Detection of Cardiac Arrhythmia using Machine Learning Algorithms

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Abstract*: Cardiac Arrhythmia is a type of condition a human being suffers from abnormal heart rhythm. This is experienced due to the malfunctioning of electrical impulses that coordinate the heartbeat. When this happens the heartbeats slow/ fast more precisely irregularly. The rhythm of the heart is controlled by a major node called the sinus node which is present at the top of the heart, triggers the electrical pulses which make the heart to beat and pumping of blood to the body. Some of the symptoms of Cardiac Arrhythmia are fainting, unconsciousness, shortness of breath, unexpected functioning of the heart. It leads to death in minutes if medical attention is not provided. To diagnose this doctor, require to study the heart recordings evaluate heartbeats from different parts of the body accurately. It takes a lot of time to evaluate so based on the research work contributed in this field we try to propose a different approach to the same. In this paper, we compare different machine learning techniques and algorithms proposed by different authors and understand the advantages and disadvantages of the system and to bring a new system in place of the existing system where all have used the same ECG recordings from the same database of MIT-BIH. With the initial research work done by us we found out that the use of Phonocardiogram Recordings (PCG) provides more fidelity and accurate compared to ECG recordings. With the initial stage of work, we take the PCG recordings dataset and convert it to a spectrogram image and apply a convolutional neural network to predict the normal or abnormal heartbeat.

***Keywords*: Cardiac Arrhythmia, PCG, Spectrograms, Convolution Neural Network, Heart Rhythm.**

I. INTRODUCTION

Cardiac Arrhythmia is a condition where a patient suffers from an irregular or abnormal heartbeat. It is due to the malfunctioning of electrical impulses in the heartbeat of an individual. Excess electrical activity at the top or bottom of the heart means that the heart does not pump efficiently. The most common symptoms of Arrhythmia include fainting, shortness of breath and unexpected loss of heart function and unconsciousness that will lead to the death of an individual [3]. Electrocardiogram (ECG) electrical technique which is used to detect the activity of the heart. ECG helps in the instinctive classification of cardiac arrhythmia which saves the time of cardiologists through quick diagnostic results [2]. The explanation of the electrocardiogram (ECG) signal is an application of pattern recognition, which instinctively group it to a system to one among a number of different classes [4].The main motive of this paper is to evolve a step forward to the latest technology from pattern recognition to machine learning to predict arrhythmia which is easy to detect using latest methodology, called Phonocardiogram (PCG) recordings which is a plot of murmurs and sound recordings at high-fidelity produced by the heart recorded by a machine called phonocardiography.[15] Thus, the recording of all the sounds made by the heart during a cardiac cycle is known as phonocardiography. The proposed system classifies and distinguish the specific cardiac arrhythmias, which is known to be Right Bundle Branch Blocks (RBBB) from the normal and paced heart beats. Where normal heart beats are the beats of a healthy adult humans and paced heart beats are artificial beats from the pacemaker device. RBBB is a type of arrhythmia that is most commonly associated with hypertensive, ischemic, rheumatic and pulmonary heart disease [1]. Hence classification of heart sound recordings using Machine Learning techniques could help to overcome the better accuracy detection problem and which is also time-efficient. Machine learning, an intelligent multidisciplinary approach which is highly used in supervised learning to construct analytical models.[13]. This plays a vital role in a wide range of serious applications, such as data mining, the processing of natural languages, image recognition, and skilled systems.[14] This approach seems appropriate to the problem of arrhythmia detection, since this problem can be transformed into a typical classification task. the aim of this paper is to identify different contributions made by various authors in detection of Cardiac arrhythmia and to enhance the view of the problem in broader perspective.

II. RELATED WORK

Cardiac Arrhythmia is one of the prominent diseases that we have come across in the field of cardiology. Its detection and analysis play a vital role and to quickly medicate the patients. The papers referred during the survey used many machine learning models to determine arrhythmia. They are Gray-Level Co-Occurrence Matrix of ECG, Biomedical signal processing, Hidden Markov model, Empirical Mode Decomposition, Backpropagation neural network, Pan Tompkins algorithm, CNN-based Generalizable Information Fusion, time-frequency joint distribution of ECG, Multi-layer perceptron, 2-dimensional deep CNN features based transfer learning, Bayesian belief network , OneR, J48 and Naïve Bayes. These are applied on MIT-BIH arrhythmia database which had ECG recordings as the prime parameter in consideration to the evaluation. They analyzed datasets, chose appropriate technique,

Revised Manuscript Received on November 15, 2019

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implemented the model and evaluated the performance on their proposed model to predict the disease. They all got an average of 75-80% of accuracy on the model they have proposed and suggested that the data available was less to increase the performance of the model. These techniques had some disadvantages in the model proposed by the authors. The following table shows the key highlights of proposed methodologies.

III. COMPARISON OF DIFFERENT METHODOLOGIES USED IN DETECTING ARRHYTHMIA

Table 1 gives us a picturesque idea of the methods used by various cardiac researchers with Machine Learning. It also gives the list of recommendations that we thought might in future have been implemented in the system.

