Lossless ECG Compression in VLSI

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Abstract- *A VLSI implementation of an efficient lossless compression scheme for electrocardiogram (ECG) data encoding to save storage space and reduce transmission time. As compression algorithm is able to save storage space and reduce transmission time, this opportunity has been seized by implementing memory-less design while working at a high clock speed in VLSI. ECG compression algorithm comprises two parts: an adaptive linear prediction technique and content-adaptive Golomb Rice code. To improve the performance, the proposed VLSI design uses bit shifting operations as a replacement for the different arithmetic operations. Proposed System shows that this design low Area & Delay architecture. This scheme is developed in Verilog HDL and simulated by Modelsim 6.4 c. To achieve synthesis of Spartan3 FPGA tools from Xilinx ISE 13.2 is used.*

Keywords- ECG Compression, Columb Rice Coding, Linear Prediction.

I. INTRODUCTION

ECG stands for "Electrocardiogram." It is a medical test that measures the electrical activity of the heart over a period of time using electrodes placed on the skin. The recorded activity is then printed or displayed on a monitor, typically as a series of waves or tracings. The ECG provides valuable information about the heart's rate and rhythm and can help diagnose various heart conditions such as arrhythmias, ischemia (lack of oxygen supply to the heart muscle), and other abnormalities. It is a commonly used tool in cardiology and is non-invasive, meaning it does not involve any penetration of the skin or body opening.

The Traditionally, "ECG" usually means a 12-lead ECG taken while lying down as discussed below. However, other devices can record the electrical activity of the heart such as a Holter monitor but also some models of smartwatch are capable of recording an ECG.ECG signals can be recorded in other contexts with other device

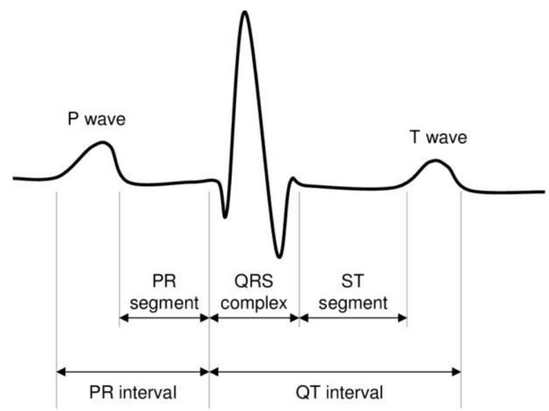


Fig. 1. Diagram – 1

The Lossless compression is a compression technique that does not lose any data in the compression process. Lossless compression "packs" data into a smaller file size by using a kind of internal shorthand to signify redundant data. If an original file is 1.5 MB, for example, lossless compression can reduce it to about half that size, depending on the type of file being compressed. This makes lossless compression convenient for transferring files across the network, as smaller files transfer faster. Lossless compression is also handy for storing files as they take up less volume. However, a lossy data compression method approaches by another way. With this method, compressing data and then decompressing it may result in it being different from the original, but "close enough" to be useful somehow. These methods are typically referred to as codecs in this context. Lossy methods are most often used for compressing sound, images, or videos. This is in contrast with lossless data compression. Depending on the design of the format, lossy data compression often suffers from generation loss, that is, compressing and decompressing multiple times will do more damage to the data than doing it once. The advantage of lossy methods over lossless methods is that in some cases a lossy method can produce a much smaller compressed file than any known lossless method, while still meeting the requirements of the application.

II. EXISTING SYSTEM

The first technique used in the proposed algorithm is adaptive linear prediction; it achieves high sensitivity and positive prediction. The second technique is content-adaptive Golomb-Rice coding, used with a window size to encode the residual of prediction error. The third technique is the use of a suitable packing format; this enables the real-time decoding process. The proposed algorithm is evaluated and verified using over forty-eight recordings from the MIT-BIH arrhythmia database, and it shown to be able to achieve a lossless bit compression rateof 2.83x in Lead V1 and 2.77x in Lead V2. The proposed algorithm shows better performance results in comparison to previous lossless ECG compression studies in real time; it can be used in data transmission methods for superior biomedical signalsfor bounded bandwidth across e-health devices. The overall compression system is also built with an ARM M4 processor. Lossless ECG compression has presented a mixed signal VLSI design of ECG compression which includes a smart analog-to-digital converter (ADC) and lossless ECG compression is performed on the basis of trend forecasting and entropy coding. Although this design is intended for low power applications yet its power consumption is quite high which makes such design unsuitable for current low power devices.

