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Meditrack: Smart Healthcare Queue and Appointment System

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Abstract:

The process of booking and managing hospital appointments has become increasingly complex, especially for patients travelling and long distances to reach healthcare centers. A patient residing in Namakkal, for instance, may have an appointment at a hospital in Chennai but lacks real-time information about the appointment sequence, token progress, or any doctor rescheduling. This leads to inconvenience, wasted travel time, and inefficient resource utilization. To address this, the proposed Smart Healthcare Appointment System uses Artificial Intelligence (AI), Blockchain, and IOT integration to provide an intelligent, secure, and automated healthcare service. The system offers AI-powered doctor recommendations, real-time slot management, emergency prioritization, and teleconsultation support. Wearable device integration allows continuous health monitoring, while blockchain ensures the secure sharing of medical records. This smart system aims to enhance accessibility, improve efficiency and build a secure, patient-centric healthcare ecosystem.

Keywords—Artificial Intelligence, Blockchain, IOT, Teleconsultation, Smart Healthcare, Appointment Scheduling.

Introduction

Healthcare accessibility continues to be one pf the most critical challenges in both urban and rural regions, particularly In developing countries loke India. Although several hospitals and healthcare institutions are adopting digital systems, The gap between patient needs and healthcare service delivery remains significant, Patients residing in small towns or rural areas often have to travel long distances to reach advanced medical facilities located in major cities. For instance, a patient from Namakkal travelling to Chennai hospital may have a scheduled appointment but faces uncertainty about he current token number being served, the availability of the consulting doctor, or unexcepted delays in the schedule. This results in wasted travel time, increased expenses, and mental stress for the patient.

Traditional hospital management systems are mostly manual or semi-automates, relying heavily on front-desk staff for scheduling and updates. Such systems often fail to provide real- time information, lack synchronization between departments, and offer little support for emergency prioritization. The absence of intelligent scheduling mechanisms leads to inefficiency, overcrowding, and poor patient satisfaction. Additionally, the manual management of health records and paper-based prescriptions often leads to data loss, duplication, and security risks.

To overcome these limitations, this paper proposes a Smart Healthcare Appointment System that leverages cutting-edge technologies such as Artificial Intelligence (AI), Blockchain, Internet of Things (IoT), and Teleconsultation to create a unified and intelligent healthcare ecosystem. The proposed system offers AI-powered doctor recommendation, real-time slot management, and emergency prioritization to ensure efficient and accessible healthcare delivery. Patients can remotely track their appointment status, receive instant notifications, and even consult doctors online without physically visiting the hospital.

Furthermore, the system integrates wearable devices such as smartwatches or fitness trackers to monitor vital health parameters like heart rate, oxygen level, and blood pressure. Abnormal readings automatically trigger alerts, prompting the system to suggest medical checkups or emergency appointments. By incorporating blockchain technology, the proposed system ensures the security, integrity, and privacy of patient medical records, allowing authorized access to healthcare professionals only.

Inclusion of a chatbot assistant enhances patient interaction by providing 24/7 support for booking, rescheduling, or cancelling appointments. It also helps in guiding patients through teleconsultation steps and offering personalized health suggestions.

In essence, the Smart Healthcare Appointment System aims to bridge the gap between patients and hospitals by providing a real-time, enhances doctor availability, and empowers patients-particularly those from remote locations-to receive timely medical attentions. The proposed solution not only modernizes hospital management but also contributes to building a digitally connected. Health infrastructure aligned with the vision of smart Heal

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II.LITERATURE SURVEY

Recent advancements in digital technology have significantly transformed the healthcare domain, leading to the emergence of intelligent healthcare framework that combine Artificial Intelligence (AI), Internet of Things, (IOT), Blockchain, and Telemedicine. Numerous researchers have explored these technologies to improve healthcare accessibility, data security, and decision making. However, most studies have focused on implementation these technologies in isolation, lacking a unified system that integrates them into a single, intelligent healthcare platform.

Recent research in healthcare technologies highlights the transformative impact of Artificial Intelligence (AI), Internet of Things (IoT), Blockchain, and Telemedicine in improving patient care and hospital operations. Despite rapid advancements, most existing systems operate in isolation — focusing only on disease prediction or data storage — without providing an integrated framework for appointment scheduling, data security, and real-time monitoring. The following sections review the most relevant contributions in this domain.

