

AI-Based ECG Signal Classification for Arrhythmia Detection

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Abstract—The use of ECG is common for diagnosing heart disorders including arrhythmia. Physicians can manually interpret traditional ECG data but this process takes a considerable amount of time. In this study, we propose an Artificial Intelligence based method which uses Machine learning and Deep learning to automatically classify the types of ECG signal patterns. Our proposed approach will be able to improve the efficiency in detecting arrhythmia.

Keywords—ECG signal, Arrhythmia Detection, Artificial intelligence, Machine Learning, Deep Learning.

I. INTRODUCTION

The Electrocardiogram has been a vital clinical tool to assess the electrical activity of the heart. The primary purpose of the ECG is to identify various types of dysfunctions that the ECG helps in diagnosing Arrhythmia, which is an irregular heartbeat. It is crucial to detect arrhythmia at early stage that serious complications do not develop and the patient does not have to face conditions such as stroke or heart failure.

Manual classification of the traditional ECG signals was done by cardiologist; manual classification could be laborious and would result in errors due to human judgement, with the introduction of AI- based now we can use automated ECG signal classification systems which can enhance both the speed and efficiency of medical diagnosis. The main objective of this study was to provide an artificial intelligent based method for arrhythmia identification through the classification methods of ECG signals.

II. PROBLEM STATEMENT

The manual review of ECG to determine whether they are normal or abnormal is a high laborious

Process that depends on highly trained cardiologists. The manual review can be slow and can have the potential for human error in diagnosing the patient rhythm conditions. This is where an AI based ECG signal processing system comes into play as it will enable the rapid and accurate identification of abnormalities with an ECG signal.

III. LITERATURE REVIEW

Several research studies have been carried out of ECG signal classification and arrhythmia detection using machine learning and deep learning techniques. Traditional methods have employed traditional machine learning-based approaches such as support vector machines and k-nearest neighbour algorithm for classification of electrocardiogram. The most recent research has employed deep learning techniques to convolution neural networks to increase ECG classification accuracy while reducing manual feature extraction. Researchers have also developed wearable ECG monitor systems utilizing Internet of Things technology that can continuously monitor a patient heart. Although some existing systems have attempted to overcome issues associated with noise in electrocardiograms, the limitations on system accuracy, and the processing power required by each system remain an issue.

Existing methods have limited accuracy need improvement in real time performance.

IV. PROPOSED SYSTEM

The suggested method automatically classifies ECG signals for arrhythmia detection using AI approaches. The ECG data is first gathered and filtered to eliminate undesired disruptions and noise. After that, key characteristics are taken out the signal and fed into the AI model. The ECG readings are classified into normal and pathological heart rhythms using a deep learning technique like Convolution Neural Network. Compared to conventional manual approaches the device aids in the detection of arrhythmia more quickly and accurately.

V METHODOLOGY/IMPLEMENTATION

- The MIT-BIH Arrhythmia dataset is used to classify ECG signals in the proposed system.
- The AI model is developed using Tensor Flow, MATLAB and Python.
- The ECG signals are first loaded from the data set and filtering techniques are used as a part of preprocessing to eliminate noise.
- The AI model is then trained by extracting key characteristics from the ECG readings.
- Following training, sample ECG data is used to test the model's ability to distinguish between normal and pathological cardiac beats, the classification accuracy is calculated to assess the system's performance.

VI BLOCK DIAGRAM OF AI-BASED ECG CLASSIFICATION FRAMEWORK

ECG Signal Output

The ECG signal is collected from the patient using ECG sensors or monitoring devices. It records the electrical activity of the heart.

Preprocessing

The collected ECG signals may contain unwanted noise. Filtering techniques are used to remove noise and improve signal quality

Feature extraction

Important features such as P, QRS, and T waves are extracted from the ECG signal. These features help in identifying heart abnormalities.

