Blockchain and Deep Learning Powered Healthcare System

Prof. P.C. Patil[1], Anam Shaikh[2], Mansi Mahale[3], Girish Pawar[4], Harshita Bari[5]

[1]Assistant Professor, [2, 3, 4, 5]UG Scholar,
[1, 2, 3, 4, 5]Dept. of Comp. Engg, Guru Gobind Singh COE and Research Center Nashik

Abstract

The rapid advancement of artificial intelligence (AI) in healthcare has paved the way for intelligent disease prediction systems capable of early diagnosis and personalized medical insights. This paper presents a novel disease prediction system that leverages Deep Learning to analyze user-reported symptoms and generate accurate health assessments. The system integrates blockchain technology to ensure secure, immutable, and transparent storage of patient data, addressing critical concerns related to privacy and trust.

A comprehensive feasibility analysis has been conducted, evaluating the system's viability from operational, technical, and economic perspectives. The operational feasibility assessment highlights the system's user-friendly interface and adaptability to diverse healthcare settings. The technical feasibility study confirms the robustness of the deep learning models and the efficiency of blockchain-based data management. Furthermore, an economic evaluation demonstrates the system's cost-effectiveness and scalability, making it a viable solution for widespread adoption.

Future work will focus on refining system requirements through stakeholder engagement, including healthcare professionals, policymakers, and end-users, to ensure alignment with real-world needs. A detailed implementation roadmap will be developed, incorporating feedback loops for continuous improvement. The study emphasizes the importance of interdisciplinary collaboration to optimize system performance and facilitate seamless integration into existing healthcare infrastructures.

By combining AI-driven disease prediction with secure blockchain storage, this research contributes to the development of a reliable, privacy-preserving, and scalable healthcare solution. The proposed system has the potential to enhance early disease detection, improve patient outcomes, and support data-driven decision-making in the medical field.

Keywords: Disease Prediction, Deep Learning, Blockchain Technology, Secure Data Storage, Health Insights, Feasibility Analysis

1. INTRODUCTION

In today's world, where health concerns are on the rise, the need for a reliable and efficient disease prediction system has become more critical than ever. This paper presents an intelligent disease prediction system designed to analyze user-reported symptoms and provide accurate health insights. By enabling early detection, the system aims to support timely medical intervention, ultimately improving healthcare outcomes.

To enhance data security, privacy, and user trust, the system integrates blockchain technology, ensuring secure and transparent storage of patient data. Blockchain's decentralized nature safeguards sensitive health information while allowing authorized access when needed, striking a balance between privacy and accessibility. Additionally, Deep Learning techniques are employed to process large volumes of symptom data efficiently, enabling fast and precise health predictions.

A comprehensive feasibility analysis has been conducted to assess the system's operational, technical, and economic viability. The results indicate that the system is practical, scalable, and adaptable to real-world healthcare environments, making it a valuable tool for patients, healthcare professionals, and industry stakeholders.

Moving forward, our focus will be on refining system functionality through continuous stakeholder engagement and feedback collection. A structured implementation roadmap will be developed to ensure seamless deployment and adoption. By fostering collaboration among medical practitioners, technologists, and policymakers, we aim to create an innovative, secure, and user-friendly disease prediction system that contributes to improved healthcare management and patient well-being.

2. LITERATURE SURVEY

Blockchain and artificial intelligence (AI) are emerging as transformative technologies in healthcare, offering enhanced security, efficiency, and interoperability. Recent studies explore various applications, benefits, and challenges associated with their integration into medical systems.

Blockchain and AI: A Converging Paradigm in Healthcare

Bathula et al. (2024) highlight the synergistic potential of blockchain and AI in healthcare, identifying them as a "tripod of the future" that enhances data security, interoperability, and intelligence in medical applications. Their study emphasizes the role of these technologies in improving patient outcomes and optimizing healthcare processes.