A. AI in Healthcare:

Artificial Intelligence (AI) has become one of the most transformative technologies in the healthcare domain, enabling data-driven decision-making, disease prediction, and intelligent patient management. The rapid growth of medical data — including patient histories, electronic health records (EHRs), and real-time sensor inputs — has made traditional manual analysis insufficient. AI bridges this gap by offering predictive insights, automated diagnosis, and personalized healthcare recommendations.

AI techniques such as **machine learning (ML)**, **natural language processing (NLP)**, and **deep learning (DL)** are now widely adopted to enhance healthcare efficiency. These algorithms are capable of learning from historical medical data, identifying hidden patterns, and providing predictive outcomes that assist healthcare professionals in early diagnosis and treatment planning. For instance, supervised learning algorithms such as Decision Trees, Support Vector Machines (SVM), and Random Forests have been effectively utilized to classify symptoms and recommend suitable medical specialists. Neural network-based models have also shown high accuracy in detecting diseases like diabetes, heart disorders, and cancer by analyzing patient symptoms and test results.

Gupta and Sharma [1] proposed an AI-based doctor recommendation model that uses patient symptom input and medical history to predict the most suitable doctor specialization. Their research demonstrated improved accuracy and efficiency in matching patients with healthcare providers compared to traditional systems. Similarly, modern AI-driven diagnostic tools analyze unstructured medical data, including doctor notes, prescriptions, and medical images, providing meaningful insights to both patients and doctors.

In the context of **appointment scheduling**, AI algorithms can forecast patient flow, optimize doctor schedules, and minimize waiting time. Predictive analytics can analyze historical booking trends, cancellation patterns, and patient urgency levels to dynamically adjust slot allocations. For example, reinforcement learning techniques can optimize the allocation of time slots by continuously learning from real-time patient interactions and hospital workload data. This not only enhances resource utilization but also improves patient satisfaction.

B. IOT and wearable Health Monitoring:

The **Internet of Things (IoT)** has emerged as a revolutionary technology in the healthcare industry, enabling continuous patient monitoring, remote diagnosis, and real-time data sharing between patients and healthcare providers. IoT-based systems connect smart medical devices, wearable sensors, and hospital networks to collect and analyze vital health data automatically. This connectivity ensures that medical decisions are based on up-to-date and accurate physiological information rather than periodic manual checkups.

Wearable health monitoring devices — such as **smartwatches, fitness trackers, ECG monitors, and pulse oximeters** — play a crucial role in gathering key health metrics like heart rate, blood pressure, oxygen saturation (SpO_2), body temperature, and physical activity levels. These devices are equipped with miniature sensors that collect biomedical signals and transmit them to cloud-based healthcare platforms via Wi-Fi or Bluetooth. The collected data can be analyzed in real-time to detect irregularities or early signs of medical conditions.

Li et al. [3] proposed an IoT-based remote health monitoring framework that continuously records physiological data and alerts doctors in case of abnormal readings. Their system demonstrated that continuous data streams could help predict health risks before they escalate into emergencies. Similarly, other researchers have utilized IoT for **chronic disease management**, **elderly patient monitoring**, and **rehabilitation tracking**. These systems allow healthcare professionals to intervene early and provide preventive care instead of reactive treatment.

C. Telemedicine and Remote Consultation

Telemedicine has emerged as one of the most impactful innovations in the healthcare domain, revolutionizing how medical services are delivered and accessed. It refers to the use of digital communication technologies — such as video conferencing, chat platforms, and mobile applications — to provide remote medical consultation, diagnosis, and treatment without requiring physical presence at a healthcare facility. This technology has become a lifeline for patients residing in geographically distant or underserved regions, where access to specialized doctors is often limited.

During the COVID-19 pandemic, telemedicine witnessed massive adoption across the globe, proving its capability to maintain healthcare continuity while minimizing physical contact. According to Kumar and Singh [4], AI-driven telemedicine systems significantly improved doctor–patient interaction and reduced unnecessary hospital visits by

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enabling secure video consultations and digital prescriptions. The integration of **AI, IoT, and cloud technologies** into telemedicine systems further enhances their efficiency by supporting real-time monitoring, predictive analytics, and intelligent scheduling.

Traditional telemedicine systems typically operate as **independent platforms**, disconnected from hospital databases or live appointment systems. This results in scheduling conflicts, incomplete patient data sharing, and inefficient communication. To overcome these limitations, the **proposed Smart Healthcare Appointment System** embeds telemedicine as a **core functional module**, tightly integrated with AI-based scheduling, blockchain-secured data management, and IoT-driven health monitoring.

