ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 7, Issue 10, October 2018

Analysis of Sleep and Awake Bruxism using EEG Signals

Kakul Khan[1],S.Hasan Sayeed[2], Mohd Maroof Siddiqui[3]
Department of ECE, Integral University,Lucknow,U.P.India

ABSTRACT

This paper represent diagnosis of bruxism using EEG signal and there analysis is done using MATLAB. Among the vast growth of the Sciences and technologies, the biomedical enginnering has observed phenomenal growth among all and its impact on the daily life needs no mention. Every aspect of the common life is benefitted by this field. We are working on Analysis of Bruxism using EEG Signals. Bruxism is one of the unsolved problems in dentistry characterized by grinding or clenching of teeth during sleep. The Bruxism is a parafunction, which is an activity that has no utility for the organism. The Electroencephalogram (EEG) is one of the useful bio signals to detect the bruxism. Electroencephalography (EEG) enlighten about the state of the brain i.e. about the electrical bustle going on in the brain. The electrical activity measured as voltage at different points of brain act as basis of EEG. These signals are generally time-varying and non-stationary in nature. These signals can be scrutinized using varioussignal processing technique. Thisresearch highlights the comparison of Normal person and Bruxism person and also their transfer function estimate with fixed length of 1min at different signals , signals like ROC – LOC , EMG and A2 – A1 are used at different frequency and the amplitude and the range of transfer function estimate is also different . In thispaper the comparision is shown between the data of Normal 7 person and of bruxism 1.

1. 1 INTRODUCTION

Bruxism is an oral phenomenon generally described as a parafunctional activity charecterized by grinding or jaw clenchingof teeth during sleep[i].Bruxism is a common oral parafuctional activity found in human or may be animals, according to the reports of prevalence range from 8–31% in the general population [ii]. It is an uncontrollable parafunctionalactivity, which means it is totally irrelevant to normal function like eating or talking.Several symptoms are commonly associated with bruxism, including hypersensitive teeth, fatigue and pain of the masticatory muscles, dull headaches, wearing of the teeth, limitation in mandibular range of motion, ear pain, neck pain, and temporomandibular joint noises, such as popping, clicking, and grating and damage to dental restorations (e.g. crowns and fillings) to teeth and other stress related habits include smoking, drinking alcohol [iii].Although the exact cause of bruxism remains unclear, psychological factors, particularly stress, have been strongly implicated in either causing or exacerbating the signs and symptoms associated with bruxism.The evidence compelled many theorists to describe bruxism as a psychophysiologic disorder. Because bruxism is often expressed nocturnally and is sensitive to psychological influence, it has been suggested that some of these patients suffer from a sleep disorder.Interestingly, only a small number of studies have attempted to find correlations between sleep architecture and nocturnal bruxism. The majority of these reports attempted to either describe in which state of sleep bruxism occurred or to describe how EEG parameters of sleep changed with bruxism events. Most are unaware that they suffer from bruxism or grinding of teeth, but symptoms may be minimal, without patient awareness of the condition.Dental attrition is a type of tooth wear caused by tooth to tooth contact [iv], resulting in loss of tooth tissues. The pathological wear of tooth surface can be caused by bruxism. Figure:1 shows the typical appearance of bruxism.There are two forms of bruxism. First one is sleep bruxism and second is awake bruxism. Dental damage occurs in both type of bruxism, but the symptoms of sleep bruxism tend to be desirable during sleep and better during the course of the day and the symptoms of awake bruxism may not be present during sleep and then desirable over the day. Sleep bruxism is considered asleep related movement disorder such as clenching or grinding teeth during sleep, snoring and pauses in breathing (called sleep apnea).Awake bruxism may be due to emotions such as anxiety, stress, anger, frustration or tension. The exact causes of bruxism are not completely understood, but it may be due to a combination of physical, psychological and genetic factor [v]. According to a survey it is found that, awake bruxism is mostly common in females, whereas males and females are equally affected by sleep bruxism [vi].

