HEART DISEASE PREDICTION USING DEEP LEARNING TECHNIQUES : A REVIEW

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Abstract - *Heart disease continues to stand as a prominent contributor to global mortality rates, underscoring the imperative for the creation of precise and effective predictive frameworks. In recent times, deep learning methodologies have garnered considerable interest due to their capacity to scrutinize intricate and multi-dimensional datasets. This scholarly paper delves into the utilization of deep learning approaches in forecasting heart diseases, scrutinizing a spectrum of models and algorithms deployed in this sphere. The manuscript furnishes a comprehensive survey of diverse deep learning architectures, such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and amalgamated models, accentuating their efficacy in processing medical data and refining prognostic precision. Furthermore, the review deliberates on the hurdles and constraints encountered by deep learning models in the realm of heart disease prediction, encompassing challenges associated with data integrity, model interpretability, and generalizability. Ultimately, the paper delineates forthcoming avenues for research, underscoring the promise of amalgamating deep learning with other nascent technologies to enrich predictive capacities and contribute to tailored healthcare solutions*.

Key Words: Heart Disease Prediction, Deep Learning, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Hybrid Models, Medical Data Analysis, Predictive Models, Personalized Healthcare, Model Interpretability, Data Quality

1.HISTORY

Heart disease, a prominent cause of mortality on a global scale, boasts a rich and intricate historical background. Ancient civilizations, such as the Egyptians and Greeks, meticulously chronicled symptoms now attributed to heart disease, albeit without a comprehensive grasp of its underlying causes. It wasn't until the 17th century that William Harvey elucidated the intricacies of the circulatory system, thereby laying the foundation for contemporary cardiology. Through the passage of time, breakthroughs in medical science unveiled the complex mechanisms of the heart and shed light on the profound influence of variables like diet, lifestyle, and genetic predispositions on cardiovascular well-being. Presently, heart disease, encompassing maladies like coronary artery disease, heart failure, and stroke, stands as a formidable global health crisis, claiming an estimated 17.9 million lives annually as reported by the World Health Organization. This burden is notably weighty in regions characterized by limited healthcare accessibility and preventive interventions, particularly in low- and middle-income nations. The worldwide repercussions of heart disease underscore the imperative of ongoing research endeavors, early detection initiatives, and innovative therapeutic approaches geared towards diminishing mortality rates and enhancing overall quality of life.

1.1.Importance of early detection and prediction in reducing mortality rates.

Early detection and anticipation of cardiovascular disease are paramount in decreasing mortality rates, as they facilitate timely intervention before the condition escalates to a critical phase. By pinpointing predisposing factors and symptoms at an initial stage, healthcare providers can implement preemptive measures, lifestyle modifications, and medical interventions that can substantially delay or even avert the onset of severe cardiac conditions. Timely diagnosis also enables the creation of tailored treatment strategies, which can be more efficacious in managing the ailment and mitigating complications. Furthermore, prognostic models, especially those driven by cutting-edge technologies like deep learning, can evaluate individual risk with remarkable precision, enabling proactive care customized to each patient. This proactive stance not only enhances survival rates but also enriches the quality of life for patients by diminishing the probability of life-threatening incidents such as myocardial infarctions or cerebrovascular accidents. In essence, early detection and anticipation are pivotal tactics in the worldwide battle against cardiovascular disease, offering the potential to preserve millions of lives annually.

2.INTRODUCTION

Heart disease, a prevalent health issue, encompasses a wide range of conditions that impact the structure and function of the heart. Among these, coronary artery disease stands out as the most common form, characterized by the narrowing or blockage of arteries supplying blood to the heart. This obstruction, often caused by the buildup of plaque, restricts blood flow and heightens the risk of heart attacks. Additionally, heart failure, where the heart struggles to pump blood efficiently, arrhythmias leading to irregular heartbeats, and valvular heart disease involving faulty heart valves are significant types of heart conditions.

The factors contributing to heart disease are multifaceted and varied. Genetic predisposition, lifestyle choices like an unhealthy diet and lack of exercise, and environmental influences such as stress and pollution all play a role. Despite significant advancements in medical science, heart disease remains the primary cause of death globally, claiming millions of lives annually. Its impact extends beyond individual health, burdening healthcare systems, economies, and families worldwide.

