC -13 Send / Receive Message
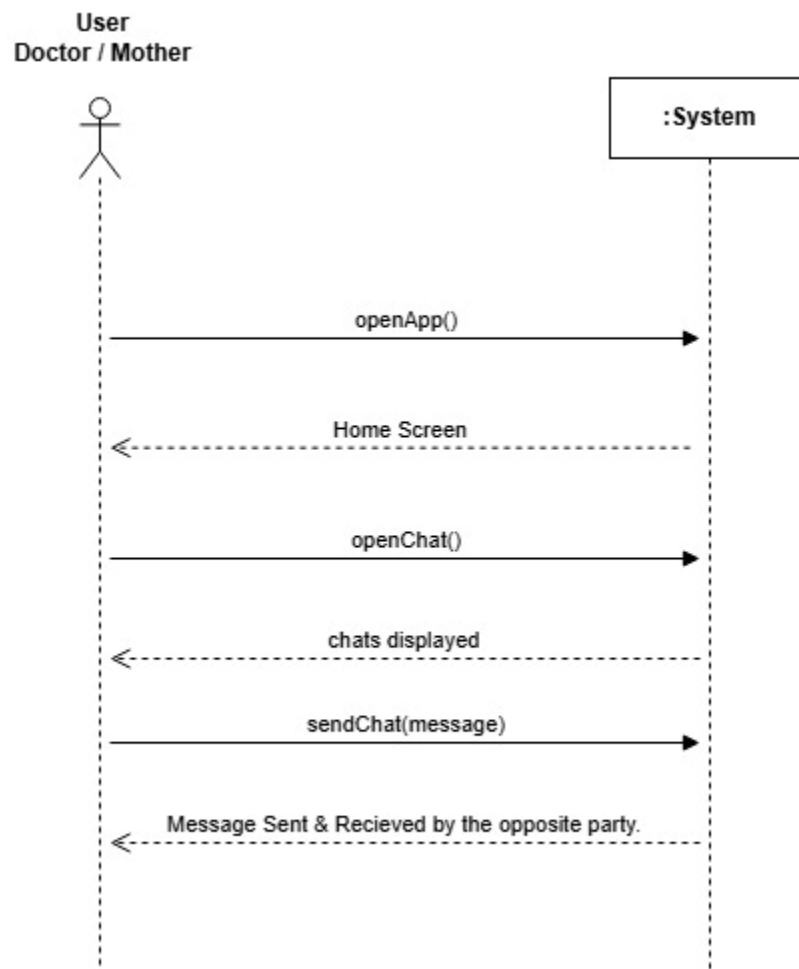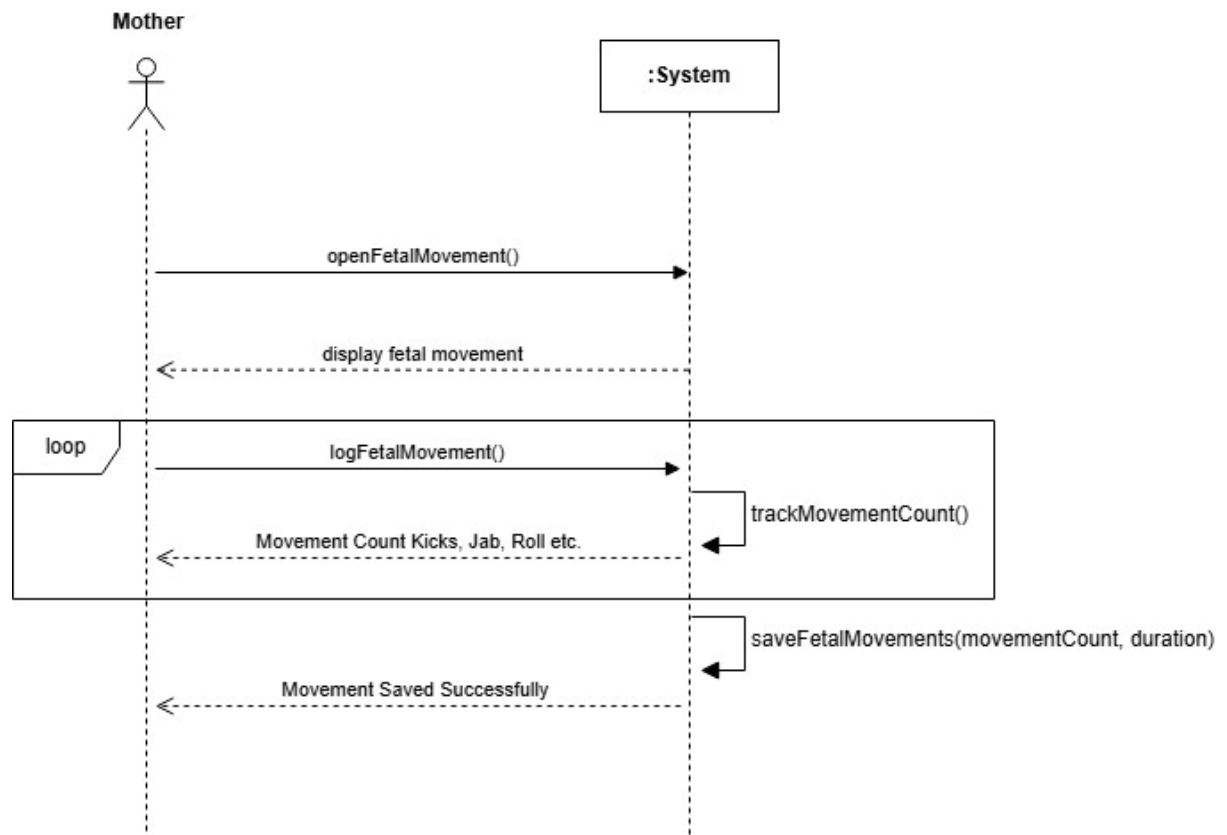
User
Doctor / Mother   **:System**

openApp()

Home Screen

openChat()

chats displayed

sendChat(message)

Message Sent & Recieved by the opposite party.