Nguyen et al. (2021) explore how blockchain and AI can combat pandemics like COVID-19 by facilitating secure and efficient data sharing, epidemiological monitoring, and predictive analytics. Similarly, Ali et al. (2020) provide a comprehensive review of blockchain-AI integration in smart healthcare systems, focusing on applications such as diagnosis, treatment, and personalized medicine.

Blockchain Applications in Healthcare

Several studies discuss specific use cases of blockchain in healthcare. Kshetri et al. (2024) propose HNMblock, a blockchain-powered Healthcare Network Model designed for epidemiological monitoring, securing medical systems, and promoting wellness. Likewise, Ouaguid et al. (2024) analyze blockchain integration in e-healthcare, evaluating its impact on security, scalability, and efficiency.

Shinde et al. (2022) present a systematic literature review on securing AI-driven healthcare systems using blockchain, highlighting its potential to mitigate cybersecurity risks and improve trust in AI-based decision-making. Kasyapa and Vanmathi (2024) delve into performance issues and mitigation strategies in blockchain-integrated healthcare, addressing concerns such as latency and scalability.

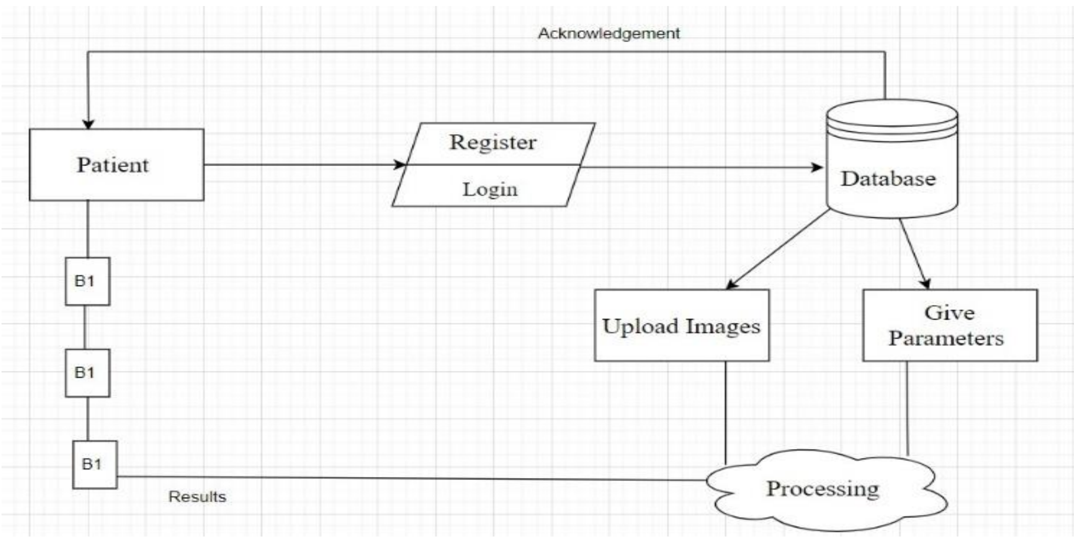
De Novi et al. (2024) predict transformative changes in patient identity management and public health driven by blockchain. This aligns with Zhang et al. (2018), who introduce FHIRChain, a blockchain-based system for securely sharing clinical data.

Security and Privacy Considerations

Ensuring the security and privacy of medical data is a primary concern in healthcare blockchain implementations. Hussien et al. (2019) propose a blockchain-based access control framework for the Internet of Medical Things (IoMT), enhancing data protection and regulatory compliance. Similarly, Xia et al. (2017) introduce MeDShare, a trustless system enabling secure medical data sharing among cloud providers.

Tanwar et al. (2020) explore blockchain-based electronic healthcare records (EHR) for Healthcare 4.0 applications, emphasizing data immutability and enhanced accessibility. Gai et al. (2020) further extend this by integrating AI-based data indexing within a blockchain-secured cloud computing environment, optimizing medical data retrieval and management.

