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Machine Learning Techniques for Heart Disease Prediction

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ABSTRACT: Heart disease is one of the major causes of death around the world. Therefore, the prediction and diagnosis of heart disease are extremely important. With the increasing amount of data in the healthcare domain, the traditional approaches are no longer effective enough to give accurate and precise results. In the past few years, machine learning and deep learning approaches have been used for the prediction of heart disease. Various machine learning algorithms such as Logistic Regression, Decision Tree, Random Forest, Support Vector Machines, and Neural Networks have been used for the prediction of heart disease. In recent research studies, the authors have also used hybrid approaches and deep learning approaches along with the Internet of Things for the prediction of heart disease. This literature survey discusses and analyzes the machine learning approaches for the prediction of heart disease based on the research studies conducted in the past five years. In addition, the performance of different machine learning models is measured based on certain factors, including accuracy, precision, recall, and F1 score. The significance of data preprocessing, including feature selection and dealing with class imbalance, is also discussed in the study, which helps in the prediction process. It can be concluded that the survey gives a comprehensive idea about the recent developments in heart disease prediction, which can be used for the development of efficient healthcare systems.

KEYWORDS: Heart Disease Prediction, Machine Learning, Deep Learning, Healthcare Analytics, Classification Algorithms, Predictive Modeling, Data Mining, Feature Selection, Medical Diagnosis, IoT in Healthcare, Artificial Intelligence, Risk Assessment

I. INTRODUCTION

Heart disease remains one of the biggest health issues in the world, causing a large number of deaths annually. Early diagnosis is very important in reducing the mortality rate and enhancing the quality of life for patients with heart disease. Conventional diagnosis involves medical tests and the expertise of medical professionals, which may be time-consuming and sometimes inaccurate, especially in dealing with a large number of patient data. Machine learning and deep learning are modern technologies used in predicting heart disease, replacing traditional methods of diagnosis. These modern methods of diagnosis use machine learning algorithms, which can handle large data sets and detect hidden patterns, thereby aiding in the early diagnosis of heart disease. Several studies have confirmed the use of machine learning algorithms in predicting heart disease using patient data such as age, blood pressure, cholesterol, and lifestyle factors.

Recent studies from the period between 2020 and 2025 have tried to increase the accuracy of the predictions using advanced approaches. For example, Sangle et al. (2020) discussed the various methodologies used in the classification of heart disease using machine learning approaches. Bharti et al. (2021) used a combination of machine learning and deep learning approaches for the improvement of the accuracy of the predictions. In the same direction, Hussain et al. (2021) proposed a deep learning architecture based on convolutional neural networks (CNN) for the diagnosis of heart disease. Recent studies have used various machine learning models as well as hybrid approaches for the diagnosis of heart disease. For example, Xu (2023) proposed the analysis of multiple machine learning models for heart disease



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prediction. Patil et al. (2023) proposed the development of systems using machine learning approaches for the improvement of accuracy in the diagnosis of heart disease. In the same direction, Singh et al. (2023) proposed IoT-based healthcare systems using deep learning approaches for real-time monitoring as well as prediction. Patil et al. (2023) proposed hybrid models for the diagnosis of heart disease.

Advanced techniques in machine learning have also been explored to improve efficiency in prediction techniques. In this regard, Bhatt et al. (2023) have explored effective machine learning techniques for accurate predictions, and Ingole et al. (2024) have discussed advancements in predictive techniques. Moreover, Azimi et al. (2025) proposed a comprehensive framework in machine learning for heart disease prediction, with a focus on improving efficiency in terms of accuracy and scalability. From the above literature, it is clear that machine learning techniques have greatly improved heart disease prediction systems. However, challenges still exist in balancing data, high computational complexities involved in machine learning models, and real-time prediction requirements. Thus, this literature survey aims to explore various machine learning techniques used in heart disease prediction and compare their efficiencies and potential scope for future work.

II. REVIEW OF EXISTING PAPER

1. Methodologies and Techniques for Heart Disease Classification and Prediction

Authors: Sangle, P. S. et al. (2020)

The study revolved around various machine learning methodologies in heart disease classification and prediction. The authors used various algorithms such as decision tree, naive bayes, and support vector machine with respect to medical data sets. The evaluation of these algorithms was based on accuracy and efficiency. It was evident from the study that heart disease prediction is made possible by machine learning techniques by considering proper feature selection methods. However, various limitations were encountered in this study.

