Software Requirements Specifications

AI Powered Hospital Information Management System

Project Code:

HIMS-AI-2526

Internal Advisor:

Mr. Aamir Zia

External Advisor:

Project Manager:

Dr. Muhammad Ilyas

Project Team:

Ali Akbar	BSCS51F22R036	(TL)
Muhammad Najee Ullah Noon	BSCS51F22S043	

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Project Manager's Signature

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Author(s)	Ali Akbar Muhammad Najee Ullah Noon
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Definition of Terms, Acronyms and Abbreviations

This section should provide the definitions of all terms, acronyms, and abbreviations required to interpret the terms used in the document properly.

Term	Description
HIMS	Hospital Information Management System
RS	Requirements Specifications
HIPPA	Health Insurance Portability and Accountability Act
GDPR	General Data Protection Regulation
LAN	Local Area Network
CNIC	Computerized National Identity Card

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1. Introduction

1.1 Purpose of Document

This document has been prepared to provide a comprehensive overview of the design, development, and implementation of the AI-Powered Hospital Information Management System (HIMS), a technological solution aimed at improving the efficiency and accuracy of hospital operations through automation and artificial intelligence. The purpose of this document is to explain the technical structure, functionality, and rationale behind the system, highlighting how it addresses real-world challenges faced in healthcare data management.

It serves as a reference for all stakeholders involved in the project, including the development team, healthcare professionals, hospital administration, and technical evaluators. By clearly defining the project's objectives, scope, methodology, system design, core features, and implementation strategy, the document ensures a clear understanding from both technical and operational perspectives.

1.2 Project Overview

Modern hospitals often struggle with inefficiencies caused by manual data entry, fragmented record-keeping, and time-consuming administrative processes. These challenges can lead to delays in patient care, errors in documentation, and an increased workload on medical staff.

To address these issues, the AI-Powered Hospital Information Management System (HIMS) is proposed as an intelligent, automated platform that integrates speech recognition and natural language processing to streamline hospital workflows.

The system functions as follows:

1. **AI-Based Conversation Recording and Analysis:**
   The system listens to doctor–patient interactions in real time, identifies the speaker, and extracts key medical information such as symptoms, diagnosis, prescribed treatments, and follow-up details.

2. **Doctor Confirmation and Data Storage:**
   Before saving, the extracted data is displayed to the doctor for verification. Once confirmed, it is securely stored in a centralized hospital database.

3. **Dedicated Dashboards:**

- **Doctor Dashboard:** Enables doctors to view patient histories, review notes, and manage consultations efficiently.

- **Admin Dashboard:** Allows hospital administrators to manage records, monitor data flow, and ensure system compliance.

- **Patient Portal:** Provides patients with access to their medical history, prescriptions, and reports.

The core objective of this project is to reduce administrative workload, improve record accuracy, and enable real-time access to patient information. By leveraging advanced technologies such as Whisper for speech-to-text processing, GPT-based models for data extraction, and PostgreSQL for secure data management, the proposed system enhances hospital efficiency and promotes the adoption of AI-driven healthcare solutions.

1.3 Scope

The scope of the AI-powered Hospital Information Management System (HIMS) is defined by its focus on improving patient record management, reducing administrative workload, and supporting accurate medical documentation through AI assistance, while keeping doctors in control of validation. The project is specifically designed for healthcare institutions and has clear boundaries on what it will and will not cover.

Inclusions:

- **AI-Assisted Medical Note Creation:** The system captures doctor-patient conversations, highlights relevant medical details (symptoms, diagnoses, tests), and presents them for doctor confirmation before saving to the database.

- **Centralized Patient Record Management:** Hospitals can maintain structured medical histories, accessible to authorized staff across visits.

- **Integrated Staff Dashboard:** "Enables staff to verify or edit patient records, and oversee hospital operations such as scheduling and reporting.

- **Secure Patient Access:** Patients can receive their reports digitally through their profile or via staff-provided printed documents.

- **Data Analytics for Hospitals:** Aggregated data helps identify trends in patient issues, treatment effectiveness, and administrative workload.

Exclusions:

- **Full Clinical Decision-Making:** The system does not recommend treatments or prescribe medicines; it only records and structures doctor-validated information.

- **Cross-Hospital Data Sharing:** Patient data will not automatically transfer between hospitals unless formally integrated with external systems.

- **Self-Registration by Patients:** Initial patient accounts will be created by hospital staff; self-service registration will not be included in the current scope.

- **Non-Medical Hospital Operations:** The system will not handle unrelated tasks such as payroll, pharmacy stock management, or facility maintenance.