The teleconsultation module within the system enables **secure video calls**, **e-prescriptions**, and **digital report sharing** between doctors and patients. Patients can connect with their preferred specialists based on the AI engine's recommendations, view available time slots in real-time, and confirm appointments instantly through the system's interface. Once the consultation is completed, the doctor can issue a **digitally signed prescription** that is automatically stored in the blockchain ledger for permanent access and future reference. This ensures data integrity, transparency, and traceability of medical transactions.

One of the major innovations of the proposed system lies in **real-time token synchronization**. Patients can track live updates about their appointment status or queue position directly from their mobile app. For instance, a patient traveling from Namakkal to Chennai can monitor which token number is currently being served, helping them plan travel more efficiently. If the patient cannot reach the hospital on time or prefers to avoid long waiting periods, they can switch to an online teleconsultation session with the same doctor using the system's integrated video module. This dynamic hybrid model bridges the gap between **in-person and virtual healthcare**.

D. Intelligent Scheduling and Resource Optimization

Intelligent scheduling plays a pivotal role in enhancing the operational efficiency of healthcare systems. In conventional hospital appointment mechanisms, scheduling is largely manual or semi-automated, often leading to issues such as overlapping appointments, long waiting queues, and inefficient utilization of healthcare professionals. These inefficiencies become more pronounced when patients travel long distances, such as from smaller towns to metropolitan hospitals, without real-time knowledge of their appointment status.

The proposed **Smart Healthcare Appointment System** addresses these limitations through **AI-driven dynamic scheduling** and **resource optimization**. Using advanced data analytics and predictive modelling, the system continuously evaluates multiple factors including doctor availability, consultation duration, patient severity, travel distance, and hospital workload. Based on these inputs, the AI engine intelligently allocates appointment slots and reassigns them dynamically in response to real-time changes.

When a doctor reschedules or cancels an appointment, the **real-time slot management module** immediately updates the availability matrix, reallocating the slot to the next waiting patient. This reduces downtime and ensures maximum utilization of medical staff. Similarly, if a patient cancels, the system automatically promotes the next eligible appointment in the queue, optimizing both time and resource usage.

Incorporating **priority-based scheduling**, the system assigns higher priority to patients exhibiting critical symptoms or abnormal health readings obtained from IoT-based wearables. For instance, if a patient's wearable device records irregular heart activity or elevated blood pressure, the AI engine flags the case as urgent and adjusts the queue to ensure faster consultation. This adaptive scheduling ensures that emergency cases receive timely medical attention without significantly affecting normal appointment flow.

Additionally, the system integrates **predictive analytics** to forecast peak patient loads, doctor fatigue levels, and expected waiting times. This data enables administrators to make proactive decisions such as increasing the number of consultation rooms, adjusting shift timings, or reallocating medical personnel to high-demand departments. Such intelligent planning minimizes overcrowding and enhances patient throughput.

On the resource optimization front, the system also manages **infrastructure resources** such as diagnostic labs, teleconsultation bandwidth, and consultation rooms. By monitoring utilization patterns, it can predict bottlenecks and redistribute workloads across available resources. This contributes to cost reduction, improved patient turnover, and enhanced service quality.

Moreover, **machine learning algorithms** learn from historical appointment data to continuously refine scheduling accuracy. Over time, the system becomes more adaptive, reducing human intervention and ensuring smoother coordination among doctors, patients, and hospital administrators.

Through this intelligent scheduling and optimization framework, the proposed system significantly minimizes waiting time, maximizes doctor efficiency, and improves patient satisfaction. The combination of AI-powered slot prediction, emergency prioritization, and automated resource allocation ensures a seamless, efficient, and responsive healthcare delivery process suitable for both urban and rural contexts.

III.PROPOSED SYSTEM

The proposed system, **CareQueue: Smart Token-Based Healthcare Appointment System**, is designed to modernize the patient appointment and consultation process through the integration of **Artificial Intelligence (AI)**, **Blockchain**, **IoT-based wearable devices**, and

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Telemedicine technologies. The goal is to create a secure, intelligent, and adaptive healthcare platform that enhances efficiency, transparency, and accessibility for both patients and healthcare providers.

