International Journal of Scientific Research and Engineering Development-– Volume 9 Issue 2, Mar-Apr 2026
Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

AI-Based Heart Disease Prediction System Using Hybrid Machine Learning and Deep Learning

Mrs. Bhawana Purohit, Lokesh Kansara, Mohit Suthar, Neeraj Aswal
(*Artificial Intelligence & Data Science*, *Poornima Institute of Engineering & Technology,*
and Jaipur, Rajasthan, India
Email: bhawanapurohit20@gmail.com)

Abstract:

In this paper we will suggest an AI based heart disease prediction system which will combine both machine learning and deep learning techniques to enhance the use and accuracy of prediction. The system uses a hybrid model that exploits the benefits of a random forest classifier and a neural network. The Random Forest model is efficient to work with structured medical data and to discover significant features whereas the Neural Network learns all the complicated nonlinear associations within the data. The system can make more reliable and robust predictions of the system by averaging the results of the two models than when compared to the single models. The proposed system will be a full-fledged system with a user-friendly interface. It enables users to enter such vital health parameters as age, blood pressure, and cholesterol levels to determine the risk of heart disease in real time. Along with the prediction of structured data, the system also uses image-based analysis based on the AI techniques that allow for expanding the diagnostic capabilities further. Moreover, the system has an intelligent chatbot, which gives the user simple health tips, offers suggestions on necessary lifestyle changes, and answers questions about the user. To enhance accessibility, there is the inclusion of multilingual assistance where the user can deal with the system using other languages. The important aspect of the system is that professional medical-style reports in PDF format are generated automatically, hence can be useful to both patients and professionals. The experimental findings suggest that the hybrid model is better in terms of prediction and gives more consistent output. Overall, the current project proves the effectiveness of AI implementation in the creation of smart, convenient, and trustworthy healthcare solutions. In the future, incorporation of real-time health monitoring equipment and enhancement of model accuracy via bigger sets of data will be implemented.

Keywords — **Deep Learning, Heart Disease, Neural Network, AI Healthcare, Machine Learning.**

I. INTRODUCTION

Heart disease is among the most critical health issues to date on a global scale and it is one of the major causes of death among developed and developing nations. It is highly essential to diagnose and prevent cardiovascular diseases early since, according to the global health reports, millions of people are affected by the disease annually. The early detection of the risk of heart disease can greatly help to decrease the death rates and to change the quality of life of patients. Nevertheless, conventional methods of diagnosis usually rely on manual examination of the medical experts, which may be time-consuming, subjective, and liable to human error. As the levels of technology have increased fast, artificial intelligence (AI) has become a force to reckon with in the health sector. The use of AI-based systems can review extensive quantities of medical data rapidly and accurately to assist in the detection of diseases at their initial stages and decision making. Machine learning (ML) procedures have been

broadly applied to detect trends in structured data, including patient records with such data as age, blood pressure, cholesterol level, and other clinical indicators. Meanwhile, deep learning (DL) models can be used to find complex and nonlinear relationships that exist in the data, resulting in better predictive performance. We will suggest a smart AI-based heart disease prediction system in this project which will utilize machine learning and deep learning in this project. The system will give Realtime predictions of accurate predictions of the data the user enters into it. The hybrid method is utilized, and a Random Forest classifier is combined with a Neural Network model to improve the reliability of predictions. This integration enables the system to enjoy the advantages of both models leading to enhanced performance as opposed to using one of the models. Besides, the suggested system is usability and accessibility oriented. It offers a user-friendly interactive interface where one can add health parameters and get risk forecasts immediately. Other features of the system are a chatbot that gives health advice, multilingual support to make the system more accessible to a broader audience, and report generation to support users and healthcare professionals. All in all, this paper is devoted to showing how AI-based solutions can facilitate the early identification of heart disease and help establish.

