Transform Based ECG Data Compression

Hemlata Shakya, A. K. Wadhwani

Abstract— Electrocardiogram (ECG) is widely used in the diagnosis and treatment of cardiac disease. The data needs to be stored and transmitted, so it is necessary to compress the ECG signal data in efficient way. ECG compression methods can be classified into three categories: Direct method, Parameter extraction method & Transform method. In this paper a comparative study of transform. ECG compression allows real time transmission over telephone networks, economic off-line transmission to remote interpretation sites, improve Holter monitor system and enables efficient ECG rhythm analysis algorithms. Wavelet compression technique was found to be optimal in terms of compression.

Index Terms— ECG, Compression, DWT, DST, CR and PRD.

I. INTRODUCTION

The "Electrocardiogram" (ECG) is an invaluable tool for diagnosis of heart diseases. The volume of ECG data produced by monitoring systems can be quite large over a long period of time and ECG data compression is often needed for efficient storage of such data. Similarly, when ECG data need to be transmitted for telemedicine applications, data compression needs to be utilized for efficient transmission. While ECG systems are found primarily in hospitals, they find use in many other locales also. ECG systems are used by paramedics responding to accident scenes in emergency vehicles. They are also used by clinicians at remote sites. Certain military and/or space missions also employ ECG. A growing area of use for ECG is the 24-hour holters that are leased by consumers. These portable ECG devices record and store the data for subsequent interpretation by a doctor. The idea of represent is signal/information in fewer bits and any signal that contain some redundancy can be compressed. Compression relies on the fact that the data is redundant, that till some extent it was generated following some rules and that we can learn those rules, and thus predict accurately the Data. A compressor can reduce the size of a file by

Deciding which data is more frequent and assigning it less bits than to less frequent data. To save time when transmitting it and to save space when storing it. Clearly compression has two parts: one guess which are the most frequent symbols, and other which outputs the "decision" of the first one using the right terminology we would say that the first is called a model and that predicts the probability of the source, it then makes a probability distribution. And that the second one is the coder and it makes and emits codes based on the probabilities assigned by the model.

Manuscript received March 31, 2012

Hemlata Shakya, Perusing ME (Measurement & control) Department of Electrical Engineering, Madhav Institute of Technology and Science Gwalior.

Dr. A. K. Wadhwani, Department of Electrical Engineering, Madhav Institute of Technology and Science Gwalior.

II. ELECTROCARDIOGRAM (ECG)

An electrocardiogram is simply a measure of volt changes in the body. Any large electrical event can be detected. The electrically-active tissues in the body are the muscles and nerves. Small brief changes in voltage can be detected as these tissues 'fire' electrically. The heart is a muscle with well-coordinated electrical activity, so the electrical activity within the heart can be easily detected from the outside of the body.

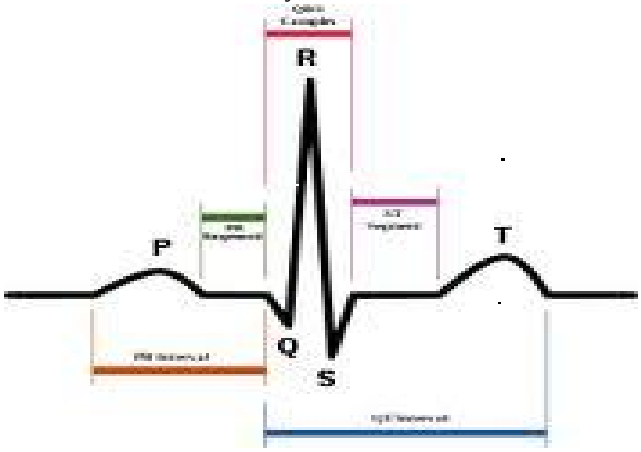

Fig.1 ECG waveform

The above diagram shows the schematic representation of normal ECG waveform. The contraction of the atria manifests itself as the 'P' wave in the ECG and contraction of the ventricles produces the feature known as the 'QRS' complex. The subsequent return of the ventricular mass to a rest state repolarization produces the 'T' wave. Repolarization of the atria is, however, hidden within the dominant QRS complex. Analysis of the local morphology of the ECG signal and its time varying properties has produced a variety of clinical diagnostic tools. In this section we review the application of the wavelet transform to the analysis of the ECG signal.

III. ECGCOMPRESSION TECHNIQUES

Many existing compression algorithms have shown some success in electrocardiogram compression; however, algorithms that produce better compression ratios and less loss of data in the reconstructed data are needed. This project will provide an overview of several compression techniques and will formulate new emerging algorithms that should improve compression ratios and lessen error in the reconstructed data.

Finally, an easy to use computer program will be written in "MATRIX LABORATORY (MATLAB)", which will allow its user to compare various compression schemes and analyze reconstructed electrocardiogram records through a graphic interface, without detailed knowledge of the mathematics behind the compression algorithms.

A. Data Compression Technique:

The idea of represent is signal/information in fewer bits and any signal that contains some redundancy can be compressed. Compression relies on the fact that the data is redundant, that till some extent it was generated following some rules and that we can learn those rules, and thus predict accurately the data. A compressor can reduce the size of a file by deciding which data is more frequent and assigning it less bits than to less frequent data. To save time when transmitting it and to save space when storing it. Generally, there are two types of compression techniques: "Lossless" and "Lossy" compression.

B. Lossless compression:

In lossless method original data and the data after compression and decompression are exactly same. Lossless methods are used when we can't afford to loss any data legal and medical document computer program. Redundant data is removed and added decompression.