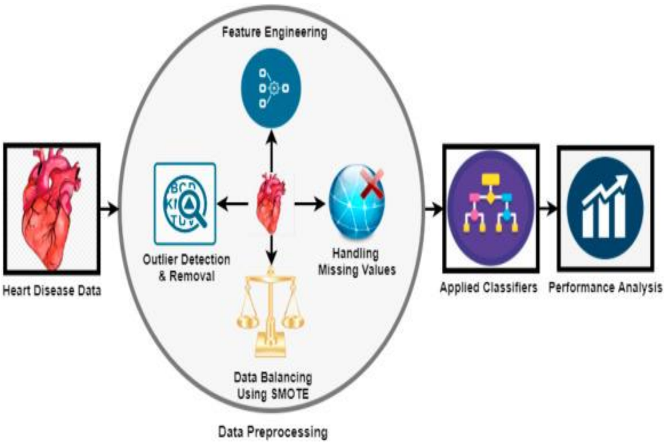

Figure-1: Heart Diasease

To address this pervasive issue effectively, a comprehensive approach involving prevention, early detection, and innovative treatment strategies is crucial. By emphasizing healthy lifestyle habits, raising awareness about risk factors, and promoting regular screenings, the fight against heart disease can be intensified. Through collective efforts and a proactive mindset, the detrimental effects of heart disease can be mitigated, ensuring a healthier future for generations to come.

3.CURRENT DIAGNOSTIC AND PREDICTION METHODS

Current diagnostic and prognostic methodologies for cardiac ailments are varied, encompassing conventional clinical evaluations to cutting-edge technological strategies. These methodologies are tailored to identify heart disease at different stages and forecast the probability of its manifestation, enabling timely intervention and treatment.

3.1. Clinical Assessments and Physical Examinations

3.1.1.Electrocardiogram (ECG/EKG)

A non-invasive test that records the electrical activity of the heart over time. It is used to detect arrhythmias, ischemia, and other heart abnormalities by analyzing the heart's rhythm and electrical patterns.

Figure-2: ECG Report

3.1.2.Blood Tests

Specific biomarkers in the blood, such as cholesterol levels, triglycerides, and high-sensitivity C-reactive protein (hs-CRP), are measured to assess the risk of heart disease. Elevated levels of troponin, a protein released during heart muscle damage, are indicative of a heart attack.

3.1.3.Echocardiogram

An ultrasound of the heart that provides detailed images of the heart's structure and function. It helps in diagnosing conditions like heart valve diseases, cardiomyopathy, and heart failure.

3.1.4.Stress Tests

These tests, including exercise stress tests and pharmacological stress tests, evaluate how the heart performs under physical exertion or stress. They help identify coronary artery disease and assess the severity of known conditions.

3.2. Imaging Techniques

3.2.1.Coronary Angiography

A procedure that uses X-ray imaging to visualize the coronary arteries. It involves injecting a contrast dye into the arteries to detect blockages or narrowing that could lead to heart disease.

3.2.2.Computed Tomography (CT) Scans

CT coronary angiography (CTCA) is a non-invasive imaging technique that provides detailed images of the heart's blood vessels. It is often used to assess coronary artery disease and calculate coronary artery calcium (CAC) scores, which predict the risk of heart attacks.

3.2.3.Magnetic Resonance Imaging (MRI)

Cardiac MRI provides high-resolution images of the heart's structure and function without the use of ionizing radiation. It is particularly useful for diagnosing complex congenital heart disease, cardiomyopathies, and assessing myocardial viability.

3.3. Predictive Models and Risk Assessment Tools

3.3.1.Framingham Risk Score

A widely used algorithm based on data from the Framingham Heart Study, which calculates the 10-year risk of developing heart disease based on factors such as age, cholesterol levels, blood pressure, smoking status, and diabetes.

3.3.2.ASCVD Risk Calculator

Developed by the American College of Cardiology (ACC) and the American Heart Association (AHA), this tool estimates the 10-year and lifetime risk of atherosclerotic cardiovascular disease (ASCVD), incorporating factors like race, gender, and cholesterol levels.

3.3.3.QRISK Score

Used in the UK, the QRISK score predicts the risk of developing cardiovascular disease within 10 years by considering variables such as age, sex, ethnicity, blood pressure, cholesterol levels, and family history.