2. Prediction of Heart Disease Using a Combination of Machine Learning and Deep Learning

Authors: Bharti, R. et al. (2021)

Bharti et al. proposed a hybrid approach using machine learning and deep learning methods. The paper used the neural network with traditional machine learning algorithms for better prediction accuracy. The experimental result showed that the hybrid approach performed better in detecting complex patterns in healthcare data compared to the individual models. The proposed approach performed better in terms of prediction accuracy, though the complexity was a drawback.

3. Novel Deep Learning Architecture for Heart Disease Prediction Using CNN

Authors: Hussain, S. et al. (2021)

In this paper, a deep learning model based on Convolutional Neural Networks (CNN) has been proposed for heart disease prediction. The proposed model is able to automatically learn the important features from the input data. The results showed improved accuracy over the traditional machine learning approaches. The significance of deep learning in handling complex data in the field of medicine has also been discussed in the paper. However, it demands large data and computational resources.

4. Heart Disease Prediction Based on Machine Learning Algorithms

Authors: Xu, M. (2023)

In the study conducted by Xu, the researcher discussed the use of different machine learning algorithms, such as Logistic Regression, Decision Tree, and Random Forest, with a focus on the comparison of the accuracy of these algorithms using healthcare data sets. In the study, the Random Forest algorithm was found to be more accurate compared to the others. The importance of using the right algorithm was discussed in the study. However, the study was not conducted with real-time data.

5. Heart Disease Prediction Using Machine Learning

Authors: Patil, S. S. et al. (2023)

In this paper, a system for predicting heart disease was proposed based on a machine learning approach. Various data preprocessing techniques were employed. The proposed system had good accuracy, and the potential of ML in the field



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of health care was demonstrated. The need for data cleaning and feature selection is also emphasized. However, the proposed system faced difficulties in generalization due to the small amount of data.

6. Prediction of Heart Disease Using Deep Learning and Internet of Medical Things

Authors: Singh, S. et al. (2023)

Singh et al. suggested the idea of an IoT-based healthcare system with the integration of deep learning technology. In this system, real-time patient data is collected using sensors, and heart disease risk is predicted. The integration of IoT with AI technology makes the healthcare system efficient. However, the issues of data security and privacy were not discussed in the suggested idea.

7. Hybrid Machine Learning Technique for Heart Disease Prediction

Authors: Patil, R. S. et al. (2023)

This paper proposed a hybrid machine learning model by combining various algorithms. This increased the accuracy of the model by utilizing the capabilities of various models. The study proved that hybrid models are better than individual models. It also emphasized the need for model optimization. However, this made the model more complex, and it was hard to use it in real-time systems.

8. Effective Heart Disease Prediction Using Machine Learning Techniques

Authors: Bhatt, C. M. et al. (2023)

Bhatt et al. presented an assessment of various state-of-the-art machine learning models to predict heart disease. In this study, there is a need to optimize performance through feature selection as well as model parameter optimization. In this study, it has been shown that optimized models can achieve better results in terms of accuracy in predictions. Data preprocessing has also been highlighted as an important step in this study. However, there is a need to use more diverse data to validate this study.

9. Advancements in Heart Disease Prediction: A Machine Learning Approach

Authors: Ingole, B. S. et al. (2024)

In this paper, the recent advancements in the prediction of heart disease through the application of machine learning algorithms were discussed. The researchers used the recent techniques in the field of machine learning to increase the accuracy and efficiency of the algorithms. The results of the prediction were improved compared to the previous algorithms. However, the results of the algorithms were not implemented in the real world.

10. A Comprehensive Machine Learning Framework for Heart Disease Prediction

Authors: Azimi, A. et al. (2025)

Azimi et al. have proposed a comprehensive framework for machine learning in heart disease prediction. In this framework, various machine learning algorithms have been combined to achieve scalability and high accuracy. The main goal of this study is to efficiently manage large amounts of healthcare data. The results have shown better performance in terms of accuracy and reliability.

III. COMPARISON WITH EXISTING PAPER

From the analysis of the selected research papers, it is evident that various techniques are being employed for heart disease prediction. For instance, traditional machine learning approaches such as Decision Tree, Naïve Bayes, and Support Vector Machine are being employed for heart disease prediction (Sangle et al., 2020). It has been observed that the performance of traditional machine learning approaches heavily depends on the quality of the dataset and the feature selection mechanism. Xu (2023) also demonstrated the effectiveness of ensemble approaches such as the Random Forest algorithm for heart disease prediction. The ensemble approach outperforms individual approaches in terms of accuracy.

