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A Survey on Detection of Ventricular Fibrillation using Wavelet Analysis

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Abstract-*Ventricular tachycardia (VT) and Ventricular fibrillation (VF) are common ventricular arrhythmia which are life threatening and require immediate attention. They can be detected using an electrocardiogram (ECG) signal. It is crucial to detect these arrhythmia conditions at an early stage for proper treatment. This paper attempts on discriminating between the two conditions to provide the correct clinical decision. Hence developing an automated, computer-aided detection tool is very useful. The methodology here makes use of the mean heart beat interval using an appropriate algorithm. Using the Continuous Wavelet Transform (CWT) we propose a wavelet transform based detection algorithm for electrocardiogram (ECG) signals such as VF, VT and so on. The detector further helps decide whether the defibrillator must provide a shock to come out of the ventricular fibrillation condition or avoid the shock in case of ventricular tachycardia. The results are tested for precise detection and the proposed algorithm is compared to other existing algorithms to test it's reliability. In this project on the basis of Continuous Wavelet Transform (CWT) we propose a wavelet transform-based detection algorithm for electrocardiogram (ECG) such as sinus rhythm (SR), VF and so on by using Matlab software.*

Key Words: Ventricular arrhythmia, ECG signal, Continuous wavelet analysis, Detection algorithm, shock, precision.

1. INTRODUCTION

Ventricular arrhythmia is a condition of the heart where the heartbeat of a person tends to be irregular, either too fast or too slow. These arrhythmia's are one of the major causes of death all over the world. Ventricular arrhythmia's are the unusual rapid irregular heart beat rates that occur in the ventricles of the heart. It damages the heart muscles. The ventricular fibrillation is the fast disorganized beating of the heart ventricles which leads to sudden death of the person. It mainly occurs due to the abnormal electrical activity of the ventricles of the heart. It even stops blood flow to the brain and other vital organs of the body.

It is well known that such a sudden cardiac arrest caused by VF decreases the survival rates by 7% to 10%. For such a serious condition, the timely usage of an defibrillator may lead to an increase in the survival rates. The American Heart Association (AHA) is being considered and has recommended for both "continuous cardiac massage" and the "early defibrillator" if VF is come across.

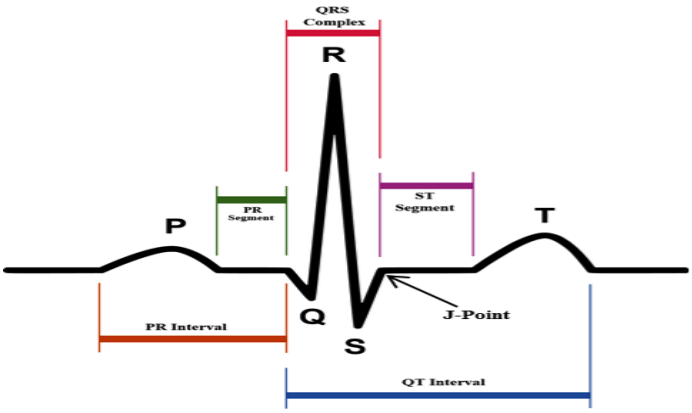

Fig.1. ECG Signal

Fig.1 explains the method we have implemented i.e PQRST may refer to one complete heartbeat in the ECG (P-wave, QRS complex, T-wave).The P wave is a small deflection wave that represents atrial depolarization. The QRS complex represent ventricular depolarization. For the inexperienced, one of the most confusing aspects of ECG reading is the labeling of these waves. The rule is: if the wave immediately after the P wave is an upward deflection, it is an R wave; if it is a downward deflection, it is a Q wave. T waves represent ventricular repolarization (atrial repolarization is obscured by the large QRS complex).

We will be following the wavelet analysis technique as shown in [7], because the differentiation performed by Hidetoshi oya et al, is the best according to the analysis performed by them, at the best of our knowledge.