AI model

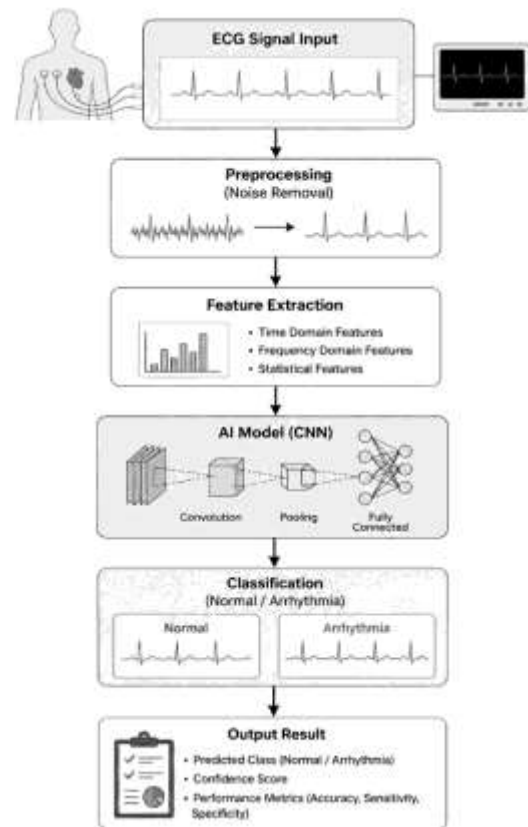
The extracted features are given as input to the AI model. A Convolution Neural Network is used to classify the ECG signals.

Classification

The AI system classifies the ECG signals as normal or arrhythmia. The final result helps in early heart disease detection.

Output result

The AI model trained using ECG data set and tested with sample data. The system accuracy is evaluated based on classification results.



VII. COMPONENTS USED

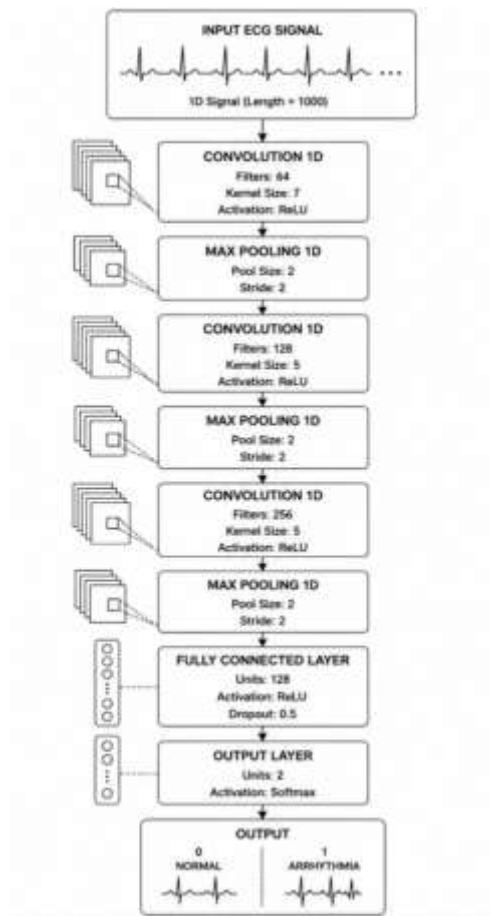
HARDWARE:

- ECG Sensor/ ECG Monitoring Device
- Electrodes
- Computer/Laptop
- Heart Monitoring System

SOFTWARE:

