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Disease classification and prevention using AI Driven System

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ABSTRACT: Since cardiovascular diseases (CVDs) constitute a major cause of death worldwide, early detection and precise assessment are essential. One of the most important markers of cardiovascular health is hypertensive retinopathy, a retinal disorder brought on by high blood pressure. This study investigates how to predict the severity of cardiovascular disease using photos of hypertensive retinopathy. The model provides information on the severity of cardiovascular illness by examining retinal pictures and extracting pertinent features that are associated with damage caused by hypertension. By using machine learning algorithms to these features, the severity of CVD can be predicted. Using easily accessible retinal scans, the non-invasive method evaluates cardiovascular risk. This approach offers a useful tool for early detection, facilitating prompt intervention and improved disease control. The results demonstrate how retinal imaging may increase the precision of cardiovascular disease predictions. The device improves diagnostic capabilities by fusing clinical data with image analysis. All things considered; this study shows how well hypertensive image-based models predict cardiovascular disease. The suggested remedy might open the door to a more effective and accessible method of diagnosing cardiovascular disease.

KEY WORDS: Cardiovascular disease, hypertensive retinopathy, retinal images, image processing, machine learning, disease severity prediction, early detection, hypertension, non-invasive diagnosis, risk assessment.

I.INTRODUCTION

Globally, millions of people suffer from cardiovascular disease, a common and frequently fatal illness. Improving patient outcomes and lowering death rates need early detection and action. Although they are efficient, traditional cardiac disease diagnostic procedures like electrocardiograms (ECG), blood tests, and imaging modalities like echocardiograms can be intrusive, costly, and time-consuming. For the early diagnosis of cardiac disease, retinal imaging presents a viable non-invasive option. The microvascular system of the body includes the retina, the light-sensitive layer at the rear of the eye. Retinal blood vessel alterations may be a sign of heart disease or a reflection of general cardiovascular health. Artificial intelligence and medical imaging advancements have enabled highly accurate retinal image analysis, identifying patterns and signals associated with risk factors for heart disease.
The goal of this project is to create an automated system that uses a multi-modal approach that integrates retinal pictures and ECG data to forecast cardiac illness. High-resolution retinal photography is used to examine the microvascular system after ECG data is gathered to identify any early indications of cardiac problems. Accurate analysis is ensured by pre-processing both datasets to improve picture and signal quality. We apply state-of-the-art convolutional neural networks to the retinal pictures in order to extract features and do prediction analysis. We specifically use a deep learning architecture called the Inception V3 model, which is renowned for its effectiveness in identifying intricate patterns in photos. Because it can process many convolutional filters of different sizes at once, Inception V3 is especially well-suited for this task. This enables it to identify minor patterns in retinal images that might be suggestive of cardiovascular illness. In addition to clinical information like blood pressure, cholesterol, and medical history, a sizable and varied dataset of labelled retinal pictures is used to train and validate the V3 model. The model's predictive accuracy is improved by combining this clinical data with retinal image analysis, which makes it an effective tool for heart disease early detection. This cutting-edge technique could revolutionize heart disease screening by making it more affordable, accessible, and non-invasive, ultimately leading to better patient outcomes through prompt intervention.

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II. LITERATURE SURVEY

The global ophthalmologist population may not be able to meet the requirements of regulatory screening due to the unintentional exposure of victims to DR and the anticipated exponential growth in the number of patients with diabetes mellitus in the future. The issue has been successfully resolved by an automated detection method that is both safe and clinically useful.

