

A Secure and Intelligent Healthcare Chatbot Using Blockchain And AI

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Abstract—In recent years, the healthcare industry has increasingly adopted digital solutions to improve efficiency, accessibility, and patient experience. However, the rapid digitization of health information raises critical concerns around data privacy, security, and unauthorized access. This project introduces a comprehensive web-based system that securely manages and stores electronic health records using Ethereum blockchain technology. Developed using Python Django, HTML, CSS, JavaScript, Bootstrap, and MySQL, the system ensures that all medical data is handled in a secure, transparent, and decentralized manner. The core of this system is built upon blockchain technology powered by Ethereum and tested on the Ganache local blockchain environment, which enables tamper-proof storage and retrieval of sensitive patient information through smart contracts.

The application comprises three main user portals: Admin, Doctor, and Patient. The Admin can register, manage, and monitor both doctors and patients while reviewing user feedback to ensure the smooth operation of the platform. Doctors can manage their profiles, handle appointment scheduling, and communicate directly with patients through a built-in messaging system. Patients can explore doctor profiles, book appointments, view their medical history, and interact with doctors in real-time. One of the key highlights of this system is the integration of a healthcare chatbot using the Perplexity API, which assists patients by responding to common medical queries, thus improving accessibility and reducing dependence on direct consultations for preliminary concerns.

Blockchain plays a vital role by providing a secure environment for health record storage. Once a record is uploaded, it is hashed and stored immutably on the Ethereum blockchain using smart contracts, ensuring that the data cannot be altered or deleted by any unauthorized party. This approach significantly strengthens the trust, integrity, and confidentiality of patient records. By combining modern web technologies, artificial intelligence, and blockchain, this project demonstrates an efficient, user-friendly, and highly secure solution for managing digital health records in a scalable and future-ready manner.

Keywords: Blockchain, Ethereum, Ganache, Health Records, Smart Contracts, Django, Secure Medical Data, Healthcare Chatbot, Perplexity API, Decentralized Storage, Web Application.

I. INTRODUCTION

The healthcare sector has witnessed significant digital transformation over the past decade, with the widespread adoption of Electronic Health Records (EHRs), online consultation platforms, and AI-based assistance. The digitization of patient data allows healthcare providers to streamline administrative tasks, reduce human errors, and provide better patient outcomes. However, as the volume of sensitive medical data grows, so do the challenges related to its privacy, integrity, and security [1]. Health records are highly confidential, and unauthorized access or data breaches can have serious legal and ethical consequences [2].

Traditional centralized systems, commonly used for storing patient information, are prone to single points of failure, making them vulnerable to cyber-attacks, data tampering, and system downtime [3]. To address these concerns, researchers and developers have increasingly turned to blockchain technology, which offers a decentralized and immutable approach to data storage. Blockchain ensures that once data is recorded, it cannot be altered or deleted without consensus, thereby preserving the integrity and trustworthiness of patient information [4].

Ethereum, one of the most widely used blockchain platforms, provides support for deploying smart contracts — self-executing programs that facilitate, verify, or enforce the negotiation or performance of a contract [5]. In this project, Ethereum is integrated with the Ganache framework, a local blockchain simulator used during the development phase to test smart contracts efficiently and securely without requiring live cryptocurrency. This decentralized storage method eliminates the need for trusting a central authority and puts control back into the hands of patients [6].

The system is designed to include three key user portals: Admin, Doctor, and Patient. Each user type is assigned specific functionalities. Admins are responsible for managing user registrations, handling feedback, and ensuring proper oversight of system usage. Doctors can register, update their profiles, manage appointments, and communicate with patients through a secure chat interface. Patients are empowered to

view doctor profiles, book appointments, maintain a record of past consultations, and securely store their medical reports on the blockchain [7].

A unique feature of this system is the integration of an API-based healthcare chatbot, developed using the Perplexity API. This feature allows patients to interact with the system for quick and reliable health-related queries, reducing the dependency on doctors for minor or preliminary concerns. AI-powered chatbots are proving to be valuable tools in modern healthcare systems by offering 24/7 support, triaging health issues, and guiding users toward the right medical action [8].