SSD UC-14 Count Fetal Movements

Figure 14 SSD UC-14 Count Fetal Movements

SSD UC-15 Reset Password

User
Mother / Doctor

:System

selectForgotPassword()

prompt registered email

submitEmail(email)

validateEmail(email)

generateOTP()

OTP, Prompt OTP

submitOTP(OTP)

Enter New Password

submitNewPassword(password, confirmPassword)

validatePasswordStrength(password)

updatePasswordInDatabase()

Password Resest Success

SSD UC-16 Logout

Mother / Doctor
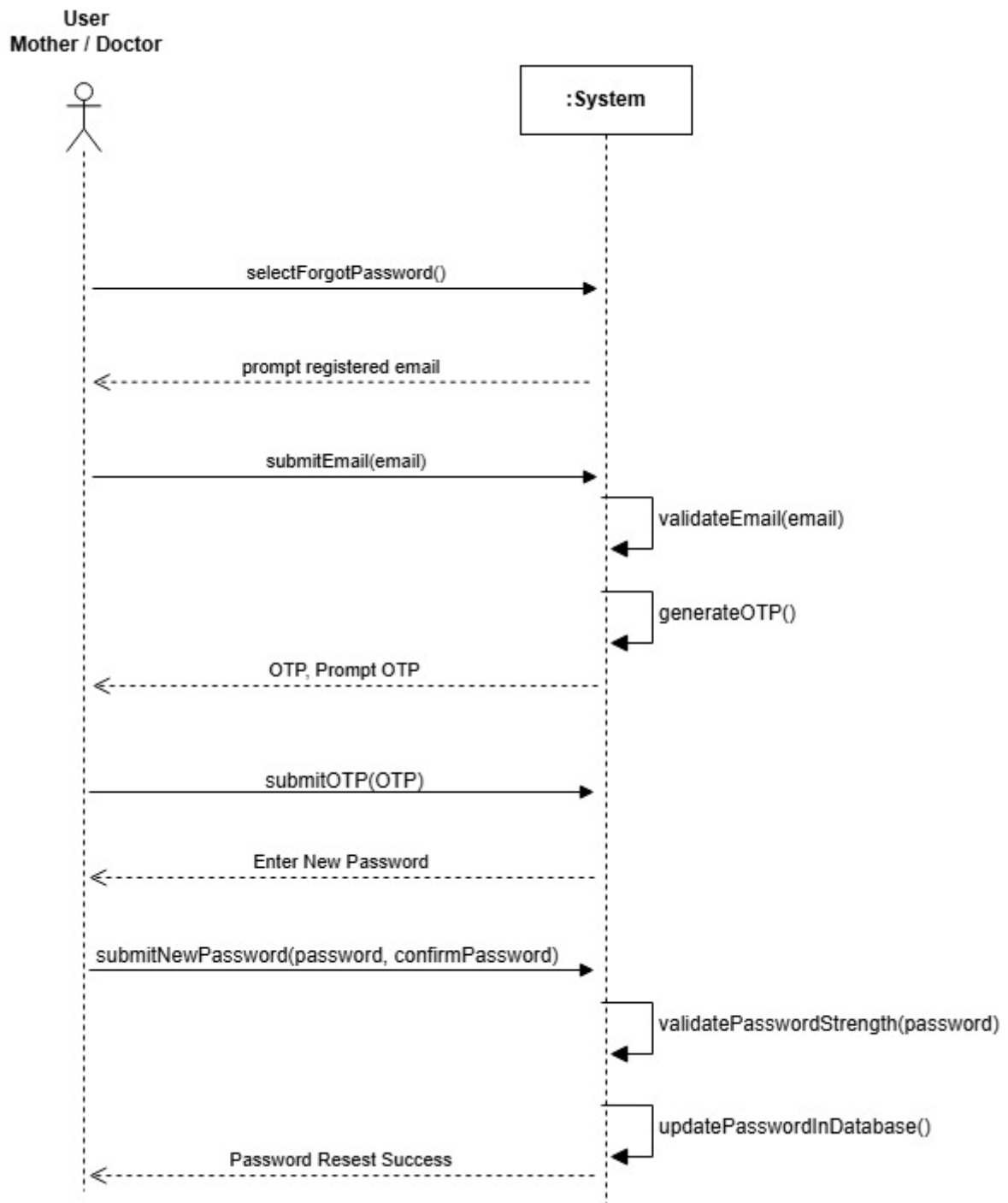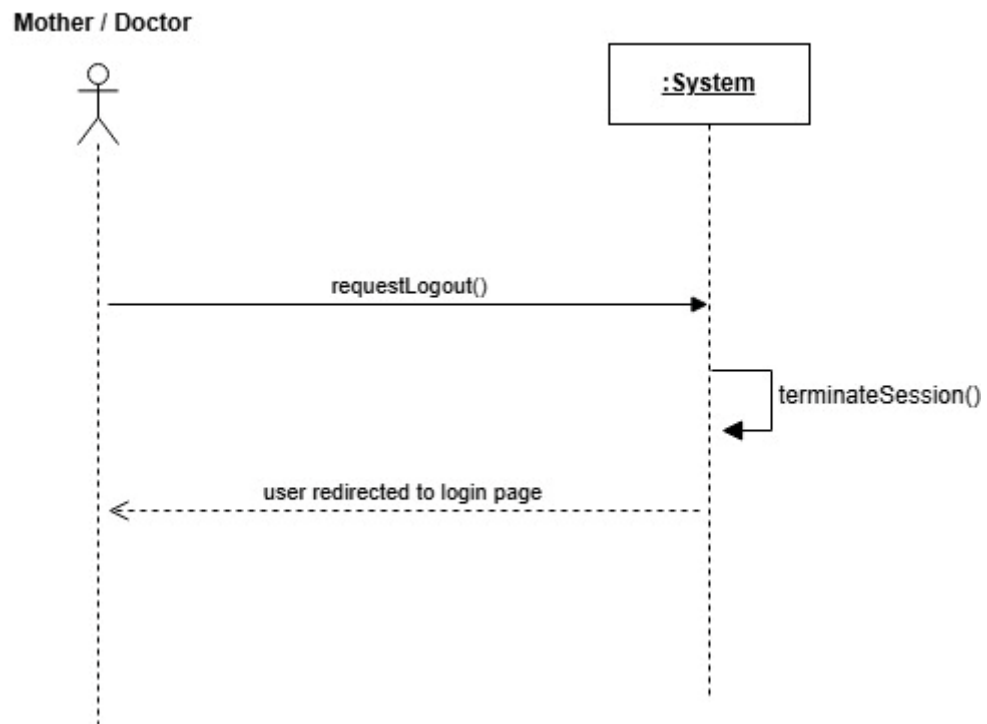
Figure 15 SSD UC-16 Logout

Domain Model

ERD DIAGRAM

UserAccount
- accountID: String «PK»

email: String
password: String
role: String
motherID: String «FK» «optional»
doctorID: String «FK» «optional»

DoctorMother
- doctorID: String «PK» «FK»
- motherID: String «PK» «FK»

linkDate: Date

Doctor
- doctorID: String «PK»

name: String
email: String
specialization: String

Mother
- motherID: String «PK»

name: String
email: String
pregnancyStage: String
medicalHistory: Text

MealPlan
- planID: String «PK»

motherID: String «FK»
doctorID: String «FK»
foodItems: Text
frequency: String
startDate: Date
endDate: Date

Wristband
- deviceID: String «PK»

motherID: String «FK»
status: String
bluetoothID: String

Prescription
- prescriptionID: String «PK»

motherID: String «FK»
doctorID: String «FK»
medicineName: String
dosage: String
frequency: String
startDate: Date

Message
- messageID: String «PK»

senderID: String «FK»
receiverID: String «FK»
content: Text
timestamp: DateTime

FetalMovement
- movementID: String «PK»

motherID: String «FK»
deviceID: String «FK»
count: Integer
timestamp: DateTime
duration: Float

SensorData
- dataID: String «PK»

motherID: String «FK»
deviceID: String «FK»
heartRate: Integer
bloodPressure: String
bodyTemperature: Float
bloodSugar: Float
timestamp: DateTime

