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Noise Compression of EPIC Generated ECG Signal

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Abstract
Electrical activity of the heart called Electrocardiagram (ECG) is a very important diagnostic parameter for the measurement of the heart activity and the health condition of the patient for the treatment purpose, The advance Non- Contact technique for the measure of the cardio ECG signal is EPIC (Electric Potential Integrated Circuit), so for the long term monitoring and analysis of the ECG data, compression techniques are very much important and necessary for the record of large data signals in a space, as small as possible for the storage with the high accuracy while retaining the important diagnostic clinical parameters in case of reconstruction of the original compressed signal. In this paper the results are complied with the compression techniques using Frequency Transformation DCT 2, are proposed for achieving these required conditions based on MATLAB Programming for Standard MIT-BIH Database Record Signal No 100 in association with reference of the work proposed of proposed data in the paper for better results for EPIC ECG signal.

1. Introduction

The Electrocardiogram (ECG) is a record of the electrical activity of the heart muscle over time. Because of its noninvasive nature and its clinical significance, the ECG still remains the most widely used diagnostic tool in cardiology. The Electrocardiogram (ECG) is the electrical manifestation of the contractile activity of the heart, and can be recorded fairly easily with surface electrodes on the limbs or chest. The rhythm of the heart in terms of beats per minute may be easily estimated by counting the readily identifiable waves. ECG wave shape is altered by cardiovascular diseases and abnormalities such as myocardial ischemia and infarction, ventricular hypertrophy and conduction problems [1]. Following figure shows the ECG waves, peaks, segments and intervals more clearly. The period of the ECG signal reflects one cardiac cycle. The ECG signal is the series of waves labeled as P, QRS, and T. If we view the cardiac cycle as a series of events, we have the epochs in an ECG waveform as illustrated in Figure 1. The necessity and the importance for the ECG signal compression are that with the help of compression has (a) increased storage capacity of ECG's as databases for subsequent comparison or evaluation. (b) Feasibility of transmitting real-time ECG's over the public phone network (c) Implementation of cost effective real-time rhythm algorithms (d) Economical rapid transmission of off-line ECG's over public phone lines to a remote interpretation center (e) Improved functionality of ambulatory ECG monitors and recorders.

Capacitive (insulated) electrodes can register ECG signals without conductive contact to the body - even through clothes - and represent an attractive alternative for a wide range of new applications. EPIC (Electric Potential Integrated Circuit) is a completely new sensor technology resulting from research at the University of Sussex (UK). Novel, ultra high impedance EPIC sensors measure electric field changes without requiring physical or resistive contact [3].

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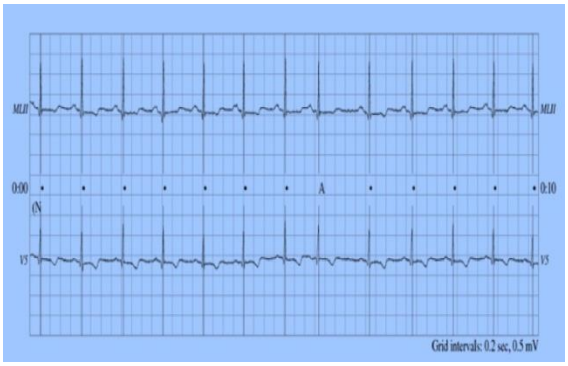

Fig. 1: The Human ECG Signal Over One Cardiac Cycle Waveforms of Record No. 100 of the MIT-BIH Arrhythmia Database [5]

2. Generation of EPIC signal: Design of Circuit

EPIC sensors are attached to the patient cloths without the contact to the patient body and the with the "Driving Right Leg(DRL) circuit the signal is acquired. The connection of the EPIC syaten and the DRL circuit is shown in the Figure 2 and Figure 3 respectively.