II. RELATED WORK

There have been many studies that have been conducted to predict heart diseases by applying different machine learning and deep learning methods. initial studies mainly centered on classical machine learning methods like logistic regression, decision trees, naive bayes and support vector machines (svm). to classify patients according to the level of risks, these models were applied to structured datasets of healthcare, including the uci heart disease dataset. logistic regression has been widely applied because of its simplicity and readability, and decision trees and random forest models have become popular because of their capability to deal with nonlinear relationships and feature importance analysis. the support vector machine has also portrayed excellent results in classification tasks, particularly in situations in which the data involved is high dimensional. nevertheless, the traditional approaches usually need a cautious feature of engineering and can be sensitive to complicated patterns found in big data. to overcome the limitations, scholars have resorted to ensemble learning methods like the random forest and gradient boosting which are methods used to integrate several models to enhance prediction accuracy and strength.

over the past years, deep learning models have received interest in healthcare analytics. complex patterns of medical data have been learned automatically with the help of artificial neural networks (anns) and more sophisticated architectures. these models have demonstrated positive outcomes in enhancing the accuracy of prediction over traditional methods. moreover, convolutional neural networks (cnns) are also under consideration as a medical image analysis model, which promotes the development of diagnostics in some tasks. even with these developments, many of the available systems are based on model accuracy and are not usable in practice. In the majority of research work, offline experiments are used, and it does not offer real-time, user-friendly applications. In addition, the additional functionalities including explainability, multilingual support, or automatic generation of reports are often not integrated into many systems but are required when it comes to real-world healthcare adoption. The proposed system, in its turn, is going to fill this gap by integrating machine learning and deep learning into importance to usability. It incorporates an easy-to-use interface, live predictive, chatbot support, visual image analysis, and automatic report creation. Such a holistic method does not only increase the performance of prediction but also makes it more accessible and practical in practical healthcare settings.

III. METHODOLOGY

The system proposed is a hybrid model that combines both machine learning and deep learning methods to enhance the accuracy and reliability of prediction of heart disease. The

methodology has several steps, such as data collection, preprocessing, model training, and the production of predictions specific responsibility in handling user interactions, processing business logic, and managing application data.

A. *Dataset*

The system has used a heart disease data that has significant medical characteristics like age, sex, chest pain type, resting blood pressure, cholesterol level, fasting blood sugar, electrocardiographic outcome, maximum heart rate, and other clinical measures. These characteristics are important in the process of identifying the risk of heart disease. The dataset is first preprocessed by taking care of missing values, normalization by standard scaling, and transformation into features before the models are trained. This makes sure that the data is clean, consistent, and appropriate for model training.

B. *Machine Learning Model*

The machine learning model that is set to be utilized in this project is called a multi-stage classifier, as shown in Fig. 1. The main machine learning model needed is a Random Forest classifier because of its high accuracy, strength, and ability to work with complex data. Random Forest refers to an ensemble learning method that employs the use of numerous decision trees and integrates their results in making a final prediction. It makes it less prone to overfitting, and it generalizes well on unseen data. It can also determine the significance of various features and hence can help in knowing which medical aspects can be most helpful in predicting heart diseases.

C. *Deep Learning Model*

This is the model that is used to predict the likelihood of a person contracting the disease. This is the model used to guess the probability of a person getting the disease. In addition to the machine learning model, a deep learning model in which a neural network is used is applied on PyTorch. The network is made up of several fully connected layers where the activation functions are REL and a single sigmoid activation at the end of the network to classify the binary. The deep learning model can retain complicated nonlinear relationships in the data that traditional models can be unaware of. It is trained on the basis of binary cross-entropy loss and optimized through the Adam optimizer.

D. *Hybrid Model*

The result of both machine learning and deep learning models is used to obtain the final prediction. This model combines the advantages of both the models, which lead to better prediction and stability. The average results of the model of the random forest (ML) and the model of the neural network (DL).