It was demonstrated that the maximizing of probability concept still applies to the most recent entries in the Fundus Algorithm, including those that make use of intricate machine learning models. As a result, they can only make a diagnosis when the disease has significantly progressed. [1]

Algorithm accuracy is one of the metrics used to assess how effectively algorithms perform because the heart is one of the body's most vital organs and heart disease prediction is a big concern for individuals. The accuracy of the machine learning algorithms depends on the dataset used for testing and training. Many Bayes Naive [2]

Using classification models, two supervised data mining algorithms—the Naïve Bayes Classifier and Decision Tree Classification—were applied to the dataset to assess a patient's risk of having heart disease. These two algorithms are used on the same dataset in order to ascertain which is more accurate. The decision tree model predicted the patient with heart disease with an accuracy rate of 91%, whereas the Naïve Bayes classifier did so with an accuracy rate of 87%. The Naïve Bayes classifier has the following accuracy rates: 91%, 87%, 85%, 86%, 87%, 88%, 90%, 91%, and 92%. % of the rate of Accuracy for Classification Methods This project states that the decision tree classification algorithm is the best and most effective way to manage a medical data collection. The system that was developed and the machine learning classification method that was used may be used in the future to predict or diagnose other diseases. The study can be improved or extended upon by adding more machine learning algorithms to automate the analysis of cardiac problems. [3]

Although the heart is a vital organ, heart disease is a major concern as it is getting increasingly prevalent globally. Therefore, we can manage heart disease if we have a model that can predict its early phases. In order to help with the less costly and uncertain detection of heart disease, we must create a machine learning model that is more accurate. It might be the primary way to assess heart health. The accuracy rate of the confusion matrix in predicting heart disease is the main focus of this article. Five algorithms' performances are compared, and the results indicate that the Logistic Regression algorithm is the most accurate. The logistic regression model's 95% accuracy rate indicates that machine learning techniques will soon be considered a standard tool for identifying heart problems. Statistics such as f1-score, recall, and precision rate have been calculated to be 95%, 95%, and 95%, respectively, for logistic regression. [4]

The fact that so much research is still being done on heart disease prediction shows how crucial accurate forecasts are to saving lives. This study demonstrates that a variety of methods, such as deep learning, machine learning, data mining, artificial neural networks, and the Internet of Things, are being investigated by researchers to forecast heart illness. Nonetheless, there is a persistent need for improved results in this area. Given the severity of this potentially lethal condition, developing more effective ensemble models is crucial. The Decision Tree Classifier demonstrated a higher accuracy rate in predicting heart disease in this investigation. With an accuracy rate of 92%, it performed better than the other machine learning algorithms evaluated, including Random Forest, Logistic Regression, K-Nearest Neighbor Classifier, and Decision Tree Classifier with Grid search. This outcome shows how accurately the Decision Tree Classifier predicts heart disease. The goal of later efforts is to identify the optimal ensemble model for the prediction of heart disease by integrating real-time data. Since even a small error could have catastrophic consequences, we must never give up on increasing precision. [5]

The major cause of death for both men and women in recent years has been heart disease. Therefore, it is believed that predicting heart disease is an essential component of clinical statistical analysis. In the past, cardiac disease has been predicted using a combination of deep learning approaches and standard machine learning methods like SVM and Nave Bayes. Due to a lack of test data, these methods are insufficient for accurately predicting heart disease. The application of BiLSTM with RF Method to increase HDP precision is presented in this thesis. For effective analysis, the input medical results were recorded in both directions. The behavior of the BiLSTM-RF system has been evaluated on the Cleveland data set and contrasted with other existing approaches. The outcomes demonstrate that the suggested BiLSTM-RF outperforms the current models in HD computation. The accuracy of the suggested BiLSTM-RF is significantly higher than that of alternative methods. [6]

In conclusion, machine learning techniques have considerable promise for the prediction of cardiovascular or heart-related conditions. Every one of the previously suggested algorithms has produced excellent results in some situations but poor results in others. Alternating decision trees have performed exceptionally well when paired with PCA;

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Vol. 12, Issue 3, March 2025

nevertheless, in some other scenarios, decision trees have fared poorly, potentially because to overfitting. Random Forest and Ensemble models have shown outstanding performance because they employ numerous algorithms (in Random Forest's case, multiple Decision Trees) to deal with the overfitting problem. The models that made use of the Naïve Bayes classifier showed remarkable performance and processing speed. [7]

