ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 2, Issue 7, July 2013

EEG Compression Using EZW Technique

Darshana D.Pawar , A.B.Nandgaonkar

Abstract— ***In order to cure various brain diseases like epileptic siezers, alziemer etc.It is required to analyze EEG signal oftenaly called as brain waves.EEG is acquired from subject for 2-8 hours, may be a day or a week. In order to store and transmit such large amount of data it is very necessary to compress EEG signal.EEG is Neurological signal with Non-stationary characteristic and random in nature. EEG characteristics are energy, spikes, frequency .While compressing EEG data it is very essential to keep all the characteristics of EEG unaffected. So, techniques used for compression of EEG data is should be lossless in order to obtain complete EEG signal at the time of reconstruction. Embedded zero tree wavelet is one of the promising method used for compression of data. This method is based on zero-tree encoding. Instead of only wavelet decomposition this method encodes the wavelet coefficients in zero trees in order to get progressive layer by layer encoding.1-D DWT analysis is used for getting WT coefficient.***

Index Terms— EEG, Compression, Embedded Zero Tree Wavelet, DWT, WT coefficient

First Author:

Miss Darshana Dilip Pawar PG student at Dr.Babasaheb Aambedkar Technological University,Lonere

Second Author:

Dr.A.B.Nandgaonkar Associate Professor at Dr.Babasaheb Aambedkar Technological University,Lonere

1. INTRODUCTION

Electroencephalography (EEG) is the acquiring the brain's electrical activity at the scalp of patient. Acquiring signals and images from the human body has become vital for early diagnosis of a variety of diseases. Such data can be in the form of electro biological signals such as an electrocardiogram (ECG) from the heart, electromyogram (EMG) from muscles, electroencephalogram (EEG) from the brain, magneto encephalogram (MEG) from the brain. This information is useful for several applications, such as medical diagnosis, psychological research.EEG signal analysis helps in sleep studies, diagnose brain disorders and brain research.

EEG is a popular way of recording electrical brain activity because it is non-invasive (i.e., it doesn't require subjects to have surgical implants in order to collect the data).For diagnosis of any disease EEG data is continuously recorded from subject’s body. As per international standard for EEG measurement, a 10-20 electrode system (21 electrodes) is employed for EEG signal acquisition. A large number of electrode arrays are employed in Brain Computer Interface (BCI), where more localized information is needed. Due to the use of large electrode arrays and prolonged recording, enormous amount of EEG data is generated. Hence an efficient compression algorithm is needed either for storage or transmission. Since EEG is so widely used, it is inevitable that problems begin to occur like the amount of data recorded, stored, and transmitted accumulates. Some medical procedures require EEG data to be recorded for a very long period of time, such as 24 hours. Even with just a single electrode, this could generate from 15 MB to over 400 MB of data, depending on the required quality of the recording. This means that a lot of disk space is required to store it, and transmitting can take a long time. Furthermore, there may be several electrodes, several patients, and several trials of each. If each electrode for each trial of each patient stores 400 MB of data, the size of the data can increase dramatically [4]. This recording can be for one-eight hour, a day or depending on disease it may extend to a week also. So in such case a continuous monitoring and transmission is necessary, which required lots of memory. This is main reason behind EEG compression. As EEG is non-stationary and random signal, it is challenging job to compress it, keeping all its characteristic unaffected. So all the necessary information will remain as it is at the time of diagnosis of a disease.

EEG is being increasingly used in the field of Brain Computer Interfaces. BCI is very emerging field in EEG analysis as it is very helpful for persons which are paralyzed by any reason.