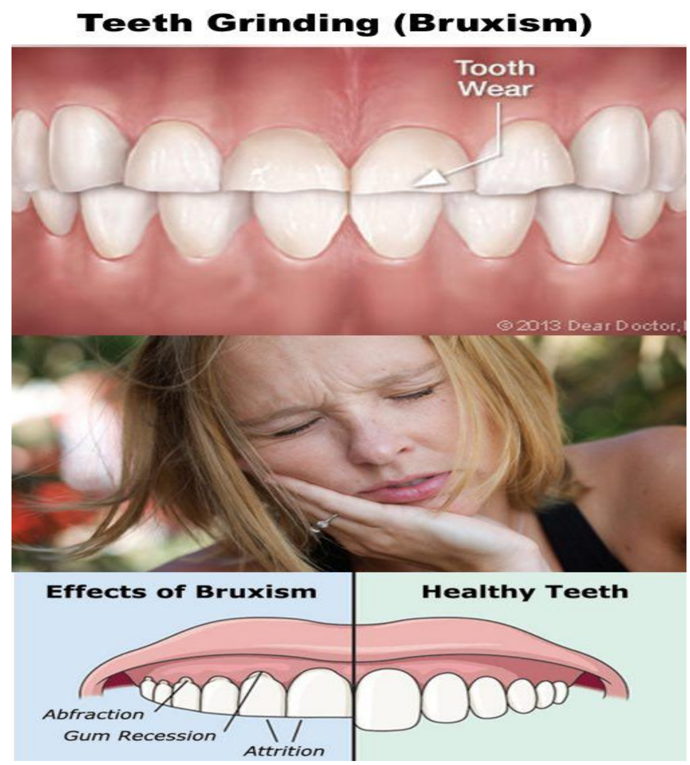


Figure 1: Effect of bruxism

The Electroencephalography (EEG) is one of the useful biosignals to identify the sleep disorder. EEG is a physiological method; it records all of the electrical activity of the human brain from electrodes which are placed on the scalp surface. For faster application, electrodes are mounted in elastic caps similar to bathing caps, ensuring that the data can be collected from identical scalp positions across all respondents.An electroencephalogram (EEG) is a noninvasive test that records electrical patterns from the brain. EEG testing is used to help diagnose conditions such as seizures, epilepsy, head injuries, dizziness, headaches, brain tumors and sleeping problems. Brain death is also confirmed from EEG signal.

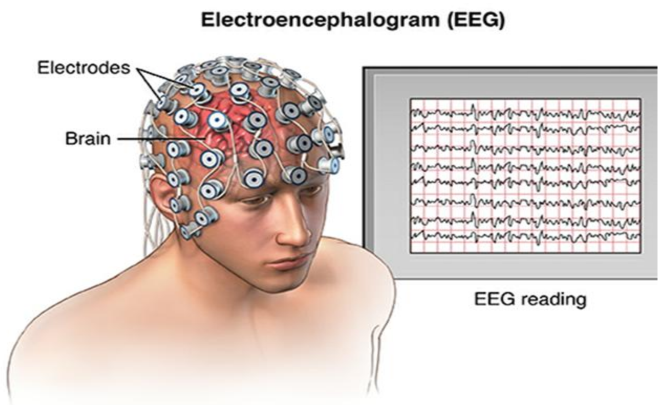


Figure: 2 Electroencephalogram (EEG) signal.

An electroencephalogram (EEG) is a test, which records the electrical activity from the brain. Brain cells are communicating with each other by electrical impulses. An EEG can be used to help detect potential problems associated with this activity. An EEG also tracks and records brain wave patterns.