RiskAlert
- alertID: String «PK»

motherID: String «FK»
dataID: String «FK» «optional»
movementID: String «FK» «optional»
type: String
description: Text
timestamp: DateTime
isValidated: Boolean
doctorID: String «FK» «optional»

Relationships:
- authenticates
- authenticates
- monitors via DoctorMother
- prescribes
- follows
- wears
- receives
- sends/receives
- prescribes
- sends/receives
- validates
- logs
- generates
- receives
- records
- collects
- triggers
- triggers

Chapter No 3

Software Design and Description

Sequence Diagrams

SD UC-1 Signup

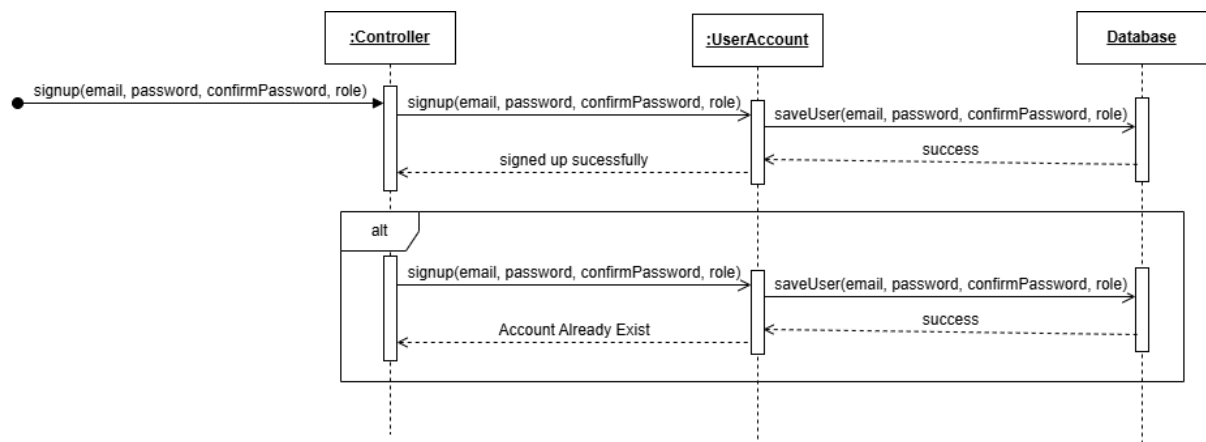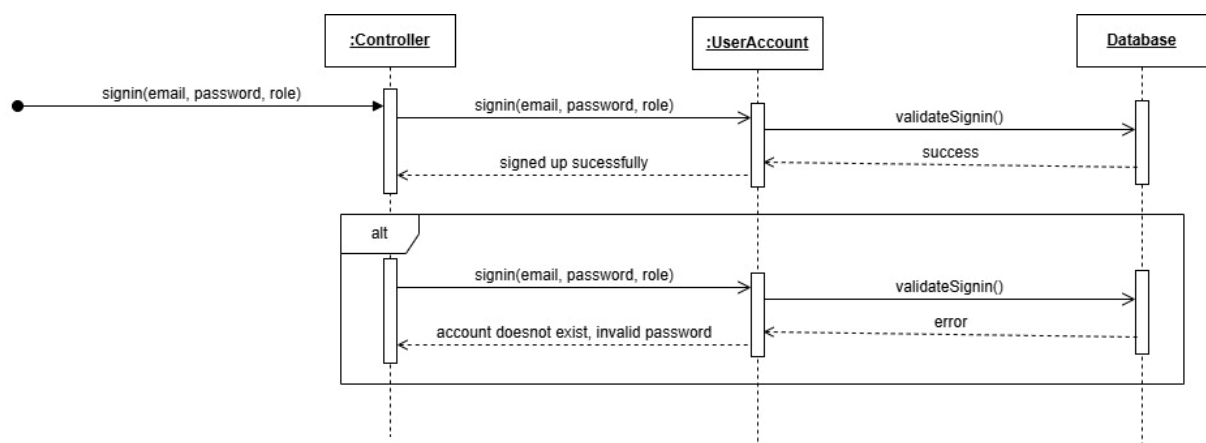*Figure 16 Sequence Diagram Signup*