2. Overall System Description

The deployment of the **AI-Powered Hospital Information Management System (HIMS)** will take place in a healthcare environment, primarily within hospitals, clinics, and diagnostic centers. The system will operate in consultation rooms and administrative offices where doctors interact with patients, and medical data needs to be accurately recorded and stored. It will require a stable internet connection for real-time AI processing, database synchronization, and secure cloud-based data access.

The **anticipated users** of the system include:

- **Doctors**, who will use the system to record, review, and confirm automatically generated medical notes based on their conversations with patients.

- **Administrators**, who will manage hospital operations, monitor data integrity, control user access, and ensure system compliance with medical regulations.

- **Patients**, who will access their verified medical records, prescriptions, and visit summaries through a patient portal (either web-based or hospital-managed).

The **development environment** will consist of standard web and AI technologies such as **Python**, **JavaScript (React.js / Next.js)** for frontend development, and **PostgreSQL** for database management. Frameworks like **Django** or **Node.js** may be used for backend services, while **OpenAI's Whisper API** and **GPT-based NLP models** will handle speech recognition and medical data extraction.

The **system will be deployed** on secure cloud infrastructure or hospital-managed local servers to ensure data privacy and HIPAA/GDPR compliance. The **hardware setup** will include microphones for capturing conversations and standard computing systems for running the application.

Known constraints and assumptions include the requirement of continuous internet access for AI processing, availability of high-quality audio input for accurate transcription, and adherence to strict data privacy standards. The system assumes that doctors will verify all AI-generated notes before storage to ensure accuracy.

Thus, the **AI-Powered HIMS** is designed to provide an efficient, reliable, and secure solution for automating medical documentation, improving hospital workflow, and promoting the integration of artificial intelligence into daily healthcare practices.

2.1 User characteristics

The **AI-Powered Hospital Information Management System (HIMS)** is designed for multiple classes of users within a healthcare setting, each with specific roles, technical familiarity, and system access levels.

2.1.1   Primary Users – Doctors

Doctors are the main users of the system, responsible for patient diagnosis, treatment, and record validation. They interact with the system during consultations, where the AI automatically records and transcribes doctor-patient conversations, extracts relevant medical information (such as symptoms, diagnoses, and prescribed medications), and presents it for confirmation. Doctors then review, edit if necessary, and approve the extracted information before it is stored in the database.

This user group requires an interface that is quick, accurate, and minimally intrusive to their workflow. Since doctors are typically focused on patient care rather than data entry, the system emphasizes automation, clarity, and reliability in displaying AI-generated medical summaries.

2.1.2   Secondary Users – Administrative Staff

Administrative staff, including hospital managers and data officers, form the second key user group. Their role involves managing hospital data, ensuring system integrity, maintaining compliance with privacy regulations, and monitoring daily operations. They interact with the admin dashboard to view patient activity logs, manage user accounts, oversee system performance, and generate analytical reports for hospital management.

These users are moderately technical and require secure login credentials. The dashboard is designed with a focus on usability and efficient data management, allowing them to perform tasks without deep technical expertise.

2.1.3   Tertiary Users – Patients

Patients are indirect users of the system who benefit from AI-generated and doctor-verified medical records. They can access their visit history, prescriptions, and reports through a patient portal or via hospital assistance. Since some patients may lack technological access or literacy, the system ensures that staff can retrieve and provide printed or digital copies of medical information when needed.

This group's interaction is limited but essential for ensuring transparency, continuity of care, and patient empowerment in the healthcare process.

2.2 Operating environment

The **AI-Powered Hospital Information Management System (HIMS)** will operate within a secure, cloud-enabled healthcare environment designed to ensure efficiency, scalability, and data protection. The following outlines the key components of its operating context:

- **Web-Based Accessibility:**
  The HIMS platform is entirely web-based, allowing access through standard browsers such as Google Chrome, Microsoft Edge, and Mozilla Firefox. Doctors, administrators, and patients can use the system from desktop or mobile devices, enabling flexibility in hospital operations.

- **Cloud Hosting and Storage:**
  The system will be hosted on a secure cloud infrastructure to ensure high availability, automatic backups, and scalability. This environment supports continuous uptime for critical hospital operations and facilitates secure remote access when needed.

- **Hardware and Software Requirements:**
The hospital environment will utilize standard computer systems with at least 8GB RAM and a stable internet connection. The system backend will be developed using **Node.js**, **Python**, and **Django**, while the frontend will employ **React.js** for responsive interfaces. The AI models for transcription and entity extraction will be integrated through **Whisper AI** and **spaCy**.

