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Early Detection of Cardiovascular Complications using Soft Computing and Deep Learning

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Abstract: 20.5 million people died of Cardiovascular diseases(CVDs) in 2021, making it the most common cause of deaths. Four out of five of these deaths were in low and middle income countries. It is said that over 80% of these deaths could have been prevented by early intervention. The reason why high income countries have lower death rates is because they are able to invest more in their health care system thus increasing the rate of early intervention. But in the USA, one third of the deaths are still caused by CVDs. This is why early an increase in accuracy of identifying CVDs and a decrease in the resources needed is necessary. This study reviews a few recent papers which are connected to CVDs.

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I. INTRODUCTION

Cardiovascular diseases are becoming more common as cholesterol filled junk food is becoming increasingly cheaper and more easily accessible to the people of today who either do not have time to cook or are too lazy to do so. Due to this, younger people also get CVDs, something that rarely occurred earlier. As a result, early intervention has become necessary to prevent the deaths of young people who are not as careful as old people when it comes to their health.

This paper will describe a few recent research papers that use modified versions of basic models like LSTM, Random forest, etc.

II. LITERATURE SURVEY

Neural Networks were first used for early detection of cardiovascular complications in 1989 under the name Applications of Neural Network in predicting Heart Diseases. It was written by King, Brande and Addams. It is considered to be one of the earliest uses of NN in medicine. Before this, only statistical data analysis techniques were used to correlate the disease with factors like cholesterol and blood sugar level. After this, in 1991, Decision tree models were used to predict CVD. While its accuracy was not high, its decision making logic was easily understandable. In 1999, fuzzy logic and genetic algorithms were applied and showed higher accuracy and flexibility in dealing with the 'gray areas' of CVDs.

The papers being reviewed here were published in either 2023 or 2024.

A. S Deepika; N. Jaisankar

It uses an advanced deep learning approach for diagnosing myocardial infarction (MI) using echocardiogram frames. It combines an enhanced Convolutional Neural Network (CNN) with a 3D network architecture (ECV-3D) to analyze and classify MI from echocardiogram data.

The uses CNNs for feature extraction from the frames, while the ECV-3D network processes the multi-dimensional nature of the data.

It has an accuracy of 97.05% and AUC of 0.82 which shows the robustness of the model.

Below is the visual representation of the model used.

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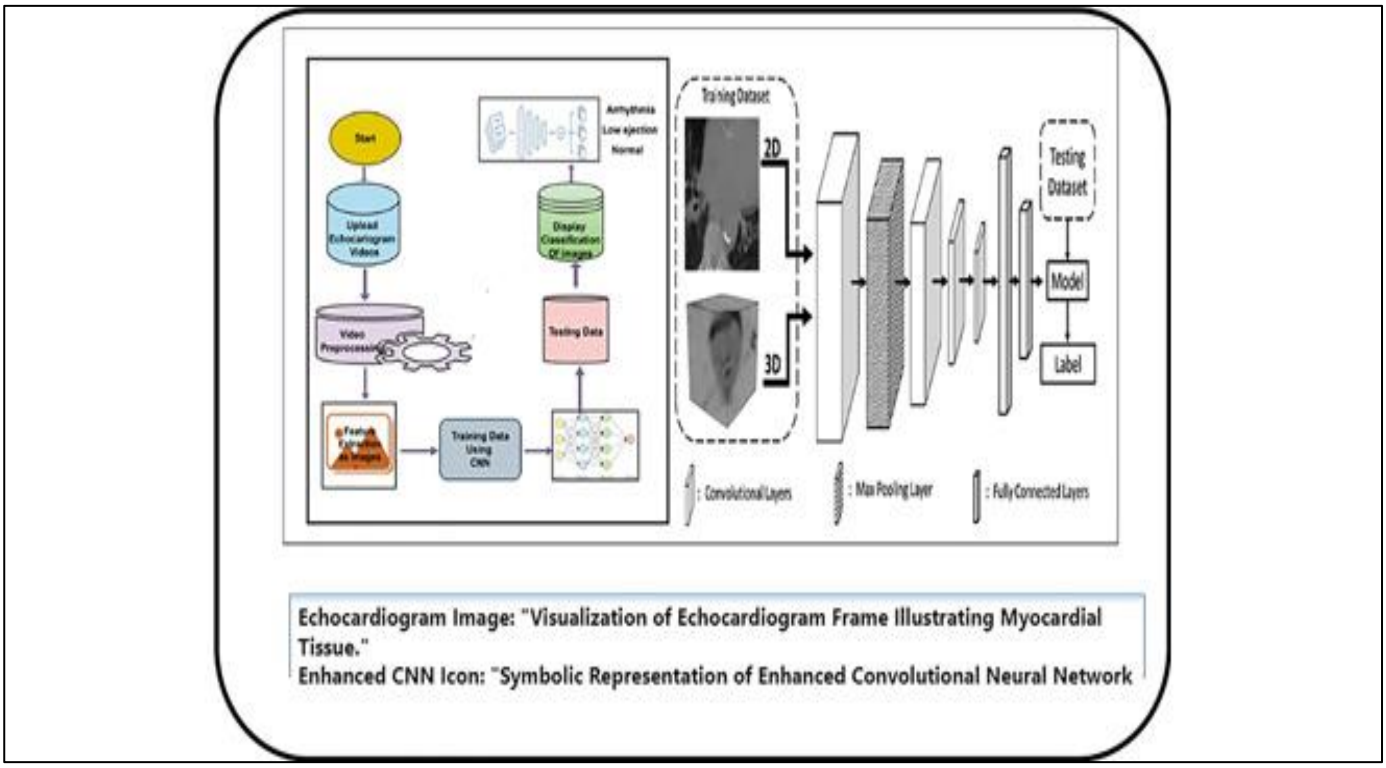