The existing investigations about EEG signals have shown that the noises in the EEG signal can be eliminated by pre-processing thereby improving the performance EEG analysis, an open source tool box called EEGLAB provided by SCCN lab, running under the cross platform MATLAB environment(The Math works,Inc.) is used for both pre-processing and analysis of the EEG data. The favouring features of EEGLAB for using in this thesis work is that it can be used for processing collections of single-trial and/or averaged EEG data of any number of channels and the available functions in the EEGLAB include EEG data, channel and event information importing, data visualization (scrolling, scalp map and dipole model plotting, multi-trial ERP image plots), pre-handling (counting relic dismissal, sifting, age choice, and averaging), autonomous part investigation and time/recurrence disintegrations including channel and segment cross-intelligibility bolstered by bootstrap measurable techniques in view of information resampling[ix]. The EEGLAB capacities are sorted out into three layers: Top-layer capacities enable clients to cooperate with the information through the realistic interface without expecting to utilize MATLAB language structure. Menu alternatives enable clients to tune the conduct of EEGLAB to accessible memory. Center layer capacities enable clients to modify information preparing utilizing charge history and intuitive 'pop' capacities. Experienced MATLAB clients can utilize EEGLAB information structures and remain solitary flag preparing capacities to compose custom and additionally group examination contents So toward the starting the information investigation was finished utilizing EEGLAB GUI, but later on batch scripts were used. All the standard data analysis functions available in EEGLAB which includes data filtering, data epoch extraction, baseline removal, data resampling and extraction of data epochs time locked to specified experimental events from continuous data were used in this thesis work for the preprocessing of the collected EEG data. The EEG data was at first referenced to Cz electrode while importing the EEG data files which were in biosemi format in to the EEGLAB. At that point the channel areas were foreign for getting data about the account terminals which is vital for plotting EEG scalp maps or to appraise source areas for information parts.

II.Analysis details:

Channel is a sort of electronic gadget without which the entire correspondence framework and flag handling whether computerized or simple will backpedal to the Dark Age. Channel characterizes, contains and gives personality to every client and hence guarantees that the normal flag has been sent to the normal bearing. In flag handling, a channel is a gadget or process that expels from the undesirable part of the flag. Diverse types of channels are utilized for various purposes. Low pass channels are utilized to pass the low recurrence band. Band pass channels are utilized to pass an appropriate recurrence band that is required for wanted applications. For evacuating clamor or cancelation of commotion we utilize different sort of computerized channel.

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 7, Issue 10, October 2018

In flag preparing, there are predominantly two kinds of channels exist they are the Finite Impulse Response (FIR) channel and Infinite Impulse Response (IIR) channel. Limited Impulse Response (FIR) channel can be planned frame Infinite Impulse Response (IIR) channel by different procedures for outlining the FIR channel, the simple channel is first worked by dynamic or uninvolved components. The simple channel is then diagramed appropriately into advanced area utilizing the required IIR channel. At that point by applying legitimate strategy, for the most part applying Fourier arrangement technique ,Frequency testing strategy or Window technique, the FIR channel can be gotten. There are a few issues incorporated into the usage of FIR channels utilizing Fourier arrangement strategy. The sudden truncation of the Fourier arrangement brings about motions in the pass band and stop band. These motions are because of moderate joining of the Fourier arrangement, especially close to the purposes of brokenness. These issues can be unraveled by utilizing a fitting window work. The broadly utilized strategy is the window method. In this work low-pass channel is actualized utilizing an effective movable window work in light of Hanning window work. The yield of the FIR plan by hanning window is completed by recreating the code in Matlab. The Matlab program comes back with an attractive outcome with appropriate greatness plotting[xiii]. FDA device of Matlab is utilized to complete the outline. Low pass channel is utilized to evacuate the high recurrence signals constituting clamor in EEG.The drive reaction, size and stage reactions of the channel are appeared in figure.3.While doing operational commotion and vibration estimations, the Hanning window is usually used Hanning windows are frequently utilized with irregular information since they have direct effect on the recurrence determination and sufficiency exactness of the subsequent recurrence range, particularly when contrasted with the impacts of different windows. The most extreme plentifulness blunder of a Hanning window is 15%, while the recurrence spillage is normally restricted to 1.5 otherworldly lines to each side of the first sine wave signal.The Hanning window begins at an estimation of zero and closures at an estimation of zero. In the focal point of the window, it has an estimation of one. This progressive progress in the vicinity of 0 and 1 guarantees a smooth change in amplitudes while duplicating the window motion with estimated flag, which diminishes the ghastly spillage.

