



## EVALUATION OF HETEROGENEOUS ECG SIGNAL COMPRESSION METHODS

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### Abstract

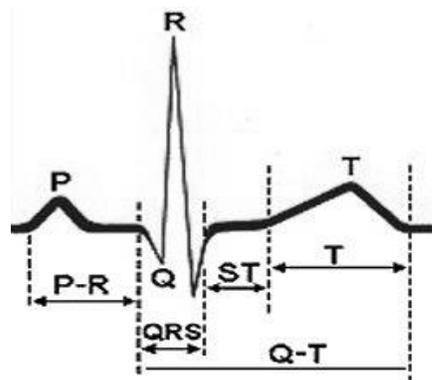
ECG i.e., Electrocardiogram assumes a major part in ID the greater part of the heart related maladies. ECG flag is a ceaseless flag with many cycles where one cycle involves P-QRS-T flag wave segments. These P-QRS-T wave segments are valuable in dissecting the flag. ECG flag recordings will create a monstrous amount of data. ECG pressure gets to be distinctly important to quickly store and recover this data from database. As of late, fluctuated investigation and procedures are created for pressure of the flag. These systems are fundamental to a scope of use beginning from symptomatic to ambulant ECG's. Subsequently, the prerequisite for powerful ECG pressure procedures is essential. A few existing pressure calculations have demonstrated some achievement in chart pressure; at the same time, calculations that turn out higher pressure proportions and less loss of data inside the remade flag are required. This paper concentrates on various systems anticipated before in writing examines for pressure of ECG flags and making a similar investigation of those methods.

**Keywords:** *ECG, ECG signal processing, data compression, signal analysis, P-QRS-T wave segments, compression ratio (CR), reconstructed signal quality, lossy compression, transform-domain techniques, performance metrics, biomedical signal processing, telemedicine.*

### I. Introduction

An ECG is just an illustration of the electrical activity of the center muscle because it changes with time, typically reproduced on paper for easier analysis. Like different muscles, muscular tissue contracts in response to electrical depolarization of the muscle cells. This electrical activity is amplified and recorded for simply some seconds, which is known as an ECG [1]. ECG signal is a continuous signal with many cycles where one cycle comprises of P-QRS-T wave components. These P-QRS-T wave components are useful in analyzing the

signal. One cycle of ECG signal with PQRST components is shown in below diagram.



**Figure 1: PQRST Diagram**

Electrocardiogram (ECG) data is utilized to analyze cardiovascular malady of a patient. In an ambulant watching framework, the amount of ECG data is basically gigantic, as an extended measure of your time is required in order to gather enough information in regards to the patient. Along these lines, a proficient data pressure topic for ECG signs is required in a few sensible applications including: a) ECG data stockpiling; b) ambulant recording frameworks and c) transmission of ECG data over telephone line or some computerized organize.

The fundamental objective of ECG pressure systems is to understand a diminished information rate, while ensure the important symptomatic data inside the reproduced flag. Practical and low computationally multifaceted nature pressure plans for restorative signs are useful in applications connected with versatile social insurance and day and age tolerant observing however moreover in enhanced databases. A data pressure algorithmic lead should allow recreation of the information with worthy devotion. Pressure procedures are sorted as those inside which the compacted data is reproduced to make the underlying sign with none blunder and systems inside which higher pressure proportions might be accomplished by presenting some mistake inside the remade flag i.e. recreation mistake.

## II. Performance Evaluation Criteria

The effectiveness of an ECG compression technique is delineated in terms of:

### 1) Compression Ratio (CR):

Compression Ratio (CR) is outlined as the quantitative relation of sum of bits representing the initial signal to the sum of bits needed to represent compressed signal. Usually a high compression ratio is preferred. Compression Ratio may be hyperbolic by reducing the redundancy within the bits. This additionally reduces the info storage needs. Compressed information should additionally represent the info with higher fidelity whereas achieving high compression ratio. The CR is given by:

$$\text{compression ratio} = \frac{\text{uncompressed size}}{\text{compressed size}}$$

Higher the CR, smaller the compressed file size.

### 2) Root Mean sq. (RMS)

Defining error criterion is one in every of the foremost troublesome drawback in ECG signal compression and reconstruction. Root Mean sq. (RMS) is employed to gauge the standard of compression algorithmic rule and it's additionally used to estimate error. The RMS is outlined as:

$$rms = \sqrt{\frac{1}{n} \frac{x^2}{1} + \frac{x^2}{2} + \dots + \frac{x^2}{n}}$$

### 3) Percentage Mean Square Difference (PRD)

$$PRD = \sqrt{\epsilon \frac{[ri - vi]^2}{\epsilon v2i} * 100\%}$$

It is the measure of error loss. This criterion evaluates the distortion between the initial and therefore the reconstructed signal.

Calculation of PRD is as follows: Where ORG is that the original signal and REC is that the reconstructed signal. The lower the PRD, the nearer the reconstructed signal is to the initial ECG information.

#### 4) Signal to Noise quantitative relation (SNR)

Signal to Noise Ratio (SNR) is the ratio between a signal power and to noise power. Its unit is logarithmic decibel scale [2].

$$SNR = 10 \log_{10} \left[ \frac{Signal\ power}{Noise\ power} \right]^2 \quad (7)$$

$$SNR = 20 \log_{10} \left[ \frac{Signal\ power}{Noise\ power} \right]^2 \quad (8)$$

Where  $E_{signal}$  : Root mean sq. amplitude of the signal

$E_{Noise}$  : Root mean sq. amplitude of the noise.

