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ECG Anomaly Detection Toward Cardiac Monitoring using Machine Learning

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Abstract: According to WHO, an estimated 17.9 million people died from CVDs each year representing 31% of all global deaths. The annual number of deaths from heart related diseases is projected to reach 4.77 million in India. This obtained data tell us monitoring and taking care of the heart is very essential part. This paper revolves around Electrocardiography (ECG) Signal readings which are further cleaned and feature extraction is done to obtain useful information. Support Vector Machine (SVM) is mainly used in for feature extraction for the dataset that is trained and tested followed by passing the updated dataset to a combination of different Machine Learning Techniques by use of K-Means in order to provide accurate training and testing accuracy results from the dataset received. This model further has the potential to be used in hospitals where huge amount of dataset is present, with training and testing of the model with the right Machine Learning algorithm the accuracy and the time results are obtained will be greatly reduced, this will further help save many people in shorter period of time.

Keywords - SVM, K-means, ECG Prediction, Arrhythmia Classification

I. INTRODUCTION

Cardiac disease is the leading cause of mortality worldwide. Every year, an estimated 17.9 million people die from it, accounting for 31% of all fatalities worldwide. The majority of cardiac patients need to be diagnosed and treated as soon as possible. As a result, a slew of new gadgets to track patients' cardiac problems have hit the market. The majority of these gadgets can record a patient's biometric signals when they are resting or exercising. Reading the vast number of raw electrocardiogram (ECG) readings from the sensors, on the other hand, takes a long time. Automatic anomaly identification for ECG readings might help doctors diagnose a heart problem more quickly. This study covers the advantages and disadvantages of the devices and algorithms discovered in the literature, as well as probable research areas for developing the next generation of ambulatory monitoring systems. Advanced heart monitors, particularly those with machine learning capabilities, offer a wonderful chance for continuous electrocardiogram (ECG) collecting, which offers a wealth of information concerning underlying cardiac problems. When someone is currently afflicted with a sickness, they must visit a doctor, which is both times demanding and costly. It may also be challenging for the user if they are out of reach of doctors and hospitals because the condition cannot be detected. So, if the aforementioned procedure can be accomplished using an automated application that saves time and money, it may be simpler for the patient, making the process go more smoothly. There are various Heart Disease Prediction Systems that use data mining techniques to evaluate the patient's risk level. heart Disease Predictor is a web-based tool that forecasts the user's heart disease based on their risk factors.

II. RELATED WORK

Malla, B.; Pokharel, J.; Paudel, M.; Khadka, M.; Thapa, I. ECG Signal Classification using K Nearest Neighbors.

[1] In this paper, authors have detected various kinds of arrhythmias based on the data provided by the patient. First the datasets are provided to system and important features are selected using Extra Tree classifier. Then the model is trained using K Nearest Neighbours (KNN) classification algorithm. The result was provided in human readable form but it was found that the value of k impacts the overall accuracy of the system. Lower value of k overfitted the model and higher value affected the class with lower data. The dataset used was obtained from UCI repository which contained a total data of 452 patients consisting 278 features each.

Rajdhan, A.; Sai, M.; Agarwa, A.; Ravi, D; Ghuli, P. Heart Disease Prediction using Machine Learning

[2] In this paper, the author emphasized the severity of heart disease and said that in this modern era there is one death per minute because of heart disease. Futher it was also mentioned that the task of heart disease prediction is complex and there is need to automate this task in order to make patients more aware in advance and avoid any risks related to it. Here, the heart disease dataset available in UCI machine learning repository was used. Different data mining techniques like Naïve Bayes, Decision Tree, Random Forest were used to predict heart diseases and classify patients risk level. This paper focused on finding the most efficient machine learning algorithm for detection of heart diseases and it was able to obtain a very satisfactory result.

Gujiri, V.; Joshi. A.; Chavan, A. ECG Signal Analysis for Abnormality Detection in the Heart beat.

