A Survey: A Real Time EEG Data Compression & Transmission for Remote Patient Monitoring System

Mrs.Seema .A.Taywade*, Dr.Mrs.R.D.Raut, Dr.C.G.Dethe*****

* Department of Electronics & Telecommunication
Smt.Kashibai Navale College of Engineering
Pune, India
** Department of Engineering, Electronics & Communication
Shri. Ramdeobaba College of Engineering & Management, Nagpur
Nagpur, India
*** Department of Engineering, Electronics & Communication
Priyadarshini Institute of Engineering and Technology, Nagpur
Nagpur, India

***Abstract*-**Today there is a need for classes of efficient compression and transmission methodology, hardware and languages' for an application which deals great efforts in a short time. The requirement of neurologist is accurate, minute details, meaningful and timely information of EEG data. For this purpose the PMS should get the data which is more accurate, error free and support to the time. Hence there is a need for an efficient compression system and transmission media, which could play a vital role for PMS. The compression of Electroencephalographic (EEG) signal is of great interest to many in the biomedical community. The motivation for this research is the large amount of low amplitude data involved in collecting EEG information which requires storage space and high bandwidth for transmission. Lossless compression of EEG provides the necessity for exact recovery of the data for diagnostic and analysis purposes. Efficient compression and transmission of the EEG signal is a difficult task due to the unpredictability in the signal and also signal is having very low amplitude. Thus with various relevant data compression and transmission for EEG signal could be the great research.

***Index Terms*-** Electroencephalographic(EEG)signal, patient monitoring system(PMS), Compression ratio(CR).

I. INTRODUCTION

EEG is one of the bio signal, which is very important in neurosurgeon point of view to deal with the brain disorder. Basically EEG is electroencephalogram signals, which deals with the brain activity. In telemedicine field using transmission media and compression techniques to deliver bio signals such as ECG, EEG for long distance medical services has become reality and challenge. For the urgent treatment or ordinary healthcare or patient monitoring system, it is necessary to compress and transmit these data for the efficient use of bandwidth. In telemedicine application, transmitting a large amount of data through limited bandwidth and compressed form become a challenge [1].

While transmitting an EEG data, if data is compressed by compression techniques then it will reduce the data volume but significant features are preserved at the time of decompression. EEG data, being the acquired output from biological and physical systems, may possess various properties and characteristics that contribute to their diagnostic value [3].

In general, EEG data compression can be of two types

1. Lossless compression**:**

In the lossless processes the original data can be exactly reconstructed from their compressed form. Lossless compression is typically adopted for text compression. In the lossless compression all information is saved and the compression is reversible[1]. For typical biomedical signals lossless (reversible) compression methods can only achieve Compression Ratios in the order of 2 to1 [11].

2. Lossy compression**:**

Other hand lossy (irreversible) techniques may produce CR results in the order of 10 to 1. In lossy methods, there is some kind of quantization of the input data which leads to CR which is defined as the ratio of the total number of bits used to represent the digital signal before and after Compression, higher CR results at the expense of reversibility. But this may be acceptable as long as no clinically significant degradation is introduced to the encoded signal. The CR levels of 2 to 1 are too low for most practical applications. Therefore, lossy coding methods which introduce small reconstruction errors are preferred in practice [3].

For the means of,

1. Effective and economic data storage.
2. Real time transmission of the signals.

The most efficient data compression technique from all the available lossless data compression techniques needs to be chosen.

II. OVERVIEW OF ALGORITHMS

To meet the requirements of the research, the survey is carried out for the well-functioning of the developed applications. The survey carried comprises of comparison and transmission between various methods to achieve EEG data

compression and transmission. For data compression the basic communication methods could give a best result. Methods like sampling, transforming, filtering and amplifying and coding can give the compression result and by using wireless network the transmission can be achieved. Following survey shows the different result of compression and transmission.

1. Leontios J. Hadjileontiadis [1] has presented a novel information on bio signal and compression standard. In this paper focus is on compression of bio signal and transmission speed in communication. This paper tries to enlighten the compression types, transforms and general issues from a telemedicine prospective.

2. Sangjoon lee, Jungkuk Kim, myoungho Lee [2] deals with the different methodologies for compression of bio signal. This paper focused on real-time algorithms for a periodic bio signal, which supports to e-health services. A mainly author introduces a real time compression and transmission algorithms. The proposed algorithm of this paper shows significantly better performance compared to the performance levels of other algorithms. Moreover, because the algorithm can compress and transmit data in real time, it can be served as an optimal bio signal data transmission method for limited bandwidth communication between e-health devices. The following evaluation factor of compression algorithm is

Sr No	Evaluation factor	Result
1.	Compression Ratio(CR)	21.30
2.	Percentage rms difference (PRD)	1.75
3.	percentage rms difference normalize (PRDN)	24.93
4.	Signal to Noise Ratio (SNR)	13.10
5.	Quality of Service (QS)	12.18

3. N.Sriraam and Eswaran [3] presents a compression of the performances of linear predictor and neural network for near lossless compression of EEG signal. The proposed near lossless scheme produces a transmission of real time as well as offline EEG signals over remote place economically and having less bandwidth utilization compared other lossless and near lossless schemes.

4. N.Sriraam and Eswaran [6] had mention the adaptive error modeling (AEM) schemes for better compression result. Main focus of proposed method is to get high compression ratio. With AEM, obtained compression ratio is 3.23.

5. Ayan Banerjee,Kanad Basu,Aruna Chakraborty [8] has studied on the variation of filter order and past sample size, and finally it has proven that's the Kalman filter is the solution for its very low RMS prediction error in comparison to filter algorithms,which are having high RMS prediction error.

