



## Time Frequency Analysis of ECG Signal Using Ramanujan Fourier Transform

Nidhi Girish\*

Department of Electrical Engineering, University of Uppsala, Uppsala, Sweden

\*Corresponding Author: Nidhi Girish, Department of Electrical Engineering, University of Uppsala, Uppsala, Sweden. E-mail: girish75@gmail.com

Received date: 22 August, 2022, Manuscript No. JEEET-22-54790;

Editor assigned date: 25 August, 2022, Pre QC No. JEEET-22-54790(PQ);

Reviewed date: 31 August, 2022, QC No. JEEET-22-54790;

Revised date: 16 September, 2022, Manuscript No. JEEET-22-54790 (R);

Published date: 28 September, 2022, DOI: 10.4172/jeeet.1000926

### Description

Electrocardiogram (ECG) is a non-invasive technique used mainly as a primary diagnostic tool for cardiovascular diseases. A pure ECG signal provides valuable information about the electrophysiology of heart diseases and the occurrence of ischemic changes. It provides necessary information about the functional aspects of the heart and cardiovascular system. The objective of this report is to automatically detect the cardiac problems in ECG signal. Recently developed digital signal processing technique is used in this report for the detection of cardiac problems. Hence this report develops a method for analysis of heartbeats to detect cardiac abnormalities in ECG signals. ECG generated waveforms are used to find patterns of irregularities in cardiac cycles in patients. In many cases, irregularities evolve over an extended period of time that requires continuous monitoring. However, this requires compression of ECG signals. The practical importance of ECG data compression has become evident in many aspects of computerized electrocardiography. Various ECG compression methods are discussed. The heart contains four chambers that is right atrium, left atrium, right ventricle, left ventricle and several atrioventricular and sinoatrial node. The two upper chambers are called the left and right atria, while the lower two chambers are called the left and right ventricles. The atria are attached to the ventricles by fibrous, non-conductive tissue that keeps the ventricles electrically isolated from the atria. The right atrium and the right ventricle together form a pump to circulate blood to the lungs. Oxygen-poor blood is received through large veins called the superior and inferior vena cava and flows into the right atrium. The right atrium contracts and forces blood into the right ventricle, stretching the ventricle and maximizing its pumping contraction efficiency.

### Conduction System

The right ventricle then pumps the blood to the lungs where the blood is oxygenated. Similarly, the left atrium and the left ventricle together form a pump to circulate oxygen-enriched blood received from the lungs to the rest of the body. In heart Sino-atrial (S-A) node spontaneously generates regular electrical impulses, which then spread through the conduction system of the heart and initiate contraction of the myocardium. Propagation of an electrical impulse through excitable tissue is achieved through a process called depolarization. Depolarization of the heart muscles collectively generates a strong ionic current. This current flows through the resistive body tissue

generating a voltage drop. The magnitude of the voltage drop is sufficiently large to be detected by electrodes attached to the skin. ECGs are thus recordings of voltage drops across the skin caused by ionic current flow generated from myocardial depolarization. Atrial depolarization results in the spreading of the electrical impulse through the atrial myocardium and appears as the P-wave. Similarly, ventricular depolarization results in the spreading of the electrical impulse throughout the ventricular myocardium. The electrically activity that spread through the heart during cardiac cycle can be deducted using electrodes placed on the skin and an instrument called an electrocardiogram. Electrocardiogram (ECG) is a diagnosis tool that reported the electrical activity of heart recorded by skin electrode. The morphology and heart rate reflects the cardiac health of human heart beat. It is a non-invasive technique that means this signal is measured on the surface of human body, which is used in identification of the heart diseases. Any disorder of heart rate or rhythm, or change in the morphological pattern, is an indication of cardiac arrhythmia, which could be detected by analysis of the recorded ECG waveform. The amplitude and duration of the P-QRS-T wave contains useful information about the nature of disease affecting the heart.

The basic rate of heartbeat is controlled by the activity of the ANS. Even when removed from the body and placed into the artificial medium the heart will continue its beat rhythmically, although more slowly. In the body, however, the demands on the blood system are constantly changing and the heart rate has to be adjusted accordingly. This is achieved by control systems, one nervous and the other chemicals. This is a homeostatic response whose overall function is to maintain constant conditions within the bloodstream even though conditions around it are constantly changing. The amount of blood flowing from the heart over the given period of time is known as the cardiac output and depends upon the volume of blood pumped out of the heart at each beat, the stroke volume, and the heart rate (number of beats per minute): Cardiac output stroke volume heart rate It is the cardiac output which is important variable in supplying blood to the body. One way of controlling cardiac output is to control the heart rate. In both time and frequency domain methods, the ECG signal is considered to be the realization of a random process. Random processes are characterized by either probability distributions and their moments or correlation function and their Fourier spectra. Such a description of ECG signals as the realization of a random process assumes a mathematical but not a biophysical model. Even though the biophysical process underlying the ECG signal itself may not be random, it may have a high degree of complexity and only a description in statistical terms may be justified. In this way, an ECG signal can be characterized by a number of average characteristics of the signal such as covariance or correlation (time domain analysis) and spectra (frequency domain analysis). Since the early days of automatic analysis of ECG signals, representations based on correlation and Fourier transform have been applied.

### Time Frequency Methods

The Fast Fourier Transformation (FFT) algorithm, invented in 1965, deserves much of the credit for early progress in this field as it significantly simplified computation of spectral coefficients. However, these methods are less suited for the frequency decomposition of the ECG signal due to the non-stationary and presence of multi components in the ECG signal. Time-frequency methods were shown

to outperform conventional methods of frequency analysis. Indeed these methods have a long history of application to ECG. The choice of time-frequency distribution is crucial for the efficiency of the proposed approach for analysis. Indeed these methods have a long history of application to ECG. The choice of time frequency distribution is crucial for the efficiency of the proposed approach for analysis. The time-frequency methods combine time domain and frequency domain analyses to yield a potentially more revealing picture of the temporal localization of the signals spectral components. Mathematically, they correspond to a joint function of time  $t$  and frequency  $f$  which is called a time-frequency representation (TFR) of the signal. Ramanujan sums, was applied to the signal processing of low frequency noise well adapted to the analysis of arithmetical sequences with many resonances  $p/q$ . Cohen initially investigated the number theoretic concepts to understand the usefulness of the so-called even functions. Introduced a special class of even symmetric periodic signals. The most distinctive feature of these signals is that their real valued Fourier coefficients can be calculated by forming a weighted average of the signal values using integer valued coefficients. The signals arise from number-theoretic concepts

concerning a class of functions called even arithmetical functions. The integer-valued weighting coefficients, being sums of complex roots of unity, are the Ramanujan sums and may be computed recursively or through closed-form arithmetical relations. Since the early days of automatic analysis of ECG signals, representations based on Fourier transform and parametric methods have been applied. These approaches are based on changes in certain frequencies bands. Such methods have proved beneficial for various ECG characterizations, but the time information is lost in the process. ECG being a chirp signal, it contains large amount time information. Since the nature of ECG signals is non-stationary and multi component, these methods are not suitable for the frequency decomposition of these signals. The fast Fourier transform (FFT) also suffer from large noise sensitivity. Parametric methods for power spectrum estimation such as autoregressive (AR), reduces the spectral loss problems and gives better frequency resolution. Since the ECG signals are non-stationary, the parametric methods are not suitable for frequency decomposition of these signals. Hence it requires a representation which can localize the components in both time and frequency.