- **Database and API Integration:**
The system will use **PostgreSQL** or **MongoDB** for storing structured medical data and patient histories. It will also integrate APIs for AI transcription, natural language processing, and authentication services to ensure smooth communication between modules.

- **Operating System and Compatibility:**
HIMS will be compatible with major operating systems, including **Windows**, **macOS**, and **Linux**, ensuring seamless deployment across diverse hospital IT infrastructures. The platform is also designed to integrate with existing hospital devices and systems while maintaining compliance with data privacy standards such as HIPAA.

2.3 System constraints

Despite being designed for efficiency, automation, and scalability, the **AI-Powered Hospital Information Management System (HIMS)** operates under several constraints that may influence its overall performance and implementation:

- **Software Constraints:**
The system's AI modules, including **Whisper AI** for transcription and **spaCy** for medical entity extraction, depend on stable third-party APIs and pre-trained models. Any updates or service interruptions in these tools could affect system accuracy and performance.

- **Hardware Constraints:**
The transcription and AI processing components require systems with sufficient computing power (minimum 8GB RAM and multi-core processors). Hospitals with outdated systems or limited network infrastructure may experience slower processing times.

- **Cultural and Language Constraints:**
Since doctor-patient conversations may involve a mix of **Urdu and English**, the system's multilingual transcription model may face limitations in perfectly recognizing accents, dialects, or regional variations, possibly affecting data accuracy.

- **Legal and Privacy Constraints:**
The system must comply with healthcare data protection laws (e.g., HIPAA or local equivalents). Strict consent is required for recording conversations, and data encryption is mandatory to prevent misuse of sensitive patient information.

- **Environmental Constraints:**
In busy or noisy hospital environments, background sounds can affect audio clarity and

reduce transcription accuracy. Use of high-quality microphones and sound-isolated consultation rooms is recommended to mitigate this issue.

- **User Constraints:**
Some users, such as elderly patients or non-technical staff, may struggle to interact with the web portal or dashboards. Simplified user interfaces and staff assistance will be necessary for accessibility.

- **Third-Party Component Limitations:**
Off-the-shelf AI services (e.g., Whisper, Hugging Face models) may have rate limits, language support restrictions, or licensing terms that constrain large-scale deployment without enterprise subscriptions.

3. External Interface Requirements

3.1 Hardware Interfaces

Device Name: Barcode Scanner / RFID Reader
Device Type: USB / Integrated Scanner
Interaction:

- The system uses barcode or RFID scanners to identify patients, staff, or medicine inventory items.

- The scanner reads encoded IDs from patient wristbands, staff cards, or medicine labels and sends alphanumeric data to the HIMS for verification or lookup.

Data Format: UTF-8 encoded text (typically alphanumeric or numeric IDs)
Communication: Plug-and-play via USB, Bluetooth, or integrated serial interface (depending on device configuration)
Control Signals:

- Triggered manually through a scan button

- Optional automated detection via proximity sensor (for contactless RFID scanning)

Display Interface:

- Standard monitor or medical display screen for system output and visualization.

- Resolution: Minimum 1366x768 supported

Printer Interface (Optional):

- Device Type: Thermal or Laser Printer

- Function: Prints patient reports, invoices, prescriptions, and test results

- Communication: USB or Wi-Fi enabled printing

3.2 Software Interfaces

Operating System:

- Windows 10/11 (for local deployment and development)

- Linux Server (for backend hosting)

Database:

- MySQL or PostgreSQL (based on hospital scale)

- **Data Exchanged:** Patient details, appointment data, billing records, prescriptions, staff profiles, and inventory logs

Backend Framework:

- Python (Django/Flask) or Node.js (Express)

- **Role:** Handles business logic, processes API requests, interacts with the database, and manages authentication

Frontend Framework / Libraries:

- React.js / HTML / CSS / JavaScript

- **Role:** Provides user interface for admin, doctors, and receptionists; displays patient data, appointments, and analytics dashboards

External APIs (if integrated):

- Email or SMS Gateway APIs for sending appointment reminders and billing notifications

- Payment Gateway API (e.g., Stripe, PayPal, or local bank) for online bill settlements

Data Format for Exchange:

- JSON (for REST API requests and responses)

- CSV (for report exports and backups)

Software Tools (Optional):

- Chart.js or Recharts (for analytics visualization)

- Excel or PDF export libraries for generating downloadable reports

3.3 Communications Interfaces

Network Communication:

