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Coastline Parameter and DWT-QA Algorithms* based Epileptic Seizure Detection

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***Abstract*— Epileptic seizures are neurological disorders that are manifested in abnormal electrical activity in brain. EEG signals are used for seizure detection. In this paper we have proposed a two stage algorithm for the detection of onset epileptic seizure. The first stage is the coastline parameter which acts as the monitoring stage and the second stage is the Discrete Wavelet Transform-Quasi Averaging (DWT-QA) which act as the detection stage. These algorithms operate in real time input data and produce processed output. This may increase the detection efficiency and consumes low power. The simulation is done by using Xilinx software.**

Index Terms— Epilepsy, seizure detection Algorithm, VLSI Signal processing.

I.INTRODUCTION

Epilepsy is a neurological disorder which affects about 1-2% of the world's population. When nerve cells in the brain fire electrical impulses at a rate of up to four times higher than normal, this causes a sort of electrical storm in the brain known as seizure. A pattern of repeated seizures is called as epilepsy .The causes epileptic seizures includes head injuries, lead poisoning, maldevelopment of genetic and infectious illness. Epileptic seizures are a transient occurrence of signs or symptoms due to abnormal excessive or synchronous neural activity of brain. Epileptic seizures are divided by their clinical manifestation into partial or focal, generalized, unilateral and unclassified seizures. Focal epileptic seizures involve only part of cerebral hemisphere and produce symptoms in corresponding parts of the body or in some related mental functions.

II.LITERATURE SURVEY

There are several literatures for detecting the onset of epileptic seizures with different efficiency. Epileptic seizures are characterized by a gradual surge in amplitude in specific frequency bands. Hence, fast Fourier transform (FFT) and short-time Fourier transform are used in the literature to develop detection algorithms [2]. Apart from FFT, the use of artificial neural network (ANN) enhances detection efficacy [3], [4]. However, the complexity of ANN makes it difficult to implement these algorithms in an energy efficient hardware. Other practical approaches are spike based detection algorithms [1]. However, their efficacy is debatable due to minimal processing of the LFP. Discrete wavelet transform (DWT) is an efficient tool to process neural data due to its ability to resolve the signal both temporally and spectrally (unlike FFT). The use of ANN along with DWT has been reported but lacks energy-efficient implementation [5]. Recently, it was shown that DWT along with a quasi-averaging (QA) operator achieves a high efficacy and practical implementation (DWT-QA) [6]. In spite of its low-power implementation and user-specific programmability, the energy from the battery is not used efficiently. In the DWT-QA algorithm, it is shown that the significant wavelet coefficients show high activity only during seizures [6]. Since the occurrence of an epileptic seizure is intermittent, the wavelet decomposition operation of LFP in the baseline phase is redundant computation and can be avoided.

III.TWO STAGE ALGORITHM

The first stage is the monitoring stage that is the coastline parameter (CL) based algorithm. The second stage is the DWT-QA based algorithm which acts as the detection stage. The onset of seizure is detected by using these two stages. By using theses algorithms the power is reduced and the efficiency is also increased.

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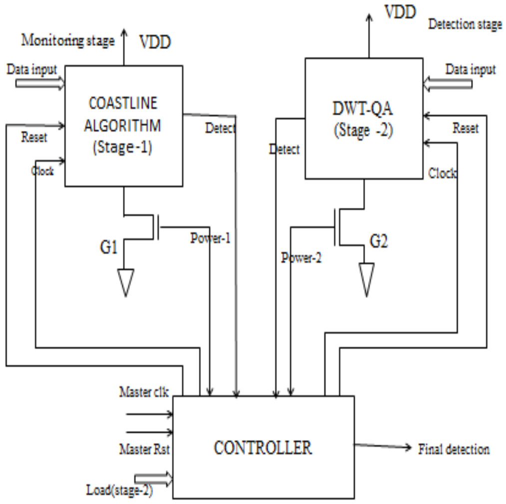

Fig.1. Block Diagram of Two Stage Algorithm.

IV.COASTLINE PARAMETER (CL) ALGORITHM

This algorithm uses sum of absolute value of distance from one data point to next as a metric in baseline monitoring. The block diagram of coastline algorithm is shown below.

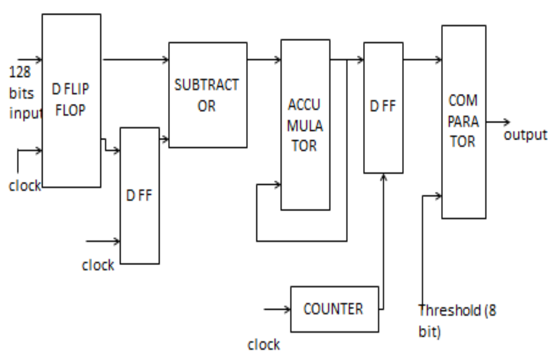

Fig.2. Block diagram of Coastline Parameter Algorithm.

This feature measures the distance between adjacent data points *x* in the signal and accumulates them over a window of width *N*. In the baseline section of the recording, this parameter remains more or less constant. The threshold for this parameter can be adjusted accordingly in the training phase. The training data is digitized into LFP recording consisting of both baseline and seizure signal. The baseline signal refers to the part of neural signal when there is no electrographic or visual evidence of seizure. Baseline algorithm refers to training data set in order to train the algorithm to minimize false positives. The mathematical expression for k th window given in

$$CL(K)=\sum_{i=1}^{N} abs|x[i+(k-1)*N]-x[i-1+(k-1)*N]| \quad (1)$$

Where x is data, k is window, and N is window width. In baseline CL is invariant.