Some brain disorders like epilepsy, alziemer EEG signal analysis is boon. In the field EEG data analysis several system are proposed for EEG compression. All these methods are differs from each other depending upon the method of compression and rate of compression. This different system also differs from each other by considering the database used for compression. In compression of EEG signal one of the most important aspect is the PSNR (Peak Signal to Noise Ratio) which should me as minimum as possible. So that compression will be lossless in order to obtain all the essential information at the time of reconstruction. The characteristics of EEG signal are linked with typical EEG is characterized mainly by its frequency bands. This frequency bands are differ from each other on the basis of its frequency and its related task .Delta wave (0-4Hz) associated with sleeping, theta wave (4-8Hz) associated with meditation, Alpha wave (8-13Hz) associated with relaxation [3]. EEG is random, non-stationary signal. Numerous lossless data compression methods have been studied for EEG data compression such as

Huffman coding, run-length, and repetition count compression. Context based loss-less or near loss-less method is introduced by Nasir Memon and its co-author which gives AR model based EEG compression [7]. Adaptive Error Modeling is achieved by N. Sriraam for loss-less EEG compression which gives compression efficiency about 70%.[6]

II WAVELET TRANSFORM

Wavelet transform is a very promising method for data compression. A wave is an oscillating function of time or space and is periodic. In contrast, wavelets are localized waves. They have their energy concentrated in time or space and are suited to analysis of transient signals. In the paper discrete wavelet transform is studied for compression of EEG data. In CWT, the signals are analyzed using a set of basis functions which relate to each other by simple scaling and translation. In the case of DWT, a time-scale representation of the digital signal is obtained using digital filtering techniques. The signal to be analyzed is passed through filters with different cutoff frequencies at different scales. Discrete wavelet transform is defined by a square matrix of filter coefficients, transforming an array into a new array, usually of the same length. If correctly constructed, the matrix is orthogonal, and in this case not only the transform but also its inverse can be easily implemented. In this paper 1-D WT is studied for compression of EEG data. In 2-D WT signal decomposed into one coarse three detail sub-bands while in 1-D WT signal is decomposed into one coarse and one detail sub-band as shown in Fig 1.[1]

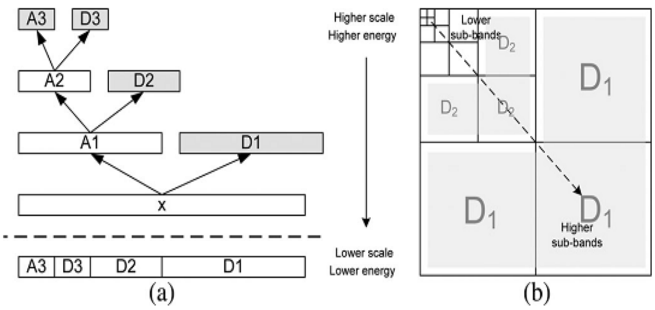


Fig1. (a) 1-D WT Decomposition (b) 2-D WT Decomposition

The decomposition shows scale of the WT, high scale denotes low resolution and vice versa. So, as a result, the wavelet coefficients are generally smaller in the higher sub-bands comparing to those in the lower sub-bands at low scale.

III DATABASE SELECTION

An EEG is having random characteristics. Database used for compression is obtained by EEGLAB a MATLAB toolbox used for analysis of EEG signals. This database contains 32 channels the sampling rate is 128 bps. This database is event related database square and right this are two events used in this database. During this selective visual attention experiment, stimuli appeared briefly in any of five squares arrayed horizontally above a central fixation cross. In each experimental block, one (target) box was differently colored from the rest. Whenever a square appeared in the target box the subject was asked to respond quickly with a right thumb button press. If the stimulus was a circular disk, he was asked to ignore it. These data were constructed by concatenating three-second epochs from one subject, each containing a target square in the attended location ('square' events, left-hemi field locations 1 or 2 only) followed by a button response ('rt' events). The data were stored in continuous data format to illustrate the process of epoch extraction from continuous data. An EEG data is a random signal so random signal can be consider as EEG data.

