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SmartMed: An AI Powered Platform for Instant Medicine Access and Prescription Understanding

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Abstract

Access to medicines during emergencies and the lack of prescription clarity remain significant challenges in modern healthcare systems. Most existing online pharmacy platforms primarily focus on home delivery services and do not provide real-time visibility of nearby pharmacy stock or intelligent prescription interpretation support. This limitation often delays treatment and creates confusion for patients. This paper presents a Smart Medicine Availability, Delivery, and AI Consultation System that integrates real-time pharmacy inventory tracking, geolocation-based vendor ranking, and artificial intelligence-driven prescription analysis within a unified digital platform. The system enables users to upload prescriptions or manually search for medicines. It verifies medicine availability across nearby registered vendors, ranks them based on proximity, and provides flexible options such as home delivery or self-pickup with navigation support. An AI-powered consultation module extracts prescription details using optical character recognition (OCR) and generates simplified explanations, dosage guidance, and precautionary information to improve patient understanding. Built using the MERN stack architecture, the system ensures scalability, secure authentication, and efficient data management. The proposed solution enhances medicine accessibility, reduces emergency response time, and improves patient awareness, thereby contributing to a more intelligent and patient-centric digital healthcare ecosystem.

Keywords: Smart pharmacy system, medicine availability tracking, AI healthcare assistance, prescription analysis, OCR-based consultation

INTRODUCTION

The integration of artificial intelligence and digital technologies has significantly transformed modern healthcare systems. Despite the rapid growth of online pharmacy platforms, patients still face critical challenges in accessing medicines instantly and understanding medical prescriptions accurately. Most existing systems primarily operate as delivery-oriented e-commerce platforms and lack real-time visibility of medicine availability in nearby physical pharmacies. This becomes a serious limitation during emergency situations, where immediate medicine access is more important than scheduled delivery convenience [1].

In addition to availability constraints, patients frequently encounter difficulty in interpreting prescriptions. Medical prescriptions often include abbreviated drug names, complex dosage instructions, intake timing specifications, and precautionary notes that are not easily understandable by non-medical individuals. The absence of a reliable automated prescription interpretation mechanism increases confusion and may result in improper medication usage p [2].

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To address these limitations, this research proposes SmartMed, an intelligent healthcare platform designed to provide instant medicine access combined with AI-driven prescription understanding. The system integrates online pharmacy services with nearby medical vendors, creating a hybrid digital ecosystem that supports both home delivery and self-pickup options based on urgency and convenience [3].

The intelligence of SmartMed is powered by three core algorithms. First, a deep learning–based Optical Character Recognition (OCR) algorithm is used to convert uploaded prescription images or PDF documents into machine-readable text. This serves as the foundational step for automated processing. Second, the extracted text is processed using Natural Language Processing (NLP)–based medical text analysis, which identifies key clinical entities such as medicine names, dosage instructions [4], intake timing, and precautionary information. This transformation of unstructured prescription data into structured and simplified explanations enhances patient awareness while maintaining safety guidelines. Third, to enable location-aware medicine access, the system utilizes the Haversine distance calculation algorithm, which computes the geographical distance between the user and nearby medical vendors using latitude and longitude coordinates. This allows accurate vendor ranking based on proximity, ensuring faster access to required medicines [5].

By combining real-time inventory verification, AI-powered prescription analysis, and geolocation-based vendor recommendation, SmartMed delivers a comprehensive solution that bridges the gap between digital pharmacy services and physical medical stores. The platform not only reduces emergency response time but also promotes informed medication usage through simplified prescription explanations [6].

Ultimately, SmartMed represents a step toward a more intelligent, scalable, and patient-centric healthcare ecosystem, where accessibility, understanding, and technology converge to enhance overall healthcare efficiency.

LITERATURE SURVEY

In recent years, extensive research has been conducted in the fields of digital healthcare systems, intelligent pharmacy platforms, and AI-assisted medical document processing. The growing demand for remote healthcare access – particularly after global health crises – has accelerated the development of online medicine ordering systems and automated prescription management tools. Many e-pharmacy and telemedicine platforms now offer features such as prescription uploads, digital payment integration, and home delivery services, significantly improving convenience and accessibility, especially in urban areas. Researchers have also explored the integration of artificial intelligence and location-based services to enhance accessibility, reduce response time, and improve patient engagement. However, despite these advancements, most existing systems remain delivery-centric and fail to provide real-time stock visibility of nearby physical pharmacies. As a result, users are often unable to determine whether required medicines are immediately available for pickup during emergency situations, highlighting the absence of a fully integrated and real-time intelligent healthcare platform [7].

Research in Optical Character Recognition (OCR) has significantly improved the digitization of medical documents. Deep learning-based OCR techniques demonstrate high accuracy in extracting text from printed prescriptions. Nevertheless, handwritten prescriptions still present recognition challenges due to varying writing styles and unclear abbreviations. Additionally, many OCR-based systems focus only on text extraction and do not extend to intelligent prescription understanding [8].

Advancements in Natural Language Processing (NLP) have enabled the identification of medical entities such as drug names, dosage patterns, and treatment instructions from unstructured text. NLP-based medical text analysis improves structured interpretation of prescriptions. However, existing implementations often operate in hospital information systems or research environments and are not commonly integrated into consumer pharmacy platforms. Furthermore, NLP systems may face limitations in handling ambiguous abbreviations or incomplete prescription data [9].

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In the domain of location-based services, algorithms such as the Haversine formula are widely used in transportation and delivery applications to compute geographical distances. While effective for distance calculation, such systems generally do not combine location intelligence with real-time pharmacy inventory verification. As a result, vendor recommendations may not reflect actual medicine availability.