V.DISCRETE WAVELET TRANSFORM –QUASI AVERAGING(DWT-QA)

Discrete Wavelet Transform (DWT) to process neural signals and detect the onset of seizure. DWT preserves both temporal and frequency domain information contained in the signal. Since the temporal window size in a DWT is variable, it leads to a much higher time-frequency resolution of signal. DWT has been used fairly recently as a tool for extracting features from the electro-encephalogram (EEG) to identify a seizure. Due to elaborate processing using DWT, the quasi averaging approximation does not degrade the efficacy of the algorithm. Since the algorithm works on a continuously moving window, it results in more accurate characterization of the onset of seizure as it takes each recorded data into account. Quasi-averaging is an approximation technique, which accurately models the average of a continuously moving window. It consists of three blocks namely wavelet decomposition block, quasi averaging block, thresholding block. The block diagram is shown below.

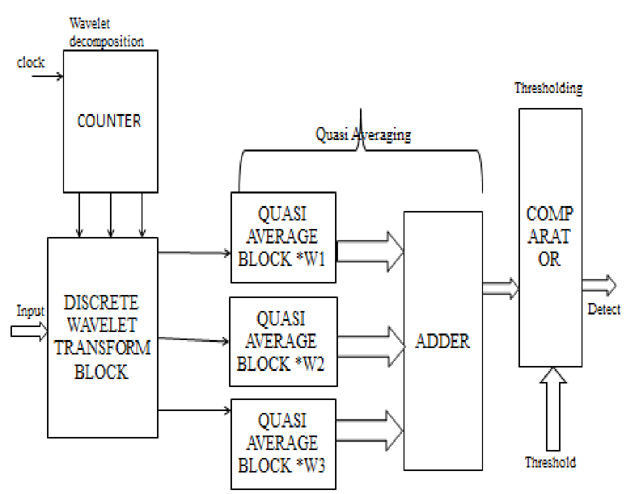

Fig.3. Block Diagram of DWT-QA.

The wavelet decomposition block is the most computationally intensive and power hungry block in the system. It consists of the discrete wavelet transform block to compute the DWT of the input and a counter to synchronize its operation. There are various ways suggested in the literature to implement efficient wavelet transform architecture. These architectures are generally apt for data compression applications and result in the loss of the intermediate derivable coefficients. The Quasi Averaging (QA) block consists of an absolute value component followed by quasi averaging units for each of the selected DWT coefficients. The DWT coefficients are in the 2's complement form. Since the input is a non-stationary random signal, calculating a moving window average on its component frequency will yield zero value. Window. If $S_{i:i+w}$ is the sum of elements x_i in the window W_k window size w, then the average of W_k is given by

$$<W_k>=\frac{1}{w}S_{i:i+W} \quad (2)$$

The average of the next window W_{k+1} can be calculated as

$$<W_{k+1}>=\frac{1}{w}(S_{i:i+w}\ x_i+x_{i+W+1}) \quad (3)$$

In the Thresholding Block, a simple comparator compares the onset detection signal to the prefixed threshold value and generates the detect flag at the onset of the seizure. The frequency of operation of the entire circuit is the same as the sampling frequency of the LFP recording. Since this frequency is very low, VDD scaling techniques can be used to reduce power dissipation.

VI.SIMULATION RESULTS

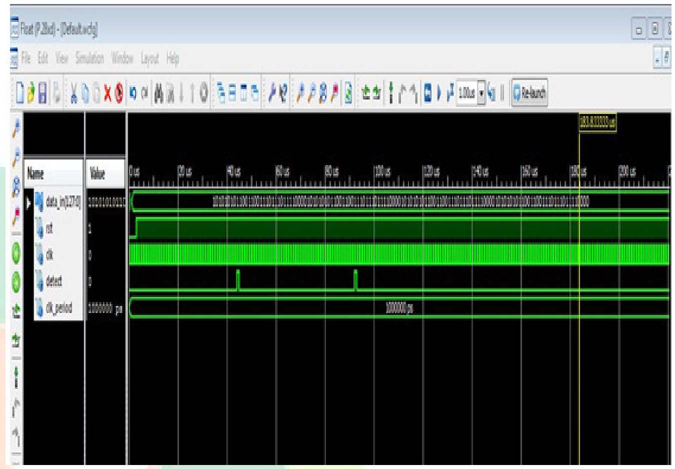

Fig.4. Simulation Results of Proposed Two Stage Algorithm.

The input to the two stage algorithm is the 128 bits datainput. The clock and reset vaiues are set, after 16 clock cycles the detector output is produced. If there is seizure it will produce the value as 1 or else as 0. The delay is increased due to the data inputs.

VII.CONCLUSION

In this paper we have presented a two stage seizure detection algorithms based on EEG signals. These algorithms are mainly used for extracting feature from EEG signals. The algorithms are used for real time data inputs and produce processed signals which will consumes low power and increase the detection rate. DWT-QA is used for minimizing false positives.

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