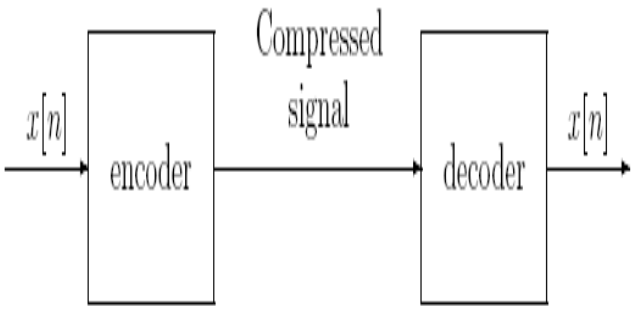

Fig.2.Lossless compression Technique

C. Lossy compression:

Loss of information is acceptable in a picture of video. Loss of information is that our eyes and ears can't distinguish stable changes. Loss of information is not acceptable in a text file or a program file .ex-JPEG, MPEG.

IV. WAVELET TRANSFORM

Time–frequency signal analysis methods offer simultaneous interpretation of the signal in both time and frequency which allows local, transient or intermittent components to be elucidated. Such components are often obscured due to the averaging inherent within spectral only methods, i.e. the FFT. A number of time–frequency methods are currently available for the high resolution decomposition in the time–frequency plane useful for signal analysis. The wavelet analysis procedure is to adopt a wavelet prototype function, called an analyzing wavelet or mother wavelet. Temporal analysis is performed with a contracted, high-frequency version of the prototype wavelet, while frequency analysis is performed with a dilated, low-frequency version of the same wavelet. Because the original signal or function can be represented in terms of a wavelet expansion (using coefficient in a linear combination of the wavelet functions), data operations can be performed using just the corresponding wavelet coefficient.

The following are applications of wavelet transforms:

- data and image compression
- partial differential equation solving
- transient detection
- pattern recognition
- texture analysis
- noise/trend reduction

V. RESULTS & CONCLUSIONS

In this paper we have compared it with other compression algorithm scheme based on Discrete Sine Transform (DST) .To reach our goal, we followed certain steps which include observing & analyzing the different waveforms and determining various performance evaluation parameters like CR & PRD obtained in MATLAB using algorithms for these two techniques. We have presented an effectives data compression algorithm to be implemented in MATLAB based mathematical tool.

In such comparison, it is found that the wavelet compression technique is very effective compared to DST compression method. A high compression ratio (CR) is achieved with a relatively low Percent RMS Difference (PRD). As compared DST technique, our method is found to give excellent reconstruction of ECG signals providing better CR and PRD. It is found that the wavelet compression technique is very effective compared to DST compression method.

V.Table I

DST compression	DWT compression
CR=89%	CR=92%
PRD=1.1	PRD=less than1%

A computer based ECG system is used in cardiac care unit. Computer based ECG instruments continuously monitor ECG of the heart patients. ECG data compression based wavelet transform method which can be implemented to save expensive disk space and to allow efficient use of available bandwidth for remote ECG analysis. Moreover, it provides excellent reconstruction of ECG signals to be used by Physicians for correct diagnosis of Heart diseases and efficient storage of such information. In these areas, our system proves to be invaluable.

ACKNOWLEDGEMENT

The authors are thankful to the UGC for their financial support under major research project sanctioned by UGC New-Delhi.

REFERENCES

1. MIT-BIH Arrhythmia Database, www.physionet.org
2. King-Chu Hung,Chin-Feng Tsai, "A linear quality control design for high efficient wavelet based ECG data compression", Computer Method Programs in biomedicine 94(2009)
3. B.R.S Reddy and I.S.N. Murty (1986) ECG data compression using Fourier description, IEEE Trans.Bio-med. Eng. BME-33
4. R. S. Khndpur, "Biomedical Engineering and Instrumentation".
5. S.jalaleddine, C.Huthens, R.Strattun, W. Coberly, "ECG Data Compression Technique-A unified approach",IEEE trans.On Biomedical Engineering, vol.37,pp. 329-343, 1990
6. Wang,Ying Chen "ECG Signal Compression Based on MSPIHT Algorithm",5th International Conference on Information technology and Application in Biomedicine,China,May30-31,2008.
7. M. Clausen and U. Baum (1993): Fast Fourier Transforms. *BI-Wiss.-Verl.*
8. Abedlaziz Ouamri "ECG compression method using Lorentzian Function model", , Science Direct, Digital Signal Processing 17(2007),8th August 2006.
9. Xingyuan Wang,Juan Meng, "A 2-D ECG compression algorithm based on wavelet transform and vector quantization ,Science Direct, Digital Signal Processing 18(2008)179-32,)28th March 2007.

AUTHORS PROFILE

Hemlata Shakya, obtained B.E (Electronics & Instrumentation) from Institute of Technology and Management University Gwalior in 2010 and perusing ME (Measurement & control) Electrical Engineering Department at the Madhav Institute of Technology and Science Gwalior.

Dr.A.K.Wadhwani, his obtained BE from SATI,vidisha & ME (Measurement & Instrumentation) from URO, Roorkee in 1993 and Phd from IIT Roorkee in 2003.He is serving is reader in MITS college Gwalior. Sir has published in 70 research paper, guided 35 dissertation, he has received 3 PhD awards, 4 Phd submitted, 5 inter progress and 7 projects in AICTE, UGC in progress.