Overall, current research and existing platforms provide partial solutions, focusing separately on medicine delivery, prescription digitization, AI text analysis, or geolocation services. The major drawbacks observed include [10]:

- *Lack of Real-Time Local Inventory Synchronization:* Most online pharmacy platforms do not maintain live synchronization with nearby physical medical stores. As a result, users cannot verify whether a specific medicine is currently available in local pharmacies, which can cause delays during urgent medical situations.
- *Delivery-Centric Operational Model:* Existing systems are primarily designed around home delivery services and often overlook self-pickup options. In emergency cases where immediate access is required, dependency on delivery timelines may not be practical or efficient.
- *Limited Integration of AI-Based Prescription Understanding:* Although some platforms allow prescription uploads, they typically do not provide intelligent interpretation of prescription content. Patients must rely on pharmacists or external consultation to understand dosage instructions, precautions, or side effects.
- *Challenges in Interpreting Handwritten Prescriptions:* Even with OCR technology, handwritten prescriptions can be difficult to process accurately due to varying writing styles, abbreviations, and unclear formatting. This May reduce extraction accuracy and affect automated prescription analysis.
- *Lack of Proximity-Based Vendor Recommendation with Stock Validation:* Many location-based systems calculate distance but do not combine geolocation with verified medicine availability. This can result in recommending nearby stores that may not have the required medicines in stock.
- *Fragmented Healthcare Services:* Current solutions often focus on individual functionalities such as delivery, prescription digitization, or teleconsultation. The absence of a unified platform integrating availability tracking, AI interpretation, and location intelligence limits overall efficiency and user experience.

These limitations highlight the need for an integrated system that combines real-time availability tracking, AI-driven prescription understanding, and geolocation-based vendor recommendation within a unified healthcare framework. The proposed SmartMed platform is designed to address these identified research gaps.

PROPOSED DESIGN

The proposed design of SmartMed follows a structured role-based architecture that integrates Patients, Doctors, Vendors, Artificial Intelligence modules, Blockchain security, and MongoDB database storage into a unified healthcare platform. The system begins with a role selection mechanism, where users register as a Doctor, Patient, or Vendor. Each role undergoes a dedicated registration process in which required personal or professional details are submitted and stored. Doctors are required to upload certification documents for verification to ensure authenticity. After login using a unique ID, users must complete their profiles. Access to system features is granted only after successful verification; otherwise, access is denied. This controlled onboarding process ensures security, reliability, and authorized participation within the platform.

A key component of the proposed design is the integration of a Blockchain Data Secure Server. Sensitive information such as doctor credentials, patient records, prescriptions, and appointment details is protected using blockchain mechanisms. This approach guarantees data immutability, tamper resistance, and enhanced transparency. By securing critical medical information on blockchain, the system strengthens trust and prevents unauthorized modification of healthcare data.

Once authenticated, each user accesses their respective dashboard. The Doctor Module enables verified doctors to manage appointment requests, availability schedules, and digital prescription generation. These prescriptions are securely linked to patient accounts within the system. The Patient Module allows users to book appointments, access doctor-issued prescriptions, search for prescribed medicines, and interact with the AI Consultant for Prescription Insights. Patients can receive dosage guidance, diet recommendations, and clarification of medical instructions, improving overall treatment understanding.

The Vendor Module is responsible for maintaining real-time medicine availability. Vendors complete their profiles by mapping their medical store location and updating inventory details. They can add available medicines, accept or deny medicine requests, and manage stock dynamically, ensuring accurate and up-to-date availability information.

The AI Consultant and Prescription Insight Module serve as the intelligent core of the system. It analyzes prescriptions generated by doctors and produces simplified explanations, dosage details, and precautionary guidance. This component bridges the gap between complex medical terminology and patient comprehension, enhancing medication safety.

Operational data such as user profiles, inventory records, and appointments are stored in MongoDB for scalability and efficient management, while blockchain ensures secure handling of sensitive medical information. Overall, the proposed design establishes a secure, scalable, and integrated healthcare ecosystem that enables instant medicine access and intelligent prescription understanding through advanced digital technologies (Figure 1).