[3] Adaptive Neuro-Fuzzy Inference System (ANFIS) preprocessed by subtractive clustering was used to detect abnormalities in the heart and to identify a number of heart diseases. MIT-BIH database was used which provided 48 ECG signal records and each each record is 30 minutes selected from 24 hours. Since ANFIS is a binary classifier, six ANFIS were trained, validated and tested which provided outputs involving 6 different heart diseases. It was found that the ANFIS subtractive clustering converged faster than gradient descent ANN. In this paper, author mentioned the advantage of being able to tune rules over black box systems like ANN.

Qingxue Zhang1, Kyle Frick., "A Least-number of Leads ECG Monitor for Standard 12-lead ECG Tracking during Motion"

[4] Cardiac illness is the leading cause of mortality in the United States, claiming the lives of almost half a million individuals each year. The gold-standard 12-lead electrocardiogram (ECG) signals are frequently employed in clinics and hospitals as cardiac vital signs. However, due to its cumbersome and unpleasant setup, as well as significant signal quality loss throughout our regular activities, it is still not generally available in our daily lives. A revolutionary ECG monitor termed All-ECG is suggested in this study, which is predicted to give a comfortable configuration while also enabling motion-tolerant 12-lead ECG tracking. To fulfil the first aim of convenience, the remaining leads are reconstructed using the fewest possible leads. A deep learning system based on long short-term memory is created to rebuild high quality ECG leads from noisy ECG leads to satisfy the second aim – robustness.

Chin-Feng Lin, "A Chaos-based Visual Encryption Mechanism in Integrated ECG/EEG Medical Signals"

[5] In this research, we provide a chaos-based visual encryption technique that may be used to encrypt medical data such as the integrated electrocardiogram (ECG) and electroencephalography (EEG). When compared to other types of random sequences, one of the key goals of adopting chaotic sequences is to improve the unpredictability. To accomplish integrated ECG/EEG visual encryption, we used a value mapping of ID chaotic scrambler and a permutation technique. Scrambling the signal values of the input integrated ECG/EEG signal by multiplying ID chaotic signal to randomise integrated ECG/EEG signal values, and then applying a chaotic address scanning order encryption to the randomise reference values is one technique to accomplish the visual encryption mechanism.

Ooi Chip Pin, Asral Bahari Jambek, Sazali Yaacob, "Circuit Architectures Reviews for Portable ECG Signal Analyzer"

[6] The circuit comparison of the electrocardiogram (ECG) heart rate detector for wearable biomedical devices is discussed in this research. The QRS complex, which represents the primary component of the ECG signal, is employed to measure heart rate in this study. The measured ECG signal must be noise-free in order for the detector to attain a high degree of accuracy. Noise like this is usually caused by power line interferences and baseline drifting. The ECG signal must be treated using the signal processing approach to remove these disturbances. The ECG detection technique is separated into two stages: preprocessing, which removes noise from the raw ECG signal, and feature extraction, which extracts the QRS complex to calculate heart rate. According to our findings, while developing a high-efficiency system, the trade-off between complexity and accuracy in ECG signal architecture is critical.

Muhammad Wildan Gifari, Hasballah Zakaria, Richard Mengko KK Teknik Biomedika, "Design of ECG Homecare:12-Lead ECG Acquisition using Single Channel ECG Device Developed on AD8232 Analog Front End"

[7] To identify cardiac problems, electrocardiogram (ECG) machines analyse electrical activity of the heart muscle. The quality of the ECG signal is crucial in detecting cardiac illness. However, the lack of ECG instruments makes ECG diagnosis time-consuming and complex. The design of a single channel portable ECG device based on the AD8232 semiconductor architecture is presented in this work. A 12-lead ECG acquisition approach is also being investigated to expand the capabilities of an ECG portable device. The findings revealed that a single channel ECG module with a 12-lead ECG collection approach may be used as an ECG Homecare device, making ECG diagnosis considerably more accessible.