SD UC-2 Sign in

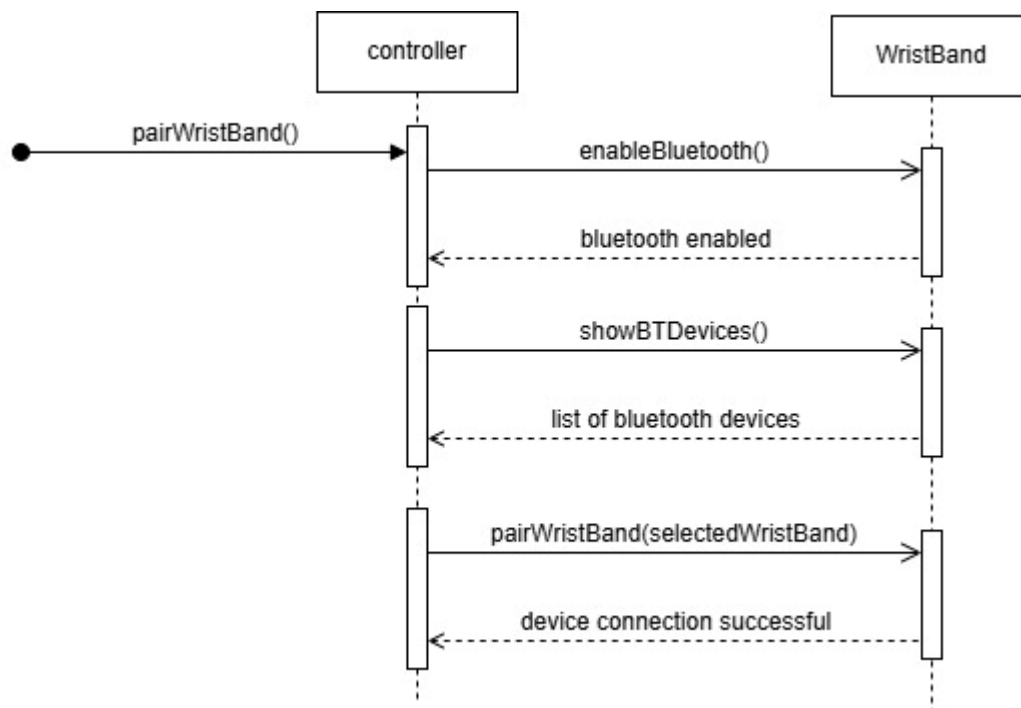*Figure 17 Sequence Diagram Sign in*

SD UC-3 Pair Wrist Band

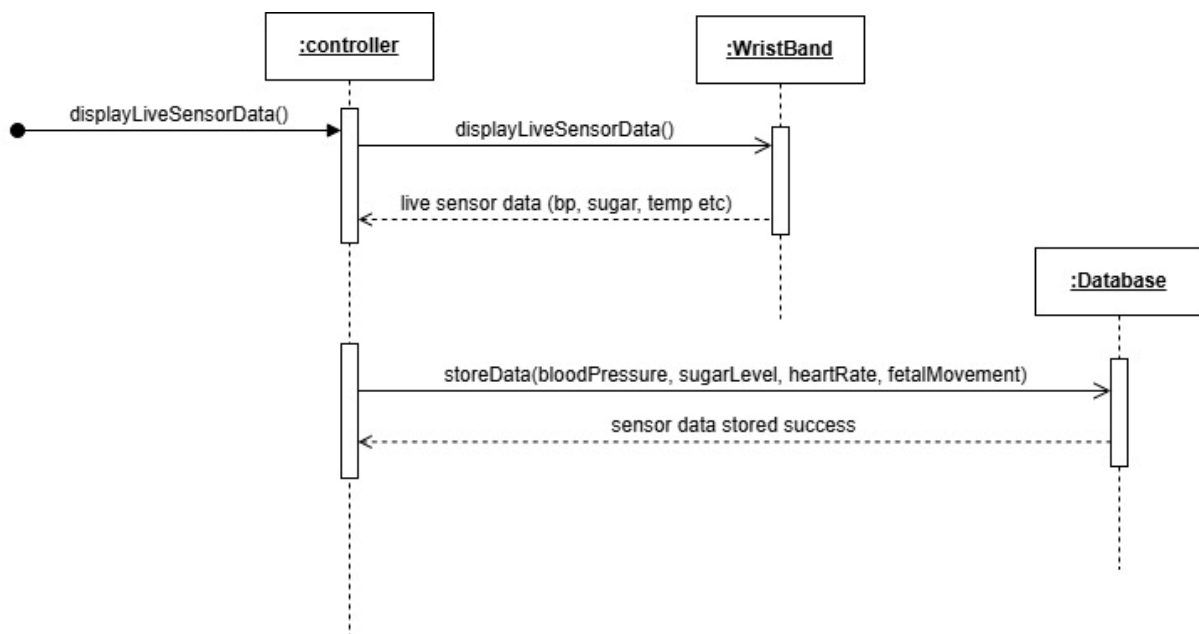*Figure 18 System Sequence Diagram Pair Wristband*

SD UC-4 View Live Sensor Data

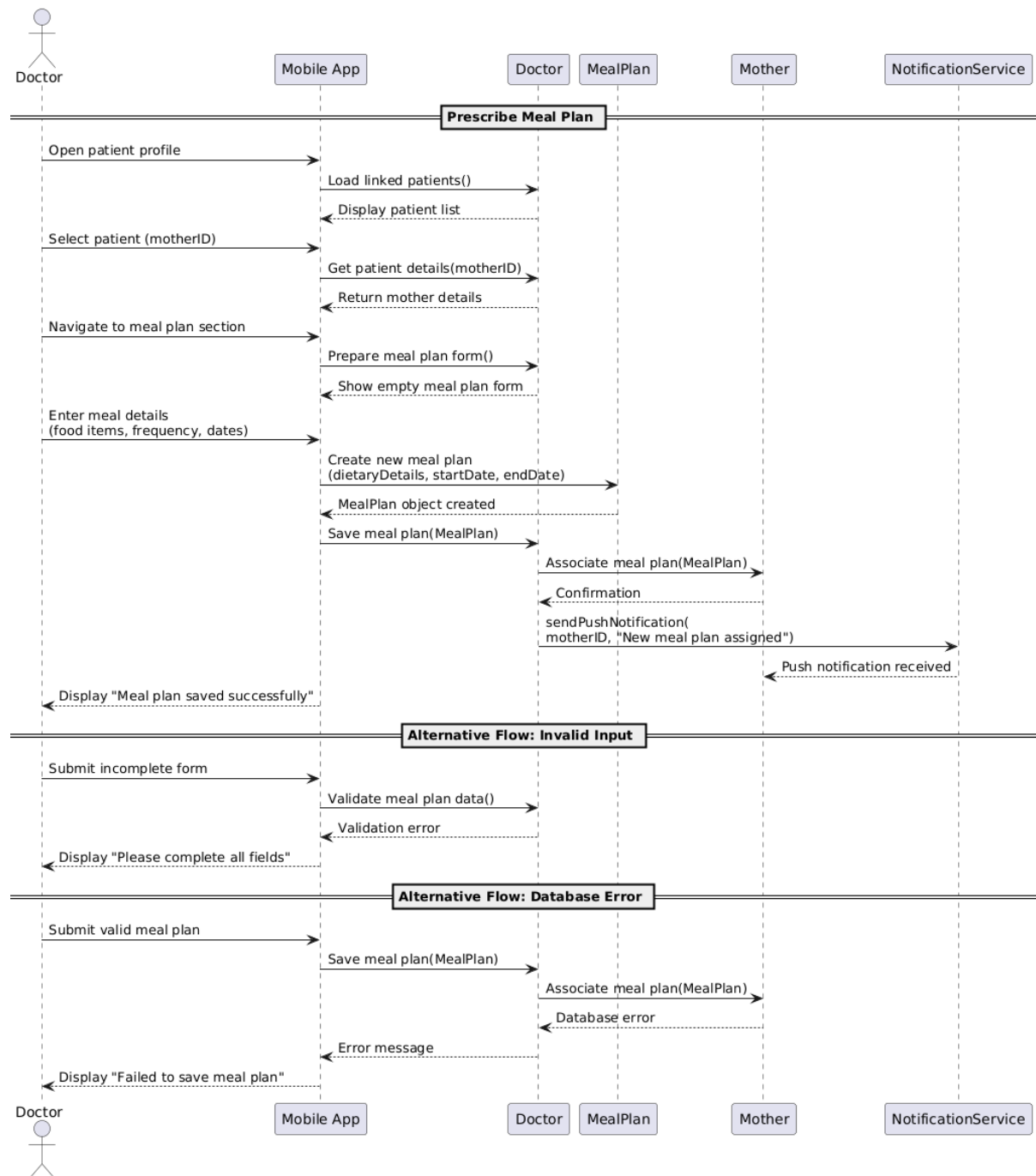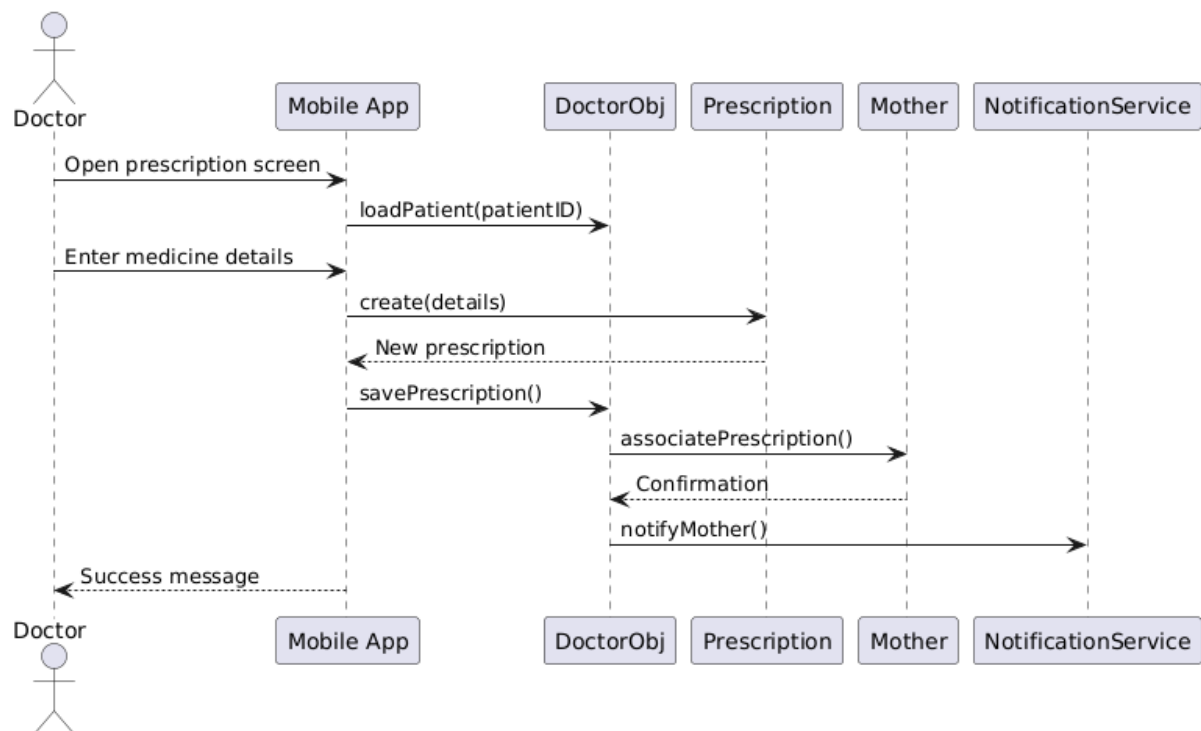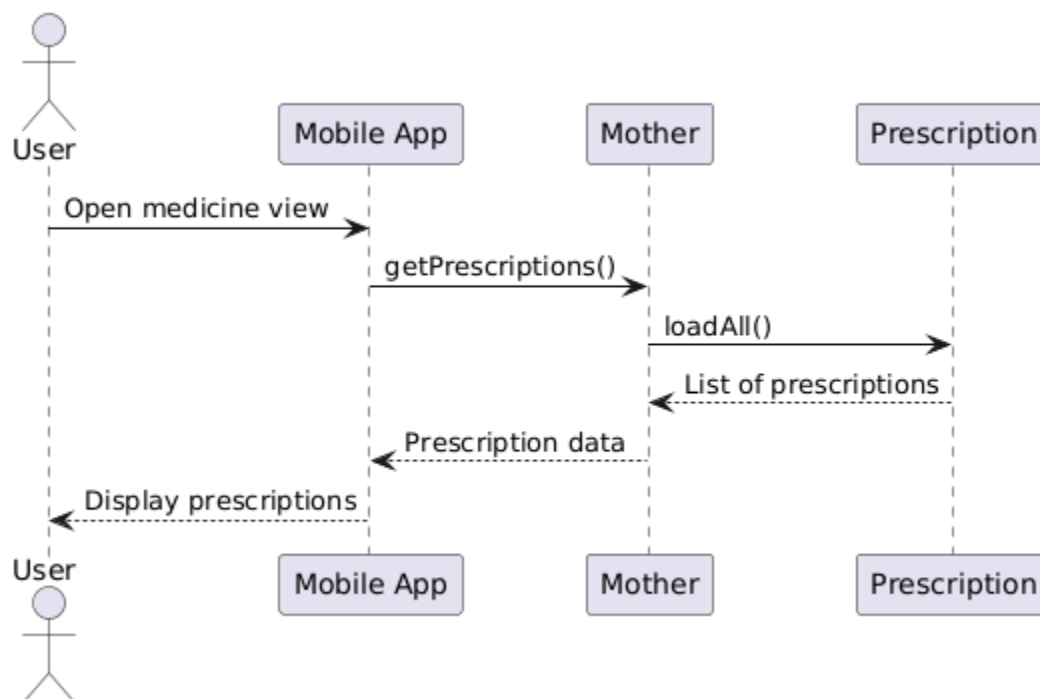*Figure 19 Sequence Diagram View Live Sensor Data*