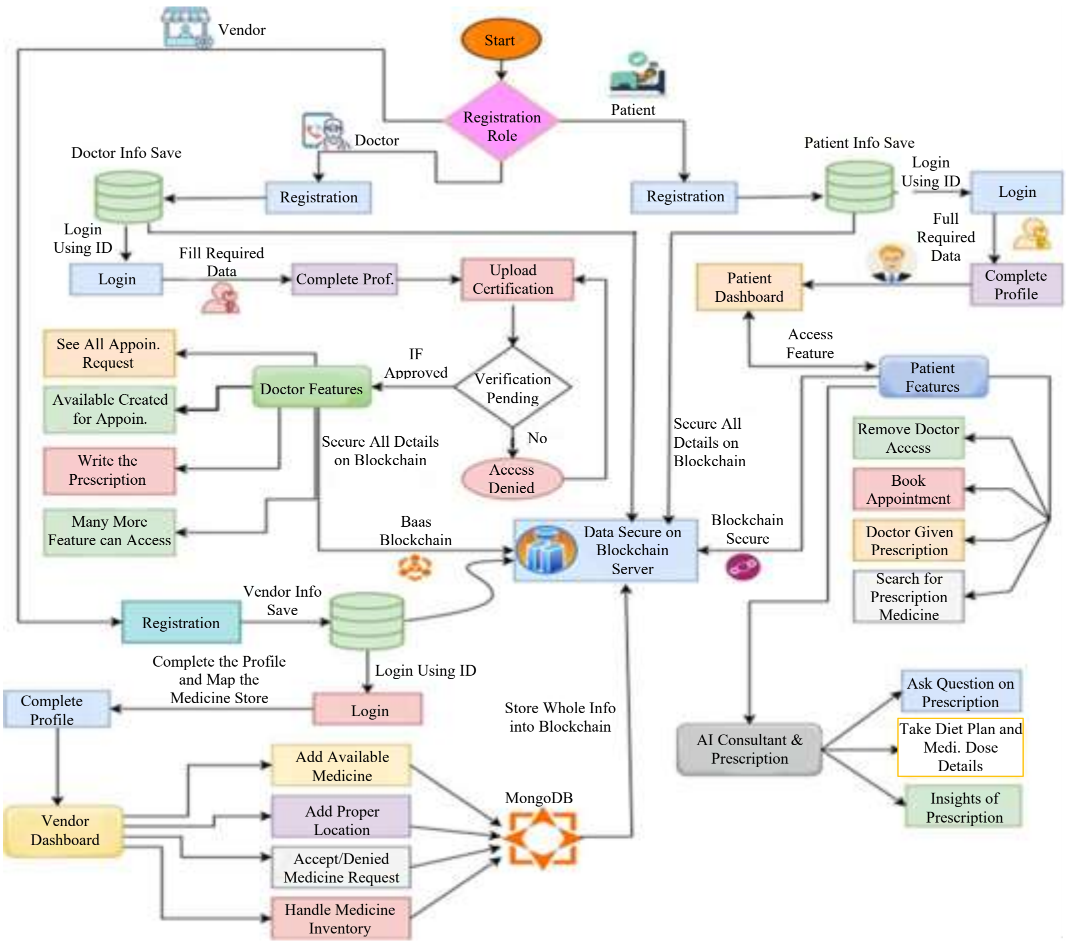

Figure 1. Proposed system architecture of smartmed.

HIGH LEVEL SYSTEM DESIGN

The High-Level System Design of SmartMed follows a layered logical architecture that separates the system into distinct functional layers to ensure scalability, modularity, security, and maintainability.

As illustrated in the High-Level Architecture Diagram, the system is divided into the Client Layer, API Gateway, Application Service Layer, AI Processing Layer, Data Persistence Layer, Blockchain Integrity Layer, and External Integration Layer.

At the top level, the Client Layer consists of three primary user interfaces: the Patient App, Doctor Portal, and Vendor UI.

These interfaces allow different stakeholders to interact with the system according to their roles. All client requests are routed through the API Gateway, which performs authentication and request routing. This gateway acts as a centralized entry point, ensuring secure communication and controlled access to backend services.

Below the API Gateway lies the Application Service Layer, which contains core business services such as the User Service, Prescription Service, Medicine Matching Service, Appointment Service, Order & Payment Service, and Notification Service.

These services handle system logic including user management, prescription processing, medicine availability matching, appointment scheduling, order handling, and notification delivery. The modular separation of services improves system maintainability and allows independent scaling of components.

The AI Processing Layer is responsible for intelligent prescription understanding and medical analysis. It includes components such as the OCR Engine, NLP Analysis Engine, Risk Detection Engine, and Dosage Interpretation Module.

The OCR Engine extracts text from uploaded prescriptions, while the NLP Analysis Engine identifies medicine names, dosage instructions, and clinical entities. The Risk Detection Engine evaluates potential medication risks, and the Dosage Interpretation Module provides simplified guidance for patients. This layer enables automated and intelligent prescription interpretation.

The Data Persistence Layer ensures efficient storage and retrieval of system data. It incorporates MongoDB for structured data storage and Redis Cache for performance optimization and faster data access. This combination enhances system responsiveness and scalability.

To ensure medical data security and integrity, the architecture integrates a Blockchain Integrity Layer, where critical prescription data is stored in the form of prescription hashes. This mechanism guarantees data immutability and prevents unauthorized modifications, thereby increasing trust and transparency in the system.

Finally, the External Integration Layer connects the system with third-party services such as the Payment Gateway, Maps API, Email/SMS services, and other external tools. These integrations support online payments, location-based vendor recommendations, and automated notifications.

Overall, the high-level system design establishes a secure, modular, and AI-driven healthcare platform that supports real-time medicine access, intelligent prescription understanding, and seamless interaction between patients, doctors, and vendors. The layered architecture ensures flexibility, scalability, and robustness, making SmartMed suitable for real-world healthcare deployment (Figure 2).