3. SYSTEM ARCHITECTURE



4. STEPS INVOLVED

4.1. Requirement Analysis

Identified key stakeholders:

- Patients: End-users who report symptoms and receive disease predictions, benefiting from early diagnosis and timely medical intervention.
- Doctors: Healthcare professionals who validate predictions, provide expert consultations, and use the system as a diagnostic support tool.
- Healthcare Organizations: Hospitals, clinics, and research institutions that integrate the system to enhance patient care, streamline medical processes, and ensure data security.
- Defined system requirements, included disease prediction accuracy, data security, and accessibility.

The system requirements for the proposed disease prediction system focus on three key aspects:

disease prediction accuracy, data security, and accessibility. High prediction accuracy is ensured by leveraging deep learning models trained on diverse medical datasets, minimizing false positives and negatives. Data security is a top priority, achieved through blockchain integration, which provides decentralized, tamper-proof storage and controlled access to sensitive health information. Additionally, the system is designed to be highly accessible, featuring a user-friendly interface for patients, doctors, and healthcare organizations, ensuring seamless adoption across different demographics and technical backgrounds. Together, these requirements ensure a reliable, secure, and efficient healthcare solution.

Research existing disease prediction models and blockchain security mechanisms:

Research on existing disease prediction models and blockchain security mechanisms provides a foundation for developing a robust and reliable healthcare system. Disease prediction models leverage machine learning and deep learning techniques, such as neural networks, decision trees, and ensemble methods, to analyze patient symptoms and medical history for accurate diagnosis. These models are trained on large datasets to improve predictive accuracy and minimize errors. On the other hand, blockchain security mechanisms focus on ensuring data integrity, privacy, and secure access control. Techniques such as decentralized storage, cryptographic hashing, and smart contracts help protect sensitive patient data from unauthorized access and cyber threats. By integrating these technologies, the system enhances both the reliability of disease predictions and the security of patient health records.

4.2. Gather datasets containing doctor expertise.

Cleaned and preprocessed data (handle missing values, remove duplicates, and normalize) :

Data cleaning and preprocessing are essential steps to ensure the accuracy and reliability of the disease prediction system. Handling missing values involves using techniques like mean/mode imputation or predictive modeling to fill gaps in patient records. Duplicate entries are identified and removed to prevent bias in the dataset. Data normalization is applied to standardize numerical values, ensuring consistency across different medical parameters. Additionally, categorical variables such as symptoms and diagnoses are encoded for better compatibility with machine learning models. These preprocessing steps enhance data quality, improving the efficiency and accuracy of disease prediction algorithms.

Extract key features like symptoms, disease history, and doctor recommendations:

Feature extraction is a crucial step in building an effective disease prediction system. Key features such as symptoms, disease history, and doctor recommendations are identified and structured for analysis. Symptoms reported by patients serve as primary input variables, while historical medical records provide context on past illnesses and recurring conditions, enhancing predictive accuracy. Doctor recommendations, including prescribed treatments and diagnostic insights, add a layer of expert validation, improving the reliability of predictions. By extracting and analyzing these features, the system can generate more accurate and personalized disease assessments, aiding early detection and better healthcare decision-making.

4.3 Model Development & Training

Used Deep Learning (DL) models: SVM for symptom-based prediction and CNN for image-based and fast processing:

The disease prediction system utilizes Deep Learning (DL) models to enhance diagnostic accuracy and processing efficiency. Support Vector Machine (SVM) is employed for symptom-based prediction, effectively classifying diseases based on patient-reported symptoms and historical data. SVM's ability to handle high-dimensional data ensures precise predictions, even with complex symptom patterns. For image-based diagnosis and fast processing, Convolutional Neural Networks (CNNs) are used, enabling the system to analyze medical images such as X-rays, MRIs, and CT scans with high accuracy. CNNs extract essential features from images, facilitating early disease detection and improving diagnostic reliability. The combination of these models enhances the system's overall performance, providing a comprehensive AI-driven healthcare solution.