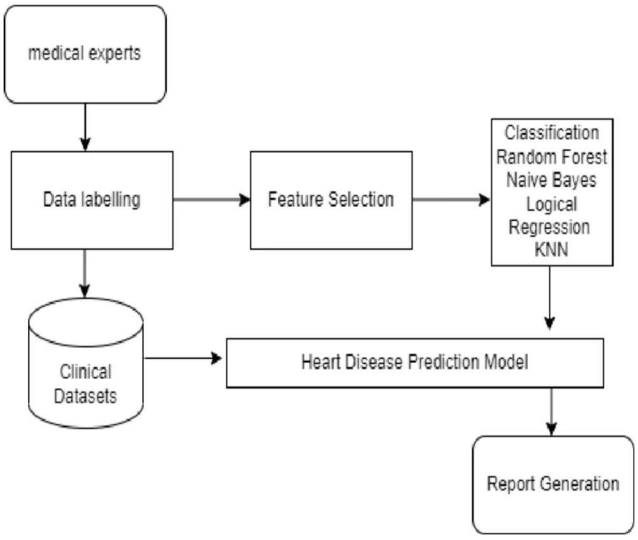

Fig. 1. Proposed system architecture of the AI-based heart disease prediction system.

IV. SYSTEM ARCHITECTURE

The heart disease prediction system proposed is an AI-based system that is developed as a modular and scalable architecture to offer an effective and easy-to-use solution to the problem. The system has been subdivided into frontend, backend, and intelligent.

A. *Frontend (HTML, CSS, JavaScript)*

The frontend offers a user-friendly interface that allows interactivity where users can enter their

health-related information which includes age, blood pressure, and cholesterol levels. It is created with HTML to provide structure, CSS to provide style, and JavaScript to provide dynamicity. Such features as graphical risk indicators, chatbot interaction, report download, and real-time prediction display are included in the interface. The design is also usable and accessible, and even non-technical users easily interact with the system.

B. *Backend (Flask)*

The server is developed on the Flask system in Python which performs all server-based functions. It receives user queries, interacts with machine learning and deep learning applications, and delivers prediction outcomes. There are also APIs that are managed by the backend to respond to chatbots, scan images, translate, and create reports. Also, it logs the predictive results in a database to be used in analysis and follow-up.

C. *ML Model (Random Forest)*

This model analyzes the patterns in the data. This model is an analysis of the trends in the data. The machine learning component is a Random Forest classifier that is trained on organized data in healthcare. It processes the input characteristics and gives the probability score that shows risk of heart disease. The model is effective, interpretable, and can work with tabular data. Input variables: age, sex, weight, and pain level (numerical values). Input variables: age, sex, weight and pain level (numbers).

D. *DL Model (Neural Network)*

The deep learning phase is carried out with the help of a neural network with several hidden layers. It fills in and fills in nonlinear relationships and complex patterns of the data and is used to complement machine learning models.

E. *Chatbot*

A built-in chatbot will offer its users some basic health tips, responses to frequent questions, and information about heart health. It increases the level of engagement with the users, and the system is made easier to use. to both users and health care professionals.

F. *PDF Report Generator*

The system has a built-in automation report generation module where professional medical-style reports are generated in PDF format. The report includes knowledge about predictions, risk score, patient information, and advice, which is useful to both users and health care professionals.