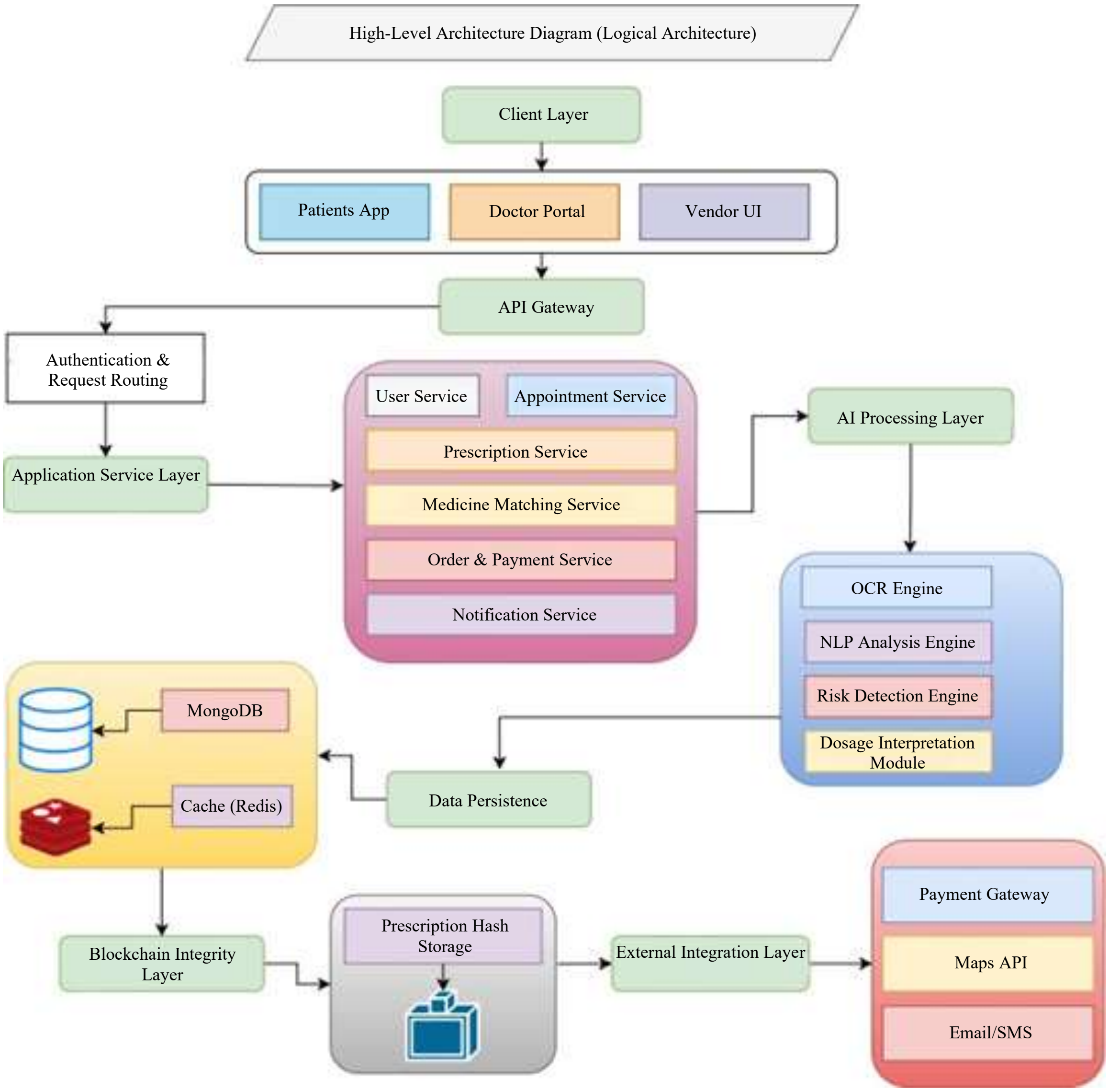

Figure 2. High-level logical architecture of smartmed.

User Flow

The User Flow of SmartMed defines the step-by-step interaction process between users and the system, starting from system initiation to secure data storage. The flow is designed to ensure role-based access control, verification, dashboard access, and secure data management through blockchain integration.

The process begins with System Start, where the user selects a role among Doctor, Patient, or Vendor. Based on the selected role, the system redirects the user to a specific registration workflow.

If the user selects the Doctor role, the doctor must complete the registration process and upload professional certification documents for validation. After submission, the system checks the verification status. If verification fails, access is denied. If verification requires review, it is forwarded for admin approval. Upon successful verification, the doctor gains access to the Doctor Dashboard, where all authorized features become available. This verification step ensures authenticity and prevents unauthorized medical practice within the system.

If the user selects the Patient role, the registration process is comparatively straightforward. After registration, patients receive direct access to complete their profile by filling required details. Once profile completion is successful, they are redirected to the Patient Dashboard, where they can access all patient-related features. This simplified process enhances accessibility while maintaining structured data collection.

If the user selects the Vendor role, the vendor completes registration and profile setup. The vendor must map the medical store location and update medicine inventory details. After completing these steps, the vendor is redirected to the Vendor Dashboard, where inventory management and system interaction features are accessible. This ensures real-time medicine availability within the platform (Figure 3).

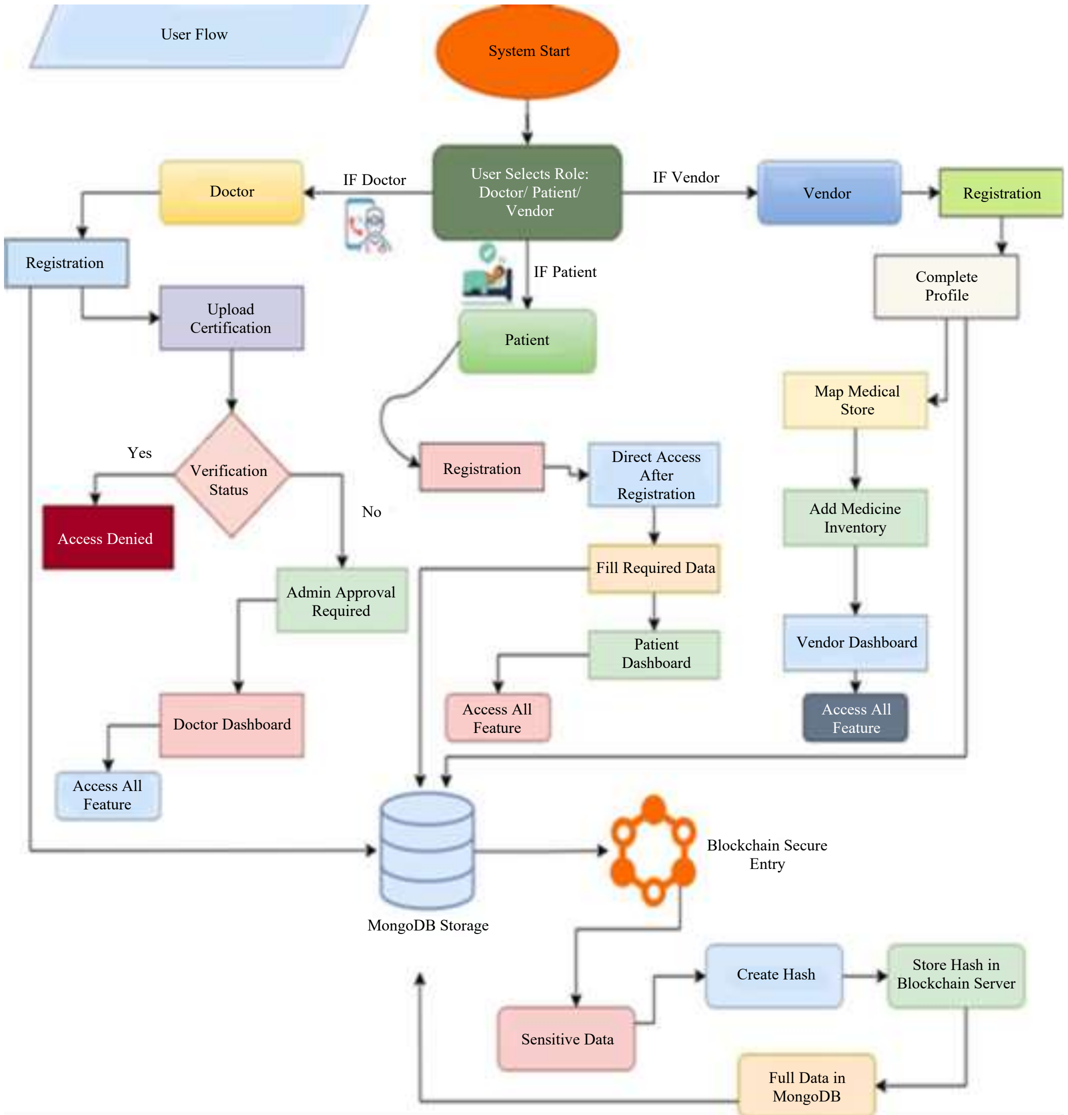

Figure 3. User flow of smartmed system.