The backend of the project is developed using Python with the Django framework, while the frontend is built with HTML, CSS, JavaScript, and Bootstrap to ensure a responsive and user-friendly interface. MySQL is used to store basic user-related information and appointment history, while the core medical records are stored securely on the blockchain. This hybrid approach optimizes performance while ensuring security and decentralization where it matters most [9].

By combining the strengths of blockchain technology, smart contracts, and AI-driven chatbot systems, this project proposes a robust and secure health record management system. It not only ensures that sensitive medical data is stored and transmitted safely but also improves patient accessibility and engagement through automation and smart assistance. Such innovations are critical in building a next-generation healthcare ecosystem that is not only secure but also patient-centric, transparent, and efficient [10].

While blockchain ensures secure and immutable storage, the scalability and practical implementation of such technology in healthcare still require thoughtful architecture and seamless integration with existing systems. As healthcare services often involve multiple stakeholders — patients, doctors, pharmacists, labs, and administrators — interoperability between different platforms is essential for effective service delivery. In this project, blockchain acts as a trusted ledger where critical health data can be verified and shared transparently without compromising privacy [10].

Moreover, decentralization not only enhances security but also grants more control to patients over their data. Unlike traditional centralized systems where hospitals and third-party organizations have ownership, blockchain empowers patients to access, share, or revoke access to their health records at any time [11]. This shift from provider-centered to patient-centered data control aligns with global trends in digital health transformation and complies with modern healthcare data regulations such as GDPR and HIPAA [12].

Another significant challenge in digital healthcare

is maintaining real-time engagement and support for users. Many systems lack interactive interfaces that can guide patients through their health journey. To address this, the project incorporates an AI-powered chatbot that provides round-the-clock assistance to users by answering common medical queries, explaining symptoms, and helping with appointment-related tasks. Chatbots, when properly trained and ethically used, reduce the workload on doctors and act as an initial filter for minor health concerns [13].

Security, accessibility, automation, and trust are the core design principles behind this project. By combining smart contracts on Ethereum, development tools like Ganache, modern web technologies like Django and Bootstrap, and conversational AI tools, the system achieves a balanced approach that addresses technical, ethical, and user experience challenges in digital healthcare [14]. The solution not only provides a scalable architecture for secure data storage but also creates a user-friendly environment that meets the expectations of modern-day patients and healthcare providers.

This project demonstrates a forward-thinking model for managing electronic health records in a secure, decentralized, and interactive manner. It can serve as a foundational prototype for larger-scale implementations in public and private healthcare institutions. With continued improvement and integration with biometric or IoT-based health sensors, such systems could evolve into comprehensive personal health management ecosystems [16].

The increasing dependence on digital platforms in healthcare has driven researchers to explore new and secure methods of storing and managing patient data. Several studies have highlighted the limitations of traditional healthcare data storage systems, especially regarding centralized architectures, which are susceptible to data breaches, unauthorized modifications, and limited transparency [16]. In response to these issues, blockchain technology has gained significant attention due to its decentralized, immutable, and transparent nature, offering enhanced data protection and traceability in the healthcare domain.

II. LITERATURE SURVEY

Dubovitskaya et al. proposed a blockchain-based approach for secure sharing of Electronic Medical Records (EMRs), emphasizing that blockchain ensures both patient privacy and tamper-proof access to records shared between institutions [17]. Similarly, Ekblaw et al. developed "MedRec," a prototype designed to handle medical data sharing through Ethereum smart contracts. Their model empowers patients to control access rights and allows data sharing

among healthcare providers in a trustless environment [18]. This early-stage research highlighted the potential of blockchain to shift data ownership from institutions to patients while reducing administrative burdens.