"Health informatics—Point-of-care medical device communication"

[8] This standard adds support for ECG annotation nomenclature to the existing IEEE 11073-10101 Nomenclature. It can be used in conjunction with other IEEE 11073 standards or on its own with other standards. ECG beat annotations, wave component annotations, rhythm annotations, and noise annotations are some of the key topics covered by the terminology. Additional numeric observation identifiers, ECG lead systems, and ECG lead identifiers, both "global" and "per-lead," are also defined.

Giulia Da Poian, Riccardo Bernardini, Roberto Rinaldo, "Separation and Analysis of Fetal-ECG Signals from Compressed Sensed Abdominal ECG Recordings"

[9] Fetal electrocardiogram (fECG) waveform analysis and foetal heart rate (fHR) assessment give crucial information about the fetus's health throughout pregnancy. Continuous monitoring of f-ECG, for example, employing technology already in use for adult ECG tele-monitoring (e.g., Wireless Body Sensor Networks, WBSNs), might improve foetal arrhythmia identification. We offer a novel framework for the compression and combined detection/classification of mother and foetus heart beats based on Compressive Sensing (CS) theory in this paper. Methods: The sparse representation of the components produced from Independent Component Analysis (ICA) is the foundation of our strategy, which we propose to use directly in the compressed domain. The active atoms in a specially built reconstruction dictionary are used for detection and classification.

III. MOTIVATION

We devised a signal processing and information mining-based ECG anomaly detection technique that is effective. Most notably, our solution can get featured ECG signal for analysis, and then apply the SVM to find abnormality information in the ECG signal. Experiments show that our idea can attain a level of accuracy of. detection of anomalies.

IV. SCOPE OF THE SYSTEM

- Improve cardiovascular health and quality of life through prevention, detection, and treatment of risk factors for heart attack and stroke.
- Early identification and treatment of heart attacks and strokes; prevention of repeat cardiovascular events and reduction in deaths from cardiovascular disease.
- After detection of anomaly from ECG, classification will be performed which will further enhance the effectiveness of the model.

V. PROPOSED SYSTEM

The research is about ECG prediction using neural networks to classify different types of ECG signal time courses. The major goal is to distinguish between normal and abnormal ECGs so that further diagnosis can be made. We introduced two detecting methods that were developed using neural networks. The experimental section allows you to load ECG signals, pre-process them, and categorise them into different groups. The outputs of the classifiers Normal and Abnormal ECG, as well as the type of Abnormality detected. In the conclusion, all experimental data from both suggested classifiers are compared

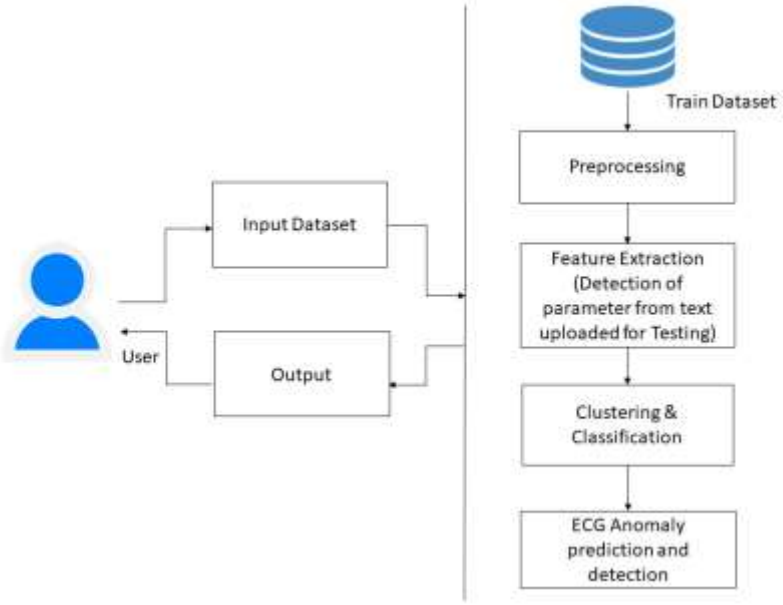

Fig.1: System Architecture

VI. METHODOLOGY

Support Vector Machine (SVM):

SVM (Support Vector Machine) is a supervised machine learning technique that may be used to solve classification and regression problems. It is, however, mostly employed to solve categorization difficulties. Each data item is plotted as a point in n-dimensional space (where n is the number of features you have), with the value of each feature being the value of a certain coordinate in the SVM algorithm.

