Hamdard University
Department of Computing
Final Year Project

INNOVATIVE APPROACHES TO AI-DRIVEN PERSONALIZED HEALTH MONITORING

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FALL 21

Document Sign off Sheet

Document Information

Project Title	Smart Vision Kit for Visually Impaired Individuals
Project Code	-
Document Name	Software Design Specifications
Document Version	3.0
Document Identifier	SDS
Document Status	Final
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Approver(s)	Dr. khurram Iqbal & Sir Afzal Hussain
Issue Date	23-6-23

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Revision History

Date	Version	Description	Author
23-6-23	1.0	Overview of project	Laiba Mubarak
12-8-23	2.0	Software upgraded	Laiba Mubarak

Definition of Terms, Acronyms, and Abbreviations

AI (Artificial Intelligence): The simulation of human intelligence processes by machines, especially computer systems, involving learning, reasoning, and self-correction.
Computer Vision: A field of AI that enables computers to interpret and make decisions based on visual data from the world.
IoT (Internet of Things): A network of physical devices embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet.
ML (Machine Learning): A branch of AI focused on building systems that can learn from and make decisions based on data.
Raspberry Pi: A small, affordable computer used for programming and electronic projects, including the development of smart devices.

UC (Use Case): A list of actions or event steps typically defining the interactions between a role (actor) and a system to achieve a goal.
User: In the context of this project, a visually impaired individual using the Smart Vision Kit.
Visually Impaired Individual: A person with significant visual impairment that cannot be corrected fully with glasses or contact lenses, affecting their ability to perform daily tasks.
Smart Vision Kit: A set of smart glasses or cap equipped with computer vision technology designed to assist visually impaired individuals by providing real-time object detection and audio feedback.
Audio Feedback: Auditory information provided to the user describing detected objects and their surroundings.
Real-Time Processing: The immediate processing of data as it comes in, without any significant delay, to provide timely feedback or results

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1 Introduction

1.1 Purpose of Document

The purpose of this Software Design Specification (SDS) is to provide a comprehensive blueprint for the design and development of the Smart Health Monitoring System (SHMS). This document elaborates on the architectural framework, component design, interface specifications, and system interactions outlined in the Software Requirements Specification (SRS). It serves as a guide for developers, testers, and stakeholders to ensure the system is implemented efficiently and adheres to the intended objectives.

1.2 Intended Audience

This document is intended for:

Development Team: To implement the design specifications.

Testing Team: To understand the design structure and validate system functionality.

Project Stakeholders: To review and approve the design approach.

Supervisors and Coordinators: To oversee the development process and ensure compliance with project goals.

1.3 Document Convention

Terminology: Adheres to definitions provided in the SRS document.

SHMS: Smart Health Monitoring System.

PPG: Photoplethysmography sensor.

BP: Blood Pressure.

Formatting:

Bold: Emphasizes key components.

Italics: Highlights significant notes or considerations.

Numbered lists for sequential steps and processes.

1.4 Project Overview

The SHMS integrates advanced technologies such as Arduino microcontrollers, PPG sensors, and Artificial Intelligence (AI) to provide real-time monitoring of vital health metrics such as blood pressure and pulse rate. The system also leverages AI-driven predictive analytics to anticipate potential health risks. Designed for both individual and clinical use, SHMS offers a user-friendly mobile application for data visualization and analysis.

Key Features:

Real-time monitoring of BP and pulse.

AI-driven predictive health analysis.

User alerts and notifications for critical health conditions.

Secure storage and retrieval of health data.

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1.5 Scope

The scope of the SHMS encompasses:

Software Development: AI models, database systems, and a mobile application.

End-to-End Testing: Validation of accuracy, reliability, and usability.

Deployment: Use in home, clinical, and remote environments.

Exclusions:

Integration with large-scale healthcare databases or telemedicine systems.

Long-term data storage beyond initial testing phases.

Design Considerations

Assumptions:

Users will have access to a smartphone to operate the mobile application.

Internet connectivity is available for data transmission and AI model updates.

Users will follow guidelines for proper device usage.

Dependencies:

Availability of Arduino microcontrollers and PPG sensors.

Reliance on machine learning frameworks such as TensorFlow or PyTorch. Third-party libraries and APIs for secure data transmission and visualization.

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2.2 Risks and Volatile Areas

Software Risks:

Bugs or vulnerabilities in AI models leading to inaccurate predictions.

Data breaches due to insufficient encryption or security measures.

Operational Risks:

User non-compliance with operational guidelines.

Unreliable internet connectivity in remote areas affecting data transmission.

Volatile Areas:

Rapid advancements in AI and IoT technology necessitating frequent updates.

Regulatory changes impacting compliance requirements for health monitoring devices.