Benchoufi and Ravaud explored how blockchain can improve transparency in clinical trials. Their work demonstrated that using blockchain to timestamp trial data can prevent data fabrication and ensure the authenticity of results submitted to regulatory bodies [19]. Building upon this, Zhang and White implemented FHIRChain, a framework combining Fast Healthcare Interoperability Resources (FHIR) standards with blockchain to allow secure clinical data sharing and audit trails [20]. These studies collectively establish blockchain as a viable solution for not only data storage but also compliance, accountability, and transparency in healthcare systems.

Beyond data security, patient engagement and interaction have also emerged as focal points in digital healthcare innovation. Chatbot systems powered by AI are increasingly being adopted to enhance user experience by providing quick access to healthcare information, booking appointments, and preliminary diagnostics. Zubaydi et al. conducted a comprehensive review of healthcare chatbots and emphasized their role in reducing workload on medical staff and enabling faster response times for routine inquiries [21]. Their research categorizes chatbots based on rule-based systems and machine-learning-driven models, suggesting that hybrid models provide optimal performance in handling healthcare queries.

Moreover, Pereira and D'iaz investigated the adoption of chatbots in the service industry and revealed how well-designed conversational interfaces can improve user trust and operational efficiency [22]. Although their study was not healthcare-specific, it provided a foundational understanding of the psychological and usability factors influencing chatbot interactions. In a more healthcare-oriented approach, Sharma discussed the potential of AI chatbots to act as virtual assistants that guide patients through self-assessment routines, provide medication reminders, and help in chronic disease monitoring [23].

Kuo et al. analyzed the application of distributed ledger technologies like blockchain in biomedical research and concluded that combining blockchain with off-chain storage can solve scalability issues while maintaining strong access control and auditability [24]. This combination of on-chain and off-chain models is critical in healthcare settings, where large imaging files and extensive documentation are involved.

Furthermore, studies focusing on secure medi-

cal record handling emphasize the importance of blockchain's immutable nature in addressing longstanding issues such as unauthorized access and data tampering. In one such approach, a smart contract-based mechanism was proposed that integrates access permissions directly into blockchain transactions, ensuring that only authorized personnel can view or modify patient records. This method not only secures the data but also facilitates auditability, as every transaction is logged and time-stamped on the chain [20].

Another study by Mukhopadhyay et al. proposed a patient-centric architecture that empowers users to control access to their data through cryptographic keys. By integrating Ethereum-based smart contracts and secure off-chain storage, the researchers provided an effective balance between decentralization and scalability [21]. Their implementation allowed patients to revoke or grant access dynamically, which proved beneficial in emergency healthcare situations.

In recent advancements, decentralized applications (DApps) built on Ethereum have shown promise for automating healthcare workflows such as appointment booking, prescription management, and billing. These applications significantly reduce reliance on centralized servers, lowering the risk of single-point failures or data breaches [22]. Blockchain also enables better interoperability between different healthcare providers, as data stored on a shared distributed ledger can be universally accessible, verifiable, and standardized [23].

Meanwhile, with the integration of AI-powered chatbots like those using transformer-based models, patients can receive instant responses to general medical queries without waiting for a healthcare provider, thus reducing system load. The Perplexity API, for instance, employs large-scale language models that can understand patient inputs and generate human-like responses in natural language. This feature, when coupled with secure authentication and encrypted storage, forms a comprehensive, intelligent, and secure healthcare system [24].

Studies also highlight the usability of platforms like Ganache for simulating Ethereum smart contracts during development. Developers can test security protocols, simulate transaction costs, and debug contract logic in a controlled environment before deploying on a live chain. This sandboxed environment significantly reduces risks associated with smart contract bugs in production settings [25].