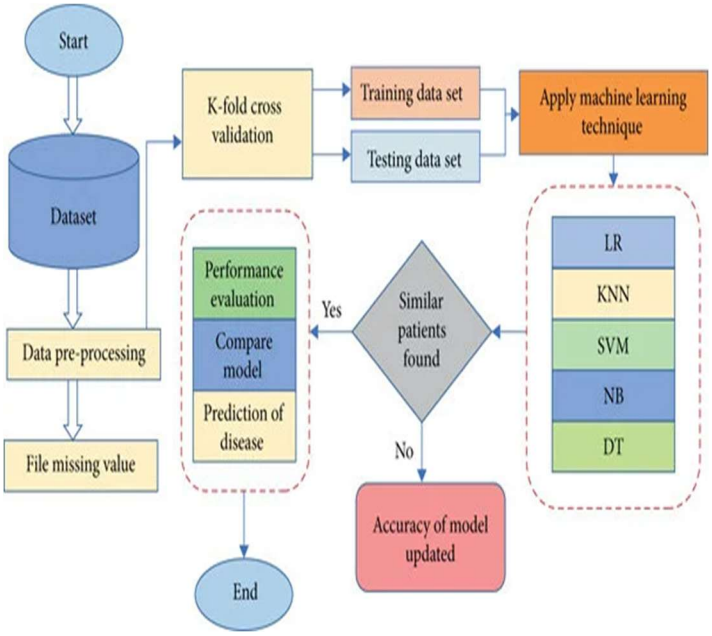

Fig. 2. Hybrid prediction workflow using Random Forest and Neural Network

V. IMPLEMENTATION

To make the proposed AI-based system of predicting heart diseases efficient, scalable, and easy to use, the implementation is done with a mixture of web technologies and machine learning frameworks. The system is based on client-server architecture with the frontend communicating with the backend using RESTful APIs. The Flask framework of Python is used to create the backend of the system. Flask is selected because the tool is lightweight, and it can also be used to construct web apps and APIs. All the core functionalities are performed by the backend, such as processing data, model prediction, responding to chatbots, scanning

pictures, and creation of reports. The machine learning model (Random Forest) and deep learning model (Neural Network) are trained and loaded into the backend to produce predictions given the input of users. The hybrid prediction is obtained by summing the outputs of the two models. Furthermore, the backend handles database activities with SQLite where the user inputs and the history of prediction are stored to be used later. The frontend will be developed based on HTML, CSS, and JavaScript that will give the dashboard a relaxed and interactive look and feel. It enables users to enter the most important health parameters like age, blood pressure, and cholesterol. Asynchronous calls to the backend APIs and the display of real-time results without a page reload are done with JavaScript. Graphical gauge has been introduced to display the level of risk to the user in a graphical manner. The interface is also multilingual as users can access the interface using various language since some languages are easier to understand. The system has other modules that increase its functionality. The image scanning is an option that enables users to post medical pictures, which are analyzed using AI algorithms to give additional analysis. It has a chatbot module to help customers through simple health-based questions and advice. Besides, one adopts a PDF report generation module with the help of the Report Lab library, which generates professional style medical-driven reports with prediction outcomes, risk scoring, patient information, and recommendations. In general, the implementation guarantees smooth integration between frontend and backend elements that will allow real-time interaction, proper predictions, and a complete user experience.

VI. RESULTS

The work of the suggested AI-based heart disease prediction system was tested concerning the accuracy of prediction, the speed of response, and the overall interface. The system provides a hybrid model, which combines a Random Forest classifier and a neural network, which is much more efficient in prediction. According to experimental observations, the hybrid approach gives more stable and reliable results by utilizing the advantages of both machine learning and deep learning methods. Random Forest model is effective when structured clinical data are involved, and it gives consistent predictions with low variance. The neural network, on the other hand, represents sophisticated nonlinear correlations in the data, which adds to the enhanced predictive power. Averaging the results of the two models, the system reduces the number of errors and maximizes the overall accuracy. This hybrid method minimizes the drawbacks of single-model methods and achieves more successful generalization on unknown data. Along with the accuracy of predictions, the system has an efficient real-time operation. The backend accepts inputs and provides predictions in a short period, which is favorable to the user's experience. The combination of asynchronous communication between the frontend and the backend enables users to obtain immediate results without relaxing on the page. This live feature is essential in healthcare applications where timely information can be used in making early decisions. The system user interface is interactive. The visualization of risks in a form of a gauge, chatbot support, and multilingual support are some of the features that enhance accessibility and user interaction. The chatbot offers Realtime reply to the queries of the users, and the multilingual option helps the user communicate with the system in various languages, placing the chatbot in the right position to cater to the diverse users. Also, this system is made more practical since the professional PDF report is created automatically. Such reports contain the results of prediction, risk scores, and medical advice, which may be easily shared or examined later. In general, the findings indicate that the suggested system, besides providing better predictions, fulfills the role of a convenient and efficient system to determine the risk of heart diseases in real-time.