SD UC-5 Prescribe Meal

Doctor | **Mobile App** | **Doctor** | **MealPlan** | **Mother** | **NotificationService**

Prescribe Meal Plan

- Doctor → Mobile App: Open patient profile
- Mobile App → Doctor: Load linked patients()
- Doctor ⟵ Mobile App: Display patient list
- Doctor → Mobile App: Select patient (motherID)
- Mobile App → Doctor: Get patient details(motherID)
- Doctor ⟵ Mobile App: Return mother details
- Doctor → Mobile App: Navigate to meal plan section
- Mobile App → Doctor: Prepare meal plan form()
- Doctor ⟵ Mobile App: Show empty meal plan form
- Doctor → Mobile App: Enter meal details (food items, frequency, dates)
- Mobile App → MealPlan: Create new meal plan (dietaryDetails, startDate, endDate)
- Mobile App ⟵ MealPlan: MealPlan object created
- Mobile App → Doctor: Save meal plan(MealPlan)
- Doctor → Mother: Associate meal plan(MealPlan)
- Doctor ⟵ Mother: Confirmation
- Doctor → NotificationService: sendPushNotification(motherID, "New meal plan assigned")
- Mother ⟵ NotificationService: Push notification received
- Doctor ⟵ Mobile App: Display "Meal plan saved successfully"

Alternative Flow: Invalid Input

- Doctor → Mobile App: Submit incomplete form
- Mobile App → Doctor: Validate meal plan data()
- Mobile App ⟵ Doctor: Validation error
- Doctor ⟵ Mobile App: Display "Please complete all fields"

Alternative Flow: Database Error

- Doctor → Mobile App: Submit valid meal plan
- Mobile App → Doctor: Save meal plan(MealPlan)
- Doctor → Mother: Associate meal plan(MealPlan)
- Doctor ⟵ Mother: Database error
- Mobile App ⟵ Doctor: Error message
- Doctor ⟵ Mobile App: Display "Failed to save meal plan"

Doctor | **Mobile App** | **Doctor** | **MealPlan** | **Mother** | **NotificationService**