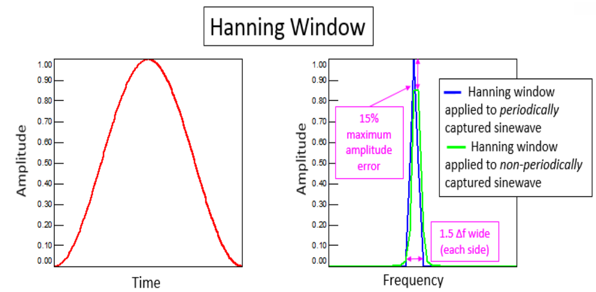


Figure 3. Time domain shape and Frequency domain effect of Hanning window

The window function of a causal Hanning window is given by equation (1).

$$w_{hann}(n) = \begin{cases} 0.5 - 0.5\cos\frac{2\pi n}{N-1}, & 0 \le n \le N-1 \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

The window function of a non-causal Hanning window is given by equation (2).

$$w_{hann}(n) = \begin{cases} 0.5 - 0.5\cos\frac{2\pi n}{N-1}, & 0 < |n| \le \frac{N-1}{2} \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

The width of the main lobe is approximately $8\pi/N$ and the peak of the first side lobe is at -32dB.

Estimating the transfer function and impulse response of a system from test data isanother situation where is is useful to have simultaneous time and frequency information. When estimating the impulse response, it is reasonable to make the restriction that the impulse response be causal and time limited[xii]. In addition, the frequency content of the transfer function should only include those frequencies that are physical realizations of the system, as opposed to noise or outside disturbances. Therefore, in order to restrict both the time and frequency characteristics of the data, there is a need for a time-frequency representation.

The general representation of a time-frequency transform is

$$X(f,p) = \sum_{p=1}^{N_W} \sum_{n=0}^{N-1} \left(x_n, w_{pn}\right) e^{-j2\pi fn\,\Delta t} \quad (3)$$

Where, w_{pn} is a set of N_W windows that filter sections of x. The set of windows essentially divide the signal into several segments or data blocks. The resulting representation of x is in matrix form, containing frequency content information for each windowed segment of the signal.

Estimating the Impulse Response

The impulse response is related to the system input and output by

y(t) = g(t) * u(t) + e(t) (4)

$$= \int_{-\infty}^{\infty} g(\tau)\,(t - \tau)d\,\tau + e(t)$$

Where, * is the convolution operator, y(t) is the output, g(t) is the impulse response, u(t) is the input, and e(t) is the disturbance or noise. Because the input and output data is sampled and finite, the convolution integral of Equation 3 must be approximated in discrete time as the sum

$$y_n = \int_{k=0}^{m-1} g_k u_{n-k}\,\Delta t + e_n \quad (5)$$

Where, each output data point depends on m previous input data points, N is the total number of sampled data points and the noise, en, is assumed to be white noise with zero mean and variance.

Fourier transforms of the correlations, φ_{yu} and φ_{uu} , are the crossspectral density φ_{yu} , and the power spectral density φ_{uu} ,. Since calculating the information matrix and vector of any Equation is very close to calculating the correlations, φ_{yu} , and φ_{uu} , it follows that estimating the impulse responsein the time domain using

$$\breve{g} = (U^T U)^{-1}(U^T y) \quad (6)$$

is analogous to using spectral analysis in the frequency domain to calculate the Empirical Transfer Function Estimate (ETFE) given by

$$\breve{G}(w) = \varphi_{uu}(w)^{-1}\varphi_{yu}(w) \quad (7)$$

Time-Frequency Decomposition

After obtaining an estimate of the impulse response, it is mapped from a one dimensional representation in time to a two dimensional representation in time andfrequency[xv]. In order to achieve this, the time-frequency transform of Equation 3 isused. The transform of the impulse response is given by

$$G(f,p) = \sum_{p=1}^{N_W} \sum_{n=0}^{N-1} \left(g_n, w_{pn}\right) e^{-j2\pi fn\,\Delta t} \quad (8)$$

The purpose of the set of windows, w_{pn}, is to divide the impulse response into N_W segments or data blocks and to simultaneously filter each block

PhysioNet offers free access by means of the web to expansive accumulations of recorded physiologic flags and related open-source programming. The PhysioNet site is an open administration of the PhysioNet Research Resource for Complex Physiologic Signals, supported by the National Institute of Biomedical Imaging and Bioengineering (NIBIB) and the National Institute of General Medical Sciences

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 7, Issue 10, October 2018

(NIGMS) at the National Institutes of Health. The PhysioNet Resource, set up in 1999, is expected to invigorate ebb and flow look into and new examinations in the investigation of complex biomedical and physiologic signs. It has three firmly reliant segments:

PhysioBankis a substantial and developing chronicle of all around portrayed advanced accounts of physiologic signs, time arrangement, and related information for use by the biomedical research group. PhysioBank as of now incorporates in excess of 60 accumulations of cardiopulmonary, neural, and other biomedical signs from sound subjects and patients with an assortment of conditions with real general wellbeing suggestions, including sudden cardiovascular demise, congestive heart disappointment, epilepsy, step issue, rest and maturing. These accumulations incorporate information from an extensive variety of studies, as created and contributed by individuals from the exploration group.