VII. CONCLUSION

We have introduced an AI-based heart disease prediction system in this paper that combines both machine learning and deep learning to give efficient and accurate risk assessment. The proposed system takes an approach to hybrid in that it will combine a Random Forest classifier and a neural network model so that it can exploit the advantages of each approach. When this is combined, the prediction of accuracy and generalization is enhanced as compared to using single models. The system is developed as a full-fledged end-to-end solution that does not only pay attention to predictive performance but also puts more emphasis on usability and accessibility. The interactive frontend allows users to input health-related parameters and predict them in real time in an easy-to-use way. The support of a graphical display of risks, chatbot assistance, and multilingual support are other features that can contribute to better user experience and make the system suitable among many users. The other important input of this work is the incorporation of a professional PDF report generation module. This is an option that enables users to get comprehensive reports with the results of predictions, risk ratings, and medical recommendations. These reports may serve either personal health purposes or be shared with the healthcare professionals. The fact that several functionalities are introduced into one system proves the practical applicability of AI to the real-life situation in healthcare. Despite the good results of the proposed system, some limitations are evident, which can be solved in the following work. The model can also be trained on larger and more diverse real-world datasets to increase the precision of the model. Also, it is possible to consider more advanced deep learning architecture and ensemble methods to achieve better performance. Connection to living health tracking devices, including wearable sensors, may be applied to sustain the input of data and actively manage health care. Finally, the current project demonstrates the possibility of AI-driven solutions in revolutionizing healthcare and improving it through early diagnoses and better decision-making, as well as making the tools accessible to users. The suggested system is a step toward the development of intelligent and user-friendly healthcare applications that may help improve health outcomes.

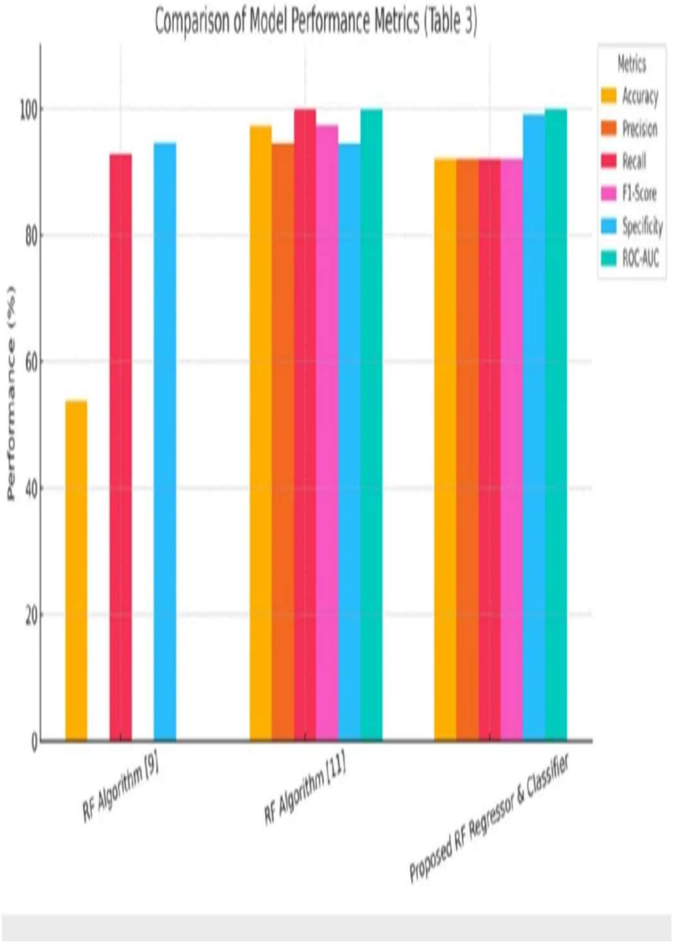

Fig. 3. Accuracy comparison of ML, DL, and Hybrid models

VIII. FUTURE WORK

Despite the fact that the suggested AI-driven system of heart diseases prediction shows the encouraging results in its performance and usability, there are a number of ways to improve and enhance the given system. Further work can be concentrated on the expansion of the system's capabilities, better accuracy, and the expansion of the applicability of the system in the real healthcare setting. The use of more sophisticated deep learning models is also an important future work direction. Although the

existing system is built with a simple neural network, it is possible to consider more advanced models like convolutional neural networks (CNNs), recurrent neural networks (RNNs), or other systems based on transformers. These models can enhance the accuracy of prediction, especially in large-scale data or in complex data such as medical images and time-series data. In general, the improvements that will be made to the system in the future will involve introducing it as a smarter, more reliable, and real-world-applicable system that would eventually lead to improved healthcare outcomes and preventative care.