Table 1. Comparison of different methodologies used in detecting arrhythmia

Ref no.	Objective	Concept Used	Results / Outcome	Advantage	Disadvantage
[1]	This paper is based on classification of morphological Arrhythmias designed for accurate detection of heartbeat in the ECG and it is robust.	Convolutional neural network (CNN)	The proposed methodology classifies the morphological arrhythmia with an accuracy rate of 92.14%	This method can be used in reducing the rate of misdiagnosed computerized interpretations of ECG.	Training data set were low, in number of hundreds.
[2]	Designing an efficient ensemble (network) of Classifiers to classify cardiac arrhythmias based on segments of ECG signals automatically.	Deep learning Ensemble learning, and evolutionary computation	The proposed method classifies ECG into 17 classes and 15 types of arrhythmias with the accuracy 99.37%	The proposed model can evaluate the cardiac health immediately by implementing mobile devices or also can be applied this in cloud computing	ECG datasets of a particular database was taken. Not implemented for different cases.
[3]	This paper is based on the classification of arrhythmia into supra-ventricular arrhythmia (S), premature ventricular contraction (V), normal (N), atrial fibrillation (AF)	Maximum Mutual Information Estimation (MMIE) theory and Hidden Markov Models (HMM)	The proposed method effectively classifies the ECG into respective arrhythmia conditions.	There may be Confusion between the classes of beats which are morphologically similar can be reduced strongly by using MMIE training.	Difference between normal and arrhythmia datasets were not mentioned.
[4]	This paper is based on the method, by Using Empirical Mode Decomposition, Arrhythmia can be detected by using ECG signals.	Empirical Mode Decomposition (EMD), N-Bayes algorithms and linear discriminant analysis (LDA)	The proposed method classifies the normal signal with accuracy 92% and accuracy of LBBB signal classification is 81%	Proposed methodology provides an algorithm for accurate detection of normal and arrhythmic ECG signals.	Lacked the explanation of model. Explanation of signal classification not clear.

[5]	This paper is based on the detection of cardiac arrhythmia with the ECG signals using deep learning	deep learning, biomedical signal processing, convolutional neural networks and transfer learning	Different cardiac conditions like, normal, paced or right bundle branch block can be classified effectively	Recognition rate of the proposed method is 98.51% and testing accuracy around 92%.	ECG signals taken and result calculation method was not proper.
[6]	Objective of this paper is automatically classifying cardiac arrhythmias and to studying the performance of the algorithms of machine learning.	OneR, J48 and Naïve Bayes algorithms.	Naïve Bayes and OneR shows the most stable rate of accuracy	The comparison between the accuracy of different algorithms helps to choose the best algorithm.	Only algorithms were considered for comparison and their working implementation is not clearly seen.
[7]	This paper is based on the classification and detection of four cardiac diseases	feature extraction algorithm (Pan Tompkins algorithm)	The proposed methodology classified four cardiac diseases like, Long Term Atrial Fibrillation (AF), Supraventricular Arrhythmia and Sleep Apnea, Arrhythmia	Forward net provides the best solution in most cases of arrhythmia	Feature extraction method employed is not appropriate in this approach.
[8]	Objective of this paper is to detect Robust heartbeat using ECG and BP signals	The comparison between the accuracy of different algorithms helps to choose the best algorithm, Convolutional neural networks	The proposed method successfully detects Robust Heartbeat	The proposed method can be generalizable and accuracy is improved	Earlier methods were used, no new techniques were incorporated.
[9]	This paper is based on Classification of heartbeat for the detection of cardiac arrhythmia	Spiking neural network (SNN)	The proposed method classifies the incoming ECG heartbeats into one of 23 different classes and detects arrhythmia with an accuracy of 95.7%	Improvement in accuracy of 22% over state-of-the-art approaches.	Classification of Arrhythmia into different stages is not clearly explained.
[10]	This paper is based on Classification of ECG Arrhythmia by Using Transfer Learning from 2-Dimensional Deep CNN Features	Convolutional Neural Network (CNN) and Recurrent Neural Networks (RNN)	The proposed method Recognizes all the patterns of the input data which resulting in higher rate of accuracy of 97.23 %	Images can preserve their fine-grained details and Very well representation of spectrograms of ECG signals	The datasets used from a single source and not preprocessing procedure is not done to eliminate noise factor.

IV. CONCLUSION

Cardiac Arrhythmia is one of the most important and attention required disorder of heart which leads to death of a person in a few minutes. So, its early detection and immediate medication provided to patient make the patient to live. In this paper we have made a survey of different authors perception provided in the detection arrhythmia and what are the techniques they have used in finding out is the major

concern of the paper. When the papers were referred, we came to know that most of the papers used Machine Learning techniques in predicting the disease and various algorithms in predicting the same. The papers used the recordings of Electrocardiogram (ECG) taken from the database of MIT-BIH arrhythmia and incorporated them into different machine learning algorithms to check whether it is a normal heartbeat or abnormal heartbeat. Some of the techniques used are Gray-Level Co-Occurrence Matrix of ECG, biomedical signal processing, Hidden Markov model, Empirical Mode Decomposition, backpropagation neural network, Pan Tompkins algorithm, CNN-based Generalizable Information Fusion, time-frequency distribution of ECG, multi-layer perceptron, 2-dimensional deep CNN features based transfer learning, Bayesian belief network, OneR, J48 and Naïve Bayes. From the above classification techniques, we learned how to approach the cardiac arrhythmia problem and to propose a new model for the existing by using the PCG recordings known as Phonocardiogram recordings dataset which provides high fidelity compared to ECG dataset. The recordings present in the dataset are calculated on time-frequency features of a raw signal, which captures the intensity and pitch of the recordings, therefore we use spectrograms for its interpretability and robustness. Thus, this paper presents a survey of various techniques and their drawbacks to detect cardiac arrhythmia and also our future work on the problem statement.

ACKNOWLEDGMENT

The manuscript is prepared by taking assistance from teachers and mentors, we are thankful to them. We also express our gratitude to our guide Dr. Paramesha.K for guiding us throughout the work.

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