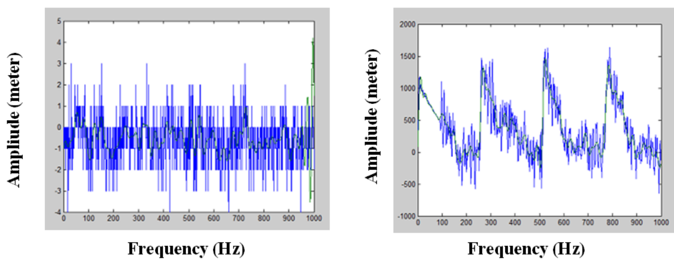
PhysioToolkit is an expansive and developing library of programming for physiologic flag handling and examination, location of physiologically noteworthy occasions utilizing both traditional procedures and novel strategies in light of measurable material science and nonlinear elements, intelligent show and portrayal of signs, making of new databases, recreation of physiologic and different signs, quantitative assessment and correlation of investigation techniques, and investigation of nonequilibrium and nonstationary forms. A bringing together subject of a significant number of the examination extends that contribute programming to PhysioToolkit is the extraction of "shrouded" data from biomedical signs, data that may have indicative or prognostic incentive in drug, or logical or prescient power in essential research. All PhysioToolkit programming is accessible in source shape under the GNU General Public License (GPL). For data about the PhysioToolkit programming, visit the PhysioTookit Software Index.

PhysioNetWorks is a virtual lab where you can cooperate with us and with associates anyplace on the planet to make, assess, enhance, report, and get ready new information and programming "works" for production on PhysioNet. Not at all like every other piece of the PhysioNet site, access to PhysioNetWorks is secret word ensured. (Records are free and a secret key can be acquired in a moment or two.) PhysioNet Works gives dependable and secure web-open reinforcement, devices for survey and clarifying your information intelligently, and a dynamic group of in excess of 3000 scientists around the globe who can help you by commenting on, breaking down, and looking into your information, and maybe by contributing extra significant information. In excess of 70 collective activities are as of now in progress.

PhysioNet isn't just the name of the Resource, yet additionally of its site, physionet.org. The PhysioNet site was set up by the Resource as its instrument for nothing and open scattering and trade of recorded biomedical flags and open-source programming for breaking down them, by giving offices to helpful investigation of information and assessment of proposed new calculations. Notwithstanding giving free electronic access to PhysioBank information and Physio Toolkit programming, and secure workspaces for synergistic improvement of new information and programming inside Physio Networks, the PhysioNet site offers administration and preparing by means of on-line instructional exercises to help clients at passage and further developed levels. In participation with the yearly Computing in Cardiology meeting, PhysioNet has a yearly arrangement of difficulties, in which analysts and understudies address unsolved issues of clinical or essential logical enthusiasm utilizing information and programming gave by PhysioNet.

III.Results

In this paper we will discuss about the comparison of Bruxism and normal person plots and also their transfer function estimate with fixed length of 1 min at the different signals. In this paperthe comparison is done between data of 1 person who have bruxism and data of 7 normal person, which can be written as 'Bruxism 1 and normal 7'. The graph is plotted between amplitude and frequency. The range of frequency is swept from 100Hz to 1000 Hz and range of amplitude is swept from -4m to 5m for normal 7 and for bruxism 1 range of frequency swept from 0 to 1000 Hz and amplitude from -1000 m to 1000m as shown in figure1(a, b).