3.4. Emerging Technologies

3.4.1.Machine Learning and AI-Based Models

Machine learning algorithms and artificial intelligence (AI) are increasingly being used to predict heart disease by analyzing large datasets, including electronic health records (EHRs), imaging data, and genetic information. These models can identify patterns and risk factors that may not be apparent through traditional methods, offering personalized predictions.

3.4.2.Wearable Devices

Wearable technology, such as smartwatches with ECG capabilities, can continuously monitor heart rate, rhythm, and other vital signs, providing early detection of irregularities and potential heart disease.

3.4.3.Genomic and Biomarker Analysis

Advances in genomics have led to the identification of genetic markers associated with heart disease. Combined with biomarker analysis, these approaches offer personalized risk assessments and targeted prevention strategies.

4.DEEP LEARNING TECHNIQUES IN HEART DISEASE PREDICTION

Deep learning techniques have revolutionized heart disease prediction by enabling more accurate, efficient, and personalized assessments. These techniques leverage complex neural network architectures to analyze large volumes of data and identify patterns that traditional methods may miss. Here's a detailed look at how deep learning is applied in heart disease prediction:

4.1. Overview of Deep Learning

4.1.1.Definition and Basic Concepts

Deep learning is a subset of machine learning that involves neural networks with many layers (deep neural networks). These networks can automatically learn and extract features from raw data, making them particularly effective for tasks such as image recognition, natural language processing, and predictive modeling.

4.2.Types of Deep Learning Models

4.2.1.Convolutional Neural Networks (CNNs)

Ideal for analyzing visual data, CNNs are used in heart disease prediction to process medical images like ECGs and MRI scans, detecting abnormalities and patterns indicative of heart conditions.

4.2.2.Recurrent Neural Networks (RNNs)

Useful for sequential data, RNNs and their variants (such as Long Short-Term Memory networks, LSTMs) are employed to analyze time-series data, such as ECG signals, to predict arrhythmias and other heart conditions.

4.2.3.Autoencoders

These are used for unsupervised learning tasks, such as anomaly detection in medical data. They can identify unusual patterns in patient data that may signify emerging heart disease.

4.2.4.Feedforward Neural Networks (DNNs)

These are employed in risk prediction models that use structured data (e.g., patient demographics, laboratory results) to estimate the probability of heart disease.

4.3.Data Used in Deep Learning Models

4.3.1.Structured Data

Includes numerical and categorical information such as age, blood pressure, cholesterol levels, and medical history. Deep learning models can integrate and analyze this data to predict heart disease risk based on complex interactions between variables.

4.3.2.Unstructured Data

Comprises medical images (e.g., CT scans, MRI, echocardiograms) and text data from clinical notes. CNNs are particularly effective at processing and interpreting these types of data, extracting relevant features that inform predictive models.

4.3.3.Data Preprocessing

- Normalization: Standardizes data ranges to improve model performance and convergence.
- Augmentation: Enhances the dataset by creating variations (e.g., rotating or flipping images) to improve model robustness.
- Feature Engineering:Involves selecting and transforming variables to better represent the data for model training.

4.4. Performance Metrics

4.4.1.Accuracy

Measures the overall correctness of the model's predictions.

4.4.2.Precision and Recall

Precision assesses the proportion of true positive predictions among all positive predictions, while recall evaluates the proportion of true positives among all actual positives. Both are crucial for evaluating the model's effectiveness in identifying heart disease.

4.4.3.F1-Score

The harmonic mean of precision and recall, providing a balanced measure of model performance.

4.4.4.AUC-ROC Curve

The Area Under the Receiver Operating Characteristic Curve quantifies the model’s ability to distinguish between positive and negative cases, with higher values indicating better performance.

4.5. Challenges and Limitations

4.5.1.Data Quality and Quantity

Deep learning models require large and high-quality datasets for training. Limited or biased data can lead to overfitting or reduced generalizability.

4.5.2.Interpretability

Deep learning models are often considered "black boxes," making it challenging to understand how decisions are made. This lack of transparency can be a barrier to clinical adoption.

4.5.3.Computational Resources

Training deep learning models can be resource-intensive, requiring significant computational power and memory, which can be a limitation in resource-constrained settings.

4.5.4.Ethical and Privacy Concerns

Handling sensitive patient data raises privacy issues and requires strict adherence to ethical guidelines and regulations.

4.6. Future Directions

4.6.1.Explainable AI (XAI)

Research is focused on developing methods to make deep learning models more interpretable, helping clinicians understand and trust the predictions.