### III. ECG Compression Methods

The ECG compression techniques may be broadly speaking categorized into: sampling/time-domain techniques, Transform frequency domain techniques.

#### 1. Sampling/Time-Domain Techniques

A direct technique performs the compression on ECG signal directly. This type is referred as time domain techniques. To urge a high performance time domain compression algorithmic rule, intelligent sample choice criteria ought to be used. The initial signal is reconstructed by an inverse method, usually by drawing straight lines between the extracted samples. The key to a prospering algorithmic rule is that the development of an honest rule for deciding the foremost important samples [3].

The direct strategies are sensitive to rate of sampling, quantization levels, and high frequency interference [4]. The sampling rate at which the ECG signal can be reconstructed without any errors can be obtained according to Shannon-Nyquist sampling theorem.

#### 2. Transform Frequency Domain Techniques

They divide the signal into frequency parts and assign bits within the frequency domain expeditiously. The sign is split into blocks of information and so hold on within the frequency domain within the variety of a vector. Then the entries within the vector are de-correlated that helps one to retain solely the helpful info.

Their main focus is to reduce the quantity of addition and multiplication operations by utilizing the symmetry property of the transformation techniques for ECG signal compression is evaluated and compared. The different compression techniques are mentioned below: In change systems, leading preprocessing of the flag is done by implies that of a straight orthogonal change thus appropriately coding the redesigned yield (extension coefficients) and lessening the amount of data expected to sufficiently speak to the underlying sign. For flag reproduction, a reverse change is performed and along these lines the first flag is acquired with an express level of mistake. Numerous particular orthogonal changes [5]-[6] are used in computerized flag delineation like Cosine Transform-CT, Fourier Transform-FT, Discrete Wavelet Transform-DWT, Karhunen-Loeve Transform-KLT, Walsh Transform-WT, and Haar Transform-HT and so on.

- **Fourier Transform-FT**

Fourier descriptors [7], includes the assurance of various coefficients inside the FT delineation of a shut form. The two-lead ECG data is separated into QRS edifices and S-Q interims, showed as a mind boggling arrangement, thus Fourier rebuilt to get the FD's. Though pressure proportions of 10:1 are feasible for the S-Q interim, the therapeutic information needs confine this quantitative connection to 3:1 for the QRS progressed. With a general CR bigger than seven, the standard of the remade flag is well proper for morphological reviews.

- **Discrete Wavelet Transform-DWT**

Discrete Wavelet Transform decomposes the signal into multiple frequency bands. Wavelet transformation permits users to resolve the resolution drawback as its having multi resolution capability. There are 2 kinds of wavelet transforms. They're the Continuous Wavelet transform-CWT & Discrete Wavelet Transform-DWT. DWT is straightforward to implement and has the advantage of extracting no overlapping info regarding the signal than CWT. Wavelet transform compresses all types of ECG with average PRD and average compression ratios that are far better than the others strategies used for comparison in [8].

- **Huffman coding technique**

Huffman code is an optimized prefix code that has shortest average codeword length. Since it's a prefix free code, cryptography method is easy. Additional often times occurring symbols are related to short code words and fewer often times occurring symbols with long code words.

Major disadvantage is that the hardware complexness is incredibly high. Selective Huffman coding to writing encodes solely most often occurring symbols, whereas the opposite symbols stay not encoded. This more reduces the hardware complexness. Another technique referred to as modified Huffman coding is employed for reduce size of ECG signal. Here the initial code for all symbols is mounted. A replacement image is the primary transmitted image that indicates the looks of a replacement image. At every time once a replacement image seems this image code is send [9].

- **KL Transform**

The best change is that the KLT (additionally alluded to as the central segments change or the eigenvector change) since amid this base scope of orthonormal capacities is expected to speak to the sign for a given RMS mistake. Furthermore, the KLT prompts to decorrelated change coefficients i.e., corner to corner fluctuation lattice and supply higher outcome than the other change in light of the fact that the aggregate entropy is diminished. In any case, the method time expected to compute the KLT premise vectors (capacities) is extraordinarily serious as a consequence of KLT premise vectors are bolstered choosing the eigen values and their relating eigen vectors of the fluctuation network of the underlying data. The extended procedure request of the KLT has brought about the work of suboptimum changes with fast calculations (i.e., FT, WT, CT, HT, and so forth). Dislike the KLT, the preface vectors of those suboptimum changes are information autonomous (foreordained). For instance, in Fourier change vectors are only sines and cosines, while premise vectors for WT are sq. floods of different groupings. It should accord out that the execution of those brisk calculations is overcome by the KLT.

There are different strategies like Simple Bit Packaging Scheme, parameter extraction techniques like Peak Picking Compression of ECG, ECG Compression by Long Term Prediction and so on. Additionally an ebb and flow based strategy is likewise there which is more productive than past techniques.

#### **IV. Conclusion**

The examination of the ECG has been comprehensively used for identification of several heart related diseases. Numerous techniques are projected earlier in literature for ECG information compression. This paper provides a summary of assorted ECG compression techniques and algorithms projected in literature. There are several ECG compression methods as mentioned in this paper. But most of them are not used in the present monitoring and medical systems. The vital reason appears to be the worry that the recovery distortions created by compression ways with loss of data would possibly result in inaccurate interpretations. In future, by combining different techniques, a more efficient framework can be developed which may enable us to make a lossless compression with accurate PQRST components.

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