Hamdard University
Department of Computing
Final Year Project

Innovative approaches to AI-Driven personalized Health Monitoring

(FYP-020/FL24)
Software Requirements Specifications

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Definition of Terms, Acronyms, and Abbreviations

Term	Description
AI	Artificial Intelligence
IOT	Internet of things
Arduino	microcontroller

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1. Introduction

The integration of advanced technologies in healthcare has transformed the way patient monitoring and management are conducted. This project focuses on the development of a Smart Health Monitoring System (SHMS) that leverages Arduino microcontrollers, Photoplethysmography (PPG) sensors, and Artificial Intelligence (AI) to provide realtime health monitoring and predictive analysis. The system aims to address gaps in current health monitoring solutions by offering continuous, accurate, and user-friendly capabilities to track vital signs such as pulse rate.

This document serves as a detailed guide for the development, implementation, and evaluation of the SHMS. It outlines the functional and non-functional requirements, system design, and development methodologies to ensure successful project execution.

1.1 Purpose of Document

The purpose of this document is to define the functional and technical requirements of the Smart Health Monitoring System. It serves as a

comprehensive reference for all stakeholders, ensuring alignment in system design, development, and implementation. This document will:

- Clearly outline the scope and objectives of the SHMS project.
- Define the methodologies for system integration, testing, and deployment.
- Establish a framework for evaluating system performance and user satisfaction.

The SRS ensures all parties involved understand the project's expectations, scope, and deliverables, paving the way for efficient and successful project execution.

1.2 Intended Audience

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2. Overall System Description

2.1 Project Background

The Smart Health Monitoring System (SHMS) project leverages advancements in Artificial Intelligence (AI), wearable technology, and IoT (Internet of Things) to address critical challenges in health monitoring. Inspired by the growing need for continuous health management, the SHMS aims to integrate real-time monitoring of vital signs such as pulse, utilizing Arduino microcontrollers and Photoplethysmography (PPG) sensors. This project not only seeks to enhance the accuracy and accessibility of health monitoring but also introduces predictive analytics to proactively address health risks.

Recent trends indicate that chronic diseases such as hypertension and cardiovascular conditions require more frequent and precise monitoring, which traditional systems fail to provide. This system bridges the, machine learning models, and mobile applications to deliver a comprehensive health monitoring solution.

2.2 Problem Statement

Current health monitoring methods are often limited by their dependency on specialized equipment and clinical visits. While wearable devices have gained popularity, they frequently suffer from issues such as:

- **Inaccuracy**: Limited precision in real-time data measurement.
- **Lack of Predictive Features**: Insufficient use of AI for health predictions and insights.
- **Accessibility Challenges**: High costs and technical complexity hinder widespread adoption.

These limitations restrict continuous monitoring and timely intervention for chronic conditions, resulting in delayed diagnosis and management. The SHMS project addresses these challenges by introducing an affordable, user-friendly, and predictive health monitoring solution.

Note: This project does not involve the development of custom. Instead, it focuses on software

2.3 Project Scope

The scope of the Smart Health Monitoring System includes:

1. **Data Integration**: Transmission of collected health data through watch
2. **AI Model Training**: Development of machine learning models for predictive health analytics.
3. **Mobile Application Development**: A user-friendly interface for visualizing realtime and predicted health metrics.
4. **End-to-End Testing**: Comprehensive testing of the system for accuracy, reliability, and usability.

2.4 Not In Scope

The following elements are beyond the scope of this project:

3. Integration with existing large-scale healthcare databases or hospital systems.
4. Management of long-term data storage beyond initial system testing.
5. Real-time telemedicine or direct physician consultations via the mobile application.

2.5 Project Objectives

3 Develop an accurate and cost-effective system for monitoring BP and pulse in real time.
4 Integrate AI-driven predictive analytics to anticipate potential health risks.
5 Ensure user-friendliness through a well-designed mobile application.
6 Minimize development costs while maintaining system reliability.
7 Validate the system’s accuracy and effectiveness through comprehensive testing.

2.6 Stakeholders & Affected Groups

Project Stakeholders:

- Healthcare providers seeking improved patient monitoring tools.
- Patients managing chronic conditions like hypertension and cardiovascular diseases.

Affected Groups:

Developers and researchers focused on IoT and AI in healthcare.

Investors and funders supporting healthcare innovation.