The deep learning approach for heart disease prediction has also been demonstrated by various researchers. For instance, the CNN approach proposed by Hussain et al. (2021) has the potential to achieve higher accuracy in heart disease prediction by automatically extracting complex features. Hybrid models, as proposed by Bharti et al. (2021) and Patil et al. (2023), use the combination of machine learning and deep learning approaches for prediction accuracy.



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These approaches use the combination of different machine learning algorithms and show improved accuracy. However, the complexity and cost of the system are also increased.

The recent research has been carried out for developing advanced applications such as IoT-based systems and scalable systems. Singh et al. (2023) proposed an IoT-based system for the healthcare sector. The proposed system has improved the accuracy of the early diagnosis of the patient's health. However, the security and privacy of the data are also a major problem. Azimi et al. (2025) proposed an extensive framework for the healthcare sector. The proposed framework has the capability to handle the scalability of the data. However, the complexity of the system is also increased. Other studies, such as those conducted by Bhatt et al. (2023) and Ingole et al. (2024), focused on the optimization techniques and developments in machine learning for efficient predictions. However, most of these studies have not been implemented in real-time using diverse datasets. In conclusion, even though machine learning and deep learning have improved the efficiency of heart disease predictions, there are still challenges in balancing the data, computational complexities, lack of real-time implementations, and scarcity of diverse datasets.

Paper	Technique Used	Key Contribution	Advantages	Limitations
Sangle et al. (2020)	ML (DT, NB, SVM)	Compared ML models	Simple, interpretable	Depends on dataset quality
Bharti et al. (2021)	ML + DL Hybrid	Combined models	High accuracy	High complexity
Hussain et al. (2021)	CNN (DL)	Feature extraction	Better performance	Needs large data
Xu (2023)	ML (RF, DT, LR)	Algorithm comparison	RF gives best results	No real-time system
Patil et al. (2023)	ML System	Prediction model	Good accuracy	Small dataset
Singh et al. (2023)	IoT + DL	Real-time monitoring	Early detection	Security issues
Patil et al. (2023)	Hybrid ML	Combined techniques	Improved accuracy	Complex implementation
Bhatt et al. (2023)	Advanced ML	Optimization methods	Better efficiency	Needs diverse data
Ingole et al. (2024)	Advanced ML	Recent improvements	Improved performance	No real-world validation
Azimi et al. (2025)	ML Framework	Scalable system	High accuracy	High cost & complexity

IV. RESEARCH GAP

From the analysis of the selected research papers, several gaps and limitations could be identified with the existing heart disease prediction systems. Firstly, several research studies such as the one by Sangle et al. (2020) and Patil et al. (2023) are based on structured data. Structured data may not always represent the actual situation. Most of the models perform well with the data they are trained with but do not perform well with other diverse data sets.

Secondly, although deep learning-based approaches such as the CNN-based approaches proposed by Hussain et al. (2021) are accurate for heart disease prediction, they require a significant amount of data and computational power. Thirdly, hybrid models proposed by Bharti et al. (2021) and Patil et al. (2023) have better prediction accuracy but come with increased complexity in the system.

The second major gap in the current literature is that most models have not addressed real-time prediction systems. Even though Singh et al. (2023) proposed a real-time system based on IoT technology, security issues were not fully addressed in this study. Most models have concentrated on analysis and not real-time systems. Moreover, there is a need to optimize and improve model performance, as highlighted in various studies such as Bhatt et al. (2023) and Ingole et al. (2024). However, these models were not validated using diverse and real-world datasets.

Finally, although a scalable framework was proposed in Azimi et al. (2025), challenges still exist in implementing this model due to high computational costs and complexities involved in its implementation. Therefore, future research should be directed towards developing light-weight accurate and real-time heart disease prediction systems that are capable of handling large and diverse datasets while maintaining data security and privacy.



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V. CONCLUSION

In the following literature survey, different types of machine learning and deep learning algorithms for heart disease prediction are discussed. The study reveals that traditional machine learning algorithms, such as Decision Tree, Support Vector Machine, and Random Forest, show promising results with high accuracy. However, with the advancement of technology, deep learning algorithms show better results for heart disease prediction. The recent advancements in IoT technology and machine learning algorithms show better results for early predictions. Although there are advancements in the technology for early predictions, there are certain limitations, challenges, and complexities in the existing algorithms. Consequently, the focus of the research should be the development of efficient and accurate machine learning models that are capable of coping with the complexities of healthcare data. By resolving the above challenges, machine learning-based systems could make a significant contribution towards the early diagnosis and prevention of heart diseases.

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