4.6.2.Transfer Learning

Utilizing pre-trained models on related tasks to improve performance on specific heart disease prediction tasks with limited data.

4.6.3.Federated Learning

Allows collaborative training of models across multiple institutions without sharing sensitive data, enhancing model robustness while protecting patient privacy.

5.APPLICATIONS OF DEEP LEARNING IN HEART DISEASE PREDICTION

Deep learning has a profound impact on heart disease prediction by offering innovative solutions that enhance diagnostic accuracy, risk assessment, and personalized treatment. Here’s a detailed exploration of its applications:

5.1. Predictive Models

5.1.1.Risk Assessment Models

Deep learning models integrate traditional risk factors such as age, sex, cholesterol levels, blood pressure, and smoking status with advanced data sources. These models analyze complex interactions between variables to predict the likelihood of heart disease more accurately than conventional methods.

5.1.2.Personalized Risk Prediction

Models like deep neural networks (DNNs) and gradient boosting machines use patient-specific data to generate personalized risk scores. For instance, algorithms can tailor predictions based on genetic information, lifestyle factors, and historical medical records, providing individualized risk assessments and preventive recommendations.

5.1.3.Longitudinal Monitoring

Deep learning models monitor continuous ECG data from wearable devices to detect and predict potential heart disease. They analyze patterns over time to identify subtle changes that may indicate emerging heart conditions.

5.2. Diagnostic Models

5.2.1.Medical Imaging Analysis

5.2.1.1.Cardiac MRI and CT Scans

CNNs are used to analyze cardiac MRI and CT images, identifying structural abnormalities, such as myocardial infarction, coronary artery disease, and valvular disorders. These models can provide detailed insights into the heart's anatomy and function, aiding in accurate diagnosis.

5.2.1.2.Automated Image Segmentation

Deep learning algorithms perform automated segmentation of cardiac structures from imaging data, such as identifying the left ventricle or coronary arteries. This process aids in quantifying the extent of damage or disease and planning appropriate interventions.

5.2.2.Anomaly Detection

5.2.2.1.Unsupervised Learning

Autoencoders and other unsupervised deep learning techniques detect anomalies in medical imaging and patient data. These models identify patterns that deviate from the norm, potentially signaling the presence of heart disease before clinical symptoms appear.

5.3. Integration with Electronic Health Records (EHRs)

5.3.1.Predictive Analytics

Deep learning models analyze EHRs to predict the onset of heart disease based on a combination of structured and unstructured data, including clinical notes, lab results, and demographic information. These models can identify high-risk patients and suggest personalized treatment plans.

5.3.2.Natural Language Processing (NLP)

NLP techniques extract relevant information from unstructured clinical notes, such as symptoms and medical history, to enhance prediction models. This integration helps provide a comprehensive view of patient health, improving prediction accuracy.

5.4. Personalized Treatment Planning

5.4.1.Treatment Response Prediction

Deep learning models predict individual responses to various treatments by analyzing patient-specific data and historical outcomes. This approach helps in selecting the most effective treatment plans and optimizing therapy.

5.4.2.Drug Discovery and Development

Models are used to identify potential drug targets and predict the efficacy of new medications for heart disease. Deep learning accelerates drug discovery by analyzing complex biological data and simulating interactions between drugs and targets.

5.5. Real-Time Monitoring and Alert Systems

5.5.1.Wearable Devices

Wearables equipped with deep learning algorithms continuously monitor vital signs, such as heart rate and ECG, providing real-time alerts for abnormal patterns that may indicate heart disease. These devices can notify users and healthcare providers of potential issues, enabling timely intervention.

5.5.2.Remote Monitoring Systems

Deep learning models analyze data from remote monitoring systems to track patients' heart health remotely. These systems can detect deteriorations in condition and provide early warnings, allowing for proactive management.

5.6. Comparative Analysis

5.6.1.Comparison with Traditional Methods

Deep learning models are compared with traditional machine learning and statistical methods to evaluate performance improvements in heart disease prediction. Metrics such as accuracy, precision, recall, and AUC-ROC are used to assess the effectiveness of deep learning approaches.

5.6.2.Advancements in Predictive Power

Research demonstrates that deep learning models often outperform traditional methods by capturing complex relationships and interactions in data, leading to better predictive power and more accurate risk assessments.

