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CAD – Prediction Model Using Artificial Intelligence

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Abstract

Heart disease is one of the most rapidly growing diseases worldwide. Detection of artery disease in the early stages is very crucial for providing the right treatment at the right time to escape from any kind of bigger risks, this is where there has been a need of an advanced system that can detect the artery disease to get a control over it at the right time.

This paper proposes a system for the medical professionals, a web application platform developed with MERN Stack for preprocessing the medical data with techniques like Regression, Random Forest, and Gradient Boosting to enhance the data quality and then processing the data by utilizing convolutional neural network machine learning model like VGG16 and ResNet50 to classify the medical data as risk or no-risk.

The convolutional neural network machine learning model is trained by publicly available and clinically validated datasets such as ISIC Archive and HAM10000 for achieving better accuracy and precision.

Keywords —Medical data prediction, artificial intelligence, convolutional neural networks, data preprocessing, machine learning, deep learning

1. INTRODUCTION

Heart Disease is one of the most extensive and perilous forms of artery disease. It is a common health concern globally and has been the center of attraction for research efforts due to its high occurrence rates and rise annually. There are many factors that can cause the Heart disease including the biological cause like family history, organ transplant recipients, HIV/AIDS patients, or the non-biological causes like UV radiations from sunlight, excess intake omega-6 fatty acids [1]

The Heart disease can be majorly classified into three types, they are Coronary Artery Disease (CAD), and Peripheral (PAD). Notably, CAD and PAD, both are classified as Cardiac Muscle types, they typically exhibit a lower fatality rate. [2]

Among them, Cardiac Muscle is the most notable type of disease. It originated from blood pressure in the vessels that have undergone a malignant transformation. Cardiac artery block are responsible for producing high blood pressure in the Heart. As a result, most cardiac artery appear brown or black. According to the World Health Organization (WHO), there are over 132,000 new cases of cardiac muscle reported annually. The Surveillance Epidemiology and End Results (SEER) study shows that 24.8% of all cardiac disease cases were found in the people of old age ranging from 65 to 74. [3]

The key to successful treatment of cardiac disease is the early detection and accurate classification of the disease. However traditional methods like visual examination and biopsy are time-consuming and also, they are subject to human errors. This highlights the need for more efficient and accurate diagnostic tools. In this study, we use deep learning (DL), a branch of AI, to improve cardiac disease classification.

To enhance data quality before processing, we apply techniques like Random Forest, Gradient Boosting , and Neural Network. These help in reducing noise and improving contrast, making it easier for the model to learn important features.

For training, we use a convolutional neural network (CNN) based model that combines VGG16 and ResNet50.

Both of these are powerful pre-trained models that can extract detailed features from data. Our model is trained on well-known, publicly available, and clinically validated datasets such as ISIC Archive and HAM10000, ensuring high accuracy and precision.

Since some types of heart disease are less common than others, the dataset has an imbalance. To address this, we use class weights during training so that all heart conditions, regardless of their frequency, are given equal importance. By combining VGG16 and ResNet50, we capture a broader range of features, leading to better classification performance.

Despite the promising advancements in AI-based heart disease classification, there are still challenges that need to be addressed. One major concern is the generalizability of AI models across different populations, as variations in heart tones, lighting conditions, and data acquisition techniques can impact performance. Further research is required to develop more robust models that can adapt to diverse datasets. Additionally, the integration of AI-assisted diagnostic tools into clinical settings requires regulatory approvals and acceptance among healthcare professionals. Addressing these challenges will be crucial for the widespread adoption of AI in dermatology.

2. LITERATURE REVIEW

Dildar et al. [4] shows the study on deep learning techniques for early detection of heart disease presented through tools, graphs, tables, the paper highlights about the dangerous behavior of heart disease and the importance of early detection by utilizing the lesson parameters like heart rate, lungs activity, previous medical condition etc. to differentiate between beginning heart disease and cardiac arrest.

Balambigai et al. [5] shows the use of CNN machine learning models using the random search optimization for classifying seven different kinds of heart disease. The study uses over 10,000 data from HAM10000 to address the challenge of selecting hyper-parameters for CNN models. The base CNN model in the study has achieved an accuracy of 73.34%.

Quadir et al. [6] shows the study on the detection of heart disease using CNN machine learning model. The study shows the designing of a mobile friendly model and constructing a neural network for the purpose of lesion edge detection. The study utilizes over 10,000 clinical data that underwent pre-processing and training the model.