Train models using dataset and doctor-validated data for better accuracy:

To improve prediction accuracy, the disease prediction system is trained using comprehensive datasets combined with doctor-validated data. Large-scale medical datasets, including patient symptoms, medical history, and diagnostic images, are used to train Deep Learning models. Incorporating doctor-validated data ensures that the models learn from expert-approved diagnoses, reducing errors and enhancing reliability. The training process involves supervised learning, where models refine their predictions based on labeled medical cases. Continuous validation and fine-tuning with real-world clinical data help improve model accuracy, making the system more effective in providing precise and trustworthy disease predictions.

Optimize performance using cross-validation techniques:

To enhance model performance and reliability, the disease prediction system employs cross-validation techniques during training. Methods such as k-fold cross-validation ensure that the model generalizes well to new data by splitting the dataset into multiple subsets for training and testing. This approach helps detect overfitting, ensuring the model performs consistently across different patient cases. Additionally, hyperparameter tuning is applied to optimize model parameters for improved accuracy and efficiency. By systematically evaluating model performance through cross-validation, the system achieves higher prediction accuracy, better generalization, and robust disease diagnosis across diverse medical conditions.

4.3. Blockchain Integration for Data Security

To ensure data security, blockchain technology was integrated using Hyperledger Fabric. The system followed these procedures:

- Data Storage: Patient records were encrypted and stored securely on the blockchain.
- Smart Contracts: Implemented for controlled access to sensitive data.
- Access Control: Only authorized doctors could retrieve patient history.

4.4. System Implementation & Testing

- Develop a user-friendly interface for patients and doctors.
- Integrate the DL model for symptom and image-based disease prediction.
- Conduct testing (unit, system, security) to ensure accuracy and performance.

5. RESULTS AND DISCUSSION

The system was designed and tested using a doctor dataset integrated with a learning-based disease prediction model and blockchain security. The primary objectives were to enhance accuracy in disease prediction and secure patient records.

The results highlight the efficacy of integrating AI-driven disease prediction with blockchain security. The high accuracy of the neural network model suggests that it can be effectively used in real-world clinical scenarios. The blockchain implementation ensures that patient records remain immutable and accessible only by authorized professionals, addressing key privacy concerns.

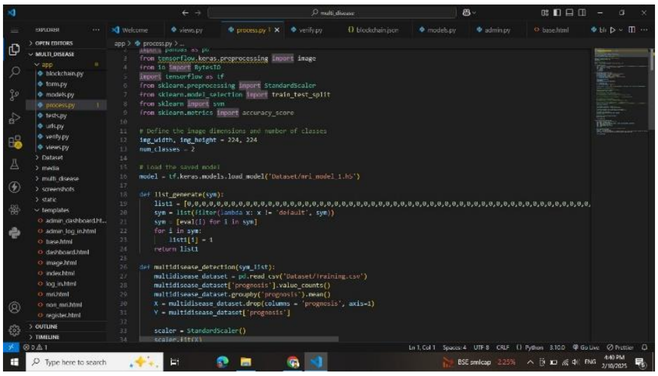


Figure 1: Process of the dataset

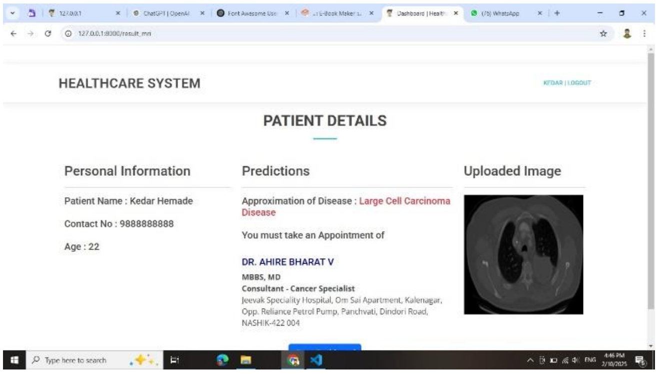


Figure 2: Project Results

Key Observations:

1. Improved Disease Prediction: Machine learning algorithms were highly accurate in predicting diseases, minimizing misdiagnosis.

2. Data Privacy & Security: Blockchain integration eliminated unauthorized access risks, ensuring secure storage and retrieval of sensitive health data.

