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# A Survey on ECG Signals Classification for Early Detection of Cardiovascular Diseases (CVDs)

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**Abstract -** *One of the major causes of human deaths worldwide is cardiovascular diseases (CVD). The increasing threats of CVD can be early detected with various medical tests including electrocardiogram (ECG), and now newly formed CVD tests like 2D Echo, Stress test etc. With the help of this signal, early detection of CVD is possible and it will help the medical system to take preventive action to reduce the cause of CVD for human life. All these signals coming from various medical equipment may be monotonous, time-consuming and stressful to inspect all this manually. To overcome this limitation of manual ECG signal analysis, this research work uses a novel discrete wavelet transform (DWT) method combined with nonlinear features for automated characterization of CVDs. ECG signals of normal, dilated cardiomyopathy (DCM), hypertrophic cardiomyopathy (HCM) and myocardial infarction (MI) are subjected to five levels of DWT. The relative wavelet of four nonlinear features such as fuzzy entropy, sample entropy, fractal dimension, and signal energy is extracted from the DWT coefficients. These features are fed to sequential forward selection (SFS) technique and then ranked using the relief method. Our proposed methodology is inclusive of multiple CVD devices signal which helps us to increase the accuracy of the data and give the right prediction to hospital as well as individual human life.*

***Key Words*** **- CVD, ECG, Discrete Wavelet Transform, Myocardial infarction, Dilated Cardiomyopathy, Hypertrophic cardiomyopathy**

## 1. INTRODUCTION

Cardiovascular Diseases (CVDs) are one of the major causes which lead to increased death rate worldwide [3]. According to the records provided by the WHO i.e. World Health Organization in 2012, 17.5 million deaths occurred due to CVDs which ultimately increases medical expenditure. The global direct medical expenses due to CVDs are approximated to US$863 billion in 2010. Also, it is predicted that these expenses will continue to rise and will reach US$30 trillion by 2030. The common cardiovascular diseases are myocardial infarction (MI) followed by heart stroke, hypertensive heart diseases, cardiomyopathy, rheumatic heart disease, congenital heart disease and heart arrhythmia [1], [2], [5], [6], [7]. So proposed methodology studies two types of cardiomyopathy i.e. hypertrophic cardiomyopathy (HCM), dilated cardiomyopathy (DCM) and myocardial infarction (MI) which are considered as distinct abnormalities of the myocardium. HCM causes because of enlargement in heart muscles which affects the ventricles and interventricular septum (IVS) resulting in thickening of them. While DCM causes due to enlargement in the left ventricle (LV) because of the stretching and thinning of the myocardium. So this has a dangerous impact on LV systolic function which leads to congestive heart failure or arrhythmias [2], [5], [6]. Myocardial infarction is a consequence of coronary artery disease (CAD) which results in the death of myocardium because of prolonged disturbance in oxygenated blood circulation. Further, this condition leads to the decline of myocardial contractility and damage percentage depends on the size of the affected region [7]. This can vary from a small area of dead myocardial tissue to a large area of infarcted myocardial tissue, which is associated with acute cardiogenic shock and death. The presence of CVD such as left ventricular hypertrophy (LVH) due to HCM is reflected on the electrocardiogram (ECG) signals as taller R waves and inverted T waves in the left-sided praecordial and lateral frontal leads, i.e. leads V5-6, and I and VL, respectively. Tall R waves are also found in DCM. ECG with ST segments either elevated or depressed with inverted T waves depending on the position of the lead characterizes the MI condition. Clinically, all these variations in ECG parameters are visually assessed and manually interpreted to detect the presence of CVDs. However, due to the non-stationary nature of the ECG signal, indicators of CVDs may appear randomly in the timescale. Moreover, some vital diagnostic details are not perceptible with manual examination and may result in errors of interpretation [3]. Therefore, to overcome these limitations during the manual assessment, computer-aided techniques may be more appropriate and useful for accurate diagnosis. Therefore, in this study, we have focused on the characterization of three CVDs (HCM,

DCM, and MI) by extracting relative wavelet nonlinear features from ECG signals.

