Wavelet Based Ventricular Tachyarrhythmia Detection System
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Abstract: - Wavelet transform has emerged over recent years as a powerful time–frequency analysis tool favoured for the interrogation of complex nonstationary signals. In this paper a new wavelet based algorithm for detection of Ventricular Tachyarrhythmia (VT) by analyzing ECG is presented. The proposed algorithm uses an efficient method for detecting VT in wavelet preprocessed ECG signals. A MATLAB routine using built in library functions for preprocessing removes high frequency noise. The preprocessed signal is applied to the spectral algorithm (SPEC) which works in frequency domain and analyses the energy content. If the algorithm decides that the ECG part contains VT, the result is accepted as true and no further investigation is required. On the other hand a further investigation is carried out to confirm the result or to disprove it. The terminal parts of the ECG signal are processed with a continuous wavelet transform, which leads to a time-frequency representation of the signal. The diagnostic feature vectors are obtained by subdividing the representations into several regions and by processing the sum of the decomposition coefficients belonging to each region. Wavelet based efficient algorithm is used for detection of VT. With this method, underlying features within the VT waveform are made visible in the wavelet time-scale half space. The proposed algorithm overcomes the non-sensitivity of SPEC algorithm utilizing its highly specific nature to the fullest, enabling the cardiologists and electro physiologists to detect VT with accuracy of more than 85%.

Key-Words: - Ventricular Tachyarrhythmia, Wavelet Transform, SPEC algorithm, MATLAB, Accuracy, Electro Physiologists

1 Introduction
Electrocardiography signal is electric measure of heart activity. Atrial and ventricular of heart contract and expand to pump the blood from lungs to body and vise versa. An arrhythmia is a change in the regular rhythm of heartbeat. It has two main types. All the arrhythmias are not dangerous. The ventricular arrhythmias are considered more dangerous than atrial arrhythmias. The ventricular tachyarrhythmias have heart rate higher than normal. Ventricular Tachyarrhythmias are fast heart beat arrhythmias produced in lower part of heart called Ventricular. There are three main categories of ventricular tachyarrhythmias i.e. Ventricular Tachycardia (VT), Ventricular Flutter (VFl) and Ventricular Fibrillation (VF). Ventricular fibrillation (VF) is a severely abnormal heart rhythm (arrhythmia) that, unless treated immediately, causes death. VTs are responsible for 75% to 85% of sudden deaths in persons with heart problems. [1]

2 Problem Formulation
Due to high risk of sudden deaths by Ventricular Tachyarrhythmias, there is a need of an efficient, accurate, sensitive system in order to help the Cardiologists and Electro Physiologists for Detection of Ventricular Tachyarrhythmia (VT).

2.1 Work Domain
In accordance with the work domain, we apply our approach in three different categories:
- Time domain, where the method is filtering the signal.
- Frequency domain, using classical spectral analysis.
- Time-frequency space, based on Wavelet Transform.

3 Problem Solution
After removing noise from the signal, spectral algorithm is applied to check whether VT is present or not. To improve the sensitivity of SPEC algorithm our detection system provides an additional check and applies four wavelet based algorithms for detection of VTs. Results are stored in .dat files with associated header files and parameters such as sensitivity, specificity, positive predictivity and accuracy are computed.
3.1 **Preprocessing**
This removes high frequency noise like interspersions and muscle noise.

3.2 **Spectral Algorithm**
The spectral algorithm (SPEC) [2] works in the frequency domain and analyses the energy content in different frequency bands by means of Fourier analysis.
If VF is identified by SPEC algorithm we move on. In case if result of VF Detection is No, We provide an additional check to agree or disagree to the result. This is done to improve the sensitivity and accuracy.

3.3 **Wavelet Decomposition**
Wavelet coefficients are computed which reveal the hidden characteristics of ECG signals [3]

3.4 **Wavelet Based Algorithms**
Four variations of wavelet based algorithms are implemented analyzing the input signal in time-frequency domain simultaneously. [4]

3.5 **Results**
Entire set of MIT [5] and CU database [6] files were tested with VT detection system. VT Detection System has shown:

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Predictivity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40%-50%</td>
<td>90.8%</td>
<td>72%-86%</td>
<td>80%-95%</td>
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* depending upon noise in data

3.5 **Comparisons**
Comparisons show that wavelet based methods better than the SPEC algorithm especially basic wavelet algorithm.

3.6 **Graphs**

**Time For Analysis of Algorithms**

![Fig.1 Analysis Time Graph](image)

4 **Conclusion**
With this method Ventricular Tachyarrhythmia can be detected with high reliability and thus providing a specific system. Such a system has broadened the horizons of research in the filed of Biomedical Engineering.

**References:**
[3] Rahat Abbas, Wajid Aziz, Muhammad Arif,
Prediction of Ventricular Tachyarrhythmia in Electrocardiograph Signal using Neuro-Wavelet Approach


[5] Massachusetts Institute of Technology, MIT-BIH ECG database:
http://www.physionet.org/physiobank/database/mitdb/

[6] Massachusetts Institute of Technology, CU database:
http://www.physionet.org/physiobank/database/cudb/