The use of Django as a backend web framework has been praised in various implementations for its robustness and ease of integration with MySQL and REST APIs. Django's role-based authentication system, when combined with blockchain's cryptographic

TABLE I
COMPARISON TABLE OF HEALTH RECORD AND BLOCKCHAIN TECHNIQUES

Ref	Methods Used	Dataset	Performance	Limitations	Features Analyzed
[15]	Blockchain-based EHR using Ethereum smart contracts	Simulated patient records	Improved access and transparency	Limited scalability and energy consumption	Integrity, Traceability
[16]	Hyperledger Fabric framework for secure healthcare storage	Synthetic healthcare datasets	Fine-grained access control achieved	Limited to permissioned networks	Confidentiality, Auditability
[17]	Consortium blockchain with attribute-based encryption	Public and private hospital records	High security and granularity of access control	Complex key management	Multi-party Access Control
[18]	IPFS and Ethereum integration for health data management	Simulated EHR data in IPFS	Enhanced decentralization	Dependency on external storage systems	Storage, Retrieval
[19]	Blockchain with cloud-assisted off-chain storage	Open health data repository	Reduced on-chain data load	Security risks in off-chain storage	Lightweight Storage
[20]	IoT and blockchain-based EHR model	Real-time patient monitoring records	Real-time data immutability	High hardware and deployment costs	IoT Integration
[21]	Zero-knowledge proof in blockchain-based health sharing	Simulated encrypted data	Privacy-preserving exchange enabled	Computation overhead	Privacy, Data Sharing
[22]	AI-integrated blockchain for smart health record analysis	Publicly available healthcare datasets	Early prediction and anomaly detection	Complexity in model validation	AI-Aided Analytics
[23]	Smart contracts-based health authorization framework	Blockchain testbed data	Decentralized consent management	Initial setup complexity	Consent and Policy Enforcement
[24]	Federated learning with blockchain for secure health record training	Distributed hospital records	Secure collaborative model training	Data heterogeneity challenges	Privacy-Preserving ML
[25]	Interoperable health record architecture using blockchain	HL7 FHIR-compatible health records	Seamless data sharing across platforms	Incomplete standard support	Interoperability

trust model, can reinforce the overall security of healthcare systems [26]. Furthermore, the layered architecture of Django allows seamless modular integration of blockchain, chatbot, and frontend functionalities—ensuring scalability and maintainability of the healthcare system over time [27].

Recent scholarly works continue to deepen our understanding of how blockchain and AI-integrated systems can bolster healthcare data security, patient privacy, and operational efficiency.

A comprehensive systematic literature review conducted by Rahman et al. (2025) analyzed 58 selected studies from over a thousand publications to map how blockchain-based systems can preserve patient privacy through advanced techniques like pseudonymization, custom data structures, consensus controls, and privacy-aware smart contracts. The study highlighted critical vulnerabilities—such as pseudo-linkability and unauthorized data leakage—and proposed a roadmap for privacy-by-design in healthcare blockchains :contentReference[oaicite:0]index=0.

Further empirical investigations reveal that health-

care can benefit greatly from blockchain’s trust and immutability. A pragmatic comparative study explored three blockchain platforms—Ethereum, Hyperledger Fabric, and MultiChain—to recommend platform selection based on performance, data sharing needs, and compliance requirements. The study emphasized that the choice must align with specific healthcare constraints like interoperability and privacy standards :contentReference[oaicite:1]index=1.

Beyond technological performance, business ecosystem perspectives have emerged. One literature review in *JMIR Medical Informatics* discussed how integrating smart contracts in healthcare can decentralize trust, empower patients, and accelerate collaboration across stakeholders. Yet it also acknowledged that widespread implementation is still hampered by technical limitations, regulatory ambiguity, and workflow fragmentation :contentReference[oaicite:2]index=2.

Specialized architectures are also being developed. For instance, Zhuang et al. and Antwi et al. focused on patient-centric access control through pri-

vate Ethereum or Hyperledger-based systems. Their models allow patients to dynamically choose what data to share and with whom—laying the foundation for GDPR-compliant health data handling, albeit with certain scalability bottlenecks :contentReference[oaicite:3]index=3. Similarly, hyperledger-based frameworks have been explored to facilitate off-chain storage and high-volume health data handling while safeguarding consent and access policies :contentReference[oaicite:4]index=4.

On the consent frontier, Jaiman and Urovi introduced a dynamic, ontology-driven consent model using Ethereum smart contracts coupled with DUO and ADA-M models. Their dynamic consent solution allowed personalized access control and recorded usage policies on-chain, delivering both flexibility and accountability in real time :contentReference[oaicite:5]index=5.