6. Jianbo Gao,Hussian Jing Hu [4] analyze an electroencephalogram- gram (EEG) signal in sleep apnea and show that the adaptive filter algorithm again more effectively reduces the Electrocardiogram (ECG) and other types of noise contaminated in EEG than wavelet approaches. The outcome obtained is that adaptive filter reduces the ECG component contaminant in EEG than wavelet approaches.

7. N.Sriraaam [7] has taken a problem approach to achieve a better compression result by neural network predictor. The

reconstructed EEG signal is evaluated and assessed by using parameters such as PRD, SNR, cross correlation and power spectral density. With low value PRD and single layer perception, reconstructed signal can be preserved for significant information.It produces better compression result compared to lossless scheme.

8. N.Sriraam [11] has reported the work on a context based error modeling for the near lossless compression of EEG signal four neural network models, namely, SLP, MLP, EN and GRNN have been considered and the compression results were compared with adaptive linear predictors such as FIR filter and AR model.

9. Yu-Ting Pai, Fan-Chieh Cheng, Shu-Ping Lu, and Shanq-Jang Ruan, [9] has presented a low bit rate transmission scheme. The contribution of the proposed scheme is the stuffing bit can be reduced conspicuously while keeping a high compression ratio.

10. Cetin, A.E., Köymen, H [10] has given a review on biomedical signal compression methods. Most of the biomedical data compression methods have been developed for bio signal However; these methods can be applied to other biomedical signals with some modifications.

11. Omid Sayadi and Mohammad Bagher Shamsollahi [12], has present efficient denoising and lossy compression schemes for electrocardiogram (ECG) signals based on a modified extended Kalman filter (EKF) structure. This method improves SNR and compression ratio.

12. Tao Ma, Pradhumna Lal Shrestha, Michael Hempel, Dongming Peng, Hamid Sharif, and Hsiao-Hwa Chen [14] has focused on the improvements in communication energy saving, higher transmission quality and security. With a proposed method author tries to reduce the transmission bit under the same compression ratio and proposed method could be applied to multimedia data transmission.

13. Brain J. Roach &Daniel Mathalon has given a detail study of EEG and examine the coupling between frequencies, within trials and within recording sites [13].

14. Yu-Ting Pai,Fan-Chieh Cheng,Shu-Ping Lu, and Shanq-Jang Ruan has given the scheme in which the stuffing bit can be reduced through compression ratio. The proposed Huffman coding is supportive to data transmission [14].

15. Benoit, Latre Bart Braem Ingrid Moerman Chris Blondia,Piet has given a survey on wireless body area network which is very useful for medical application. Network has a wide range of implementations in Medical rehabilitation, digital IDs, military

and ultimately to personal entertainment systems [15].

16. M. Somasundaram and R.Shivakumar.has given survey on the issues related to security and possible solutions taken to address them in the research and the forthcoming IEEE standard. The survey brings out that the current proposed solutions in security are still having limitations needing further research and hence the survey also highlights further areas of research being proposed in the literature [16].

III DISCUSSION

Many algorithms has been proposed for compression and transmission of bio signal and these algorithms are applied on various types of EEG data .As these signals are having very low amplitude so all relevant details should reached to neurosurgeon properly. So there is a need of research in the area of compression and transmission.

Through this study it is very clear that while transmitting a biomedical signal for patient monitoring system it should be free from error, reconstructed signal should be like original one with less communication bandwidth and it should be accurate.

So the algorithm based on sampling can provide good data rate requires by EEG data, different transforming techniques use to improve the compression ratio, noise cancellation and to improve the performance parameter like signal to noise ratio (SNR)can be achieve by filtering and amplifying methods, coding can be used for encoding a data in real time. The mention techniques and methods could produce the best compression ratio.

As per as a wireless transmission media concern the different wireless networks were used for PMS. Channel is used for transmission of the data. The channels are of two types: Wired and wireless. In wireless the increasing use of wireless networks and the constant miniaturization of electrical devices have empowered the development of Wireless Body Area Network (WBAN). With WBAN the reliability of transmission of data, quality of service and security & privacy could be obtained, which is a need of medical applications [16, 17].

IV. CONCLUSION

Compression of EEG data remains an important issue, despite the vast increase in storage capacity and transmission speed in communication pathways. This is due to their diagnostic characteristics, which set a common endeavor to all compression approaches i.e., efficient EEG data compression and transmission yet unaffected diagnostic characteristics. In this paper, algorithms that are commonly used and the ones recently developed are discussed. Over the years there has been an improvement in the detection algorithms but their performance is still not perfect. To address the challenge in real time compression and transmission for EEG data there is still scope to improve the parameters such as compression ratio, bandwidth, Signal to noise ratio (SNR), quality score (QS),cross correlation, reliability of data, quality of service, security and privacies etc.

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AUTHORS

First Author – Mrs Seema.A.Taywade, M.Tech (Electonics Engineering), Smt.Kashibai Navale College of Engg.Pune,India. taywadeseema@yahoo.co.in

Second Author –Dr.R.D.Raut, PhD (Electronics) Department of Engineering, Electronics & Communication Shri. Ramdeobaba College of Engineering & Management, Nagpur,India. raut.rajeshree@gmail.com

Third Author – Dr.C.G.Dethe (Electonics Engineering), Priyadarshini Institute of Engg.& Technology,Nagpur,India. cgdethe@rediffmail.com

Correspondence Author – Mrs Seema.A.Taywade, M.Tech (Electonics Engineering), Smt.Kashibai Navale College of Engg.Pune,India. taywadeseema@yahoo.co.in
Mob.No:9881713403