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Efficient ECG Signal Compression using Various Coding Techniques

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***Abstract*: The paper explains about the different types of signal compression techniques that is used to compress an ECG signal using signal processing. The field of signal processing is a very important field of study and one that makes possible various other fields such as communications. MP3 music files contain processed, transformed, and compressed music signal data. Signal processing enables high-speed data communication, even in the presence of interference or noise. Here we use the ARDUINO MEGA 2560 module and a ECG sensor to analyze the ECG signal. The ECG sensor reads the input and gives out the ECG signal. The coding techniques such as RLE and DWT are applied to the signal and compressed.**

***Keywords*: Arduino, DWT (Discrete Wavelet Transform), ECG (Electro Cardiogram Signal), RLE (Run Length Encoding).**

1. Introduction

The electrical activity of the heart is monitored continuously over a period of time by connecting the electrodes either three leads or twelve leads are attached to the skin. The measurement of electrical activity is called as Electro Cardiogram (ECG). One Cardiac cycle of ECG signal consists of P wave, T wave and QRS complex. P wave represents depolarization, T wave represents rapid polarization and QRS complex represents ventricular depolarization. While measuring ECG signal, there is a chance of artefacts being recorded along with the signal. These artefacts may cause interruption or wrong diagnosis of the cardiac parameters. The QRS complex is the most significant part in the ECG because of its high amplitude compared to P and T waves and uses in R peak detection to find the heart rate of a person. The major steps in analysis of ECG signal includes eliminating the noise from the ECG signal using noise filtering techniques and detecting cardiac cycle by detecting the QRS complex.

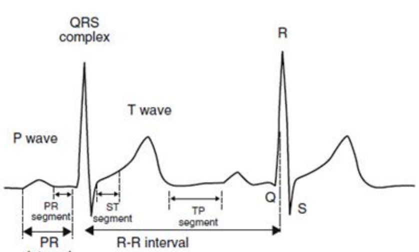

Fig. 1. Wave showing URS complex

2. System design

The overall system design includes electrodes, Arduino Uno, ECG sensor, MATLAB software, Arduino software. The full ECG setup comprises at least four electrodes which are placed on the chest or at the four extremities. The AD8232 is a neat little chip used to measure the electrical activity of the heart. ECGs can be extremely noisy, the AD8232 Single Lead Heart Rate Monitor acts as an op-amp to help obtain a clear signal from the PR and QT intervals easily. The ECG Monitoring Sensor module kit for Arduino is designed to extract, amplify, and filter small bio – potential signals in the presence of noisy conditions, use the transform methods to compress the signal. Among the transform methods, our proposed method involves the wavelet transform and run length coding because of their good localization properties in the time and frequency domain. The compressed signal results are designed using MATLAB.

3. Hardware module

Our hardware module consists of Arduino Uno, ECG sensor and the ECG electrodes. The ECG electrodes are connected to the human body. The electrodes are connected to the sensor and the Arduino. The sensor senses human body heartbeats. The embedded program for sensing the signal is dumped in the Arduino. The signal is seen in the Arduino software. The signal is then converted to MATLAB file as .mat file.

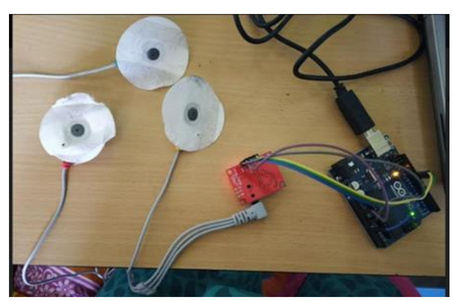

Fig. 2. Hardware setup

4. Software description

Here we use MATLAB software to compress the signal. MATLAB is a language for technical computing. The mathematical calculations can be easily done. It is mainly used for algorithm development, modelling, simulation, data analysis, scientific and engineering graphics. It is an interactive software whose data element is matrix in form. This help us to solve many technical problems mainly vector calculations in a fraction of time. MATLAB features toolboxes. Toolbox help us to learn and apply specified technology. Areas in which toolbox helps us include signal processing, control systems, fuzzy logics, wavelets, simulation and many others. When MATLAB is clicked the desktop opens. Command window is available to enter and run the values.

The ECG signal is taken from the human body and it is dumped in the Arduino. To check the ECG signal we use the Arduino IDE software. In this the program for ECG signal is written. The code is compiled, uploaded. Then run the code. The output is shown in the serial monitor. It supports languages like C and C++.

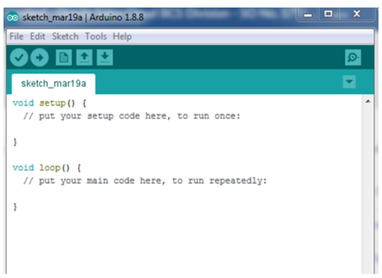

Fig. 3. Arduino window

5. Results and discussion

The main objective of the proposed system is to find the best compression technique that can be benefited in many ways. Two types of coding techniques are considered. Run length coding and wavelet coding. The extracted ECG signal is compressed by these techniques. The compression ratio for the signal is identified. By comparing the compression ratio of the techniques the conclusion is given that run length coding is considered to be best.

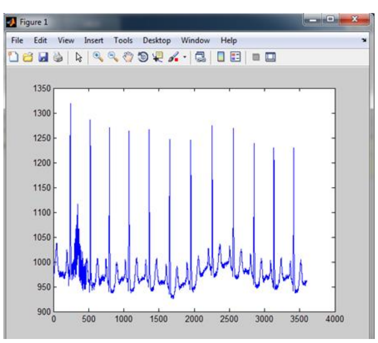

Fig. 4. ECG signal

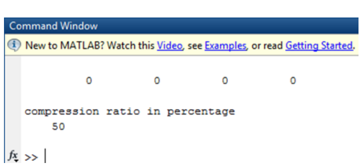

Fig. 5. Compression ratio in percentage

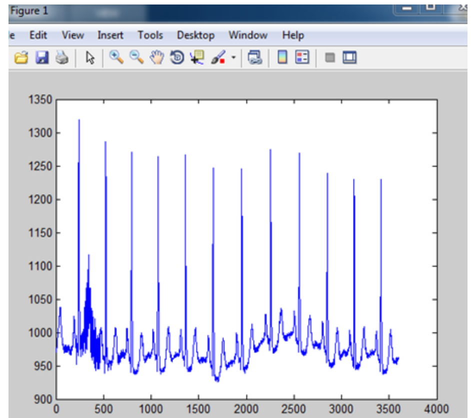

Fig. 6. ECG signal

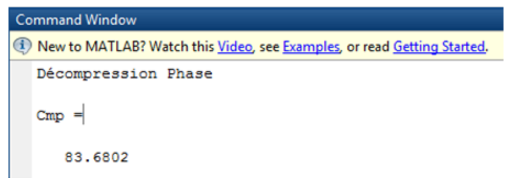

Fig. 7. Decompression phase

6. Conclusion

Signal compression plays a significant role in reducing the transmission and storage cost. All the signal compression techniques are useful in their related areas, and every day a new compression technique is developing which gives better CR. In this compression process, DWT with coefficients, optimization process and RLC coding is used. As the CR is increased, the value of PSNR will decrease. This will degrade the quality of the image, and the RLE will provide better compression results at low CR. From the experimental results, it is evident that the proposed compression technique gives better performance compared to other traditional techniques. The maximum PSNR of the image is 40.771 and CR is 0.93 in the optimized wavelet image compression process.

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