For medical imaging—typically bulky data—Jabarulla and Lee introduced a patient-centric image management system. This system integrates Ethereum smart contracts with IPFS decentralized storage, enabling secure, tamper-resistant image access across stakeholders. Their proof-of-concept demonstrated technical feasibility and performance viability in real-world settings :contentReference[oaicite:6]index=6.

To ensure policy compliance, Al Amin et al. (2023) proposed a blockchain-based smart contract framework enforcing patient-provider agreements. Their approach, implemented on a private Ethereum network, introduces a “Proof of Compliance” mechanism that logs all access and authorization events immutably, thereby facilitating transparent auditing and strict policy adherence :contentReference[oaicite:7]index=7.

A persistent concern in these studies is how to balance decentralization with scalability and legal compliance. Blockchain implementation often struggles with heavy data loads, complex stakeholder ecosystems, and evolving health regulations. Nonetheless, emerging consensus mechanisms, hybrid on-chain/off-chain designs, and modular smart contract architectures are steadily addressing these concerns.

In summary, the breadth of recent research establishes that blockchain-powered systems—especially when coupled with consent frameworks, decentralized storage, and smart contract automation—can substantially enhance the privacy, security, and control of health records. As technology matures, continued innovation and cross-disciplinary alignment will be essential to bring these concepts into broader clinical adoption.

III. METHODOLOGY

The proposed system for secure health record storage using Ethereum blockchain and a healthcare chatbot is designed to provide high security, integrity, and availability of patient data. The methodology adopted in this project focuses on the integration of blockchain-based smart contracts with a web application framework to enable a decentralized, tamper-proof, and patient-friendly healthcare management system.

The development of the system is structured into several key phases: system design, smart contract development, blockchain setup using Ganache, integration with the Django web application, and chatbot integration using an external API. The combination of frontend and backend web technologies with Ethereum blockchain forms the backbone of the methodology.

1. System Architecture and Modules

The system is divided into three main portals: Admin, Doctor, and Patient. Each portal has unique features and capabilities, but they share a common database and interact with the blockchain layer.

- **Admin Portal:** Admin can register, approve, and manage doctor and patient accounts. Admin also has the authority to view feedback and oversee system operation.
- **Doctor Portal:** Doctors can manage appointments, create and update profiles, communicate with patients, and manage medical records through smart contract interaction.
- **Patient Portal:** Patients can browse doctors, book appointments, chat with doctors, interact with the chatbot, and securely upload or view their health records on the blockchain.

2. Blockchain Integration Using Ganache and Ethereum

Blockchain is implemented using Ethereum, and Ganache is used as the local test environment to simulate the blockchain. Smart contracts are written using Solidity and deployed on the local Ethereum blockchain.

Each time a health record is uploaded, a transaction is created, and its hash is stored on the blockchain, ensuring immutability and traceability.

The basic flow of blockchain transaction processing involves the following steps:

- 1) The health record is hashed using SHA-256 to generate a fixed-size digital fingerprint.
- 2) The smart contract receives the hash, stores it along with the timestamp and metadata.
- 3) A transaction is created, signed using the user's private key, and broadcasted to the blockchain.