## 2. LITERATURE SURVEY

Automated detection of congestive heart failure from Electrocardiogram signals using Stockwell transform and hybrid classification scheme [2] by R.K Tripathy, Mario R.A, Juan G. Arrieta, Alejandro Zamora-Mendez, Ganesh R. Naik studies about the Congestive Heart Failure (CHF) which is a life-threatening cardiac disease arises when the pumping action of heart is less than that of the normal case. This paper proposes the novel approach to design a classifier-based system for the automated detection of CHF. Electrocardiogram signals from a database are taken and then preprocessing is done using Butterworth high-pass filter with a cut-off frequency of 0.5HZ to remove noise. The filtered ECG is divided into frames and each has 4-sec duration. Depending upon it CHF is detected. A time-based analysis is done and data is transformed in various forms like Discrete Fourier Transform, M of spectral coefficient, Gaussian Matrix, and S transform. Entropy is extracted. A survey on ECG analysis [3] by Selcan Kaplan Berkaya, Alper Kursat Uysal, Efnan Sora Gunal, Semih Ergin, Serkan Gunal, M. Bilginer Gulmezogl studies about the ECG, its features and use. A detailed study of ECG signals is done and its processing is also mentioned.

Automated characterization of cardiovascular diseases using relative wavelet nonlinear features extracted from ECG signals [1] by Muhammad Adam, Shu Lih Oh , Vidya K Sudarshan, Joel EW Koh, Yuki Hagiwara, Jen Hong Tan, RuSan Tan, U Rajendra Acharya have focused on hypertrophic cardiomyopathy (HCM) and dilated cardiomyopathy (DCM) and MI, which are all distinct abnormalities of the myocardium. Firstly prepossessing of the signals is done to remove noise and are segmented into 4 s each. Each segment then is decomposed into 5 levels of DWT to extract non-linear features energy, fuzzy entropy, sample entropy and fractal dimension from these sub-bands of DWT. The sequential forward feature selection method is used to select a significant subset of features. ANOVA and Relief methods are used to rank the features and then classification is done with the kNN classifier. This methodology yielded a maximum acc, sen, and spec of 99.27%, 99.74%, and 98.08% respectively. Automated Diagnosis of Myocardial Infarction ECG Signals Using Sample Entropy in Flexible Analytic Wavelet Transform Frameworks [7] by Mohit Kumar, Ram Bilas Pachori, U. Rajendra Acharya have proposed a methodology for diagnosis of MI using ECG beat with flexible analytic wavelet transform. Firstly segmentation of ECG signals is performed and then FAWT is applied to each ECG beat which decomposes them into subband signals. Sample entropy is calculated from these signals and fed to the random forest, J48 decision tree, backpropagation neural network (BPNN) and least squares support vector machines (LS-SVM) classifiers to choose highest performing one. LS-SVM has achieved maximum accuracy i.e. 99.31%.

Evaluation of Classification Techniques for Arrhythmia Screening of Astronauts [6] by Deepthi S, Aswathy Ravikumar, R. Vikraman Nair have presented automated computation system that can assist in the screening of the astronaut by considering the present CVS conditions. The main focus is given to arrhythmia disease. The system makes use of the majority voting technique. Five base classifiers named SVM, kNN, CART, LDA, and Naïve Bayes are used. A survey of multiple classifier systems as hybrid systems [4] by Michał Woźniak, Manuel Graña, Emilio Corchado have proposed a system that performs information fusion of classification decisions at different levels overcoming limitations of traditional approaches based on single classifiers. This paper presents an up-to-date survey of multiple classifier systems (MCS) for Hybrid Intelligent Systems. The article discusses major issues, such as diversity and decision fusion methods, providing a vision of the spectrum of applications that are currently being developed. Feature extraction of ECG signal for detection of Cardiac Arrhythmias [5] by P.D. Khandiat N.G. Bawane, S.S. Limaye deals with improved ECG signal features extraction using Wavelet Transform Techniques which may be employed for arrhythmia detection. This improvement is based on a suitable choice of features in evaluating and predicting life-threatening ventricular arrhythmia. Electrodes are placed on the user's skin to detect the bioelectric potential given off by the heart that reaches the skin surface. The ECG signals show the information of the normal heart condition and CVD condition which is essential to enhance the patient living quality and for the appropriate treatment. It is an important tool in diagnosing the condition of heart diseases. Each ECG cycle is recorded to show the heart activity.