2.7 Operating Environment

The SHMS will operate in the following environments:

- **Home Settings**: For individual users who require continuous health monitoring.
- **Healthcare Facilities**: Clinics and hospitals can utilize the system for patient management.
- **Remote Locations**: The system is designed to operate with minimal infrastructure, enabling deployment in rural or resource-limited areas.

2.8 System Constraints

3 **Connectivity**: Reliance on stable internet or Bluetooth for data transmission.
4 **Battery Life**: Dependence on power-efficient watch to ensure uninterrupted monitoring.
5 **Regulatory Compliance**: Adherence to medical device regulations and standards.

2.9 Assumptions & Dependencies

1. **Assumptions:**

1.9 Users will have access to a smartphone for the mobile application.
1.10 Internet connectivity is available for data transmission and AI model updates.
1.11 Users will follow the necessary guidelines for operating the device.

2. **Dependencies:**

2.9 Dependence on external suppliers for Arduino boards and PPG sensors.
2.10 Availability of machine learning frameworks such as TensorFlow or PyTorch.

3. External Interface Requirements

3.10 Software Interfaces

4. **Arduino IDE**: The microcontrollers will be programmed and calibrated using the Arduino IDE.
5. **Database Systems**: Data collected from sensors will be transmitted to a centralized database (e.g., MySQL or Firebase) for storage and analysis.
6. **Mobile Application**: The app will interface with the backend through RESTful APIs to visualize health metrics and analytics.
7. **Machine Learning Libraries**: TensorFlow and PyTorch frameworks will be used for model development and data processing.

3.11 Communications Interfaces

4 **Wireless Connectivity**: Data will be transmitted wirelessly via Bluetooth or Wi-Fi to the database or user's smartphone.

5 **API Communication**: RESTful APIs will facilitate the exchange of data between the mobile application and backend services.

6 **Serial Communication**: Arduino boards will use UART (Universal Asynchronous Receiver-Transmitter) for real-time sensor data collection and processing.

4.System Functions / Functional Requirements

6.11 System Functions

The SHMS will provide the following key functions:

1. Real-time monitoring of vital signs (pulse).
2. Storage and retrieval of collected data in a centralized database.
3. Analysis of health metrics using AI models to predict potential risks.
4. Display of real-time and predictive health data on a mobile application.
5. Notifications and alerts for abnormal readings or critical health conditions.
6. User account management for secure and personalized data access.

6.12 Use Cases

- ***Actors & use cases***

4.2.1 List of Actors

- **Patient**: The primary user monitoring their health metrics.
- **Healthcare Provider**: Accesses patient data for diagnosis and monitoring.
- **System Administrator**: Manages system configurations and user accounts.
- **Database**: Stores and retrieves health data.

4.2.2 List of Use Cases

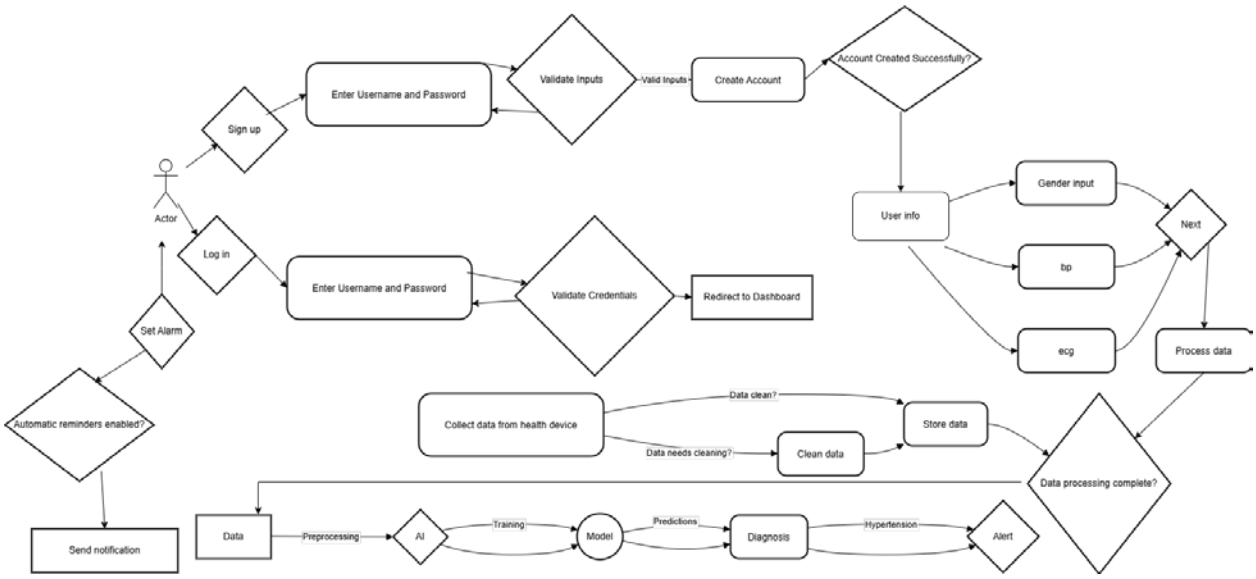
1. Collecting real-time pulse data.
2. Storing health metrics in the database.
3. Running predictive analysis on health data.
4. Visualizing health metrics on the mobile app.
5. Alerting users about abnormal health metrics.