1. System Overview

The system provides a unified digital framework that connects patients, doctors, and hospital administrators through an intuitive interface. Patients can register, provide health-related details, and schedule appointments either in person or virtually. The system automatically analyses the provided data to recommend suitable doctors, manage time slots, and issue real-time digital tokens. All patient data, medical records, and prescriptions are securely stored in a **blockchain-based ledger**, ensuring confidentiality and immutability.

2. AI-Based Diagnosis and Doctor Recommendation

At the heart of the proposed system lies the **AI-driven decision support engine**. It employs machine learning algorithms and natural language processing (NLP) techniques to interpret symptoms entered by the patient. Based on this analysis, the system identifies the probable medical specialization and recommends the most relevant doctor.

The AI engine also integrates emergency detection logic — if input data or wearable readings indicate critical symptoms such as high blood pressure, chest discomfort, or abnormal heart rate, the system automatically elevates the case priority. This ensures that emergencies receive immediate attention without manual intervention.

3. Dynamic Scheduling and Smart Token System

Traditional appointment systems often suffer from delays and poor time utilization. The proposed system introduces a **smart token mechanism** that dynamically adjusts the appointment queue based on doctor availability, consultation duration, and emergency cases. Patients receive real-time updates regarding their token number, expected waiting time, and consultation slot through mobile notifications. This reduces uncertainty and allows hospitals to handle patient flow more effectively.

4. IoT-Enabled Health Monitoring

IoT integration enables the system to continuously gather physiological data from wearable sensors such as smartwatches, heart rate monitors, and SpO_2 trackers. These devices send real-time readings to the central server, where the AI module processes and analyzes the data. If any critical parameter is detected — for instance, oxygen levels dropping below safe limits — the system alerts both the patient and the hospital staff. This proactive monitoring helps in early diagnosis, reduces the risk of complications, and supports preventive healthcare.

5. Blockchain-Based Record Management

Data privacy and authenticity are major challenges in digital healthcare. The proposed system employs a **blockchain-based record management framework** to securely store patient data, prescriptions, and consultation histories. Every transaction — from appointment confirmation to medical updates — is stored as an encrypted, immutable block, ensuring traceability and eliminating the risk of unauthorized data modification. Only verified users with permissioned access can retrieve or share medical data, maintaining full transparency and compliance with data protection standards.

6. Telemedicine and Remote Consultation

To improve accessibility, particularly for rural or distant patients, the system includes a **teleconsultation module** that enables real-time virtual doctor–patient interactions through secure video conferencing. Doctors can review uploaded reports or wearable data during the session and generate **digital prescriptions**, which are securely stored in the blockchain. This feature reduces travel time, supports continuous care, and ensures that patients can receive timely medical advice even from remote locations.

7. Real-Time Notifications and Alerts

The notification subsystem provides instant alerts for upcoming appointments, doctor availability changes, emergency escalations, and token progress. These notifications are synchronized across mobile and web platforms, ensuring that patients and healthcare staff remain informed at every stage of the consultation process. This reduces administrative overhead, minimizes patient confusion, and ensures smooth coordination between different departments within the hospital.

8. System Benefits

The proposed CareQueue system introduces a significant advancement in healthcare operations through the following benefits:

Reduced Waiting Time: Smart tokens and dynamic scheduling optimize patient flow.

Enhanced Accuracy: AI-powered doctor recommendations ensure correct specialist matching.

Improved Security: Blockchain guarantees tamper-proof and auditable health records.

Predictive Monitoring: IoT devices enable early detection of health abnormalities.

Remote Accessibility: Teleconsultation bridges geographical barriers to healthcare access.

Operational Efficiency: Automated processes reduce human error and improve resource utilization.

9. Implementation Potential

The CareQueue system can be implemented across hospitals, clinics, and diagnostic centers with minimal infrastructure modification. Its modular design allows easy scaling and integration with existing hospital management systems. Future enhancements could include **predictive analytics** for patient flow forecasting, **AI-based disease progression models**, and **integration with national healthcare databases** for unified medical record management. By combining the strengths of AI, IoT, Blockchain, and Telemedicine, the system offers a holistic, patient-centric healthcare solution that promotes efficiency, reliability, and trust.