2. LITERATURE SURVEY

Ventricular fibrillation and Ventricular tachycardia occur when the heart rate has 180 beats per min. They may proved to be fatal if proper detection and prevention methods are not taken on time. The introduction of an automatic external defibrillator (AED) helped recognise and treat this in the absence of an medical practitioner [1]. The high accuracy of

the algorithm used in these devices is of great importance. This algorithm makes use of time and frequency domain analysis. The algorithm is found to have high accuracy for both shockable and non-shockable rythms of the heart.

The detection of atrial flutter and fibrillation, a methodology based on the pattern analysis of electrocardiogram (ECG) is used. This technique makes use of continuous wavelet transform (CWT) coefficients on the ECG signals and the heart beat features. Different basis functions of wavelet are used to derive CWT coefficients. Some of these functions include Daubechies-4, Symlet-2, Mayer, etc. A method known as K-fold cross validation is also made use of in order to prevent biasing in choosing the sets for training and testing. A comparison of the results obtained is done in [2].

Author in [3] proposed a cost and energy efficient real time Ventricular Fibrilation Detection method with combining off filter processes, extracting data and imposing the VF detection algorithm on an embedded system such as microcontroller .This method proposed proves that this method is five into more times efficient than using wireless medi for the communication of continuous transmission of electrocardiogram signal. The embedded (hardware and software)) model which can imposed by efficient & practical detection system. The paper even states that this method is the most revolving or advanced method been proposed.

The current evaluation method in [4] promises the reliable and accurate detection of the life threatening ventricular Fibrillation during chest compression even while not interrupted. The paper even concludes the validation results imposes that their proposed method is superior to the other proposed methods is superior to the other proposed techniques. The algorithm can be included into current versions of AED's as well as into defibrillators for use in medical domain by professionals, in and out of hospital in CPR settings.

A time-delay method for the detection of ventricular fibrillation. Parameters like Positive Predictively and Accuracy also called as quality parameters are calculated using this new algorithm. This method is based on the reconstruction of the phase space. Signal y(t) is plotted to get a two dimensional phase space. Differentiation between VF signal and sinus rhythm is done in the following way, the curve produced by VF signal is irregular whereas curve produced by normal sinus rhythm is regular in shape. The area of the plot under the curve is calculated and the number of boxes under the ECG curve is calculated [5]. The above obtained data is compared with threshold. If obtained data is greater than threshold then the signal is classified as VF.

A time domain approach to the algorithm, known as threshold crossing sample count (TCSC). This method is also considered as the improved version of the algorithm for TCI (threshold crossing interval) which is used in VF detection. TCSC does not count the pulses present instead calculates the time the ECG remains outside the threshold that is fixed.

The selected ECG signal undergoes a series of filtering process then multiplied with cosine window function [6]. The absolute maximum value normalizes each segment of the signal. The normalized signal is then converted into a binary string. Le and Na values for the signals are calculated, where Le is the second ECG episode. If calculated Na is greater than Nd (value obtained from probability distribution of Na) then VF is detected. The proposed method helped in the accurate and fast detection of VF.

3. GAPS IN LITERATURE SURVEY

The technology used in above paper is complex. it is very important that the ECG analysis algorithm used by AEDs differentiate quickly and reliably, between shockable VF and other non shockable arrhythmias. In particular, correct and prompt detection of VF is of great importance. People often use implants and do not trust normal methods of detection, thus making a more reliable method is very necessary.

4. PROPOSED WORK

The work proposed here is different from existing devices or technology. Hence to find solutions to above mentioned problems we propose a detection algorithm for various ECG signals based on Continuous Wavelet Transform (CWT) by using Matlab tool. By adopting Threshold Crossing Sample Count (TCSC) and NSI and introducing some indices based on NSI, we develop a detection algorithm. However, which is reliable, accurate and quick detection of ventricular arrhythmia from the ECG. Besides, we will compare the proposed detection algorithm with the existing methods.

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