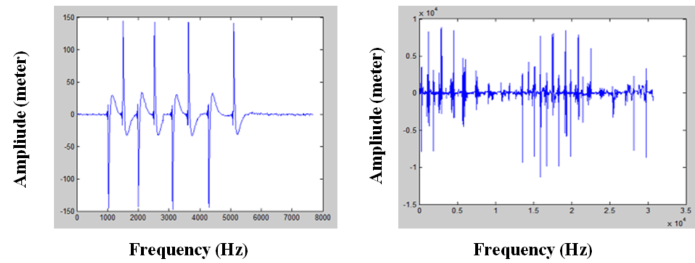


(a) (b)

Figure 4: Comparison between normal 7 and bruxism 1 **(a)**Graph between frequency and amplitude for normal 7
(b) Graph between frequency and amplitude for bruxism 1.

From figure 4 (a, b), it is clearly shown that there is significant difference between the signals for normal 7 and and bruxism 1.In normal 7 signal O2 – A1 is used and in bruxism 1 signal ROC - LOC is used with fixed length which is 1 min. Same database is applied in both the plots i.e. CAP Sleep Database (capslpdb).Normal 7 and Bruxism 1 , their Annotations is also similar is sleep stage and CAP phase A annotations (st) and Time Format is time/data is also same in both the plots and Data Format is also similar which is standard but their plots are far different from each other.

Second comparison is done between Normal 7 and Bruxism 1 and their graph is plotted between amplitude and the frequency as first comparison, the only difference is that their ranges are different. In Normal 7 , amplitude range is -150m to 150m and frequency range is 1000Hz to 8000Hz and in Bruxism 1 , amplitude range is 1.5m to 1×10^4m and frequency range is 0.5Hz to 3.5×10^4 Hz. The graph is shown in figure 5(a, b).



(a) (b)

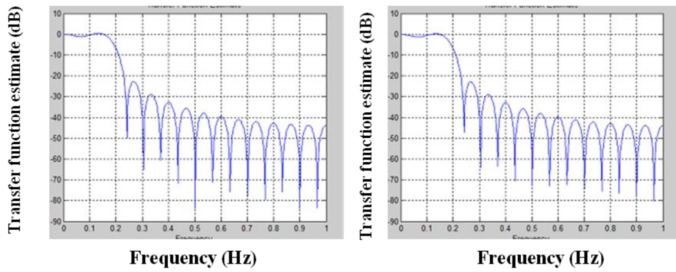
Figure 5: Comparison between normal 7 and bruxism 1 **(a)** Graph between frequency and amplitude for normal 7
(b) Graph between frequency and amplitude for bruxism 1.

From figure 5 (a, b), it is clearly shown that there is significant difference between the signals for normal 7 and bruxism 1. In normal 7 signal O2 – A1 is used and in bruxism 1 signal ROC - LOC is used with fixed length which is 1 min. Same database is applied in both the plots i.e. CAP Sleep Database (capslpdb). Normal 7 and Bruxism 1 , their Annotations is also similar is sleep stage and CAP phase A annotations (st) and Time Format is time/data is also same in both the plots. Data Format is also similar which is standard. Their plots are also totally different from each other.

Third comparison is donefor Transfer function estimate of Normal 7 and Bruxism 1. Their graph is plotted between transfer function estimate and the frequency and their ranges are similar in both the plots. Range of Transfer function estimate is from -90dB to 10dB and the range of frequency is 0.1Hz to 1Hz. Their plots are shown in figure 5(a , b). It is shown that there is no significant change in signals for normal 7 and bruxism 1.In normal 7 signal O2 – A1 is used and in bruxism 1 signal ROC - LOC is used with fixed length which is 1 min. Same database is applied in both the plots i.e. CAP Sleep Database (capslpdb).Normal 7 and Bruxism 1 , their Annotations is also similar is sleep stage and CAP phase A annotations (st)

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 7, Issue 10, October 2018

and Time Format is time/data is also same in both the plots. Data Format is also similar which is standard. The variations in plot 6(a) and 6(b) is at point 0.5 and 0.9 their transfer is different from each other.



(a) (b)

Figure 6: Comparison between normal 7 and bruxism 1 **(a)** Graph between frequency and Transfer fuction estimate for normal 7 **(b)**Graph between frequency and Transfer fuction estimate for bruxism 1.