III. PROPOSED SYSTEM

- Adaptive linear prediction technique
- content-adaptive Golomb Rice code

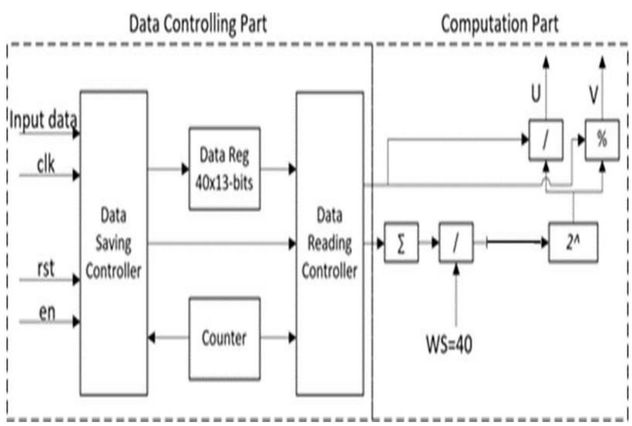


Fig. 2.Block Diagram

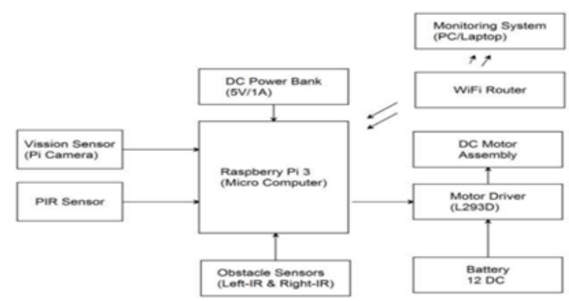
In the above computational block, we use the ripple carry adder to increase the performance and CR ratio. In the Golomb Rice Coding is worked in to two parts that is Data controlling part and Computational block. In the Data controlling part, the four input i.e. input data, clk, rst, enable pass to the data saving controller. The data saving controller is used to save the inputs with the help of data register. The input pass into the data reading controller and it is used to read the input data. As the same time, counter is used to count the inputs how many times the input are used. In the computational part, the output comes from the data reading controller is goes to the carrysave adder with the constant threshold value 40. It requires two values that means U and V. U is the quotient value and V is theremainder value. The U value performs the divide operation and V value performs the modules operation

1. MODULES DESCRIPTION

1. Adaptive Linear Prediction
2. Golomb-Rice code
3. Data Packing Format
4. Error Predictor

ADAPTIVE LINEAR PREDICTION

ALP module, 11-bit input is being processed at every clock cycle. For the first four inputs, linear prediction is performed differently as compared to other inputs as discussed in the proposed original algorithm. This leads to the designing of two different linear predictors. In Fig., a control unit is controlling the input data by generating control signals for the selection of linear prediction unit as well as sending data from linear prediction units to error predictor.



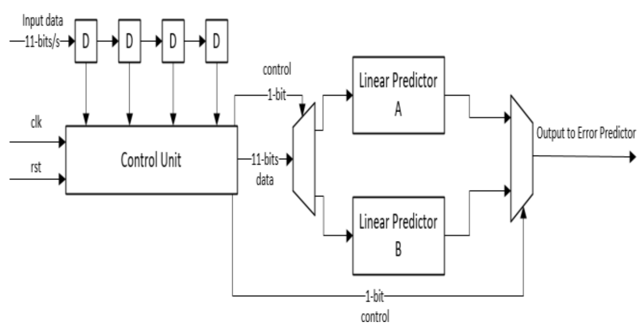


Fig. 4. . Hardware architecture for data processing for ALP

GOLOMB-RICE CODE

Golomb coding is a data compression scheme based upon entropy encoding and is optimal for alphabets with a geometric distribution. The Golomb-Rice code comprises two parts: quotient and remainder, which are represented by quotient: The hardware architecture design for Golomb Rice coding module. Input data is post-processed data of the error predictor module. Data is processed for one complete window so there is a 40x13-bits register to save one window’s values.

When new window's values are arriving then previous window's values are processed to find the value of U and V, where U and V represent quotient and remainder respectively. So, in general, this module's architecture can be divided into two parts; data controlling part and computation part. In the computation part, operations have been divided into different clock cycles to reduce the processing delay. Instead of using the built-in operators of division or power, bit shifting has been used to perform the multiplication, power, mod and division operations. By using this bit tweaking, the design is able to benefit from the reduction of a number of gates and power consumption.

SOFTWARE REQUIREMENT VERIFICATION TOOL

- Modelsim 6.4a SYNTHESIS TOOL
- Xilinx ISE 9.1/ Xilinx 13.2.

2. COMPARISON RESULT

Compression Ratio
So=85; Sc=54; CR=85/66= 1.57
Existing Compression Ratio
So=85; Sc=46; CR=85/66= 1.87

IV. CONCLUSION

This paper presents a low power VLSI implementation of the lossless ECG compression algorithm. The proposed implementation has been tested Text Datasets. The design runs for real- time data processing and core power consumption is only which makes this design suitable for modern day low power applications. The design has a core area with FPGA Spartan 3 technology. In biomedical devices, the low-cost low-power and low-area embedded genetic algorithm running VLSI architecture are strongly desired. MICS detectors with improved RF circuits are critical foundations for auditing, investigation & control functions for biogenic devices. The additional VLSI design strategies are implementing FPGA, computer vision computation and neuro-fuzzy methodology, which are difficult in medicinal application. The FPGA carries out parallel loading at a faster speed. The primary feature of high durability is microelectronic computing. Cardiology systems are useful for most realistic medical applications. The existing literature and analysis table can assist the observer for further research in this are Power consumption can be reduced for this design. The leakage power can be reduced by using clock gating and multi-threshold voltage cells algorithm.

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