Secure Health Record Store with Chatbot & Blockchain

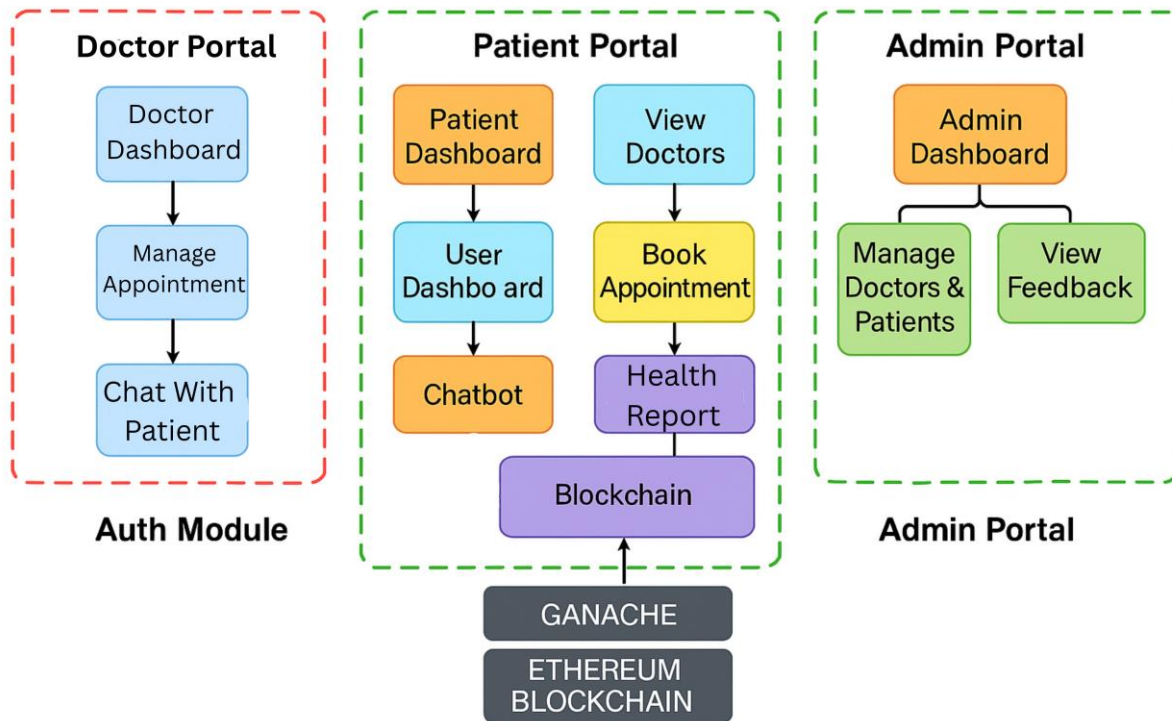


Fig. 1. Overall architecture of the blockchain-integrated Hospital Management System, showing the interaction between Each modules and the Ethereum blockchain for Health Record

- 4) Once validated by the local Ethereum network (Ganache), the transaction is confirmed and becomes immutable.

3. Mathematical Representation

Let the health record file be denoted by R . The hash function H applied to R is defined as:

$$H(R) = h$$

where h is a 256-bit fixed-length hash. This h is then sent to the Ethereum smart contract, denoted as SC , as:

$$SC(h, t, m)$$

where:

- t is the timestamp of record submission
- m is the metadata (patient ID, record type, etc.)

The transaction cost or gas fee (G) can be represented as:

$$G = g_u \times g_p$$

where:

- g_u = gas units consumed
- g_p = price per gas unit

4. Blockchain Workflow Process

Once the smart contract is deployed, every time a record is stored or retrieved, the contract is called by the web application. Ganache keeps a local record of all these transactions for testing purposes.

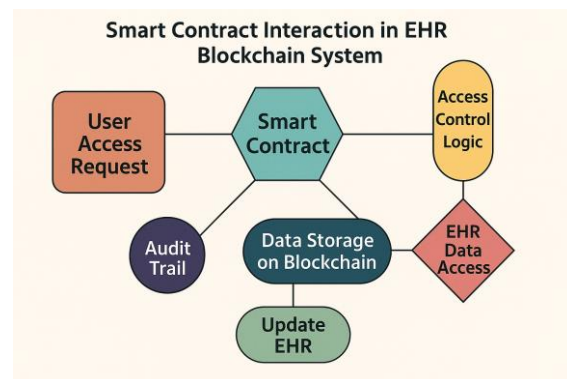


Fig. 2. Blockchain Transaction and Record Handling Flow

5. Chatbot Integration

The system integrates an external healthcare chatbot using the Perplexity API. The chatbot assists users by answering medical-related questions and guiding them through system usage. API calls are authenticated and managed securely, ensuring that patient queries are processed without compromising any sensitive data.