Non-invasive patient prediction of the start of heart disease is essential given the expanding population and the need to reduce the death rate in developing countries. Using the retinal information that is provided, this study creates a very accurate risk prediction algorithm for the onset of cardiovascular disease. Classifiers like SVM and RFC are used to categorize heart illness. When the data is compared using the two classifiers, It has been shown that RFC works well for identifying cardiac disease. The application of the Chase picture collection for retinal heart disease identification is investigated in this work. Changes in the eyes might suggest a variety of ailments. We also discuss how to use SVM and Random Forest classifiers, as well as how to prepare data and extract features. evaluated following the results of the trial. [8]

Upon reviewing numerous studies and their publications, we found that the accuracy of various algorithms varied. Although the accuracy of machine learning and deep learning algorithms continued to improve, we were unable to accurately forecast silent heart attacks. In order to increase the system's precision and effectiveness in predicting silent heart attacks and immediately warning the user, we therefore looked into using RNN and GRU in the study that followed. With a 92% prediction accuracy, this method has proven to be an excellent tool for silent heart attack prediction. [9]

Heart conditions are dangerous and are usually caused by complete blockage or constriction of the arteries that feed the heart with oxygen and blood. Medical groups produce vast volumes of data that are not being used to their full potential. Thus, an effective prediction system can enable early detection. A few DL and ML techniques have been used to increase prediction accuracy. The major cause of death for both men and women in recent years has been heart disease. Therefore, it is believed that predicting heart disease is an essential component of clinical statistical analysis. In the past, cardiac disease has been predicted using a combination of deep learning approaches and standard machine learning methods like SVM and Nave Bayes. Due to a lack of test data, these methods are insufficient for accurately predicting heart disease. The application of BiLSTM with RF Method to increase HDP precision is presented in this thesis. [10]

A model for the diagnosis of cardiovascular disease has been developed using three machine learning classification modeling approaches. This work predicts who will have cardiovascular disease by extracting the patient's medical history that contributes to a fatal heart ailment from a dataset that contains the patient's medical history, such as blood pressure, sugar levels, chest pain, etc. This heart disease detection system assists patients based on their clinical history and previous heart disease diagnosis. [11]

In this work, we used machine learning techniques to identify heart diseases. We used three different sampling approaches on the dataset because raw datasets may contain imbalanced samples of the class distribution. Following the application of sample methodologies, recall and accuracy rates significantly rose. The best accuracy for random oversampling is provided by SVM. The best accuracy for Synthetic Minority Oversampling is provided by Random Forest and Extra tree Classifier. The best accuracy for adaptive synthetic sampling is provided by Random Forest and Extra Tree Classifier. [12]

An effective paradigm for the identification of hypertension and diabetes has been devised in this research. We have demonstrated that the disease may be predicted by employing learning strategies and the correlations between several variables, including hard exudates, cotton wool, bleeding, and many other features. As a result, both the sensitivity and specificity of our algorithm are higher. As a result, ophthalmologists can quickly identify the condition and stop more vision loss. [13]

This work proposes a predictive model for multi-level risk prediction of developing heart failure using C4.5 decision tree classifier, based on an open-source data set of heart illnesses available online at. In order to increase the prediction accuracy, three additional features—risk factors—have been added to the dataset. A performance evaluation has been conducted using the 10-fold cross-validation approach. The prediction model's sensitivity, specificity, and accuracy were assessed using statistical measures. With 86.5% sensitivity, 95.5% specificity, and 86.53% accuracy, the prediction model outperforms a large number of previous models. [14]

The proposed model provides a more comprehensive approach to DR detection by using a Deep Neural Network to identify retinal images, hence relying less on human feature extraction.

According to certain metrics, this approach is applicable in relation to the complexity of such collection. Efficiency can be increased even further by greatly increasing the dataset and retraining a learning system with new retinal pictures. It is actually a standard procedure that improves a system. Even though people with the condition may not yet fully trust

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Vol. 12, Issue 3, March 2025

the procedure, future advancements may benefit patients as well as surgeons. Surgeons may rely on the technology to reduce their heavy workload, while patients might trust it to offer an accurate diagnosis. [15]