Ghosh et al. [7] shows the study on exploring the various kinds of CNN models like VGG19, ResNet50 for the detection of cardiac disease. The study uses a dataset of patient disease record. The study highlights the potential of deep learning in aiding timely disease diagnosis.

Rizqi Amaliatus [8] shows the study on disease classification in cardiac muscle using deep learning techniques. The study employs VGG16 and VGG19 CNN architectures to categorize four different types of illnesses in cardiac muscle. The study achieved an average accuracy of 91%, proving the effectiveness of deep neural networks in classifying diseases in cardiac muscle.

Weirong Chen [9] shows the study on developing a deep learning-based approach for identifying cardiac diseases. The study achieved a higher performance compared to other existing methods, with an average recognition accuracy of 97.73% across multiple cardiac disease categories. The study also demonstrates the competitiveness and reliability of the proposed method in the identification of cardiac diseases.

Trong-Yen Lee [10] shows the study on an efficient CNN framework designed for identifying cardiac diseases. The study focuses on data processing techniques to build a training set and optimizes the model using Adam and cross-entropy for analysis. SoftMax was used as the final decision-making function. The study highlights the reduction in convolution layers and resources while maintaining high accuracy. According to the experimental results, the model achieved 99.53% accuracy in detecting plant diseases while also reducing parameter usage by 99.39% on average.

Garcia [11] shows the study of detection of coronary artery disease using the deep learning techniques on dermoscopic data. The study focuses on leveraging non-medical data on the classification of medical data. The study also observed

a 20-point performance increase in detecting the melanoma and distinguishing between malignant and benign moles by fine tuning a ResNet model pre-trained on a small sample of from three three different medical datasets.

Tembhurne et al. [12] shows the study on the importance of accurate diagnosis of cardiac disease, particularly melanoma. The study introduced a new methodology that combines the deep learning and machine learning techniques for the detection of cardiac disease. The proposed approach uses a neural network for extracting features from the lesion disease and then processing them with machine learning techniques like local binary pattern histogram. When tested on Kaggle dataset from ISIC Archive dataset the models achieved a 93% accuracy rate overall.

3. METHOD

The traditional method of detecting coronary disease is usually done by dermatologists by visual inspection by looking at the lesion's color, medical record , lungs condition etc. However, this method highly relies on the experience of a dermatologist and can lead to error. The other method is biopsy, where the sample is tested in labs, but this is too time consuming and highly expensive. In recent times many machine learning models of CNN like ResNet and VGG are introduced in the field for the detection of heart disease with the help of artificial intelligence. Still there are challenges for improving accuracy, handling dataset imbalance and more for real world medical use.

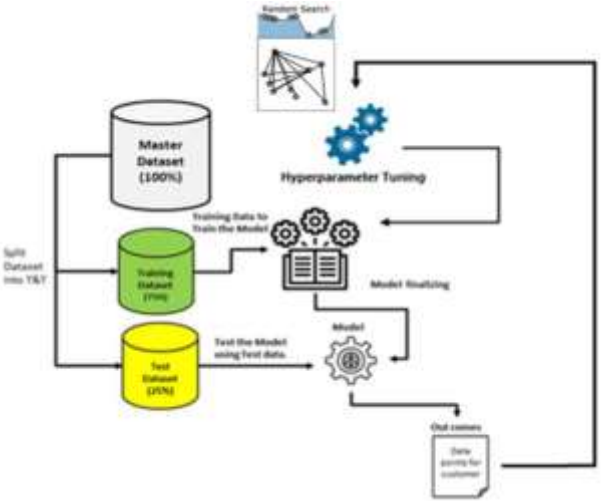

Fig. 1. Proposed Model Architecture

S. No.	Author(s)	Technique	Collection	Precision (%)	Sensitivity (%)	Particularity(%)
1	Jojoa Acosta et al. [13]	Deep Convolutional Neural Networks	PH2 and ISIC 2017	95	93	95
2	Rashmi Patil et al. [14]	Fully Convolutional Networks on VGG16 and Inception	The Int. Symposium on Biomedical training in 2016, commonly referred to as ISBI 2016.	88.92	69.33	93.75
3	A. A. Adegun et al. [15]	The integration of Convolutional Neural Network with a focus on deep region-based	The Int Symposium on Biomedical data train in 2016, commonly referred to as ISBI	94.2	98	94