2 System Architecture

2.1 System Level Architecture

System Architecture

The system-level architecture of the SHMS encompasses software, and communication layers, integrated to deliver seamless health monitoring and predictive analysis. The primary components include:

Software Layer:

Data Collection Module: Interfaces with sensors to collect health data.

AI Analytics Module: Processes collected data for predictive health analysis.

User Interface Module: Mobile application for real-time data visualization and notifications.

Communication Layer:

Wireless Connectivity: Utilizes Bluetooth or Wi-Fi for data transmission to the mobile app.

API Integration: RESTful APIs for communication between the mobile application and backend services.

The architecture ensures modularity, scalability, and reliability, enabling the system to meet performance and usability requirements.

4 Design Strategy

The design strategy for the SHMS focuses on modular, scalable, and robust development to ensure efficient implementation and future adaptability. This strategy includes:

Modular Design:

Segregate the system into independent modules (software, and communication layers) to simplify development and testing.

Ensure easy integration and maintenance by defining clear interfaces between modules.

Scalability:

Design the system to handle increased data loads and user interactions without performance degradation.

Employ scalable technologies such as cloud databases and machine learning models.

Reliability:

Implement fail-safe mechanisms to ensure uninterrupted monitoring during software failures.

Use robust error-handling techniques to maintain system stability.

Security:

Encrypt all data transmissions to protect user privacy.

Incorporate user authentication and authorization mechanisms to prevent unauthorized access.

User-Centric Design:

Develop an intuitive and accessible mobile application interface.

Provide features such as multi-language support and voice commands to enhance usability.

Iterative Development:

Employ Agile methodologies to deliver incremental updates and incorporate stakeholder feedback throughout the development process.

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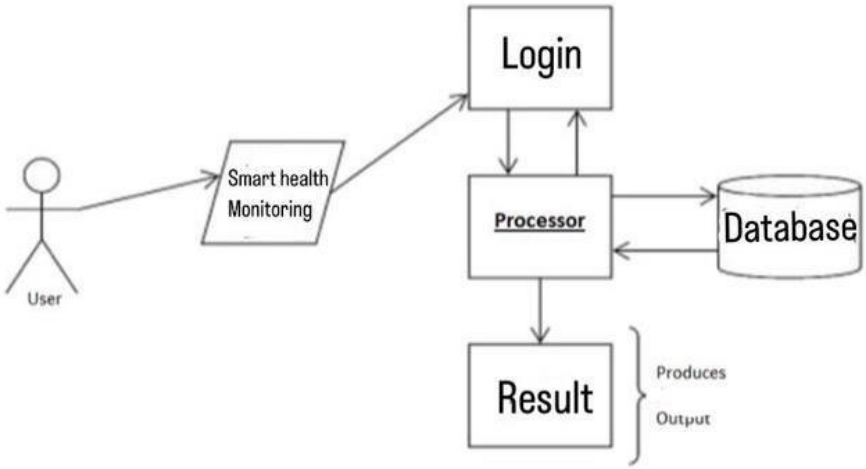
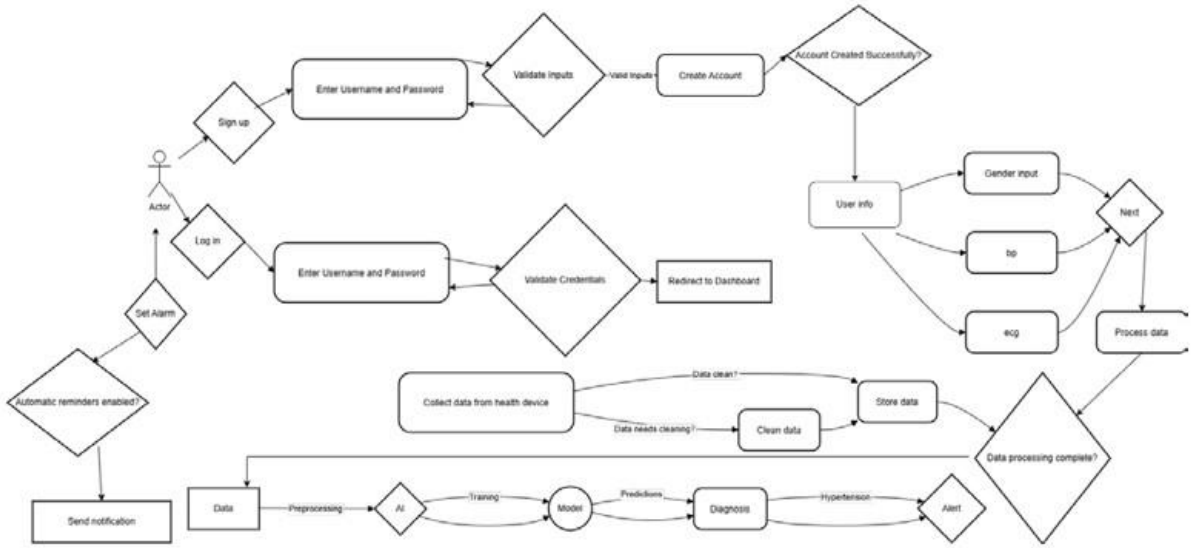
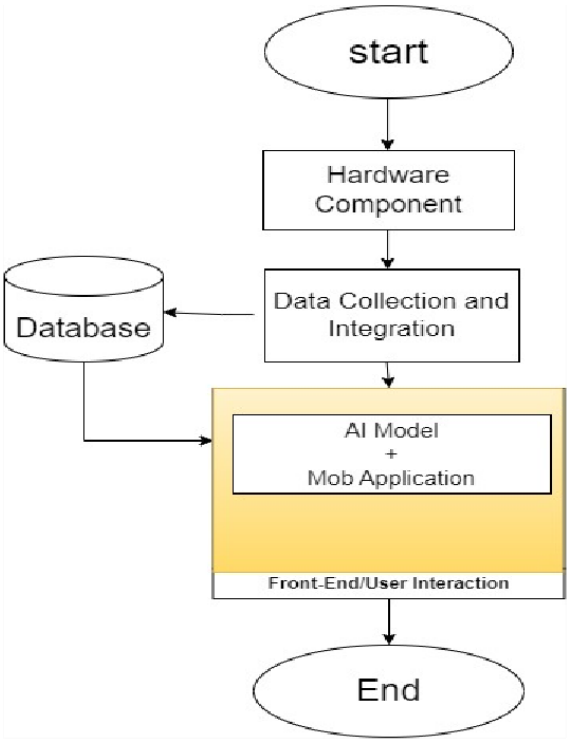
5. Detailed System Design