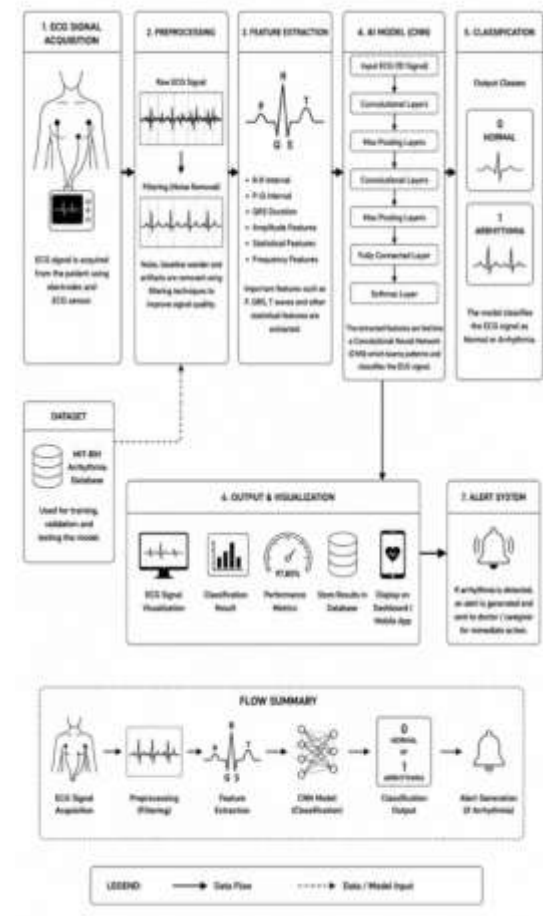
- Python
- TensorFlow/MATLAB
- CNN (Convolutional Neural Network)
- MIT-BIH Arrhythmia Dataset
- Signal Processing & Feature Extraction Techniques

VIII. PROPOSED SYSTEM ARCHITECTURE FOR AI-BASED SIGNAL CLASSIFICATION



After being obtained from the patient, the ECG signal is pre-processed to eliminate noise. A CNN model is used to classify important features that have been extracted. The ECG signal is categorized by the model as either arrhythmia or normal. If an irregular rhythm is found, the results are shown and warning is generated.

IX. CNN ARCHITECTURE FOR ECG CLASSIFICATION

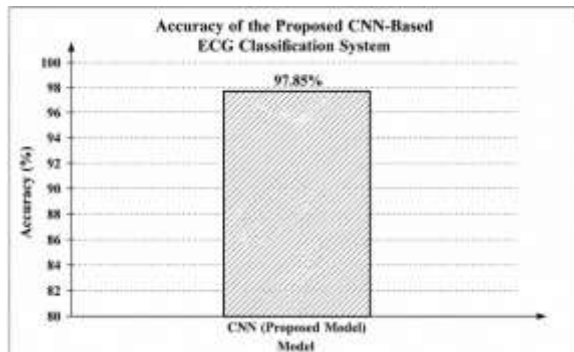


The CNN model receives the pre-processed ECG signal as input. Important features are automatically extracted from the ECG data by convolution and max-pooling layers. The Soft max output layer forecasts whether the signal is normal arrhythmic, whereas the fully linked layer carries out categorization.

X. RESULT

The proposed AI-based ECG classification system is expected to improve arrhythmia detection accuracy and reduce manual effort. Actual performance evaluation will be carried out during implementation and testing. Using the MIT-BIH Arrhythmia dataset, the suggested AI-based ECG classification system was able to distinguish between normal and arrhythmia ECG signals. When compared to conventional machine learning techniques, the CNN model offered higher classification accuracy. Techniques for feature extraction and noise reduction increased system performance and the quality of the ECG signal. The system allowed for quicker and more accurate ECG 97.85% accuracy.

Expected performance comparison:



ANALYSIS OF THE RESULT

- ECG signals were successfully categorized as normal or abnormal.
- High accuracy and reduced misclassification.
- Misclassification is the result of the CNN model.
- Early detection of cardiac anomalies is possible using the method.

XI. ADVANTAGES

- Offers quick and automated ECG analysis
- Increase the precision of arrhythmia detection
- Aids in the early detection of cardiac conditions
- Suitable for real-time monitoring

XII. LIMITATIONS

- Needs a sizable ECG data set in order to train.
- Noisy signals may cause performance to decline.
- It can acquire a lot of processing power.
- The quality of data set affects accuracy
- Appropriate hardware support is necessary for real time implementation.

XIII. FUTURE SCOPE

- Integration with wearable ECG devices
- Mobile health monitoring
- Cloud-based patient monitoring
- Real-time alert generation

XIII. CONCLUSION

The suggested AI based ECG signal classification system uses deep learning techniques to successfully identify arrhythmia. When compared to conventional techniques, the CNN model increases the speed and accuracy of ECG analysis. Early diagnosis and real-time monitoring are supported by the system. Cloud-based

healthcare monitoring and wearable device integration are potential future enhancements.

XIV. REFERENCES

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