Fig 1: Visualization of use of Echocardiogram Frames as Input to Model

B. T. Ullah et al

The model uses multiple feature extraction techniques to improve the accuracy of the model. It first extracts features from ECG signals and then applies feature selection techniques like FCBF (Fast Correlation-Based Filter), MrMR (Minimum Redundancy Maximum Relevance), and Relief. The features are further optimized with Particle Swarm Optimization (PSO).

It has 100% accuracy using classifiers such as Random Forest, demonstrating its high potential for CVD detection. It works well with both small and large datasets.

C. Satria Mandala et al

It focuses on detecting MI from phonocardiogram (PCG) signals. The methodology involves segmenting the feature extraction process and applying a transfer learning-based CNN model for classification. The dataset used consists of 560 recordings from both normal subjects and those who had suffered MI, with the data divided into training and testing sets.

The diagram below shows the process and accuracy of the model.

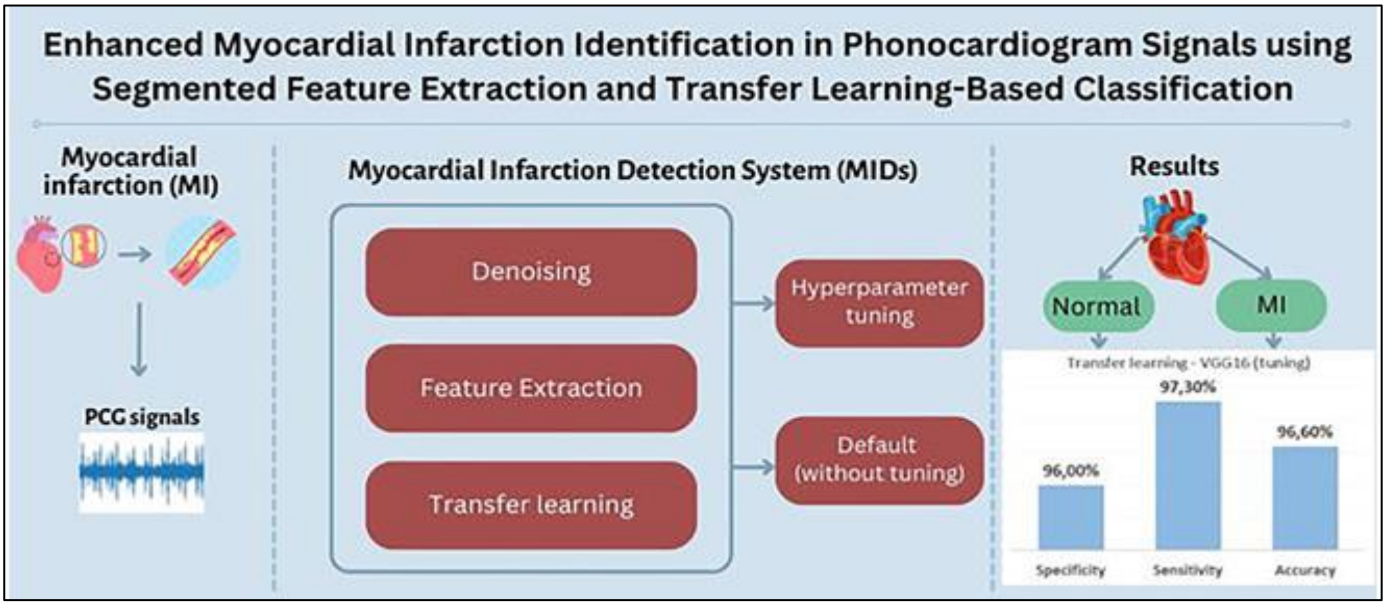

Fig 2: Shows Result Found using above Model

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D. N. A. Vinay et al

It focuses on combining a Recurrent Neural Network (RNN) and Bidirectional Long Short-Term Memory (Bi-LSTM) with Generative Adversarial Networks (GANs) to analyze heart sound data for early detection of cardiovascular diseases. The model optimizes feature extraction through a hybrid approach, enhancing classification accuracy.

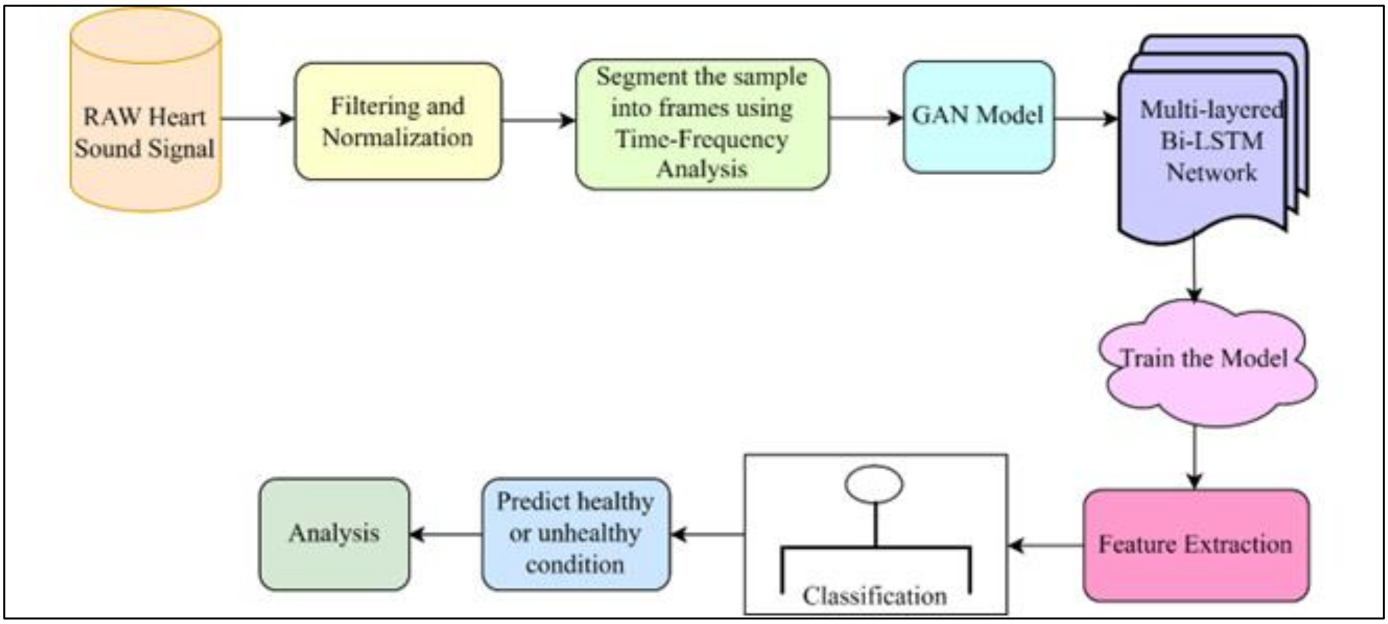

Fig 3: Shows Flowchart of Process

E. T. Sinha Roy et al

It uses a combination of Convolutional Neural Networks (CNN) and Random Forest classifiers within an Internet of Things (IoT) framework. Heart sound recordings were collected from patients with various valvular heart conditions. An electronic stethoscope connected to a Raspberry Pi 4B to enable real-time data processing and analysis.

