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# EEG SIGNAL TRANSMISSION METHOD: A COMPREHENSIVE REVIEW

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**Abstract -** In the field of biomedical communication secure transmission of EEG signal is a vital issue. EEG signals reflects the brain activities which help in the determination of brain dysfunction. Chaotic behavior of EEG signal makes it hard to predict . So it should be analyzed by the experts itself. For the effective analysis and treatments either the patients have to move towards the place where experts are available or the experts have to move towards the patient, but both are not the effective if it is an emergency. So that the EEG signal have to be securely transmitted for accurate and timely treatments. In traditional methods copper wires are commonly used for this but the efficiency is very minimum .This paper explains the various studies in the field of EEG transmission

***Key Words*: EEG, Optical, LED, Electrode, wireless.**

## 1. INTRODUCTION

Electroencephalogram is abbreviated as EEG, which is used to determine the brain activities and get into conclusion of various physical and mental stability of a living being. These signals are highly random in nature and hard to predict. Efficient acquisition and transmission is important for the timely treatments. But the secure transmission of this highly sensitive signal is so difficult as it is highly effected by the acquisition time and transmission time noises.

In traditional methods, Copper wires are used for the transmission of the EEG signal but due to the high telephonic charges, low data rate, minimum encryption rate it turn out to be an inefficient method[1].

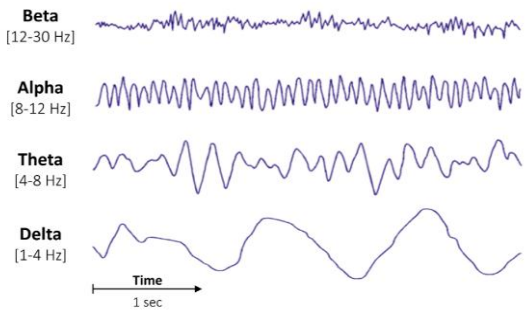
As the technology improves the advancement in field of wireless communication also contributes in effective biomedical signal transmission, but the cost of components and encryption issues remained as the same. Later on different wireless methods with various electronic modules are introduced which provides cost effective communication contributes high speed long distance communications but the channel impairments turn out to be drawback there. Communications but the noise effects are quite high, introduction of optical

Optical communication is an important area of research in the modern days due to its better capability to provide fast and secure way of communication. Optical communication achieves a better place in the biomedical domain also, various biomedical signals including EEG can be effectively transmitted over optic fiber. This paper includes the various studies of EEG signal, their advantages and disadvantages to the latest advancements.

### 1.1 EEG ACQISITION

An EEG test is used to evaluate the electrical activity of the brain and get into the conclusion of various brain disorders. Brain is composed of billions of cells and they are capable of producing very small electrical signals which can be easily captured by placing metal plates called electrodes to the scalp[2]. Thereby non-linear electrical pulses can be captured which are generally known as Brain waves. These brain waves are categorized on the basis of frequencies given in fig 1, normally brain waves are within the frequency range of 3Hz to 35Hz all other signals above and beyond this range is considered as noises.

The first EEG signal acquisition was performed on animals later on the year 1924 Hans Berg recorded first human EEGs. In the year Fisher and Lowenback demonstrated epileptiform spikes. Then the further studies introduced various types of EEG devices which differ in number of electrodes and performance. The advancement brought the EEG acquisition to al level of convenience by acquisition at home itself rather than moving on to the hospital.




Earlier days the normal telephone lines were used for the EEG signal transmission, in this method the collected EEG signal will be transmitted in the form of normal audio signal with frequency modulation [3]. It is helpful in the long distance EEG transmission but the major problems are the lack of encryption and noise effects. The another major issue is the high cost of the copper wire. Later on the advancement in the field of Rf communication led to wireless transmission of EEG signal[4].In this method the acquired EEG signal is given to a

Butterworth bandpass filter to filtered out the EEG to the range of 3Hz to 35Hz, then it convert the signal to its digital domain by Atmega 1281 microcontroller. Then those signals are transmitted to the maxstream X24-019 Rf modem through the microcontroller USART. This method can be used for long distance communication but the noise effect is quite high due to which the performance of the entire system is degraded and slow transmission will be the results.