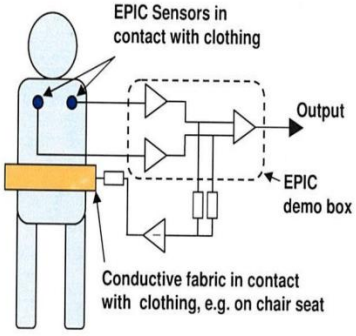

Fig 2: Basic configuration of non-contact ECG measurement including capacitive-coupled DR circuit. [3]

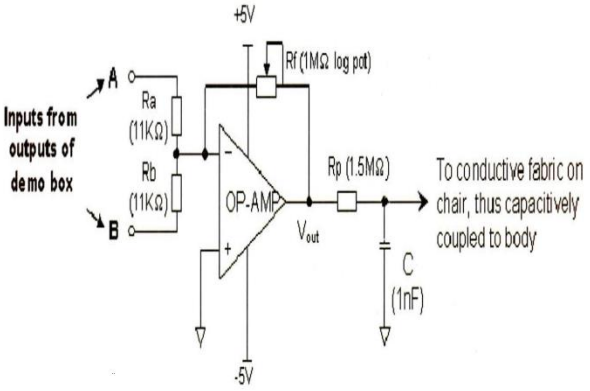

Fig 3: DRL circuit voltage gain is set by Rf ;Rp limits current feedback to the body[3]

3. Performance Metrics for Noise Compression

Compression Ratio (CR) and Percentage Root Mean Square Error (PRD) are the Performance Metrics for the evaluation of compression Technique. High value of CR indicates the high degree of compression and low value of PRD gives the indication of less error in the reconstructed signal for same the compressed signal. Compression Ration (CR) is defined as the ratio of the number of bits in the original signal to the number of bits in the compressed signal [6].

Compression Ratio (CR) = Number of bits in original signal / Number of bits in compressed signal (1)

The Compression Ratio can also be define in terms of number of samples of the signal as the ratio of the number of samples before compression to number of samples after compression.

Compression Ratio (CR) = Number of samples before compression / Number of bits in compressed signal (2)

$$PRD^2 = \frac{\sum_{n=0}^{n-1}(x[n] - X[x]^2 \text{ x100}}{\sum_{n=0}^{n-1}(x[n])^2} \quad (3)$$

Where x[n] and x[n], n = 0, 1,..., N - 1, represent the values, in mV, of the samples of the original and reconstructed signal, respectively then PRD is calculated as [6] For an effective compression techniques high value of CR and Low value of PRD is desirable[7].

4. Proposed compression Technique for EPIC signal

Frequency transformation technique DCT 2 are used with MATLAB programming for this work and the same proposed study are used for the comparing the results with the existing method [4] for the same record signal of MIT-BIH

Record No. 100/ML II [5] For theproposed work first the .dat file is convertedinto .m file for the MATAB program as an input and then with the program developed for the compression for DCT2 it is compressed and then with the help of the inverse DCT2 the original signal is reconstructed and the performance evaluation have been made and the value of CR and PRD are recorded.

The block diagram for the compression for the EPIC generated ML/II signal is shown in figure 4.