All user data generated during registration and system interaction is stored in MongoDB Storage for operational efficiency. However, for sensitive medical information, the system implements a Blockchain Secure Entry mechanism. Sensitive data is processed to create a cryptographic hash, which is then stored on the Blockchain Server, while the complete data remains in MongoDB. This hybrid approach ensures data integrity, immutability, and enhanced security, preventing unauthorized modification of critical healthcare information.

Overall, the user flow ensures a secure, structured, and role-driven interaction model. By integrating verification mechanisms, dashboard-based access control, database storage, and blockchain security, the system maintains reliability, transparency, and scalability while enabling seamless interaction among doctors, patients, and vendors.

IMPLEMENTATION

Frontend Implementation

The frontend is developed using React.js, providing separate interfaces for:

- Patient Application.
- Doctor Portal.
- Vendor Dashboard.

Each interface is designed using reusable components and role-based routing. Authentication state is managed using JWT tokens, ensuring that users can only access authorized features.
The frontend communicates with backend services through RESTful APIs.

Backend API Development

The backend is implemented using Node.js and Express.js, structured into modular services:

- User Service.
- Prescription Service.
- Medicine Matching Service.
- Appointment Service.
- Order & Payment Service.
- Notification Service.

Each service is exposed through secured API endpoints. Middleware is implemented for:

- Authentication verification.
- Role-based authorization.
- Error handling.
- Request validation.

This ensures secure and scalable server-side operations.

Database Implementation

The system uses MongoDB as the primary database for storing:

- User profiles.
- Doctor details.
- Vendor inventory.
- Appointments.
- Orders.
- Prescription records.

MongoDB collections are structured using schema validation. Indexing is applied to frequently queried fields such as medicine names and vendor locations to improve performance.

For performance optimization, caching mechanisms such as Redis (optional layer) can be integrated for faster repeated queries.

Prescription Processing Integration

The prescription upload feature allows patients to upload images or PDF files. The backend handles file storage and forwards the file to the AI processing pipeline.

The OCR module processes the image and extracts text. The extracted text is then passed to the NLP-based medical analysis module, which converts unstructured prescription data into structured entities such as medicine name, dosage, and frequency.

The processed output is stored in the database and displayed in a simplified format to the patient.

Medicine Matching and Vendor Filtering

After extracting medicine names, the system queries the vendor inventory collection to identify vendors with available stock. Only vendors meeting availability conditions are considered for recommendation.

This ensures that users are shown only relevant and in-stock options.

Geolocation and Vendor Ranking

The system captures the patient's location using a Geolocation API. Vendor coordinates are retrieved from the database, and the Haversine distance algorithm is applied to calculate the distance between the patient and each vendor. Vendors are sorted in ascending order of distance, and the nearest available options are displayed to the user. This supports both home delivery and self-pickup decisions.

Order and Payment Integration

Once a vendor is selected, an order record is created in the database. The system integrates with an external Payment Gateway API for secure online transactions.

Order status updates are stored and notifications are sent via Email/SMS services.

OVERALL IMPLEMENTATION

The SmartMed system is implemented using a modular architecture based on the MERN stack, integrating frontend interfaces, backend services, AI processing modules, and secure data management mechanisms. The system supports role-based access for Patients, Doctors, and Vendors, with authentication handled through JWT to ensure secure and controlled access to features.

After registration and verification, users access their respective dashboards. Doctors manage appointments and generate digital prescriptions, patients upload prescriptions and search for required medicines, and vendors maintain real-time medicine inventory and update stock availability. Uploaded prescriptions are processed through an OCR module for text extraction, followed by an NLP-based analysis module that converts unstructured prescription text into structured medical information such as medicine name, dosage, and usage instructions.

The extracted medicines are matched with vendor inventory stored in MongoDB. To provide location-aware recommendations, the system applies the Haversine distance calculation to rank vendors based on proximity to the patient. Sensitive prescription data is further secured using blockchain-based hashing to ensure integrity and prevent unauthorized modification. The overall implementation ensures scalability, security, and efficient real-time medicine access within an integrated healthcare platform.

Blockchain-Based Data Integrity

To ensure medical data security, sensitive prescription information is processed to generate a cryptographic hash, which is stored in a blockchain layer. The full data remains in MongoDB, while the hash ensures tamper detection and integrity verification.

This hybrid storage model enhances trust and protects critical healthcare information.

Deployment Considerations

The SmartMed system is designed for secure and scalable deployment on cloud platforms. The application can be hosted using modern cloud infrastructure with HTTPS security for safe data transmission. Containerization tools such as Docker can be used for consistent deployment, while API security mechanisms and database indexing ensure system reliability and performance as the number of users grows.

APPLIED ALGORITHMS

The SmartMed system integrates three primary algorithms to enable intelligent prescription processing and location-aware medicine access. These algorithms operate sequentially to convert prescription images into structured medical data and recommend the nearest available vendors.

Deep Learning-Based Optical Character Recognition (OCR)

The first algorithm applied in the system is a Deep Learning-based OCR model, which converts uploaded prescription images into machine-readable text. Given an input image
$I \in \mathbb{R}H\times W\times C$.

The objective of the OCR module is to learn a mapping function:
$f: I \to T$.

Where $T = \{t1, t2, tn\}$ represents the extracted text sequence.