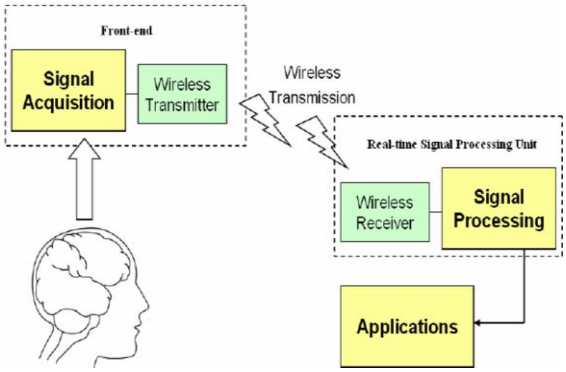



**Fig -2** Wireless EEG Transmission

Later on another research which provides a cost effective manner of EEG acquisition and transmission is introduced in the year 2014 [5]given in Fig 3 and Fig 4. It also follows Wireless mode of communication. In this method the EEG signal is collected by wet electrodes and transmitted to the AD624 for amplification, this amplified signal is then passed over a 4th order Butterworth filter ( Butterworth is used to get sharp cut off frequency). IR based transmitter is used for the transmission .Here the frequency range will be 100Hz rather than the normal 0 to 35 Hz. So that at the receiver side the entire frequency range can be obtained. The usage of wet electrodes will cause electromagnetic interference is the drawback of this proposed method. This method is possible in flexible and mobile BCI paradigms.

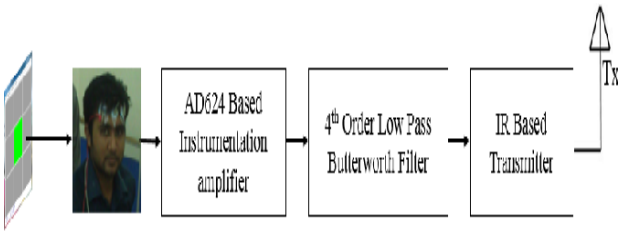



**Fig-3:** Receiver Side

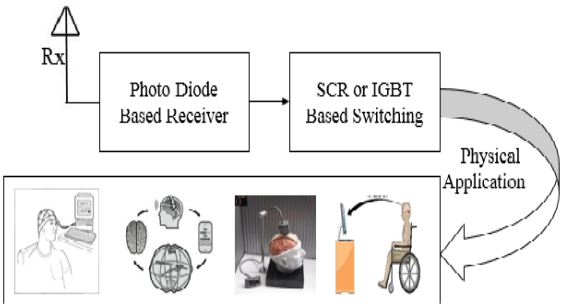



**Fig -4**: Receiver Side

In the research paper [6] explains how effectively this EEG signal can lively transmitted and received at the receiver for timely treatments. This method consist of three components: an upload application, a data server and viewing application. In this method the data will be collected from the person who is suspected to have the neurological condition. The acquired EEG data saved to the file server, the upload application is invoked by the EEG data file. All the data collected will be immediately uploaded to the file server. The upload application periodically determines whether any changes have occurred. If so it will be uploaded. Then the collected data will transmitted to the receiver side and the neurophysiologist at the remote location will be contacted. The system fig 5 is designed in such a way that the experts can log on to the data server and selects the appropriate recording. A window will opens, providing the continuous updated view of collected data for the experts .The disadvantage behind this method is that the users must need certain plugins and a huge possibility of bugs due to the interaction of plugins and acquisition software.