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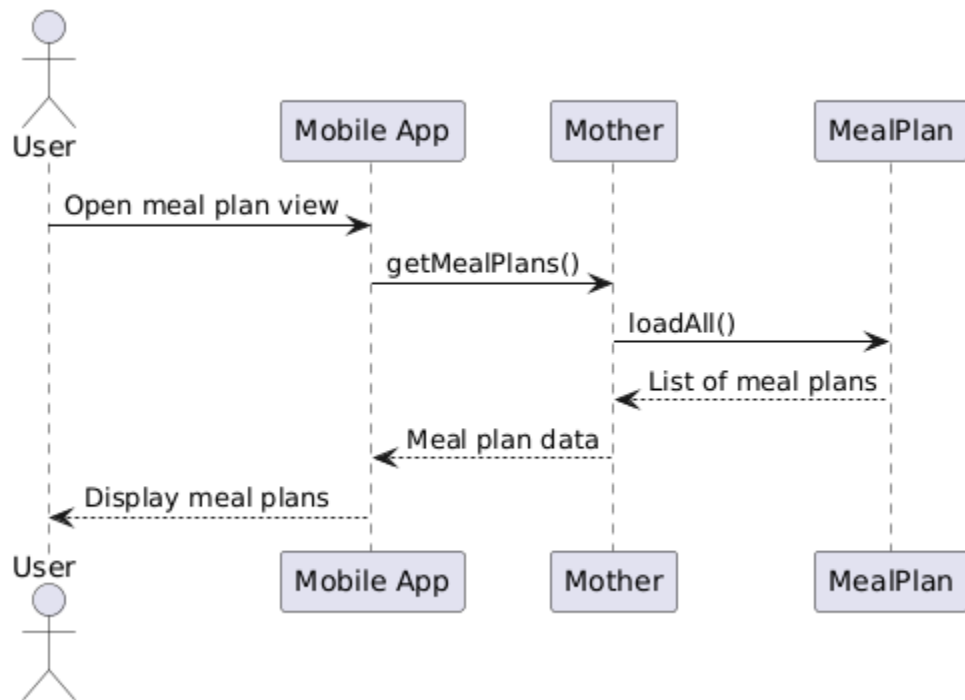
SD UC-6 Prescribe Medicine
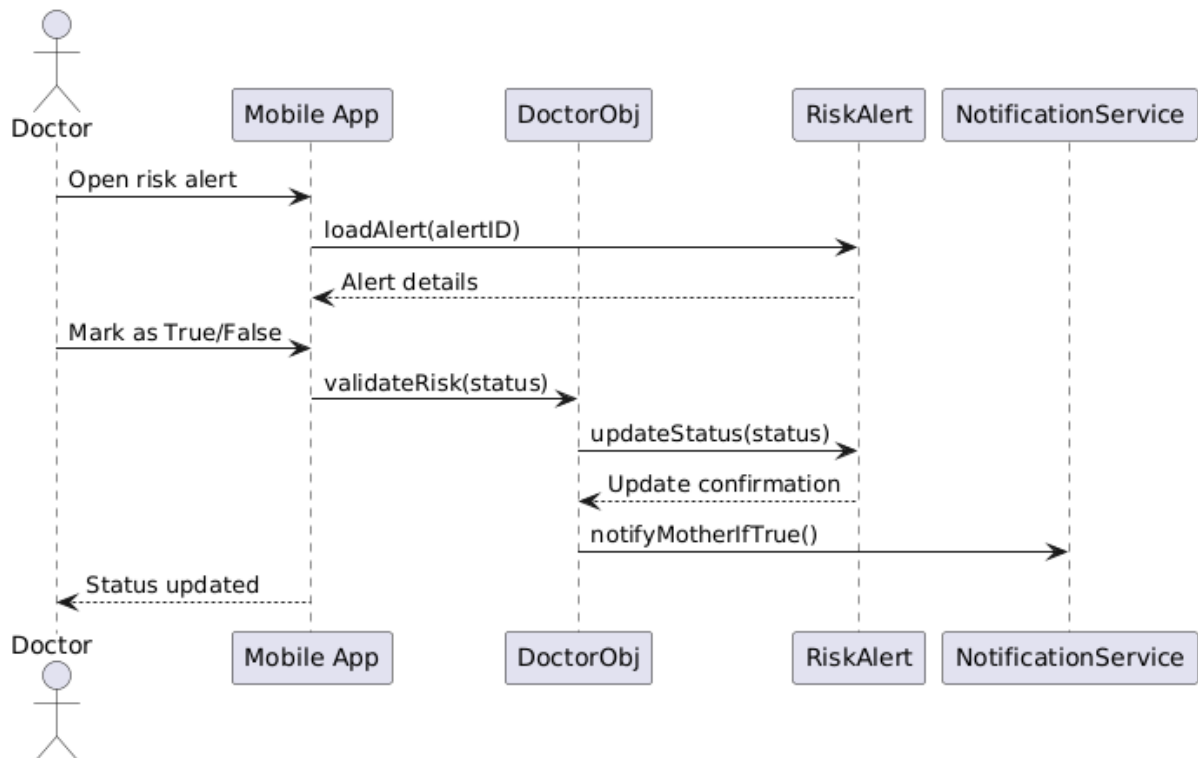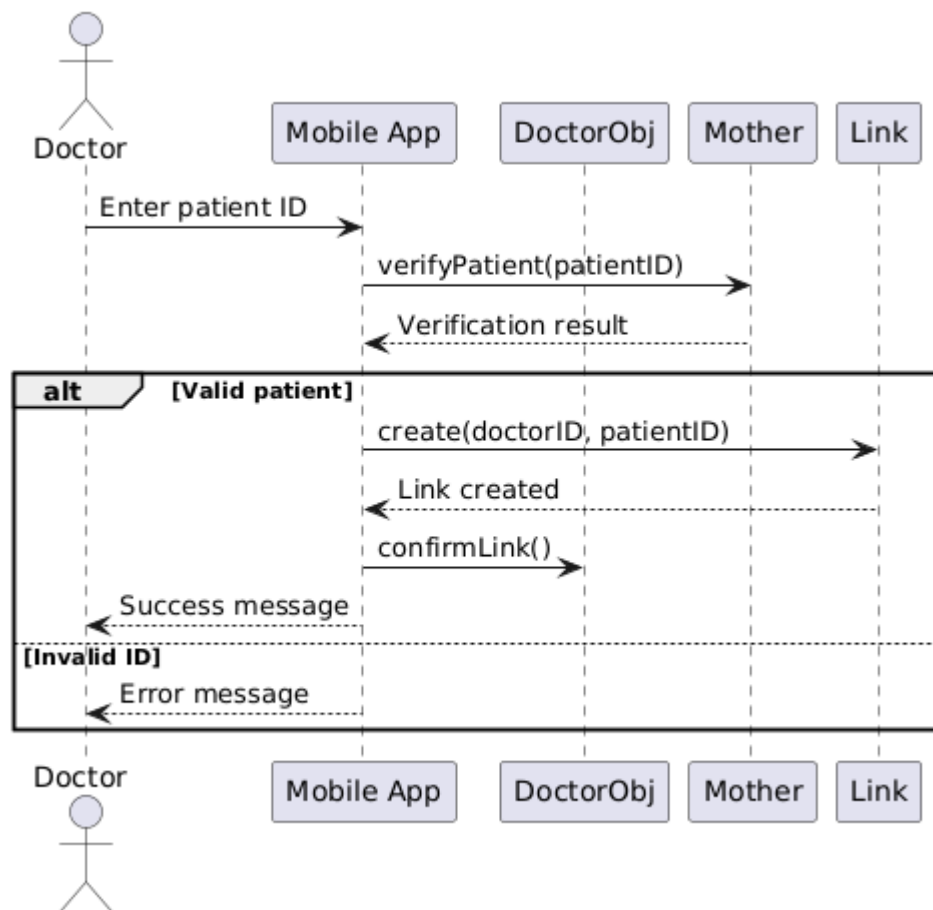