5.7.Challenges and Considerations

5.7.1.Data Quality and Generalization

The effectiveness of deep learning models depends on the quality and diversity of the data used. Models trained on diverse and high-quality datasets are more likely to generalize well across different populations.

5.7.2.Regulatory and Ethical Issues

Ensuring that deep learning models comply with medical regulations and ethical standards is crucial. Transparency, interpretability, and patient privacy must be addressed to gain acceptance in clinical practice.

6.LITEARURE REVIEW

In the literature review section, we have examined the preceding research papers pertaining to the conventional prediction of heart disease. A comprehensive summary of all the aforementioned research papers is detailed below.

Latha & Subramanian. The proposed CANFIS model combined the neural network adaptive capabilities and the fuzzy logic qualitative approach which is then integrated with genetic algorithm to diagnose the presence of the disease. CANFIS model combined neural network and fuzzy logic for heart disease prediction. Genetic algorithm used to diagnose the presence of heart disease. CANFIS model with GA shows potential in predicting heart disease. Computers complement doctors in evaluating areas highlighted by detection.

Chitra & Seenivasagam. The results show the CNN classifier can predict the likelihood of patients with heart disease in a more efficient way. Heart disease prediction using supervised learning algorithm. Cascaded Neural Network classifier improves prediction efficiency. The proposed CNN classifier can predict the likelihood of patients with heart disease more efficiently.

The SVM classifier is also used for heart disease prediction.

Aditya et al. The proposed system will use the multilayered feed forward neural network and back propagation neural network algorithms for the prediction of heart disease in four stages using the dataset provided by the University of California, Irvine [UCI] machine learning repository. Heart disease prediction system using multilayered feed forward and back propagation neural network. Dataset from UCI machine learning repository used for training and testing. Increase in heart disease cases due to population growth. Proposed system improves accuracy and speed of disease diagnosis.

Marikani & Shyamala. This paper aims at analyzing the various data mining techniques namely Decision Trees, Naive Bayes, Neural Networks, Random Forest Classification and Support Vector Machine by using the Cleveland dataset for Heart disease prediction to provide a quick and easy understanding of various prediction models in data mining. Heart disease prediction using data mining techniques. Analysis of various supervised learning algorithms for prediction. Different supervised learning algorithms were used for heart disease prediction. The accuracy of the algorithms varied depending on the attributes and tools used.

Kathleen & Julia. Clinical diagnoses of coronary heart disease were reliably and accurately derived from the developed DNN classification and prediction models, which can be used to aid healthcare professionals and patients throughout the world to advance both public health and global health, especially in developing countries and resource-limited areas with fewer cardiac specialists available. DNN model aids heart disease diagnosis with high accuracy. Focus on coronary heart disease diagnosis and prognosis improvement. Developed deep learning models achieved high diagnostic accuracy. Results exceed those of currently published research.

Poornima et al. An effective heart disease prediction system (EHDPS) is developed using neural network for predicting the risk level of heart disease using multilayer perceptron neural network with backpropagation as the training algorithm. EHDPS predicts heart disease risk using neural network and 15 parameters. Multilayer perceptron neural network with backpropagation algorithm used for training. MLPNN with BP algorithm predicts heart disease with 100% accuracy. EHDPS assists in early diagnosis and planning for patients.

Shahid et al. The number of techniques in Artificial Neural Network (ANN) is enlighten and the accuracy is calculated and visualized such as ANN gives 94.7% but with Principle Component Analysis (PCA) accuracy rate improve to 97.7%. Heart disease prediction using Artificial Neural Network. Accuracy rate improved to 97.7% with PCA. ANN gives an accuracy rate of 94.7%. PCA improves the accuracy rate to 97.7%.

Amin et al. The proposed machine-learning-based decision support system will assist the doctors to diagnosis heart patients efficiently and can easily identify and classify people with heart disease from healthy people. Machine learning-based system for heart disease prediction using heart disease dataset. Seven popular machine learning algorithms and three feature selection algorithms used. Developed machine-learning system accurately predicts heart disease. Feature reduction impacts classifier performance in accuracy and execution time.

Annisa et al. A simulation which can be used to diagnose the coronary heart disease in better performance than the traditional diagnostic methods is proposed and deeper neural network (DNN) is proposed to the model in this work. Proposed DNN model for CHD diagnosis outperforms traditional methods. Achieved 96% accuracy, 99% sensitivity, and 92% specificity. Automated CHD diagnosis based on chest pain type input. Angina is a common symptom of CHD.