		architecture. (Deep R–CNN) with Fuzzy C-Mean Clustering	2016.			
4	Jayapriya K et al. [16]	Densely Connected Convolutional Networks with IcNR	The Int. Symposium on Biomedical Data in 2017, commonly referred to as ISBI 2017.	93.4	93	-
5	Nudrat Nida et al. [17]	Enhanced Convolutional Neural Network (CNN)	The combination of DermIS and DermQuest databases.	93	99.4	94
6	Nudrat Nida et al. [17]	Leveraging transfer learning in conjunction with a pre-existing deep neural network.	The MED-NODE dataset.	97.7	97.3	97.4
7	Muhammad Attique Khan et al. [18]	Utilizing an ensemble approach that incorporates both ResNet and Inception V3 architectures.	The Int. Symposium on Biomedical Training in 2018, commonly referred to as ISBI 2018.	89	86.2	79.6
8	Shuchi Bhadula et al. [19]	Combining Latent Dirichlet Allocation (LDA) with Convolutional Neural Networks (CNN)	The Int. Symposium on Biomedical data in 2017, commonly referred to as ISBI 2017.	85.8	52	97.4
9	Khalid M. Hosny et al. [20]	Convolutional Neural Networks (CNN) with an innovative regularize	The ISIC Archive	97.49	94.3	93.6

Our approach is to fill the gap in the process of heart disease detection with the use of artificial intelligence. The approach first uses preprocessing techniques like Random Forest Algo, Gradient Boosting, and Neural Network normalization to enhance the quality of data set. The preprocessing of the data helps to remove the noise, improve contrast, and make features of the data more clear. After the preprocessing of the data, a CNN based model, combination of VGG16 and ResNet50 is used to process the data, The models extract the features from the lesion data and classify them as infected or not. The model is trained with the publicly available dataset from ISIC Archive and HAM10000 to ensure clinical validation and reliability.

Garcia [11] shows the study of detection of coronary artery disease using the deep learning techniques on dermoscopic data. The study focuses on leveraging non-medical data on the classification of medical data. The study also observed a 20-point performance increase in detecting the melanoma and distinguishing between malignant and benign moles by fine tuning a ResNet model pre-trained on a small sample of from three three different medical datasets.

4. RESULT AND DISCUSSION

The result of the approach discussed shows that the preprocessing techniques used in the approach enhances the quality of the data, the gaussian blur reduces the noise by up to 30% whereas CLAHE improves the accuracy by 25-40%. The hybrid or the

combined CNN model of VGG16 and ResNet50 performs better than the standalone CNNs architecture with an expected accuracy exceeding 91.9% mark. The advantages include reduced diagnostic time and minimized human error.

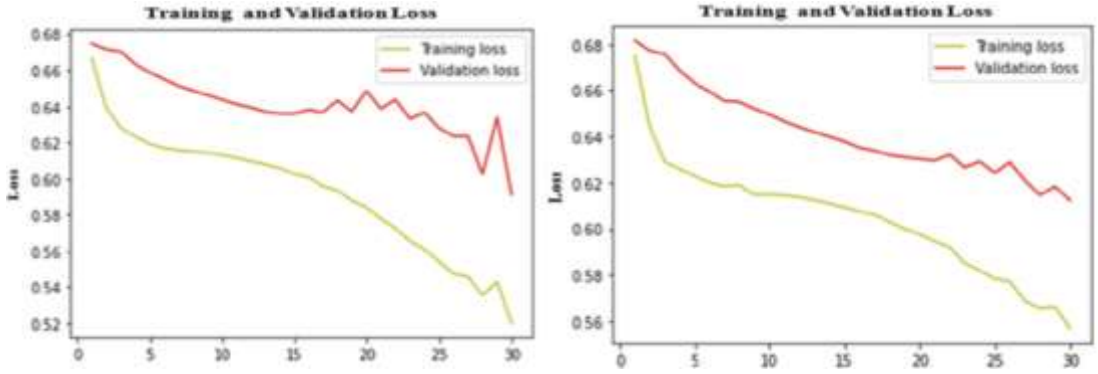

Fig. 2. Training and Validation Accuracy Graph of ResNet50 and VGG16

5. CONCLUSION

In the above research, we have found out how heart disease is growing so fast and why it is necessary to detect the disease early. Traditional methods of heart disease detection depend on visual inspection and biopsy, these methods can be time consuming, prone to errors or expensive. So our approach is to use preprocessing

techniques like Random Forest Algo, Gradient Boosting, and Neural Network for enhancing the data quality and reducing noise. Then after the CNN model combined with VGG16 and ResNet trained with dataset from HAM10000 and ISIC Archive process the heart lesion data to classify it as risk or no risk.

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