SD UC- 7 View Prescribed Medicine

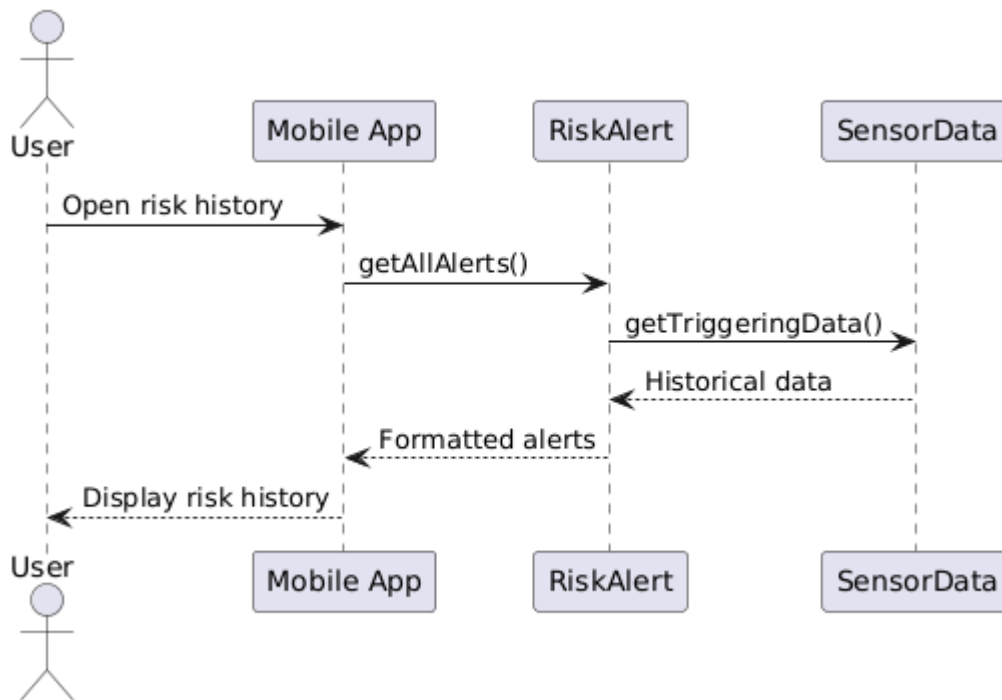
SD UC-8 View Prescribed Meal Plan
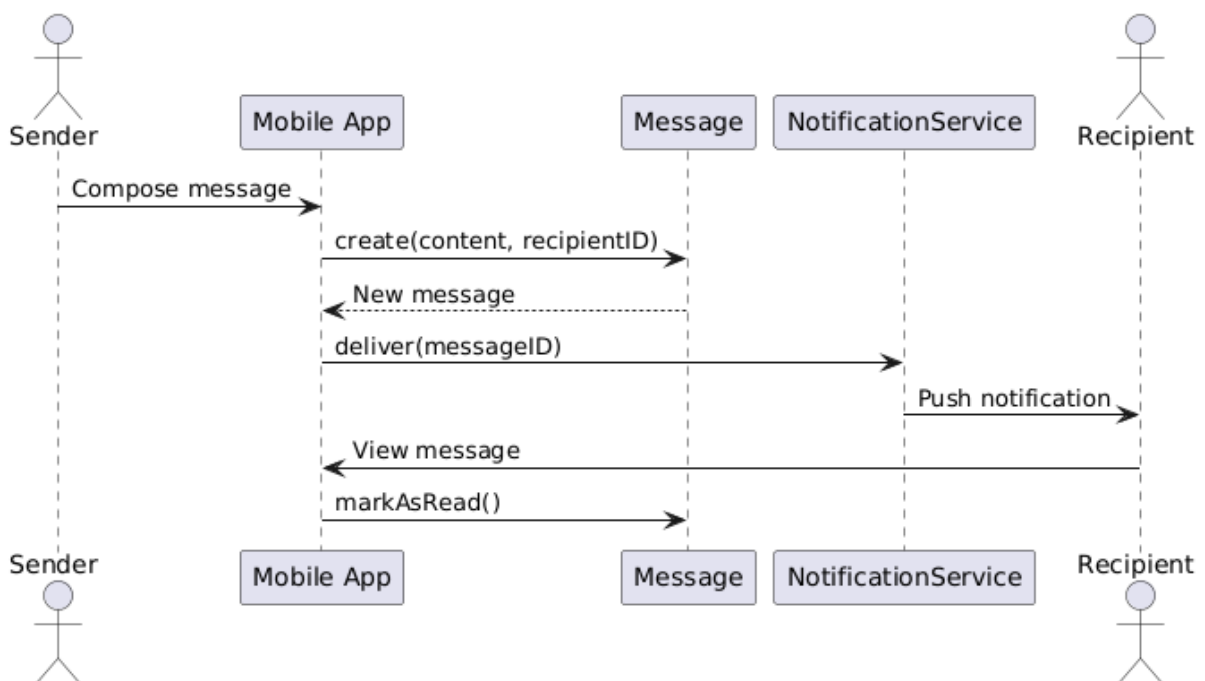
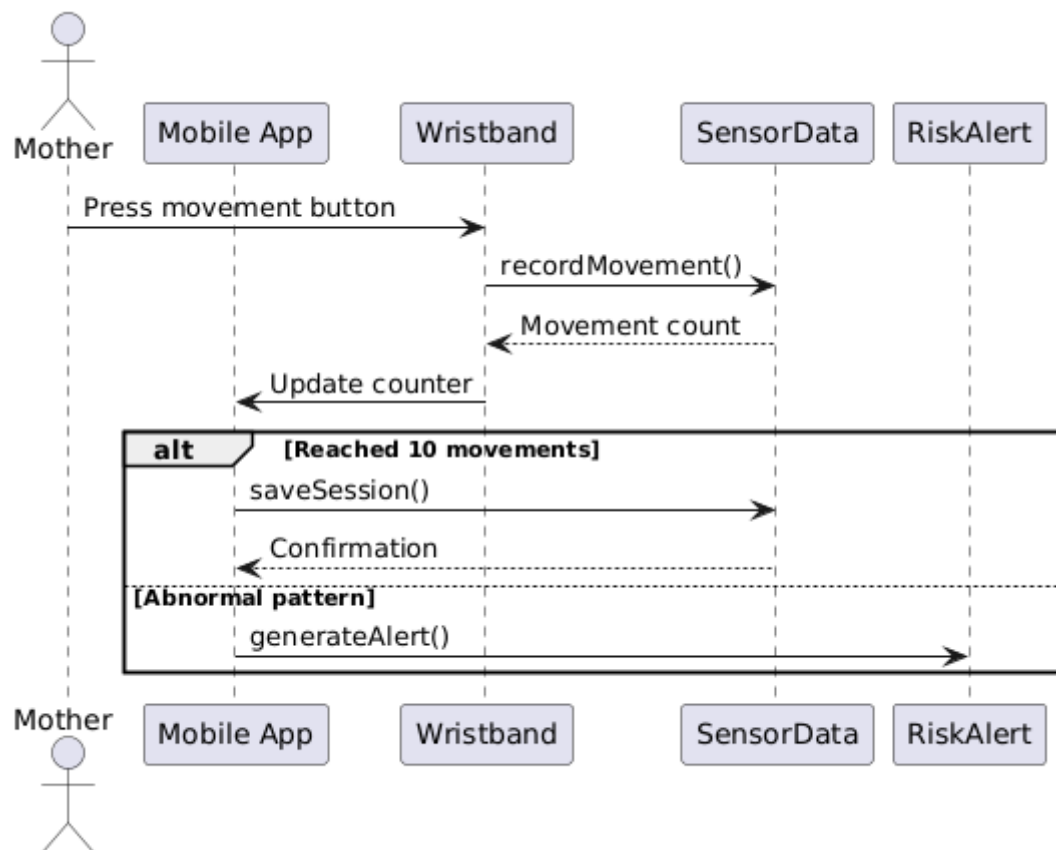SD UC-9 Mark Risk (T/F)