Sowbarnica et al. The proposed approach significantly improves the accuracy from 51% to 76.66% and will help doctor to explore their data and predict heart disease accurately. Heart disease prediction using K-Nearest Neighbour classification. Proposed approach improves accuracy from 51% to 76.66%. Heart Disease Prediction

System using K-Nearest Neighbour Classifier provides reliable outputs. The system significantly improves heart disease prediction rate.

Saranya Manavalan. It is proved that the accuracy of the Fuzzy Deep belief network is superior to the Deep Belief network and that the FDBN system is one of the best classification models in efficiently predicting cardiovascular diseases with the lowest error rate and maximum accuracy. Heart disease prediction using Deep Belief Neural Network with Fuzzy Logic. Fuzzy Deep Belief Network outperforms Deep Belief Network in accuracy. Fuzzy Deep Belief Network outperforms Deep Belief Network. FDBN is efficient in predicting cardiovascular diseases with high accuracy.

Dominic et al. The model system assists clinicians in survival rate prediction of an individual patient and future medication is planned for, and the families, relatives, and their patients can plan for treatment preferences and plan for their budget consequently. Model predicts heart disease using data mining classification techniques. Attributes used for prediction expanded to include obesity and smoking. Proposed model uses Naive Bayesian, decision tree, and KNN classifiers. Decision tree has high precision and less error rate.

Irfan et al. The strength of the proposed ensemble approach such as voting based model is compelling in improving the prognosis accuracy of anemic classifiers and established adequate achievement in analyze risk of heart disease. Machine Learning techniques used to predict heart disease with improved accuracy. Ensemble voting based model achieved 2.1% increase in accuracy. Ensemble voting model improves heart disease prediction accuracy by 2.1%. ML techniques and deep learning models enhance prognosis accuracy significantly.

Yahaya et al. This paper investigates the state of the art of various clinical decision support systems for heart disease prediction, proposed by various researchers using data mining and machine learning techniques. Heart disease diagnosis and treatment are complex. Clinical decision support systems for heart disease prediction. Marginal success achieved in creating predictive models. Need for more complex models with diverse data sources.

Viraj et al. In this paper, the authors proposed to use convolutional neural network algorithm as a disease risk prediction algorithm using structured and perhaps even on unstructured patient data to predict the risk of diseases. Predict heart disease risk using CNN algorithm with 85-88% accuracy. Implement machine learning algorithms on structured patient data for prediction. Convolutional neural network algorithm predicts heart disease risk. Accuracy ranges between 85 and 88%.

Singh et al. The main objective of this research is developing such a model Intelligent Heart Disease Prediction System (IHDPS) with the help of three data mining modelling techniques, namely, Decision Trees prediction model, Naïve Bayes probability technique and Neural Network. Develops Intelligent Heart Disease Prediction System using data mining techniques. Aids in diagnosing heart disease and making intelligent clinical decisions. The paper proposes an Intelligent Heart Disease Prediction System (IHDPS) using data mining techniques. The IHDPS enables better diagnosis and assists healthcare practitioners in making intelligent clinical decisions.

Abhay. The main objective of this research paper is to summarize the recent research with comparative results that has been done on heart disease prediction and also make analytical conclusions. Heart disease prediction using machine learning algorithms. Naive Bayes, Decision Trees, and Artificial Neural Networks improve accuracy. Naive Bayes with Genetic algorithm, Decision Trees, and Artificial Neural Networks improve heart disease prediction accuracy. Data mining and machine learning techniques are summarized.

Jakkrit & Hathairat. The results show that the Logistic Regression model is better performance than Neural Network model in predicting the heart disease detection by using data mining techniques. Predictive model for heart disease detection using data mining techniques. Logistic Regression model outperforms Neural Network model.

Maria et al. This paper aims to provide a solution of the dimensionality problem by proposing a new mixed model for heart disease prediction based on the Naive Bayes algorithm and several machine learning techniques including Support Vector Machine, K-Nearest Neighbors, Decision Tree, and Random Forest. Heart disease prediction model using Naïve Bayes algorithm and machine learning techniques. Proposed model improves performance and selects best features. Proposed model improves heart disease prediction system performance.Naive Bayes approach outperforms Genetic Algorithm and Principal Component Analysis approaches.