- **Protocol:** HTTPS

- **Function:** Secure communication between client browsers, backend server, and database

- **Data Format:** JSON for all request/response cycles

Security:

- SSL/TLS encryption for secure data transfer

- Input validation and sanitization to prevent SQL injection or cross-site scripting (XSS)

- Encrypted authentication tokens for session management

Network Standards:

- TCP/IP network protocol for all internal and external communications

- Local area network (LAN) or Wi-Fi connectivity within hospital premises

Optional Alerts and Notifications:

- **Medium:** Email or SMS

- **Trigger Events:** Appointment reminders, low inventory alerts, patient discharge notifications, or billing confirmations

- **Message Format:** Simple text with timestamp, patient ID, and event description

Synchronization:

- Real-time or near real-time data synchronization across all modules (delay < 3 seconds)

- Automatic updates reflected across dashboards, EMR, and billing systems simultaneously

4. Functional Requirements

Patient Registration and Management	• The system allows hospital staff to register new patients by entering demographic details, contact information, and medical history. • Patients can be assigned a unique hospital ID for future tracking and appointments. • The system enables editing, updating, and searching of patient records quickly and securely.

Appointment Scheduling	• Doctors and receptionists can schedule, reschedule, or cancel patient appointments through the system. • Patients can view their appointment details, assigned doctor, and time slot. • The system ensures no time conflicts in doctor scheduling and maintains daily appointment logs.
Electronic Medical Records (EMR)	• The system stores and manages patient medical records, including diagnoses, prescriptions, and treatment history. • Authorized doctors can update medical records after each visit. • Records are accessible only to authorized personnel to ensure confidentiality.
Billing and Payment Management	• The system automatically generates bills based on treatments, tests, and services provided. • Supports multiple payment modes such as cash, card, and insurance billing. • Generates invoices and maintains transaction history for audit purposes.
Doctor and Staff Management	• Allows hospital administrators to add, update, or remove doctor and staff profiles. • Stores details such as specialization, availability, and assigned department. • Enables scheduling and duty roster management for doctors and nurses.

Authentication and Role Management	• Provides secure login for different user roles such as admin, doctor, nurse, pharmacist, and receptionist. • Each role has access to specific modules and data based on authorization level. • Password recovery and update options are available.
Data Analytics and Reporting	• The system generates statistical and analytical reports for hospital management, such as patient inflow, revenue trends, and medicine consumption. • Graphical dashboards provide insights into operational efficiency and performance. • Reports can be exported in PDF or Excel format.
Notification and Alert System	• Sends appointment reminders, bill payment alerts, and report availability notifications to patients via email or SMS. • Notifies staff about low inventory, or unprocessed bills. • Allows admins to configure notification preferences.

Backup and Recovery	• The system automatically backs up critical data on a scheduled basis to prevent loss due to system failure. • Admins can restore data from backup when necessary. • Ensures data integrity and business continuity.
Exclusions	• The system does not provide telemedicine or video consultation features. • External insurance claim processing systems are not integrated in the current version. • Real-time integration with third-party pharmacy or lab systems is outside the current project scope.
Actors	• **Patients:** Register, book appointments, and access their records. • **Doctors:** Manage appointments, update patient medical records, and view reports. • **Receptionists:** Register patients, manage appointments, and handle billing. • **Admins:** Manage staff accounts, view system analytics, and oversee hospital operations.

5. Non-functional Requirements

5.1 Performance Requirements

The Hospital Information Management System (HIMS) must deliver consistent, reliable, and efficient performance to ensure seamless hospital operations and patient data handling. Key performance requirements include:

- The system should retrieve patient records from the database within **20 seconds** of a query being made.

- Appointment scheduling, billing, and patient registration processes should complete within **5 seconds** of data entry.

- The system must support **up to 100 concurrent users** (doctors, nurses, and administrative staff) without performance degradation.

- Data synchronization between modules (e.g., patient registration, billing, pharmacy) should occur in **real-time** or within a **maximum delay of 7 seconds**.

- Report generation (e.g., discharge summaries, billing statements, inventory reports) should be completed within **7 seconds** for up to **5,000 records**.

- The web-based interface must load within **6 seconds** on a standard hospital network connection.

5.2 Safety Requirements

Since the HIMS operates in a healthcare environment where data accuracy and safety are critical, the system must include safeguards to prevent harm, data loss, or operational disruption. The safety requirements are as follows:

- The system should prevent unauthorized modification or deletion of critical medical or patient data.

- Automatic **data backup** must occur daily to secure patient and hospital records against accidental loss or system failure.