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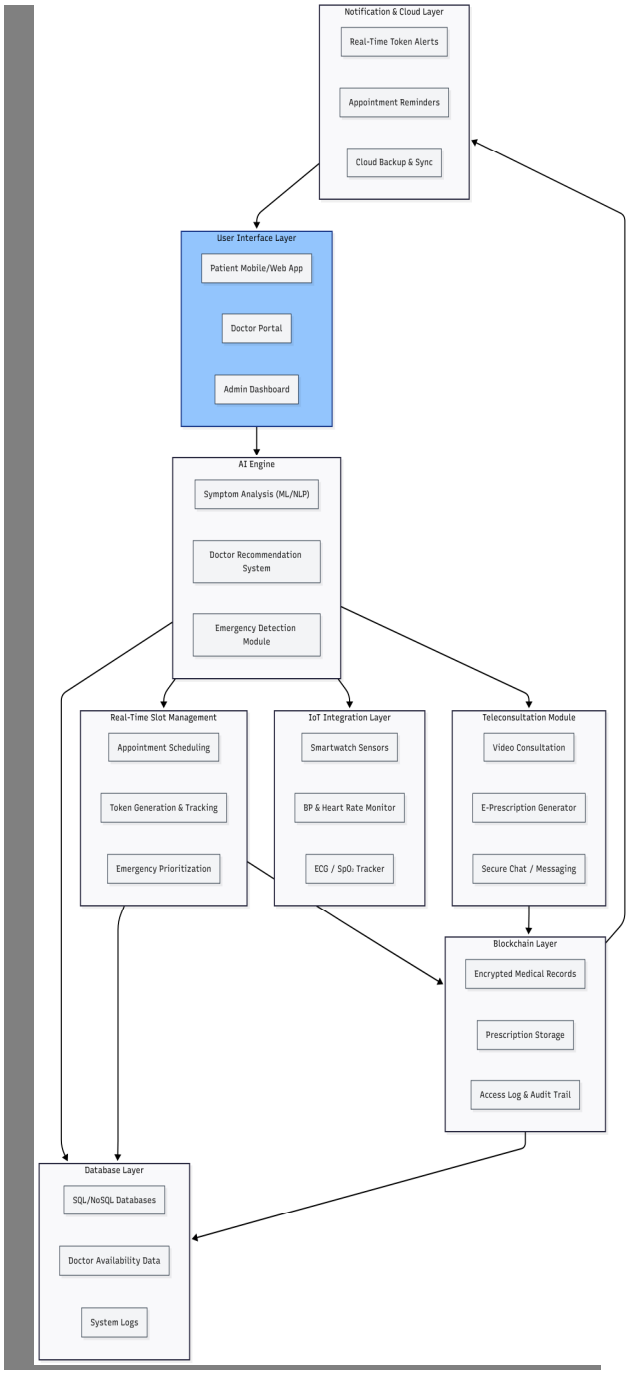
IV.WORKFLOW ARCHITECTURE



The proposed architecture of the CareQueue: Smart Token-Based Healthcare System is designed as a multi-layered framework that integrates AI, IoT, blockchain, and cloud technologies to deliver a seamless and intelligent healthcare experience. The architecture is composed of several interconnected layers — User Interface Layer, AI Engine, Real-Time Slot Management, IoT Integration Layer, Teleconsultation Module, Blockchain Layer, Notification & Cloud Layer, and the Database Layer — all functioning together to ensure efficient patient care, secure data management, and real-time health monitoring.

At the top of the architecture, the User Interface Layer serves as the primary interaction point for all stakeholders. It includes the Patient Mobile/Web Application, Doctor Portal, and Admin Dashboard. Patients can register, book appointments, view live token updates, and consult doctors through the mobile or web app. Doctors use the portal to manage appointments, view patient histories, and conduct online consultations, while the admin dashboard allows hospital administrators to monitor system operations and manage hospital resources efficiently.

The AI Engine acts as the brain of the system, enabling intelligent automation and decision-making. It performs symptom analysis using machine learning and natural language processing (ML/NLP) techniques to interpret patient input and recommend appropriate doctors or departments. The AI also includes a Doctor Recommendation System, which suggests specialists based on symptom data and availability, and an Emergency Detection Module that identifies high-risk or critical cases, ensuring such patients are prioritized in the appointment queue.

The Real-Time Slot Management Module handles the dynamic scheduling of appointments and token generation. It automatically allocates time slots to patients based on doctor availability and the severity of the case. This module minimizes waiting times and prevents overcrowding in hospital waiting areas. In emergencies, it adjusts scheduling in real-time to prioritize urgent consultations, thereby improving hospital workflow efficiency.