The OCR implementation consists of:

- Image Preprocessing (grayscale conversion, noise reduction, normalization).
- CNN-based Feature Extraction for capturing spatial stroke patterns.
- Bi-Directional LSTM for contextual sequence learning.
- CTC (Connectionist Temporal Classification) Decoding for generating final text output.

This architecture enables recognition of variable-length handwritten or printed prescriptions without manual character segmentation (Figure 4, 5).

Performance of the OCR model is evaluated using:

- Character Accuracy Rate (CAR).
- Word Accuracy Rate (WAR).
- Edit Distance.

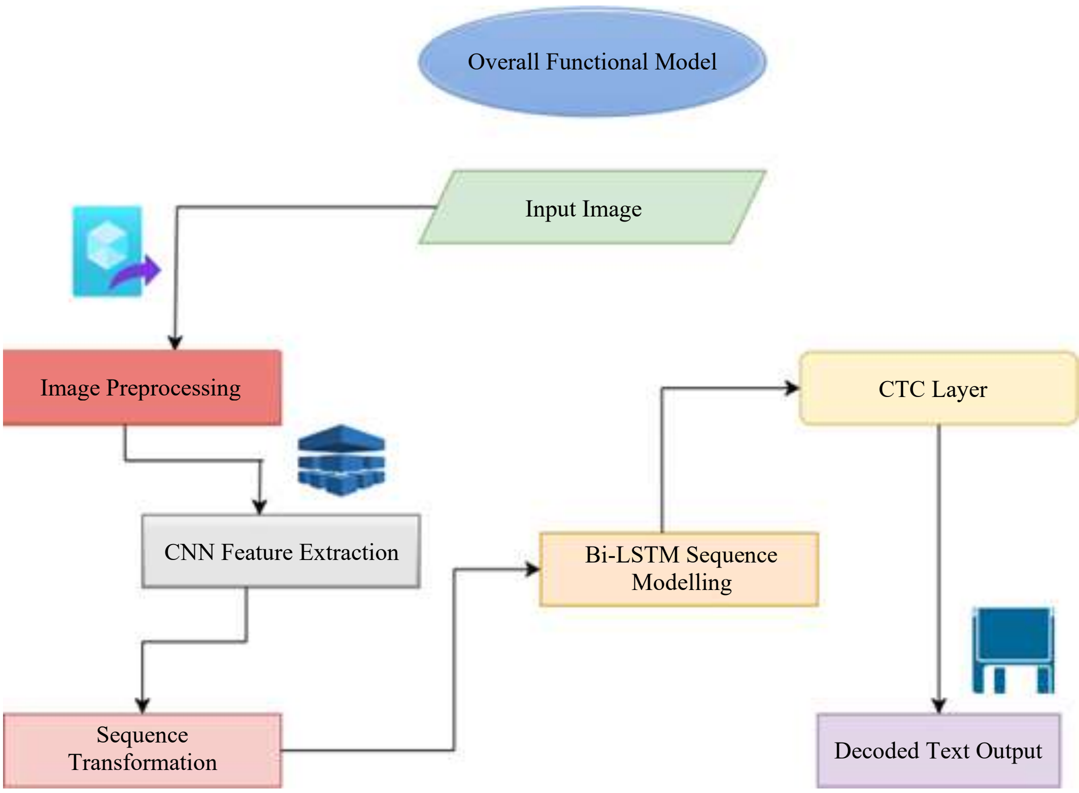

Figure 4. Architecture of deep learning-based OCR model.

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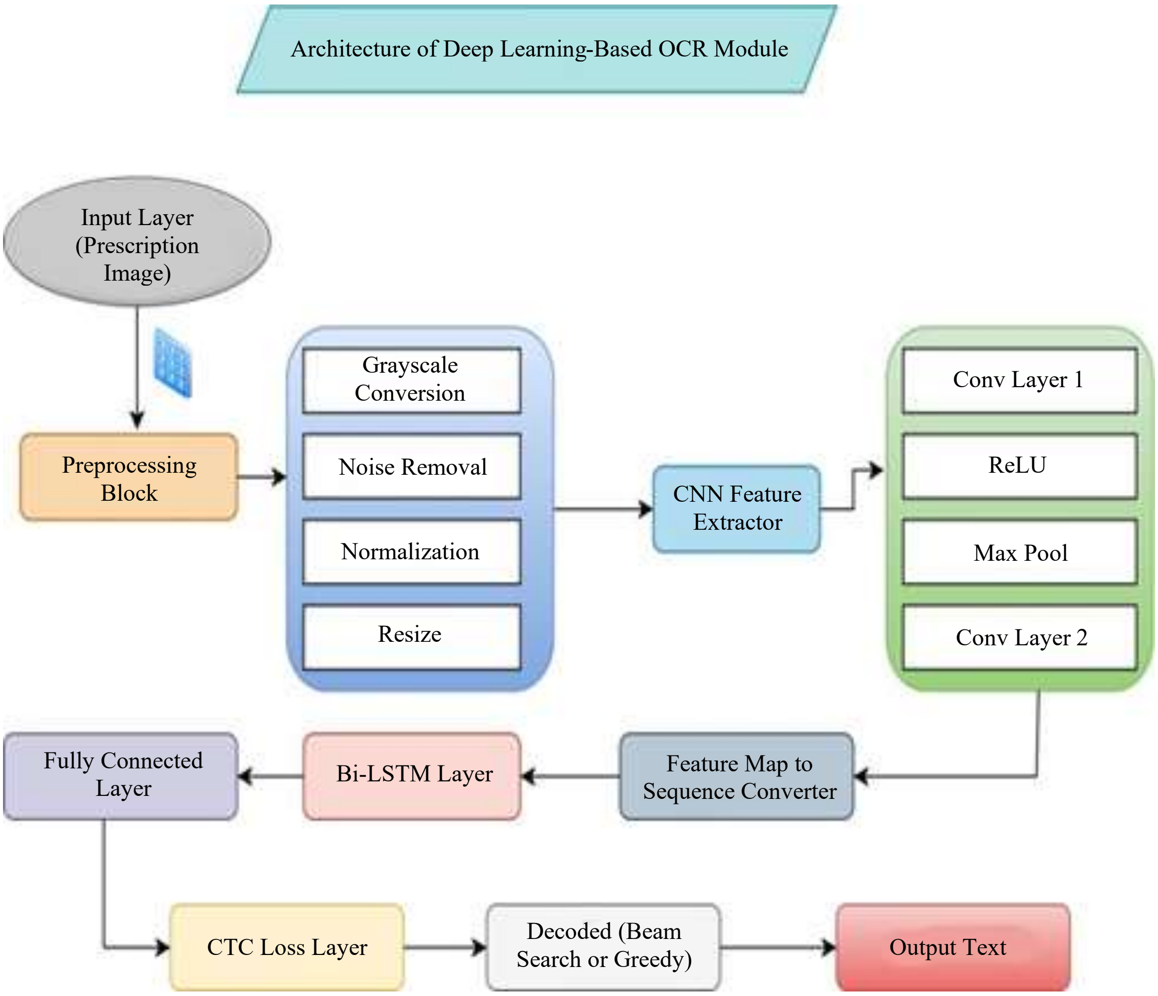