Table1 Comparative analysis of existing system

Paper Title	Database	Pre-Processing	Algorithm	Input	Classification	Accuracy
"Inception-v3 Based CNN Architecture for Diabetic Retinopathy Detection"	Messidor, APTOS 2019 Blindness Detection	Image Resizing, Histogram Equalization, Data Augmentation	Inception V3 (Transfer Learning)	Retinal Fundus Images	5-class DR classification	90-92%
"Heart Disease Prediction Using Machine Learning Algorithms	UCI Cleveland Heart Disease Dataset	Handling Missing Data, Normalization, Feature Selection	Logistic Regression, Decision Trees, Random Forest, SVM, Neural Networks	Patient Data (e.g., Age, BP, Cholesterol, ECG Results)	Binary Classification (Heart Disease/No Heart Disease)	90-92%
Prediction of Heart Disease Using Machine Learning Algorithms	UCI Cleveland Heart Disease Dataset	Handling Missing Data, Normalization, Feature Selection	Logistic Regression, Decision Trees, Random Forest, SVM, Neural Networks	Patient Data (e.g., Age, BP, Cholesterol, ECG Results)	Binary Classification	87%
Heart Disease Prediction Using Machine Learning Techniques	UCI Cleveland Heart Disease Dataset	Data Cleaning, Normalization, Feature Selection	Logistic Regression, Random Forest, SVM, k-NN, Naive Bayes, Neural Networks	Patient Data (e.g., Age, BP, Cholesterol, ECG Results)	Binary Classification (Heart Disease/No Heart Disease)	88%
A Comparative Study of Heart Disease Prediction	UCI Cleveland Heart Disease Dataset	Data Cleaning, Normalization, Feature Selection	Logistic Regression, Random Forest, SVM, k-NN,	Patient Data (e.g., Age, BP, Cholesterol, ECG Results)	Binary Classification (Heart Disease/No Heart Disease)	86%

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Vol. 12, Issue 3, March 2025

using Machine Learning			Naive Bayes, Neural Networks			
Heart Disease Prediction Using Effective Machine Learning Techniques	Kaggle Dataset	normalization	Decision Tree	Patient Data (e.g., Age, BP, Cholesterol, ECG Results)	Binary Classification (Heart Disease/No Heart Disease	88.1%
Heart Disease Prediction Using Machine Learning Techniques: A Survey	UCI Cleveland Heart Disease Dataset, Other datasets reviewed	Data Cleaning, Normalization, Feature Selection	Survey of various machine learning techniques	Patient Data (e.g., Age, BP, Cholesterol, ECG Results)	Survey of classification techniques	80%

III. METHODOLOGY

The major goal of this study is to develop a reliable, noise-tolerant method for diagnosing cardiovascular disease. This study employs deep learning technology to recognize depth of cardiovascular disease. degrees. Before the pictures were uploaded to the network, several procedures were finished. To detect cardiovascular disease using retinal images, we first gather a diverse dataset of retinal images labeled with cardiovascular risk factors or diagnoses from public medical databases or medical institutions. The collected images undergo quality assessment to filter out poor-quality images, followed by normalization to scale pixel values appropriately. Data augmentation techniques like rotation, flipping, zooming, and color adjustments are applied to enhance dataset diversity and prevent overfitting. The images are then resized to 299x299 pixels to match the input size required by the Inception v3 model. For model preparation, a pretrained Inception v3 model, initially trained on ImageNet, is fine-tuned on the retinal image dataset. The top fully connected layers of the model are replaced with layers tailored for cardiovascular risk prediction, often including a global average pooling layer followed by dense layers and a softmax or sigmoid output layer depending on the classification task. The model is then trained using the preprocessed retinal images, with a suitable loss function and optimization algorithm, ensuring to use techniques like early stopping and learning rate adjustments to improve performance. During training, the model learns to extract relevant features from the retinal images that correlate with cardiovascular risk factors. Post-training, the model's performance is evaluated using separate validation and test datasets, measuring metrics such as accuracy, precision, recall, and F1-score. Once validated, the model can be integrated into a clinical decision support system, where it can assist healthcare professionals in early detection and risk assessment of heart disease from retinal images, providing a non-invasive and efficient diagnostic tool. Future work includes improving model generalization, interpretability, and integration into clinical workflows to enhance its practical application and reliability.