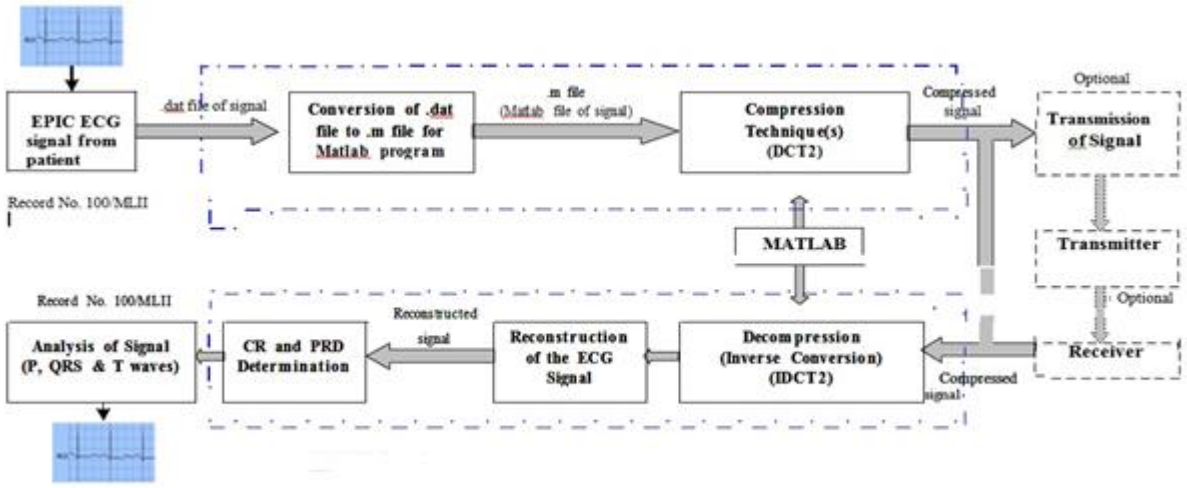

Fig. 4 Block diagram of ECG compression scheme

5. Result Evaluation and Comparison

With the help of the developed Matlab Program the following DCT2 waveforms are received for the EPIC Signal, The Compression Ratio (CR) received is 95.7700 and the Percentage Root Mean Square Difference (PRD) 1.3319 is achieved. Waveforms are shown in figure 5.

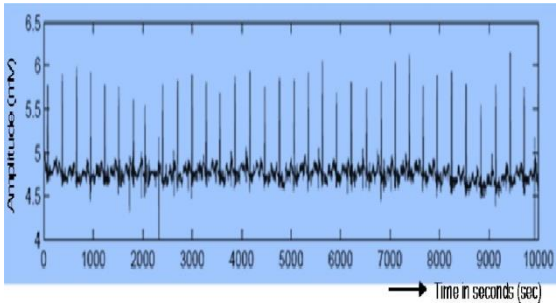

Fig. 5(a): Original MIT-BIH Record No. 100/MLII

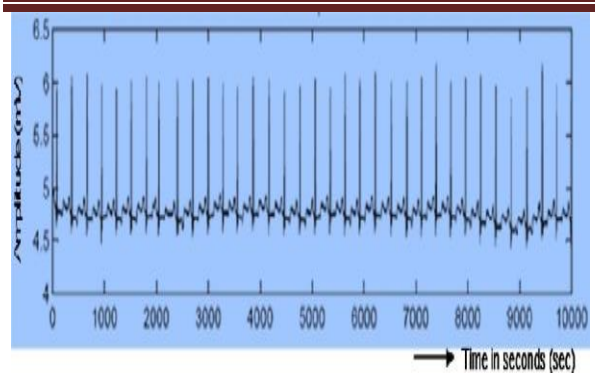

Fig. 5(b): IDCT2 Reconstructed ECG

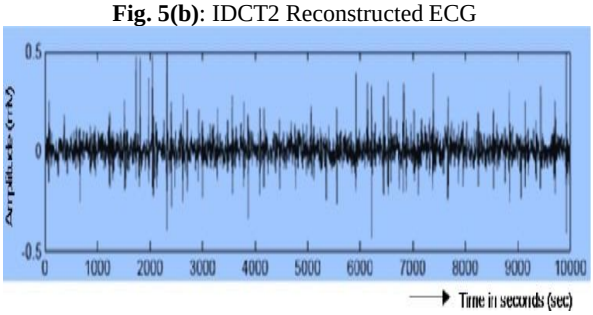

Fig. 5(c): Error Signal (PRD)
Fig. 5(a,b,c): DCT2 Compression Waveforms

6. Conclusions

It is observed with the results obtained that the non-contact ECG received from the EPIC scheme is valuable for the compression of the signal while maintaining the clinical importance parameter for the diagnosis and low PRD is achieved for the same for the reduction of the noise present in the signal. The same technique can also be practiced on the research basis for the other signals of ECG of the MIT-BIH data base so that this scheme can be versatile for the other signal also. These are the promising technique for the future and more research can be done in this area.

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