IV .EMBEDDED ZERO TREE WAVELET TRANSFORM

Embedded Zero-Tree Wavelet Transform is discovered by Shapiro. The embedded zero tree wavelet algorithm (EZW) is a simple and remarkably effective, image compression [algorithm. This coding algorithm producing an embedded code has the property that the bits in the bit stream are generated in order of importance. This property allows all the low rate codes to be included at the beginning of the bit stream. The EZW algorithm is based on the hypothesis that
"if a wavelet coefficient at a coarse scale is insignificant with respect to a given threshold T, then all wavelet coefficients of the same orientation in the same spatial location at finer scales are likely to be insignificant with respect to given threshold."[4]

Thresholding criterion can be applied for compression depending upon the maximum approximation coefficient. So, the first piece of information to be included in the compressed bit stream is the starting value of T for the first pass. The value of T is chosen as the largest power of two which is smaller than or equal to the largest coefficient magnitude present in the data. This ensures that no coefficient is smaller than –2T or larger than 2T.[1],[2].

Threshold=$2\log_2$ (maximum coefficient)

Depending on the value of the threshold the coefficient can be sorted into two passes:

1. Dominant Pass
2. Refine Pass

1. Dominant Pass:

If a coefficient is larger than T in absolute value, it is encoded as "large" and is kept aside for future updates. Otherwise, it is left for the next pass, and encoded as "small". Again this coefficients are encoded as "large" are encoded using two symbols "positive large" and "negative large" depending on the sign of each coefficient.

2. Refine:

The encoded coefficients kept aside are refined, i.e., a single bit is stored indicating whether the difference between the coefficient and T (or –T) is larger or smaller than half of T .

V. EZW Encoding

When all the wavelet coefficients have been scanned, the threshold T is divided by 2 and the coefficients are scanned again in the next pass in order to add more details to the already encoded signal. This process is repeated until all the wavelet coefficients have been encoded completely or another criterion has been satisfied, e.g., maximum bit rate is reached. An additional technique is used to efficiently encode larger ensembles of coefficients which are below the current threshold. This is done by using a so-called zero-tree. In the 2-D case, a zero-tree is defined as a quad-tree—one root and four descendants—in which all descendants are smaller than or equal to the root as shown in Fig. 2.[1]

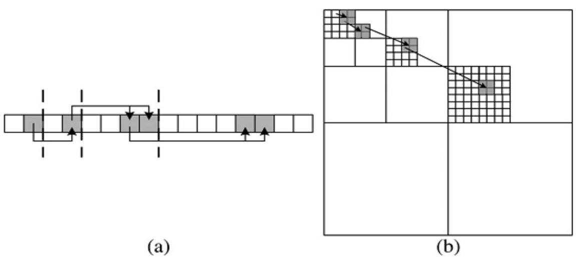


Fig 1. Sample Zero Tree (a) 1-D Decomposition (b) 2-D Decomposition

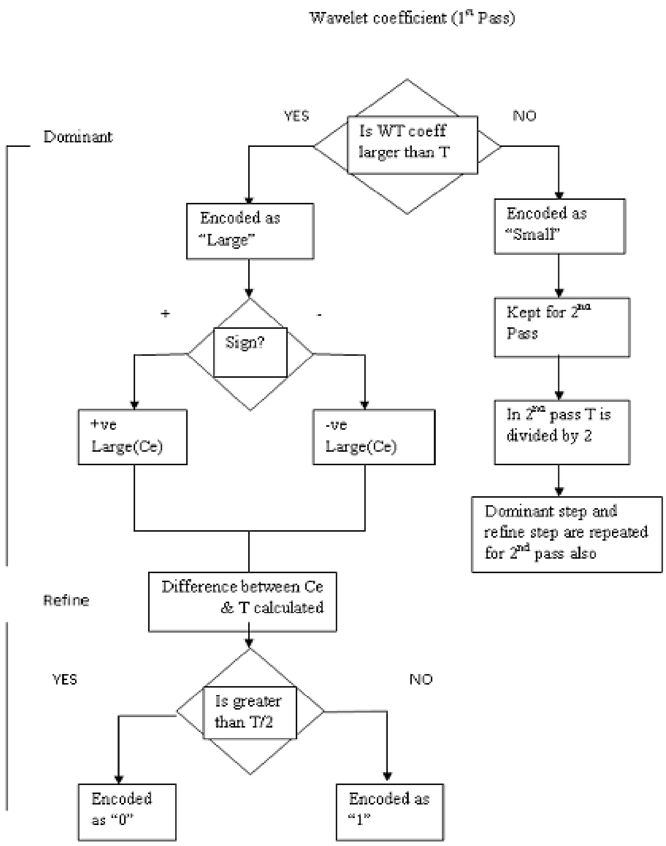
The tree is coded with a single symbol and reconstructed by the decoder as a quad-tree filled with zeroes, if the root is smaller than the current T. This is based on the fact that there is a very high probability that all the coefficients in a quad-tree will be smaller than a certain threshold if the root is smaller than this threshold. In the 1-D case, however, the zero-tree is not a quad-tree anymore but a binary tree, as each element in sub-band points to only two adjacent elements in higher sub-band. rather than four in the 2-D case, as shown in Fig.2