IV.Conclusion:

In this paper, comparison of Bruxism 1 with Normal 7 has been done at different signals with fixed length i.e. 1 min. The variation of amplitude with different frequency and the transfer function estimate at has been discussed through the comparison of Bruxism 1 with Normal 7 . This research work providedthe researchers, to understand the difference between normal person and those person who has been suffering from bruxism. Comparison of Bruxism 1 Normal 7 has been measured at different signals , in this research paper signal ROC-LOC , EMG and O2-A1 is used. From the analysis it has been seen that there is significant change in signals amplitude at different frequenciesfor normal 7 and bruxism 1 but there is no significant change in transfer function estimate of signal at different frequencies for normal 7 and bruxism 1.The statistical features are analyzed and it is inferred that discrimination between normal and bruxism segments can be performed in an better manner if these are included along with spectral features. From the analysis it has been seen that there is significant changes in signals amplitude at different frequencies for normal 7 and bruxism 1 but there is no significant change in transfer function estimate of signal at different frequencies for normal 7 and bruxism 1.These signals can be scrutinized using various signal processing

References-:

[i]Wassell R, Naru A, Steele J, Nohl F (2008).Applied occlusion. London: Quintessence. pp. 26–30. ISBN 9781850970989.

[ii]Manfredini D, Winocur E, Guarda-Nardini L, Paesani D, Lobbezoo F (2013). "Epidemiology of bruxism in adults: a systematic review of the literature". Journal of Orofacial Pain. 27 (2): 99–110. doi:10.11607/jop.921. PMID 23630682.

[iii]Tyldesley WR, Field A, Longman L (2003). Tyldesley's Oral medicine (5th ed.). Oxford: Oxford University Press. p. 195.ISBN 0192631470.

[iv] Darby, M., Walsh, & EBL ebook. (2009). Dental Hygiene Theory and Practice. (3rded.).London:Elsevier Health science.

[v]Cawson RA, Odell EW, Porter S (2002).Cawsonś essentials of oral pathology and oral medicine (7th ed.). Edinburgh: Churchill Livingstone. pp. 6,566,364,366.ISBN 0443071063.

[vi]Shetty S, Pitti V, SatishBabu CL, Surendra Kumar GP, Deepthi BC (September 2010). "Bruxism: a literature review". Journal of Indian Prosthodontic Society. 10 (3): 141–8. doi:10.1007/s13191-011-0041-5. PMC 3081266 Freely accessible.PMID 21886404.

[vii] Pawel S Kostka, Ewaryst J Tkacz, Multi-sources data analysis with sympatho-vagal balance estimation toward early bruxism episodes detection. Member, IEEE 978-1-4244-9270-1/15/2015 IEEE

[viii] T.V.K.H. Rao and DhongadeDayanandVishwanath, Detecting Sleep Disorders Based on EEG Signals by Using Discrete Wavelet Transform, ELSIEVER, vol. 42, pp. 109–116, 2014

[ix] Tommasocastroflorio, lucamesin, gianlucamartinotartaglia, chiarellasforza, and dario farina, use of electromyographic and electrocardiographic signals to detect sleep bruxism episodes in a natural environment, IEEE journal of biomedical and health informatics, vol. 17, no. 6, november 2013

[x] N antawacharaJirakittayakom, Y. odchananWongsawat , An EMG Instrument Designed for Bruxism Detection on Masseter Muscle,2014 Biomedical Engineering International Conference (BMEiCON-2014) :26,S91-S97.

[xi] Basson RA. The Significance of Sub Threshold Symptoms of Anxiety inthe Aetiology of Bruxism [master's thesis]. Cape Town, South Africa:University of the Western Cape; 2007.

[xii] A. Palumbo,C.Pace , An example of System on Chip design for biomedical applications: bruxism therapy" Computer Science and Systems, University of Calabria

[xiii] Bertrand O, Bohorquez J, Pernier J. Time-frequency digital filtering based on an invertable wavelet transform: An application to evoked potentials. IEEE Transactions on Biomedical Engineering, 41 (1): 77-88, 1994

[xiv]Noriyuki Narita , Masahiko Funato, Effects of jaw clenching while wearing an occlusal splint on awareness of tiredness, bite force, and EEG power spectrum, January 2009, Elsevier Ireland.

[xv] Dora, Ballesteros, M., Andrés,. Gaona and Luis, Pedraza F. Discrete Wavelet Transform in Compression and Filtering of Biomedical Signals. *INTECH Europe*