A. Integration with wearable devices

The proposed heart disease prediction system can be significantly improved with real-time monitoring that will allow assessing the health of a user on a constant basis. At present, the system is based on manually entered data at a certain moment. It can be expanded to live data streams in the future to sensors, wearable devices, or other connected health systems. This would enable the system to be dynamically updated with the predictions provided that new data is available. The system will be able to record immediate variations in vital parameters (e.g. heart rate, blood pressure, or the level of activity) with real-time monitoring. The changes can be examined in real time to recognize the possible health threats and provide a timely warning or suggestions. This preventive measure may contribute to avoiding acute diseases because it can be used to intervene early. Also, real-time data analysis enables the system to trace trends and patterns over time, which is more accurate and personalized in the prediction. It also increases the involvement of the user as it provides continuous feedback and insights. In general, the addition of real-time monitoring will turn the system into an active predictive tool as a dynamic and intelligent healthcare system that will assist in constantly managing.

B. Real-time monitoring item Wearable devices

The computer will work with wearable devices, as well. Another area of enhancement of the suggested system to consider in future is the connection to wearable devices like smartwatches or fitness bracelets. All these devices have the capability of constantly checking critical health parameters such as heart rate, physical activity, sleep habits, and oxygen levels in the blood. With the integration of the system into such devices, real time health data will be collected automatically without the necessity of the user to input the data into the system. Such integration would allow constant monitoring and early detection of abnormal patterns which could reflect possible heart-related risks. As an example, an uneven heartbeat or unexpected alterations in exercise can be recognized and implemented to cause alerts or suggestions. Moreover, wearable devices that have gathered data over a long period of time can be used in trend analysis and enhance the precision of predictions in the long term. In addition, the feature would contribute to the convenience of the users in terms of seamless data collection and immediate feedback. Customers will be able to get individualized health insights and recommendations depending on their daily activities. In summary, the system, through the incorporation of wearable devices, will be changed into a proactive and smart healthcare product, which will encourage the timely diagnosis and effective management of health.

C. Advanced deep learning models

The other significant area of future work is the utilization of advanced deep learning models to enhance the accuracy and efficiency of predicting heart diseases. The existing system makes use of a simple neural network; it can be expanded to consider more advanced designs like Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) or Transformer-based architectures. Such models can be used to model complex patterns and relationships in big and high-dimensional data that can help in mostly predicting results. As an example, CNNs can be utilized in medical image analysis, which allows the system to manipulate medical imaging data, like ECG or heart scan data. Time-series data can be analyzed with the help of RNNs and Long Short-Term Memory

(LSTM) networks, and this is why they can be used to track the patient's health trends over time. Transformer-based models can also construct performance further by processing sequential data in a more efficient way and long-range dependencies. The use of these advanced models may result in more precise and valid predictions, particularly in situations involving large and heterogeneous datasets. In general, the application of high-order deep learning algorithms will enhance the functionality of the system and make it more applicable to the actual health care practice.

REFERENCES

[1] UCI Machine Learning Repository: Heart Disease Dataset [2] Breeman, L. (2001). Random Forests. [3] Goodfellow, I. (2016). Deep Learning.

[3] K.-D. Seo, M. J. Kang, G. S. Kim, J. H. Lee, S. H. Suh, and K.-Y. Lee, ‘‘National trends in clinical outcomes of endovascular therapy for ischemic stroke in South Korea between 2008 and 2016,’’ J. Stroke, vol. 22, no. 3, pp. 412–415, Sep. 2020.

[4] A. Lathigara et al., “Intelligent Heart Disease Prediction System Using AI, IoMT, and Modified Particle Swarm Optimization,” 2025..

[5] K. Kavin Kumar, S. K. Sashithra, M. C. Mahesh, S. K. M. Shantha Kumar, P. Dwivedi, and N. S. Kumar, 2025.

[6] M. Chaar and D. Vetri Thangam, “Advances in Heart Disease Detection Using Hybrid CNN-LSTM Model,” 2025

[7] S. Kanagaraj, “Leveraging Cloud-Based Deep Learning for Cardiovascular Diseases Prediction: Challenges and Solutions,” 2025.