4.2.4 Description of Use Cases

1. **Data Collection**:
   - Actors: Patient, Arduino, PPG Sensor.
   - Description: The system collects BP and pulse data through the sensors and transmits it to the microcontroller.
2. **Data Storage**:
   - Actors: Arduino, Database. ○ Description: The collected data is transmitted to a centralized database for analysis and long-term storage.
3. **Health Prediction**:
   - Actors: AI Model, Database.
   - Description: AI models analyze stored data to predict potential health risks and abnormalities.
4. **Data Visualization**:
   - Actors: Patient, Mobile Application. ○ Description: Users can view real-time and predictive health metrics on the mobile app.
5. **Alerts and Notifications**:
   - Actors: Patient, Mobile Application. ○ Description: The system sends notifications to users in case of abnormal health readings.

6.12.1 Use Case Diagram

Create the system level use case diagram



7 Non - Functional Requirements

7.11 Performance Requirements

8 The system must process and display real-time health data with a maximum delay of 2 seconds.
9 AI models should analyze data and provide predictions within 5 seconds of receiving inputs.

7.12 Safety Requirements

8 All software components must comply with medical safety standards to prevent electrical hazards.
9 The device must alert users in case of sensor malfunction or abnormal readings.

7.13 Security Requirements

7 All data transmissions must be encrypted to ensure patient privacy.
8 User authentication will be mandatory for accessing health data on the mobile application.
9 The system must comply with relevant data protection regulations (e.g., GDPR, HIPAA).

7.14 Reliability Requirements

The system must operate with 99.9% uptime to ensure

•**Redundancy**: The system should incorporate backup mechanisms to prevent data loss during software failure.
•**Error Handling**: Any system errors or failures should be logged and reported to the system administrator for troubleshooting.

•**Scalability**: The system must handle increased loads efficiently, especially during peak usage periods

7.15 Usability Requirements

10 **User-Friendly Interface**: The mobile application must be intuitive and easy to navigate for users of all technical backgrounds.
11 **Accessibility**: Features such as voice commands, adjustable text size, and multi-language support should be included to enhance accessibility.

12 **Training**: Minimal user training should be required, with clear and concise user guides or onboarding tutorials availableConsistent Design: Uniform interface across the app.

7.16 Supportability Requirements

•**Software Updates**: The system should support remote updates for both the mobile application and AI models to improve functionality and security.
•**Technical Support**: Users should have access to a support portal or hotline for troubleshooting and assistance

7.17 User Documentation

•**Comprehensive Manuals**: The project should include detailed user manuals covering setup, operation, and troubleshooting.
•**Online Resources**: Documentation, FAQs, and video tutorials should be available online for easy access.
•**Version Control**: Ensure that all user documentation is version-controlled to match system updates or changes

8 References

List References

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  - Mery Subito, Alamsyah, and Ardi Amir. “Design of health telemonitoring system on vital sign patient’s mobile-based,” *Department of Electrical Engineering, Tadulako University, Palu, Indonesia*, July 30-31, 2019.
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- **Online Resources**:
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  - Mayo Clinic: Details on symptoms and causes of abnormal heart rate.
  - NCBI: Research on health monitoring and telemedicine.
  - Tutorials Point - Python GUI Programming: Useful for building the mobile application GUI.

- Computer Hope: Explanation of GUI concepts.
- **Healthcare Standards**: • ISO 13485: International standards for medical device design and manufacturing.
- HL7 Standards: Framework for electronic health information interoperability.