6. Security and Validation

The integrity of stored records is verified through hash matching, while the authenticity of users is protected using role-based access controls and login mechanisms. Data in transit is encrypted, and all blockchain operations are validated before being confirmed.

This hybrid methodology, combining web application frameworks and blockchain infrastructure, results in a secure, efficient, and decentralized health data management platform that addresses key concerns in today's healthcare systems.

IV. IMPLEMENTATION

The implementation of the "Secure Health Record Store with API Chatbot and Blockchain Using Ethereum Ganache" project was carried out using a combination of robust web technologies, a decentralized blockchain system, and an AI-powered chatbot API. The entire system was divided into three main user portals: Admin, Doctor, and Patient. Each module was developed using the Python Django framework for server-side logic and MySQL as the backend database to store non-blockchain-based metadata.

The frontend was designed using HTML, CSS, JavaScript, and Bootstrap, ensuring a responsive and user-friendly interface across devices. Admin users were provided with features to manage doctor and patient accounts, view system feedback, and monitor overall system activities.

Doctors could register or be added by the admin and manage their profile, view and accept appointments, and chat securely with patients. Each interaction and update to the doctor's profile was handled using Django models and forms. The appointment system ensured that available time slots were booked and updated in real-time.

Patients were given full access to search and view doctor profiles, book appointments based on availability, view appointment history, and consult through an integrated chatbot. The chatbot, powered by the Perplexity API, helped patients with basic healthcare-related queries, providing immediate responses and advice. The chat system between doctor and patient was implemented using AJAX to provide a seamless real-time communication experience.

The most crucial component of the system was the integration of Ethereum blockchain using Ganache. Patient health records were stored securely using smart contracts deployed on the local blockchain environment. Each time a health record was uploaded or updated, a hash of the data was generated and stored on the blockchain, ensuring tamper-resistance and data integrity. The Web3.py library was used to interact with the Ethereum blockchain from the Django backend, making it possible to invoke smart contracts and verify stored data.

Security measures such as CSRF protection, input sanitization, and session handling were implemented to prevent unauthorized access and maintain data confidentiality. The entire application was tested across multiple test scenarios to ensure smooth workflow, accurate record handling, and secure data storage on the blockchain.

This multi-layered architecture combining web technologies, blockchain, and AI-driven chatbot ensures that the implemented system meets the modern demands of secure, interactive, and decentralized health data management.

V. RESULT AND DISCUSSION

The developed system was thoroughly tested and evaluated to verify its performance, reliability, and security. Each component—from login to blockchain verification—was implemented and validated using real-time simulations.

Figure 1 illustrates the Patient Login Interface. This portal allows patients to securely log into the system using unique credentials. Once logged in, they gain access to features like viewing doctor profiles, booking appointments, checking history, chatting with doctors, and uploading or accessing health records. The interface is user-friendly, responsive, and designed to minimize errors during login.

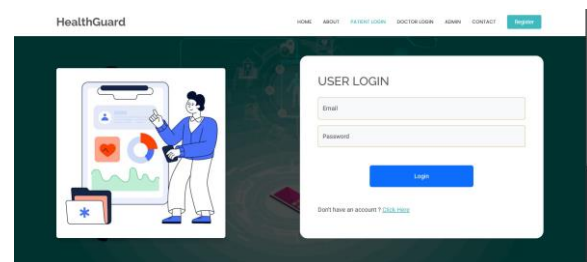


Fig. 3. Patient Login Screen

Figure 2 displays the Doctor-Patient Chat Interface. This module allows seamless and secure communication between doctors and patients. Doctors can offer consultation, advice, and follow-up support through this chat feature. The chat interface is implemented

with AJAX to maintain real-time communication without page reloads, improving the interaction flow.