1. Collection of Data

The process begins with gathering a large dataset of retinal images, particularly focusing on those exhibiting signs of hypertensive retinopathy. Alongside these images, clinical data such as blood pressure, cholesterol levels, and other relevant cardiovascular metrics are collected. The diversity and quality of this data are crucial for training a robust model.

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Vol. 12, Issue 3, March 2025

2. Data Pre-processing, Data Augmentation, and Splitting of Dataset
Before feeding the images into the model, the data must be pre-processed to improve quality and consistency. Pre-processing steps typically include resizing images to match the input size required by Inception V3 (e.g., 299x299 pixels), normalization, and enhancement of image contrast. Data augmentation techniques such as rotation, flipping, and zooming are applied to artificially increase the size of the dataset and make the model more robust to variations.
The dataset is then split into training and validation sets. The training set is used to train the model, while the validation set is used to monitor the model's performance and tune hyper parameters.
3. Adding Pre-Trained Inception V3 Model
Inception V3, a deep convolutional neural network, is chosen for its ability to capture intricate patterns in images. The model is pre-trained on ImageNet, a large dataset of general images, which allows it to have a strong baseline understanding of features. The pre-trained model is imported, and the final classification layer is replaced with a layer suited to the specific task of predicting cardiovascular disease severity. This process, known as transfer learning, allows the model to leverage pre-learned features and adapt them to the specific characteristics of retinal images.
4. Visualizing Design Model
Visualizing the model's architecture is important for understanding the flow of data through various layers of Inception V3. This step involves creating a graphical representation of the model, showing the input layer, convolutional layers, pooling layers, inception modules, and the final fully connected layer. Visualization helps in identifying the strengths and potential bottlenecks in the model's design.
5. Setting the Learning Rate and Checkpoints
The learning rate, a crucial hyper parameter, determines how quickly the model updates its weights during training. A carefully chosen learning rate ensures that the model converges effectively without overshooting the optimal point. Additionally, checkpoints are set up to save the model's state at various points during training. This allows for recovery if the training process is interrupted and ensures that the best-performing model is saved.
6. Adding the Early Stopping Feature
Early stopping is a regularization technique that halts training when the model's performance on the validation set no longer improves. This prevents overfitting, where the model becomes too specialized to the training data and performs poorly on unseen data. By monitoring validation loss, early stopping ensures that the model maintains a good balance between training accuracy and generalization to new data.
7. Training the Model
With the pre-processed data, optimized hyper parameters, and early stopping in place, the model is trained. During training, the Inception V3 model processes the retinal images, learns from their features, and adjusts its weights to minimize prediction errors. The process involves multiple epochs, where the entire training dataset is passed through the model repeatedly, allowing it to fine-tune its understanding of the data.
8. Evaluating the Best Results
Once training is complete, the model's performance is evaluated on the validation set. Key metrics such as accuracy, precision, recall, and F1 score are calculated to determine how well the model is predicting the depth of cardiovascular disease. The best-performing model (as determined by validation performance) is selected, and further fine-tuning may be performed if necessary.
9. Predicting the Depth of Disease
With the trained Inception V3 model, predictions are made on new, unseen retinal images. The model analyzes these images and outputs a prediction of the severity or depth of cardiovascular disease based on the features it has learned during training. These predictions can be used by clinicians to assess the risk level and potentially guide treatment decisions.

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Vol. 12, Issue 3, March 2025