Figure 5. Overall functional model of smartmed.

NLP-Based Medical Text Analysis Algorithm:

After OCR extraction, the raw prescription text is processed using a Natural Language Processing (NLP) algorithm to convert unstructured text into structured medical entities.

Let the extracted text be:
$T = \{t1, t2, tn\}$.

The NLP module transforms it into:
$S = \{(Mi, Di, Fi, Ui)\}$.

Where:
- Mi = Medicine Name.
- Di = Dosage.
- Fi = Frequency.
- Ui = Usage Instructions.

The NLP module uses a hybrid approach consisting of:
- Named Entity Recognition (NER) using BiLSTM-CRF or Transformer-based models.
- Rule-Based Dosage Pattern Recognition (e.g., 1-0-1, BD, TDS).
- Medical Knowledge Base Validation.

- Risk Detection Engine for overdose or conflicting medicines.
- Simplification Module for patient-friendly explanations The model performance is evaluated using:
  - Precision.
  - Recall.
  - F1-Score.

This hybrid approach ensures both contextual understanding and clinical safety validation (Figure 6).

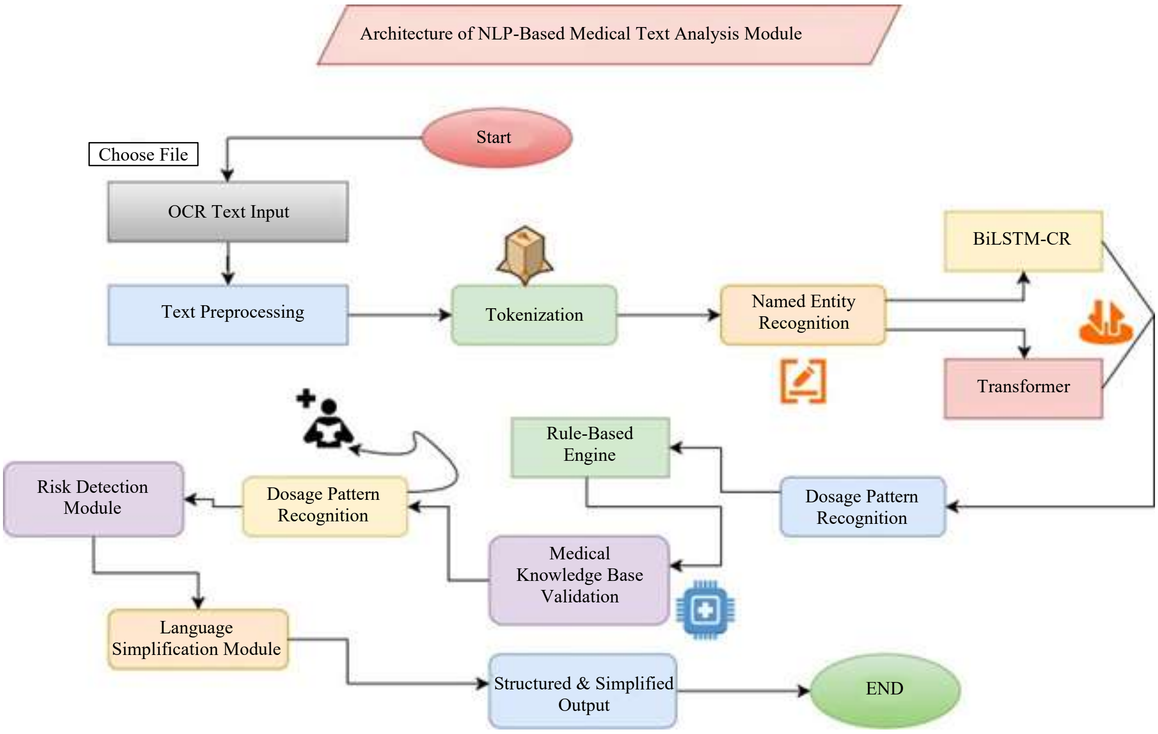

Figure 6. Architecture of NLP-based medical text analysis module.

The diagram represents the workflow of the NLP-Based Medical Text Analysis Module used in SmartMed. The process begins with OCR text input, which contains the extracted prescription text. This text first undergoes text preprocessing, where it is cleaned, normalized, and prepared for analysis. The processed text is then passed to the tokenization stage, where it is divided into meaningful tokens.

Next, Named Entity Recognition (NER) is applied using models such as BiLSTM-CRF or Transformer-based architectures to identify medical entities like medicine names, dosage, frequency, and instructions. The extracted entities are further processed by a rule-based engine and dosage pattern recognition module, which detect patterns such as 1-0-1, BD, or TDS.

The system then performs medical knowledge base validation to verify drug information and ensure safe dosage limits. A risk detection module identifies potential issues such as overdose or conflicting medications. Finally, the language simplification module converts complex medical instructions into patient-friendly explanations, generating a structured and simplified output.

This architecture combines deep learning, rule-based validation, and medical knowledge verification to ensure accurate, safe, and understandable prescription interpretation.