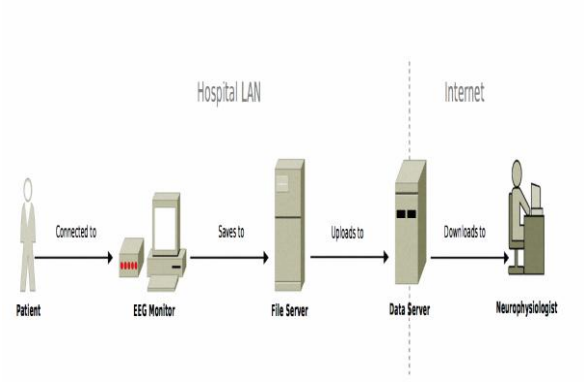



**Fig -5** Live EEG Acquisition

EEG transmission in optical domain is verified by the researchers by using Visible light [7]. In this method the EEG signal is captured using 10 channel electrode and the data stream will followed by sampling and quantization ,the ADC data then modulated by OOK and three duplicated parallel sequence is generated . Each data sequence will follow a particular colour (RGB) for transmission. At the receiver side RGB LED's array is placed to receive the data sequence and each LED array receives the data of its own colour only Fig 4. By this they achieves a synchronization with transmitter. So easily by resampling and dequantization the transmitted EEG signal can be obtained at the receiver side. It is effective method suitable to deal with the highly sensitive nature of the EEG signals. But it provides transmission distance of about 3m only.

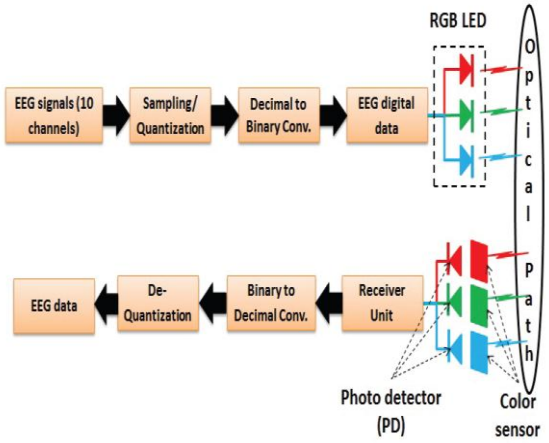



**Fig -6** : EEG transmission using Visible Light

## 2. CONCLUSIONS

EEG signals can be used as an authentic indicator, which allows us to observe mental conditions and brain dysfunctions. It can considered as a highly sensitive chaotic signal. The transmission of EEG has the same importance as that of the its acquisition. EEG signal transmission is an important research area from early years itself. The transmission of EEG is very difficult as it is highly sensitive to noises. In this paper explains the various studies in the field of EEG signal transmission. Achieving long distance without effecting BER is the major issue in EEG based transmission schemes.

## REFERENCES

[1]D. P. Subha, P. K. Joseph, R. Acharya, and C. M. Lim, "EEG signal analysis: A survey," J. Med. Syst., vol. 34, no. 2, pp. 195212, 2010.

[2] https://www.ncbi.nlm.nih.gov/books/NBK390348

[3] Reed M, Gardner, Donald R, Bennet, "Eight Channel data Set For Clinical EEG Transmission Over Dialup Telephone Network" May 1974

[4] https://www.researchgate.net/publication/266663863

[5] M. K. Hasan, R. Z. Rusho, T. M. Hossain, T. K. Ghosh and M. Ahmad, "Design and simulation of cost effective wireless EEG acquisition system for patient monitoring," 2014 International Conference on Informatics, Electronics & Vision (ICIEV), Dhaka, 2014, pp. 1-5, doi: 10.1109/ICIEV.2014.6850797.

[6] P. D. Healy, R. D. O'Reilly, G. B. Boylan, and J. P. Morrison, ``Web-based remote monitoring of live EEG,'' in Proc. 12th IEEE Int. Conf. e-Health Netw. Appl. Services (Healthcom), Jul. 2010, pp. 169_174.

[7] Durai Rajan , Atul Sewaiwar, and vikramadithya Tiwari, "EEG biomedical signal transmission using visible light communication," Internal conference on Industrial instrumentation and control, May 28-30,2015.