Raniya et al. In this article , the authors used an artificial neural network (ANN) model to construct a deep learning diagnosis system for heart disease prediction, which achieved 93.44% accuracy, which is 7.5% higher than a traditional ML model support vector machine (SVM). ANN model achieved 93.44% accuracy for heart disease prediction. Traditional ML model SVM had 7.5% lower accuracy.

Gupta & Seth. In this paper , different machine learning classifiers and a deep learning algorithm multi-layer perceptron (MLP) were applied on two different datasets, Framingham heart study dataset and UCI heart disease dataset for prediction of heart disease. Machine learning and deep learning algorithms were used to predict heart disease. Random forest algorithm had the highest prediction accuracy of 97.13%. Random forest algorithm had highest prediction accuracy of 97.13%. Multi-layer perceptron (MLP) performed well on both datasets.

Jasjit et al. A model based on Machine learning techniques has been proposed for early and accurate prediction of heart disease and it is found that the results of proposed model gives the better performance in terms of simulation error, response time and accuracy in heart disease prediction. Predicting heart disease using efficient machine learning model. Utilizes feature optimization, selection, and ensemble learning techniques.

Tuba. In this paper , a machine learning approach was used for heart disease prediction using Support Vector Machine (SVM), K-NN, Random Forest Classifier, Decision Tree, and Logistic Regression. Heart disease prediction using machine learning models. Logistic regression and K-NN produced best results. Logistic regression and K-NN models produced the best results. Machine learning models can optimize heart disease prediction.

Chintan et al. In this article , the authors proposed a method of k-modes clustering with Huang starting that can improve classification accuracy, which achieved the highest accuracy of 87.28% on a real-world dataset of 70,000 instances from Kaggle. Machine learning used to predict cardiovascular diseases. Multilayer perceptron achieved highest accuracy of 87.28%. Multilayer perceptron with cross-validation achieved the highest accuracy of 87.28%. The proposed models have AUC values ranging from 0.94 to 0.95.

Deng et al. Wang et al. as mentioned in this paper proposed an indicator vector to indicate whether the value is true or be padded, which fast solves the missing values and helps expand data dimensions. And a multi-head self-attention mechanism is applied to gain whole channel information, which is essential for the system to improve performance. Deep learning system predicts heart failure mortality with multi-head attention. Utilizes indicator vector, CNN, and focal loss function for accuracy. CNN deep learning model effectively predicts HF mortality. Multi-head self-attention and focal loss improve performance.

Yewale et al. In this paper , the authors proposed a framework for effective prediction of heart disease based on ensemble techniques, without the need of feature selection, incorporating data balancing, outlier detection and removal techniques, with results that are still at par with cutting-edge research. Framework for heart disease prediction using ensemble techniques. Achieves superior performance in accuracy and other metrics. Proposed approach outperforms existing work in accuracy. No previous research focused on these performance parameters.

Haque et al. Attention learning predicts heart failure efficiently using cardiovascular data. Serum creatinine and ejection fraction are key predictive features. Proposed attention learning approach efficiently predicts heart failure. Outperforms LSTM approach in heart failure prediction.

Latifi et al. Fast, cost-effective method for diagnosing cardiac abnormalities with high accuracy. Multi-Branch Deep Convolutional Network and LSTM-CNN for heart sound classification. High accuracy in diagnosing cardiac abnormalities using innovative neural networks. Superior results over state-of-the-art techniques in heart sound classification.

7.CONCLUSION

In recent years, the application of deep learning techniques for heart disease prediction has shown significant promise, offering improved accuracy and efficiency over traditional methods. By leveraging large datasets and complex models, deep learning algorithms can uncover patterns and relationships within medical data that were previously inaccessible. This review has highlighted the various deep learning architectures employed in heart disease prediction, such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and hybrid models, all of which have demonstrated varying degrees of success. Despite the advancements, several challenges remain, including the need for large, high-quality datasets, the complexity of model interpretability, and the potential for bias in predictive models. Addressing these challenges is crucial for the widespread adoption of deep learning in clinical settings. Future research should focus on enhancing model transparency, integrating multi-modal data, and developing models that can be generalized across diverse populations. While deep learning techniques offer a powerful tool for heart disease prediction, careful consideration of the underlying challenges and a focus on ethical implementation are essential to ensure these technologies benefit patients globally.

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