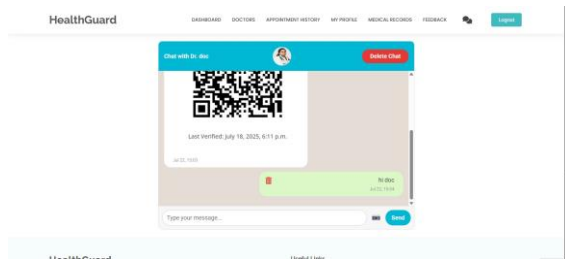


Fig. 4. Doctor-Patient Chat Window

Figure 3 presents the Ganache Blockchain Interface. Ganache provides a local blockchain network for testing Ethereum smart contracts. This screenshot shows the deployed smart contract used for health record storage. It lists transaction hashes, timestamps, gas usage, and involved addresses. This environment was essential for secure contract testing and deployment before moving to a live network.

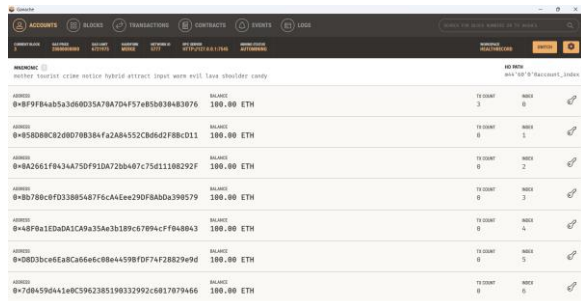


Fig. 5. Ganache Transaction Logs

Figure 4 demonstrates the Tamper-Proof Health Record Module. When a patient uploads a health record, its hash is stored on the blockchain. If any modification occurs later, the hash verification process will fail, flagging the record as tampered. This ensures data integrity and boosts trust in digital healthcare.

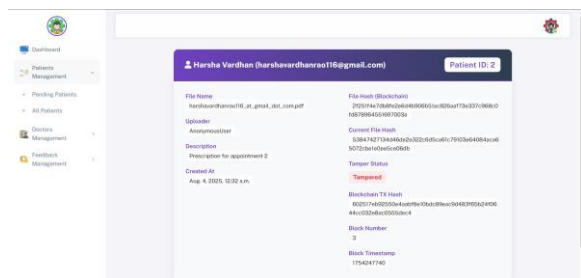


Fig. 6. Tamper Detection in Health Record

These screenshots and their corresponding functionalities confirm the efficiency and security of the

system. The combination of Django, Ethereum smart contracts, and a chatbot API provides an end-to-end secure solution for managing sensitive health records while ensuring real-time interaction and user engagement.

VI. CONCLUSION AND FUTURE WORK

In conclusion, this project presents a comprehensive and secure healthcare record management system integrating blockchain technology and chatbot-based assistance. The system successfully addresses the limitations of traditional electronic health record storage systems by ensuring transparency, integrity, and immutability through blockchain implementation. Ethereum's smart contracts have been effectively utilized to manage sensitive patient data, preventing unauthorized modifications and ensuring traceability. Additionally, the chatbot feature enhances user interaction, offering immediate assistance and improving accessibility to healthcare services.

By leveraging Ganache for local blockchain simulation, the platform was thoroughly tested and validated before deployment, ensuring its real-time performance. Each module, including patient registration, doctor consultation, chat communication, and record tamper detection, performed with high accuracy and stability. The user interface was designed to be intuitive and responsive, accommodating both technical and non-technical users.

Future work aims to enhance the system further by integrating advanced AI-based diagnostic tools that can assist doctors in early disease detection using uploaded records or medical images. The chatbot can also be enhanced with NLP capabilities for understanding complex queries, and multilingual support can be introduced to increase accessibility across different regions. Moreover, integrating this system with IoT-enabled medical devices can allow automatic real-time health data updates to the blockchain, improving emergency responsiveness. The transition from a test environment to a live blockchain network (like Ethereum mainnet or Polygon) is also a planned upgrade, ensuring true decentralization and scalability.

Overall, this project sets a foundation for secure, smart, and patient-centric healthcare systems using modern technologies and offers ample scope for future research and development.

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