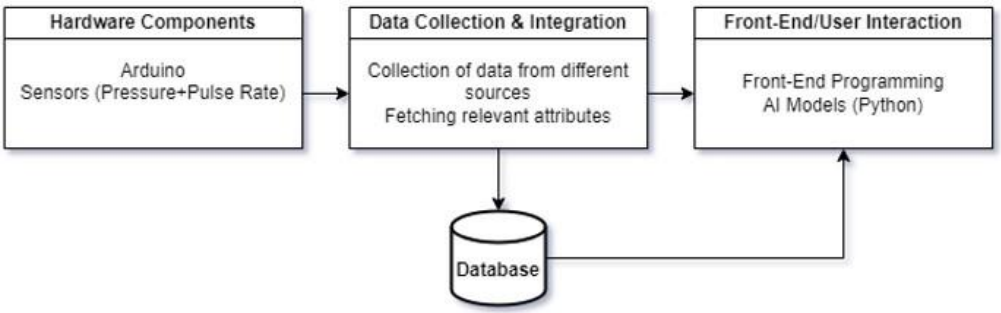
5.1 Working



6. Flow Chart



7. Context Diagram



8 References

- Medical News Today: Overview of blood pressure monitoring systems.

- Mayo Clinic: Details on symptoms and causes of abnormal blood pressure.
- 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.

9 Appendices ○ Glossary

- PPG (Photoplethysmography): A non-invasive optical technique used to measure changes in blood volume in tissue.
- SHMS (Smart Health Monitoring System): The project system designed for real-time health monitoring.
- Machine Learning Model: AI-based algorithms used for processing health data and making predictions.
- IoT (Internet of Things): Interconnection of devices like sensors and mobile apps for data collection and monitoring.
- 9.2 References
- SRS Document for SHMS: The System Requirements Specification, outlining the functional and non-functional requirements of the Smart Health Monitoring System.
- IEEE Std 1016-2009: Software Design Descriptions Standard.
- Research Paper: “AI-Driven Personalized Health Monitoring: Techniques and Applications.” ○ 9.3

Diagrams and Models

- System Architecture Diagram: Includes a high-level representation of the SHMS components (sensors, microcontroller, AI model, mobile application).
- Data Flow Diagram: Illustrates the flow of data from sensors to the AI model and mobile application.
- Sequence Diagram: Demonstrates the interaction between software, and the user interface. ○ 9.4 Additional Notes
- The SHMS must operate in environments with limited internet connectivity and ensure seamless local data storage and transfer.

- Assumptions:

- The user has a smartphone capable of running the mobile application. ○ The PPG sensor is calibrated and functioning accurately.

- 9.5 Change Log

Version	Date	Description	Modified By
1.0	01/01/2024	Initial draft of the SDS document	Team Lead
1.1	20/01/2024	Updated sequence diagrams and glossary terms	System Analyst ○ 9.6 Related Documents

- System Requirements Specification (SRS): Describes the goals, requirements, and constraints of the SHMS project.

- Test Plan Document: Details the testing strategy and procedures for validating the SHMS components.

- User Manual: Provides guidance for using the SHMS system and mobile application.

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