## 3. EXISTING SYSTEM

Nowadays patients undergo several tests other than ECG, which also determines the functioning of the heart and reveals critical information about heart [3]. Therefore, to be more accurate about our detection of CVD we should also consider those tests. Current systems are only working on ECG signals, which may result in low accuracy. In addition, the current system considers many features for calculation of accuracy [1], [2]. Sometimes it becomes a difficult and time-consuming task to evaluate all the features and to consider them for accuracy calculations

because we analyze large datasets for each feature calculation we have to consider each value from the dataset. So the number of features which are considered for accuracy purpose should be reduced. Also, algorithms which are used for classification purpose or the methods used for ranking purpose are common and are used repetitively [4]. Other algorithms that are used rarely should be tried and the same accuracy should be achieved.

## 4. PROPOSED SYSTEM

The proposed system considers ECG signals for feature extraction but fewer features are considered. Initially, the ready ECG dataset is taken and preprocessing is performed on the same. Therefore missing, duplicate values are excluded and we get a clean dataset. After that features are extracted to calculate the accuracy. Here we apply discrete wavelet transform method so the ECG signal is decomposed up to five levels and then coefficients are obtained which useful for feature extraction. Various features such as energy, entropy, fractal dimension, relative wavelet are extracted. Further linear features are extracted from these non-linear features. But overall less number of features should be considered for classification purpose.

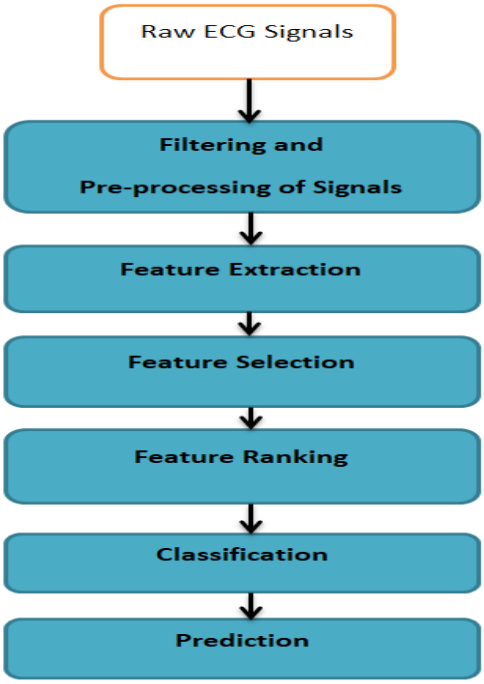


**Fig - 1**: System Architecture diagram

So to choose the correct subset of features feature ranking is done. For this purpose, ANOVA (Analysis Of Variance) and Relief methods are used. In the ANOVA method linear relationship between independent and dependent variables is computed and F-value determines the deviation between different classes. Higher the F-value larger is the difference between the features. So the highly ranked feature will be having higher F-value and is fed to the classifier. The relief method uses the k nearest neighbor searching method for ranking purposes. The value of the feature is considered for the nearest class selection. Also capacity to discriminate among the classes decides the weight of the feature. The weights that are exceeding the given threshold are selected. Then classification is performed. Any of the classification algorithm can be used for this purpose. While selecting the algorithm accuracy should be considered and accordingly the one which gives high accuracy should be considered. Prediction is done by classifying the ECG segments into four classes i.e. normal, HCM, DCM, and MI.

## 5. CONCLUSION

We can detect cardiovascular diseases (CVDs) by using the ECG signal dataset. As ECG signals reveal important information about the heart. It is very much important to inspect them carefully for an accurate diagnosis. Because of the non-stationary nature of ECG signals, it is a tedious task to visualize every sub-segment of it and to interpret it. So our system will be helpful and can easily be installed in the hospitals. Also if the number of features which are considered is reduced then the time for evaluation purpose will be decreased which will produce faster results. The proposed system is efficient from a cost perspective and it helps to improve human health.

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