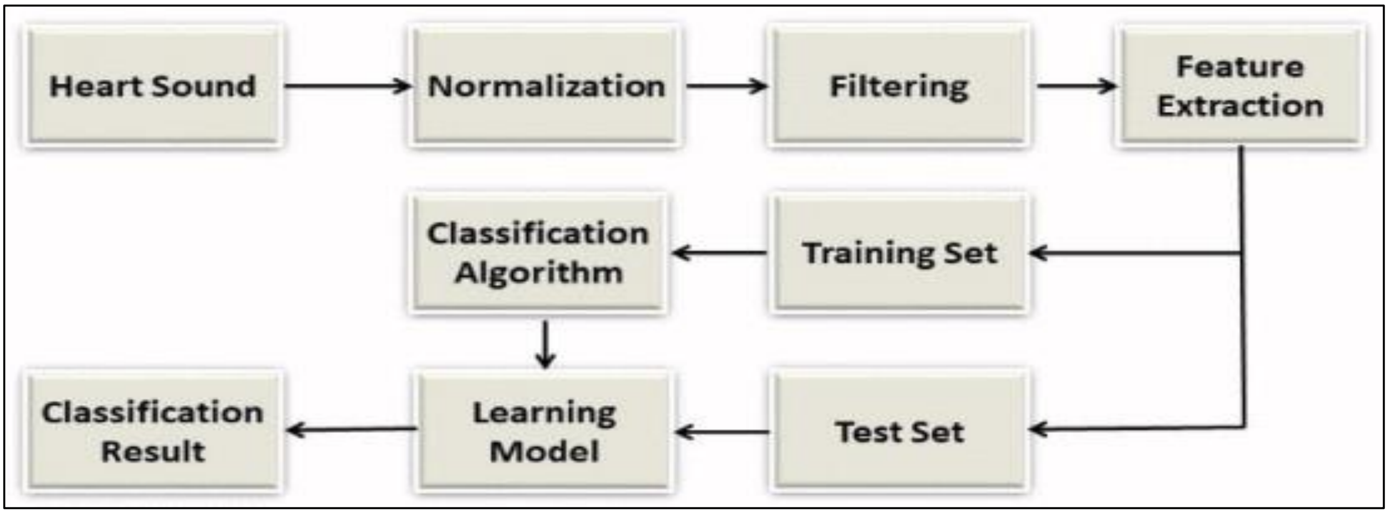

Fig 4: Shows Flowchart of Process

The model gives an accuracy of 93%.

F. Zou et al

It combines the discrete wavelet transform (DWT) and convolutional transformer networks for ECG classification tasks. The model's purpose is to leverage the time-frequency information from ECG signals through DWT and apply it to the transformer-based architecture for better classification accuracy.

The ECG signals are first processed using the Discrete Wavelet Transform (DWT), which decomposes the signal into various frequency components.The hybrid model consists of convolutional layers for initial feature extraction followed by a transformer layer for capturing long-term dependencies and temporal information from the ECG signals.

It has an accuracy of 0.86.

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G. Y. Omkari and K. Shaik

It uses a two-layer voting mechanism that integrates multiple machine learning classifiers. The first layer combines both hard and soft voting techniques to optimize feature selection. The second layer applies ensemble classifiers such as Random Forest, Gradient Boosting, and Support Vector Machines for final prediction. Clinical and demographic features, including BMI and cholesterol levels, were used for prediction.

It has a 94% accuracy.

III. CONCLUSION

A lot of work has been done in the field of detection of CVDs using different deep learning and machine learning algorithms on various datasets and a high accuracy can be seen but a lot more can be done. Getting a 100% accuracy is not a pipe dream as seen by T. Ullah et al's paper where many kinds of feature selection methods were compared and combined.

FUTURE DIRECTION

Using the right features and proper datasets to go with it can give a 100% accuracy. Of course, overfitting must still be avoided as it gives a bad accuracy on testing data and thus cannot be used in real life diagnosis. Using methods like transfer learning to reduce overall cost is also needed so that the model can be used in real life diagnoses.

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