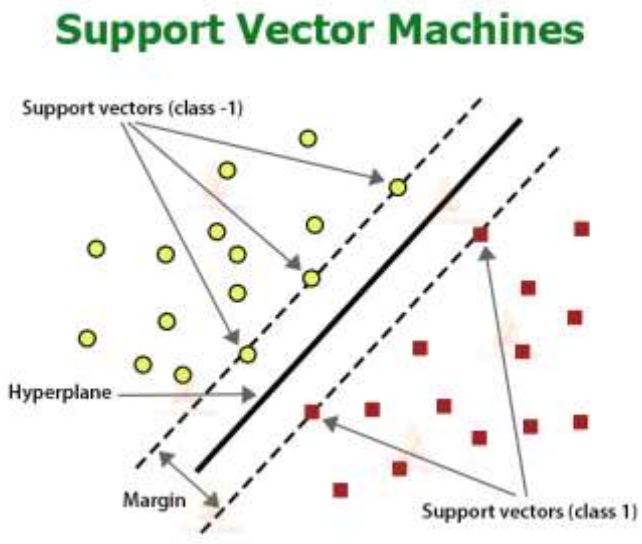

Fig.2.1: Support Vector Machine

K-means algorithm:

For the k means algorithm, the image outcome is as follows:

The K-means Algorithm is a method for calculating the average of a set of numbers. The K-means method is an iterative technique that aims to divide a dataset into K unique non-overlapping subgroups (clusters) where each data point belongs to just one group. Unsupervised learning algorithm K-Means clustering Unlike supervised learning, there is no labelled data for this grouping. K-Means divides things into clusters based on their similarities and differences with objects from other clusters.

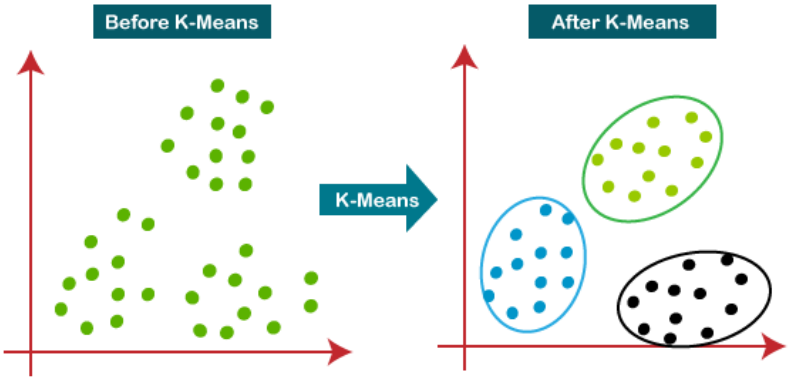

Fig.2.2: K-Means

VII. ACKNOWLEDGMENT

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VIII. CONCLUSION

Heart being one of the most important primary organ of the circulatory system, the diseases or abnormalities related to heart can be fatal. The proposed research states the use of classification algorithms in order to identify abnormalities in heart from an ECG signal at early stages. The proposed model is used with the right combination of pre-processing techniques with the ML classifier in order to give the right technique for prediction in Cardiac Arrhythmia. With this research study many numbers of human species can be saved with the early detection of heart abnormalities. As per the consequences of exploratory investigations, it tends to be expressed that ECG waves designs were effectively separated in given time series and perceived utilizing recommended strategy, as can be seen from figures in Experimental Result segment. It may bring about better planning of the time series conduct for better expectation

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