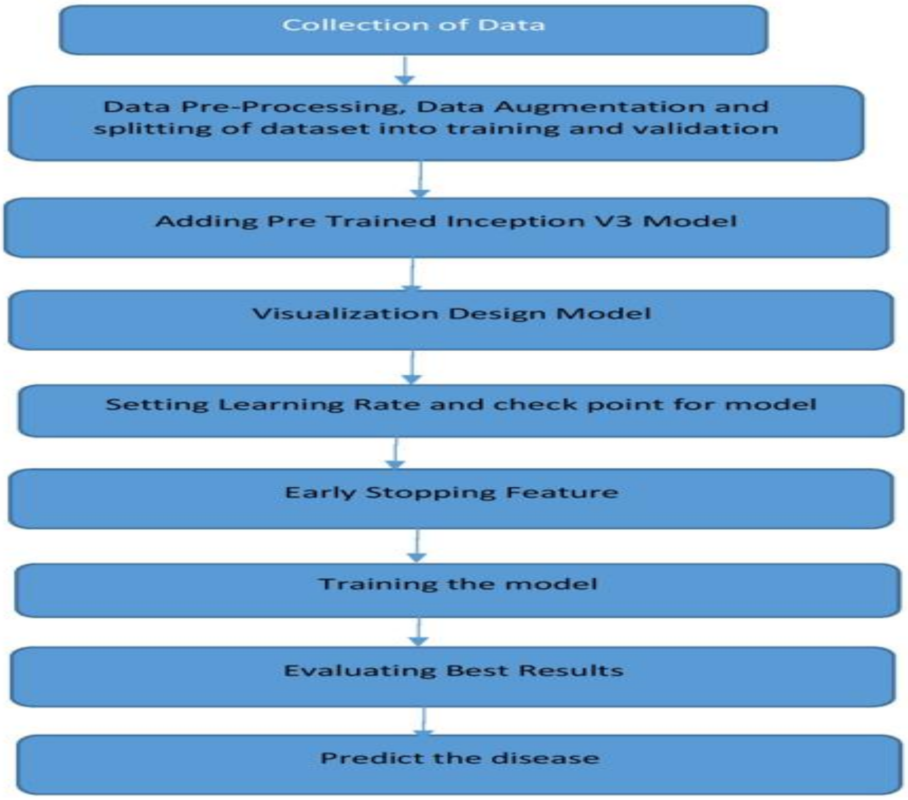

Fig1. System Design

Predicting the depth of cardiovascular disease using hypertensive retinopathy images, the InceptionV2 (or InceptionV3, as the more recent version) model can be leveraged for image classification or feature extraction. The model is pre-trained on the ImageNet dataset and can be fine-tuned to recognize specific patterns in retinal images associated with hypertensive damage. We can load the pre-trained InceptionV3 model, excluding the top fully connected layers, and replace them with custom layers suitable for your task, such as a dense layer with a sigmoid activation function for binary classification. The model is compiled with a low learning rate to prevent disrupting the pre-trained weights, and data augmentation techniques, such as rotation, width and height shifts, and zooming, are used to enrich the training dataset and prevent overfitting. The training process involves using an image generator to preprocess and feed the retinal images, followed by model evaluation on validation data. Fine-tuning can be performed by unfreezing some layers of the pre-trained model and continuing training with a smaller learning rate for better adaptation to your specific dataset. Finally, after training, the model can be saved for future predictions or deployment. This approach offers an efficient and non-invasive method for detecting and assessing the severity of cardiovascular diseases based on retinal images, which can significantly enhance diagnostic capabilities.

Dataset Used

Kaggle's Retinal Fundus Image Dataset:

Description: Contains retinal images from various fundus cameras, often used for studies involving both hypertensive and diabetic retinopathy.

IV. CONCLUSION AND FUTURE WORK

The integration of retinal imaging with deep learning provides a non-invasive and efficient method for early heart disease detection. By utilizing convolutional neural networks (CNNs) and incorporating clinical data, this approach enhances

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Vol. 12, Issue 3, March 2025

predictive accuracy. It enables the identification of individuals at risk of cardiovascular disease with greater reliability. The non-invasive nature of retinal imaging makes screening more accessible and cost-effective. This technology has the potential to transform cardiovascular healthcare by facilitating early diagnosis and timely intervention. Improved detection rates can lead to better patient outcomes and reduced healthcare costs. The use of deep learning algorithms ensures continuous enhancement in diagnostic precision. By automating analysis, it minimizes human error and speeds up diagnosis. This method supports preventive healthcare by identifying risks before severe complications arise. Overall, it contributes to a more effective and proactive approach to cardiovascular disease management.

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