- In the event of a **power outage or server crash**, the system should automatically recover to the last stable state without losing transaction data.

- The system should display clear **warning messages** for invalid operations (e.g., missing patient ID, incomplete prescription entry, or failed database connection).

- Sensitive medical actions such as prescription updates or patient discharge approvals should require **authorized confirmation** before execution.

- Hardware components such as barcode scanners or terminals must comply with **electrical safety and hospital equipment standards**.

- All patient interactions and system alerts must avoid causing confusion or operational risks to staff in critical care areas.

5.3 Security Requirements

Given that the HIMS handles sensitive patient and hospital information, strong security and privacy measures are mandatory to protect data integrity and confidentiality. The system's security requirements include:

- Only **authorized users** (e.g., doctors, nurses, pharmacists, and administrators) can access specific modules based on **role-based access control (RBAC)**.

- User **authentication** (via username and password) must be required for all system access points.

- All patient data—including medical history, CNIC, and billing details—must be **encrypted** both at rest and during transmission (using AES and SSL/TLS).

- The system must maintain **audit logs** of all user activities, including record creation, modification, and deletion, for accountability and traceability.

- Session timeouts must automatically log out inactive users to prevent unauthorized access.

- Data privacy must comply with **relevant healthcare data protection policies** (such as HIPAA-equivalent or local data privacy laws).

- The system must restrict **external API access** to authorized services only, ensuring that no unauthorized third-party system can retrieve hospital data.

- Regular **security audits and vulnerability checks** should be performed to identify and mitigate potential threats.

5.4 User Documentation

To ensure ease of use, smooth adoption, and minimal training requirements, the Hospital Information Management System (HIMS) will include comprehensive documentation and in-system guidance for all user roles. The following documentation resources will be provided:

- **User Manual:**
  A detailed user manual will be provided for doctors, nurses, pharmacists, and administrative staff. It will explain how to log in, manage patient records, schedule appointments, access lab results, and process billing through step-by-step instructions and annotated screenshots.

- **Admin Guide:**
  A separate administrative guide will outline procedures for managing user accounts, configuring security settings, performing data backups, and maintaining system performance. It will also cover integration with external modules such as pharmacy and laboratory systems.

- **Troubleshooting Guide:**
  This document will help users diagnose and resolve common issues—such as login failures, network connectivity problems, or missing data entries—without requiring technical support. Each issue will include cause explanations and recommended actions.

- **Built-in Help Documentation:**
  The system interface will include a "Help" or "Support" section that offers quick access to FAQs, tooltips, and contextual help directly within the dashboard and form screens.

- **Training and Tutorial Modules:**
  Interactive, step-by-step tutorials will guide hospital staff on essential tasks, such as recording patient information, generating reports, and updating treatment details. Short video guides and practice simulations may also be included for enhanced understanding.

- **Version Control and Updates:**
  All documentation will be version-controlled and updated regularly to reflect system enhancements, security patches, and new feature rollouts.

6. Assumptions and Dependencies

6.1 Assumptions

- The hospital's medical staff and administrative personnel will cooperate fully in adopting the new HIMS platform and provide accurate input data during initial setup and daily usage.

- The hospital's existing hardware infrastructure (computers, microphones, and secure servers) will meet the minimum system requirements for smooth operation.

- Internet connectivity within the hospital premises will remain stable to enable real-time data synchronization and AI model processing.

- Doctor-patient conversation recordings will be conducted in environments with minimal background noise to ensure the accuracy of the speech-to-text and entity extraction modules.

- All users—including doctors, nurses, and administrative staff—will receive basic training on how to use the system effectively.

- The hospital's policies and workflows will remain consistent during the system's development and deployment phases, ensuring alignment between technical and operational procedures.

6.2 Dependencies

- The AI modules depend on external speech-to-text and natural language processing APIs for transcribing and extracting key medical data from doctor-patient conversations.

- The system relies on a stable connection to the hospital's central database for data storage and retrieval of patient records, diagnoses, and treatment histories.

- Regular data updates and maintenance must be performed by authorized IT personnel to ensure accuracy and prevent inconsistencies.

- Integration with existing hospital modules (e.g., billing, pharmacy, and lab systems) depends on the availability and compatibility of their APIs or export functionalities.

- The system's deployment and maintenance depend on compliance with healthcare regulations such as HIPAA or local data protection laws to ensure security and confidentiality.

- Timely software updates, API key renewals, and support from external AI service providers are necessary to maintain full functionality and performance.

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7. Appendices

This section should include supporting detail that would be too distracting to include in the main body of the document.