The IoT Integration Layer connects the system to wearable health-monitoring devices such as smartwatches and medical sensors. These devices continuously track vital parameters including heart rate, blood pressure (BP), oxygen saturation (SpO_2), and ECG signals. The data collected is transmitted to the AI Engine and Database Layer, enabling continuous health monitoring. Any abnormal readings trigger instant alerts to both the patient and healthcare provider for timely medical intervention.

For remote healthcare delivery, the Teleconsultation Module provides virtual communication channels between doctors and patients. It includes video consultation, secure chat/messaging, and an e-prescription generator. This enables patients, especially those in rural or remote areas, to receive medical advice and prescriptions without physically visiting the hospital.

To ensure data integrity and security, the Blockchain Layer stores sensitive medical data in an encrypted form. It maintains electronic health records (EHRs), prescription storage, and audit trails that track every access or modification. Blockchain ensures transparency, immutability, and patient data confidentiality, addressing one of the major concerns in modern healthcare systems.

The Notification and Cloud Layer ensures real-time communication and synchronization. It manages appointment reminders, token progress alerts, and cloud data backup. By integrating with cloud services, this layer ensures that the entire system remains accessible, scalable, and reliable, supporting real-time updates and remote accessibility for both patients and doctors.

Finally, the Database Layer acts as the backbone of the system, storing structured and unstructured data in SQL/NoSQL databases. It maintains patient information, doctor schedules, appointment histories, system logs, and sensor data. The integration between the database and upper

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layers allows for efficient retrieval and analysis of data, supporting AI-driven decisions and system monitoring.

Overall, the architecture ensures seamless interaction between multiple components, enabling intelligent scheduling, continuous health tracking, secure data handling, and real-time decision-making. This layered design not only enhances patient experience but also optimizes hospital operations through automation, predictive analytics, and secure digital connectivity.

CONCLUSION

The proposed **CareQueue: Smart Token-Based Healthcare System** presents an innovative, technology-driven approach to modernizing hospital operations and patient management. By integrating **Artificial Intelligence (AI)**, **Internet of Things (IoT)**, **Blockchain**, and **Cloud Computing**, the system effectively addresses the limitations of traditional appointment systems, long waiting times, and inefficient resource allocation in healthcare institutions. The multi-layered architecture enhances system intelligence, automation, and security while ensuring scalability and interoperability across various healthcare services.

Through AI-driven modules such as **Symptom Analysis** and **Doctor Recommendation**, the system enables intelligent decision-making and improves diagnostic accuracy. The **Emergency Detection Module** further enhances patient safety by automatically prioritizing critical cases, ensuring timely medical attention. The **IoT Integration Layer** supports real-time health monitoring using wearable sensors that continuously track vital signs like heart rate, SpO_2 levels, and blood pressure, promoting proactive healthcare management and early detection of anomalies.

Moreover, the incorporation of **Blockchain technology** provides a secure and transparent framework for managing sensitive medical data. Encrypted electronic health records and immutable audit trails ensure data integrity, privacy, and accountability, thereby building trust among patients and healthcare providers. The **Teleconsultation Module** extends healthcare accessibility beyond physical boundaries, enabling remote consultations, digital prescriptions, and secure communication, which is especially beneficial for patients in rural or underserved regions.

The **Real-Time Slot Management** and **Token Generation System** eliminate the inefficiencies associated with manual scheduling by dynamically managing doctor availability and patient flow. This not only reduces waiting times but also optimizes hospital resources and staff workload. Additionally, the **Notification and Cloud Layer** enhances communication through automated reminders, token updates, and data synchronization, ensuring seamless connectivity and operational continuity even in high-demand scenarios.

Overall, the proposed system demonstrates a comprehensive solution for creating a **smart, patient-centered, and secure healthcare ecosystem**. It bridges the gap between patients and healthcare providers through automation, intelligent scheduling, and continuous health tracking. The integration of cutting-edge technologies contributes to the vision of **next-generation healthcare systems** that are efficient, accessible, and reliable.

In future work, this system can be expanded by incorporating **predictive analytics** for disease forecasting, **AI-driven chatbots** for patient support, and **interoperable health data exchange frameworks** to connect with national and global health networks. By embracing these advancements, **CareQueue** can evolve into a fully autonomous, intelligent healthcare management platform that revolutionizes digital healthcare delivery.

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