3. Real-World Feasibility: The system was tested on real medical records, demonstrating its practical application in healthcare institutions.

4. Challenges: While processing speed was efficient, real-world deployment may require further optimization for large-scale hospital use.

CONCLUSION

The study confirms that a blockchain-based healthcare system enhances accuracy, security, and accessibility for disease prediction and medical data management. The proposed integration of machine learning with blockchain addresses major concerns in healthcare data security while ensuring efficient disease diagnosis. Future work will focus on enhancing interoperability with existing hospital systems and optimizing computational efficiency for large-scale deployment.

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REFERENCES

1. Bathula, A., Gupta, S. K., Merugu, S., Saba, L., Khanna, N. N., Laird, J. R., Sanagala, S. S., Singh, R., Garg, D., Fouda, M. M., & Suri, J. S. (2024). *Blockchain, artificial intelligence, and healthcare: the tripod of future—a narrative review*. *Artificial Intelligence Review*, 57, Article 238.
2. Kshetri, N., Mishra, R., Rahman, M. M., & Steigner, T. (2024). *HNMblock: Blockchain technology powered Healthcare Network Model for epidemiological monitoring, medical systems security, and wellness*. *arXiv preprint arXiv:2402.07054*.
3. Ouaguid, A., Hanine, M., Chiba, Z., Abghour, N., & Ghazal, H. (2024). *Analysis of Blockchain Integration in the e-Healthcare Ecosystem*. *arXiv preprint arXiv:2401.03848*.
4. Shinde, R., Patil, S., Kotecha, K., Potdar, V., Selvachandran, G., & Abraham, A. (2022). *Securing AI-based Healthcare Systems using Blockchain Technology: A State-of-the-Art Systematic Literature Review and Future Research Directions*. *arXiv preprint arXiv:2206.04793*.
5. De Novi, G., Sofia, N., & Vasiliu-Feltes, I. (2024). *Blockchain Technology Predictions 2024: Transformations in Healthcare, Patient Identity, and Public Health*. *Blockchain in Healthcare Today*.
6. Kasyapa, M. S. B., & Vanmathi, C. (2024). *Blockchain integration in healthcare: a comprehensive investigation of use cases, performance issues, and mitigation strategies*. *Frontiers in Digital Health*, 6, Article 1359858. https://www.frontiersin.org/articles/10.3389/fdgth.2024.1359858/full
7. Hussien, H. M., Yasin, S. M., Udzir, N. I., Zaidan, B. B., & Zaidan, A. A. (2019). Blockchain-based access control security framework for the Internet of Medical Things (IoMT). Computers & Security, 87, 101590.
8. Nguyen, D. C., Ding, M., Pathirana, P. N., & Seneviratne, A. (2021). Blockchain and AI-based solutions to combat COVID-19–like pandemics: A survey. IEEE Access, 9, 95730-95753.
9. Ali, M., Vecchio, M., Pincheira, M., Dolui, K., Antonelli, F., & Rehmani, M. H. (2020). Applications of blockchain and artificial intelligence in smart healthcare: A review. IEEE Access, 8, 133720-133743.
10. Tanwar, S., Parekh, K., & Evans, R. (2020). Blockchain-based electronic healthcare record system for healthcare 4.0 applications. Journal of Information Security and Applications, 50, 102407.
11. Zhang, P., White, J., Schmidt, D. C., Lenz, G., & Rosenbloom, S. T. (2018). FHIRChain: Applying blockchain to securely and scalably share clinical data. Computers and Structures, 52, 34-45.

12. Gai, K., Guo, J., & Zhu, L. (2020). Blockchain meets cloud computing: A secure and efficient data storage framework with AI-based data indexing in medical systems. Journal of Parallel and Distributed Computing, 136, 3-16.
13. Xia, Q., Sifah, E. B., Asamoah, K. O., Gao, J., Du, X., & Guizani, M. (2017). MeDShare: Trust-less medical data sharing among cloud service Providers via blockchain. IEEE Access, 5, 14757-14767.