Haversine Distance Calculation Algorithm:

To enable location-aware vendor recommendation, the system applies the Haversine Distance Algorithm, which computes the great-circle distance between two geographic coordinates.

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Let:

- User location = ($lat1$, $lon1$).
- Vendor location = ($lat2$, $lon2$).

The distance is calculated as:

$d = 2rd$ arcsin ($\sqrt{}$sin 2($\Delta\phi$/2) + cos ($lat1$) cos ($lat2$) sin 2($\Delta\lambda$/2))

Where:

- r = Earth's radius (≈ 6371 km).

d = distance between user and vendor The algorithm operates by:

- Capturing user location via GPS.
- Retrieving vendor coordinates from database.
- Computing distance for each vendor.
- Ranking vendors in ascending order.

Displaying only vendors with available stock. The computational complexity is:

- $O\ (m)$.

Where $m$represents the number of vendors.

The Haversine Distance Calculation Algorithm is a mathematical formula used to determine the shortest distance between two points on the surface of a sphere, based on their latitude and longitude coordinates. Since the Earth is approximately spherical, the Haversine formula provides a more accurate distance measurement compared to simple planar or Euclidean distance calculations.

The algorithm computes the great-circle distance, which represents the shortest path over the Earth's surface between two geographic locations. It takes into account the curvature of the Earth, making it highly suitable for geolocation-based systems and navigation applications.

Mathematically, if two points are represented as ($lat1$, $lon1$) and ($lat2$, $lon2$), the formula calculates the angular difference between these coordinates and applies trigonometric functions to determine the central angle between the two points. This angle is then multiplied by the Earth''s radius to obtain the actual distance.

System Working and Functional Validation

The SmartMed system was comprehensively tested to validate the correctness, stability, and integration of all functional modules. The platform successfully supports role-based access control, allowing users to register and operate as Patients, Doctors, or Vendors. The authentication mechanism ensures secure login using credential verification, and profile completion workflows operate correctly for each role.

The Doctor module was validated for schedule configuration, appointment management, patient interaction, and prescription generation. Doctors can define availability slots, block specific dates, review consultation requests, and issue digital prescriptions. The appointment lifecycle – from booking to completion – was tested and confirmed to function accurately with proper status updates and prescription linkage.

The Vendor module was tested for medicine addition, inventory management, and order tracking. Vendors can update medicine details, monitor stock levels, and respond to order requests efficiently. Real-time inventory validation ensures that only available medicines are displayed during patient search queries, confirming accurate database synchronization.

The Patient module enables appointment booking, prescription viewing, document upload, and AI-based consultation. Uploaded medical documents are successfully processed through the OCR and NLP pipeline, which extracts relevant medical entities such as medicine names and dosage instructions. The structured output is presented in a simplified format, improving patient understanding. The AI consultation interface provides interactive assistance based on uploaded reports, validating the integration of intelligent processing components.

The geolocation-based vendor recommendation mechanism was tested to confirm accurate distance computation and ranking of nearby medical stores. The Haversine distance calculation correctly determines proximity, and inventory filtering ensures that recommended vendors meet medicine availability requirements.

All modules demonstrated seamless communication with backend APIs and MongoDB database storage. Sensitive prescription data handling was validated through blockchain-based hashing, ensuring data integrity and tamper detection. The system maintained stable response time during testing, confirming its scalability and suitability for real-time healthcare interaction.

Overall, the functional validation confirms that SmartMed operates as an integrated, secure, and intelligent healthcare platform capable of managing prescription understanding, appointment scheduling, vendor coordination, and medicine accessibility within a unified ecosystem.

RESULTS AND CONCLUSION

The development and evaluation of SmartMed: An AI-Powered Platform for Instant Medicine Access and Prescription Understanding demonstrate that the proposed system effectively integrates artificial intelligence, geolocation intelligence, and secure data management into a unified healthcare solution. The system successfully performs complete end-to-end processing, beginning from prescription upload and concluding with proximity-based vendor recommendation and medicine access. The deep learning–based OCR module accurately converts prescription images into machine-readable text, handling printed as well as moderately complex handwritten prescriptions with consistent recognition accuracy. Although extremely unclear handwriting may slightly affect character-level precision, overall extraction performance remains reliable for real-world healthcare deployment.

The extracted prescription text is further processed by the NLP-based medical text analysis module, which transforms unstructured medical content into structured entities such as medicine names, dosage values, frequency patterns, and usage instructions. The integration of Named Entity Recognition (NER), rule-based dosage validation, and medical knowledge base verification ensures both contextual understanding and clinical safety. The inclusion of a risk detection mechanism enhances the system by identifying potential overdose situations or conflicting medications, thereby promoting safer medication practices and improved patient awareness.

The application of the Haversine Distance Calculation Algorithm enables accurate computation of geographical distance between patients and registered vendors. By combining real-time geolocation capture with inventory-based filtering, the system recommends only those vendors that are both nearby and have the required medicines in stock. This significantly reduces search time, improves emergency response capability, and supports both home delivery and self-pickup decision models. The linear computational complexity of the algorithm ensures scalability as the number of vendors increases.

From a system architecture perspective, the implementation based on the MERN stack provides modular service separation, secure API routing, and efficient database management. The use of JWT-based authentication ensures controlled access to system features, while blockchain-based hashing mechanisms protect sensitive prescription data by ensuring immutability and preventing unauthorized modification. The overall system maintains acceptable response time for real-time user interaction, validating its feasibility for deployment in practical healthcare environments.

In conclusion, SmartMed demonstrates that the integration of OCR-driven digitization, NLP-powered prescription interpretation, geospatial vendor ranking, and blockchain-backed data integrity can significantly enhance digital healthcare platforms. The system not only improves medicine accessibility and emergency responsiveness, but also strengthens prescription clarity, patient safety, and operational efficiency. By combining intelligent automation with secure architecture, SmartMed contributes toward the development of a scalable, secure, and patient-centric digital healthcare ecosystem capable of addressing modern healthcare accessibility challenges.

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