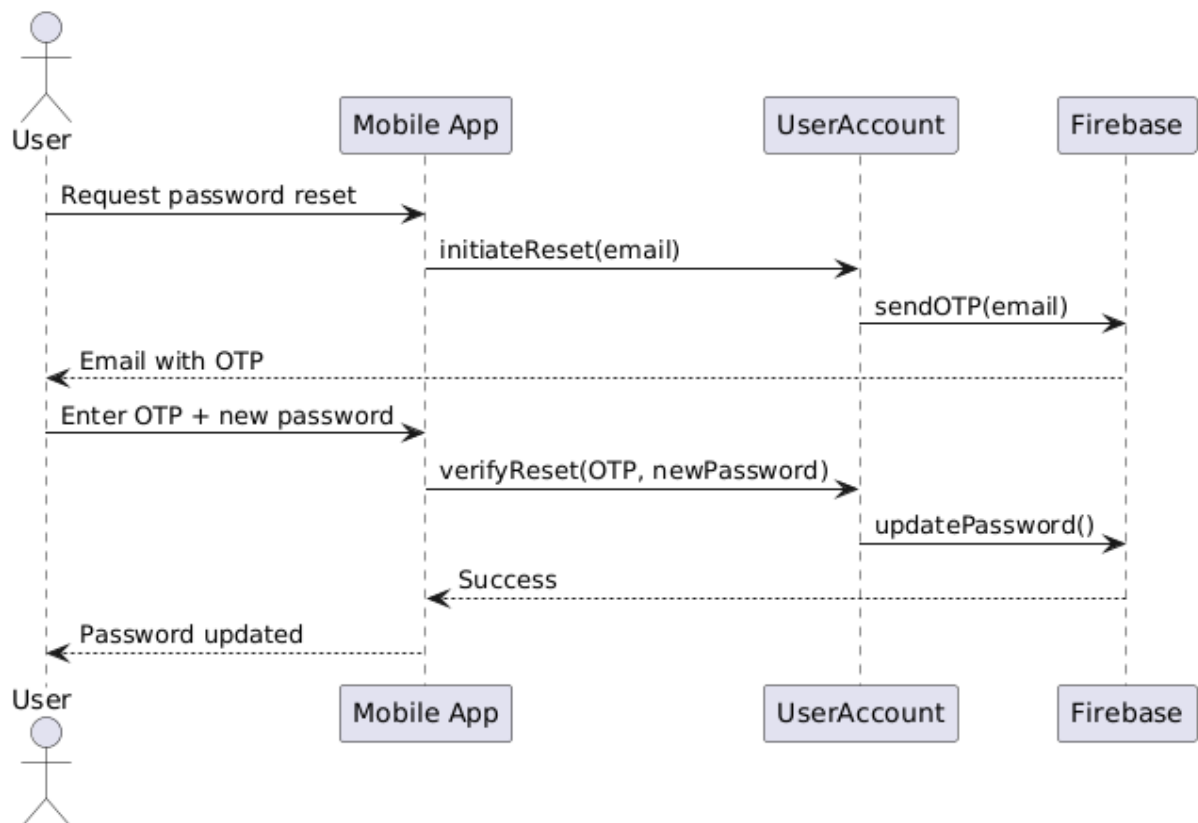SD UC-10 Link Patient

SD UC-11 Unlink Patient

SD UC-12 View Risk

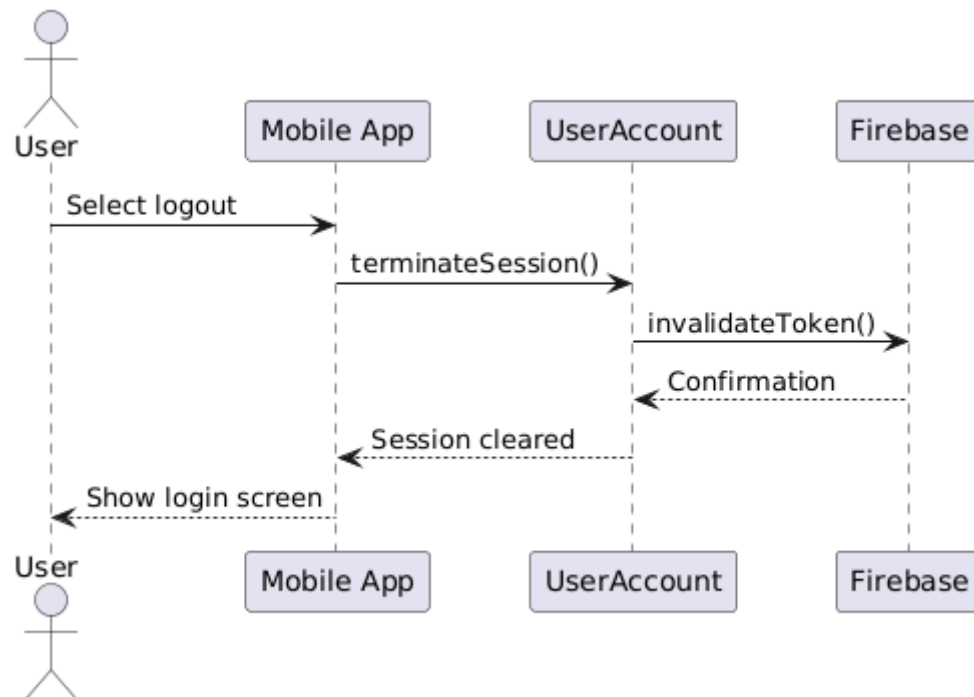SD UC-13 Send/ Receive Messages

SD UC-14 Count Fetal Movements

SD UC-15 Reset Password

SD UC-16 Logout

Class Diagram