VI EZW Decoding

The EZW decoder begins with the initial threshold value T which depends on maximum coefficient and then starts to fill out the empty table of coefficients with values T , −T , or 0, based on the incoming dominant pass bit stream indicating "larger" (T), "smaller" (−T), and "zero" (0). If the codeword "zero-tree" is defined, then the current placeholder and the children in its binary tree are all set to zero. Then, the refine pass information helps further adjust the value of nonzero coefficients by determining whether the present value of each tracked coefficient is going to be increased or decreased. When it is time to process the next set of dominant pass encoded information, T is divided by 2 and the process repeats again, this time updating the nonzero coefficients already in table and hopefully replacing some other zero coefficients with the value of the new T . In theory, if there is no stop condition at the encoder side, the encoder can encode each coefficient at the finest precision, and the decoder can fully reconstruct it [1].

VI. Conclusion

The method discussed in this paper is most promising and effective technique for single or multi-channel EEG compression.EEG compression can be carried by using EZW technique as this technique gives progressive encoding which can be stopped anywhere or depending upon required bit rate. Data can be compressed using this technique can give good compression ratio. Different Wavelet Transform techniques can also be used to get the better result.



REFERENCES

[1] *Vahid R. Dehkordi, Student Member, IEEE, Hoda Daou, Student Member, IEEE and Fabrice Labeau, Senior Member, IEEE*" A Channel Differential EZW Coding Scheme for EEG Data Compression", IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 15, NO. 6, NOVEMBER 2011

[2] J. M. Shapiro, "Embedded image-coding using zerotrees of wavelet coefficients,"IEEE Trans. Signal Process., vol. 41, no. 12, pp. 3445–3462,Dec. 1993.

[3] S. Sanei and J. Chambers, EEG Signal Processing. Chichester, U.K.: Wiley, 2007.

[4] Neyre Tekbıyık And Hakan Şevki Tozkoparan, "EMBEDDED ZEROTREE WAVELET COMPRESSION", Electrical and Electronic Engineering Department Eastern Mediterranean University.

[5] Y. S. Mo, W. S. Lu, and A. Antoniou, "Embedded coding for 1-D signals using zerotrees of wavelet coefficients," in Proc. IEEE Pacific Rim Conf. Commun., Comput. Signal Process., Aug. 1997, vol. 1–2, pp. 306–309.

[6] N. Sriraam, Member, IEEE ,and C. Eswaran, Senior Member, IEEE" An Adaptive Error Modeling Scheme for the Lossless Compression of EEG Signals", IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 12, NO. 5, SEPTEMBER 2008.

[7] Nasir Memon, Xuan Kong, Senior Member, IEEE, and Judit Cinkler," Context-Based Lossless and Near-Lossless Compression of EEG Signals", IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, VOL. 3, NO. 3, SEPTEMBER 1999.

[8] http://sccn.ucsd.edu/eeglab Matlab Toolbox.