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Detection of Periodic Limb Movement with the Help of Short Time Frequency Analysis of PSD Applied on EEG Signals

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Abstract: Periodic limb movement disorder (PLMD) is recurring cramping or jerking of the legs during sleep. "Periodic" refers to the detail that the actions are recurring and rhythmic, arising concerning every 20-40 seconds. The detailed disorder discussed below is the Periodic Limb Movement (PLM). As the name suggests, PLM is the periodic movement of the inferior part of leg during the sleep hours of a human being. It takes place at some definite period of time in this paper we diagnose the PLM through EEG signals. In this research article, quality and waveform of EEG Signals of human being are analyzed. The plan of this examine is to draw the consequence in the form of signal range analysis of the changes in the domain of dissimilar stages of sleep.

Keywords: PLM, Analysis of EEG Signal, Estimation of PSD.

1. INTRODUCTION

Periodic Limb Movement (PLMD) is repetitive cramping or jerking of the legs during sleep. It is the only movement disorder with the purpose of occurs only throughout sleep, and it is sometimes called periodic leg (or limb) actions during sleep. "Periodic" refers to the fact that the actions are recurring and rhythmic, occurring about every 20-40 seconds. PLMD is also careful a sleep disorder, because the movements often interrupt sleep and lead to daytime tiredness.PLMD may happen with other sleep disorders. It is often concurrent with restless legs syndrome, but they are not the similar thing. Restless legs syndrome is a state involving odd sensations in the legs (and sometimes arms) while conscious and an irresistible urge to move the limbs to alleviate the feelings.

2. SYMPTOMS OF PERIODIC LIMB MOVEMENT

The most common symptoms with PLMD are not leg movements but unfortunate sleep and daylight sleepiness. Many persons with PLMD are uninformed of their leg movements except their bed associate tells them. Leg movements grip single or both limbs. Naturally the knee, ankle and big toe joints all curve as part of the movements. The movements vary beginning slight to exhausting and wild kicking and beatinsg. The movements last about 2 seconds (and thus are much slower than the leg jerks of myoclonus). The movements are recurring and recurring and occur every 20-40 seconds.

3. DETECTION OF PERIODIC LIMB MOVEMENT

There is no lab examination or imaging learns that can prove that being have PLMD. However, certain tests can recognize underlying medicinal causes such as anaemia other deficiencies, and metabolic disorders that might cause PLMD. You may have blood strained to check your blood cell counts and hemoglobin, essential organ functions, chemistry, and thyroid hormone levels. Also may be checked for convinced infections that could cause secondary PLMD. A urine example may be composed to check for traces of drugs that can source sleep problems. Polysomnography (sleep lab testing) is the only way to corroborate that you have PLMD. As person should sleep in the lab, leg movements can be recognized.

4. EEG SIGNAL ANALYSIS

We consider about 10 PLM disorder cases and 7 normal cases. Data collected from physionet.org On giving command load (matName) the signal with matName'plm1rem_edfm.mat' is loaded in MATLAB workspace and the name of various signal and their details are loaded from file 'plm1rem_edfm.info'. Load (matName) command gives a signal in workspace named as 'val'. This figure shows the full signals and is on time basis. The signal is of 1 minute.

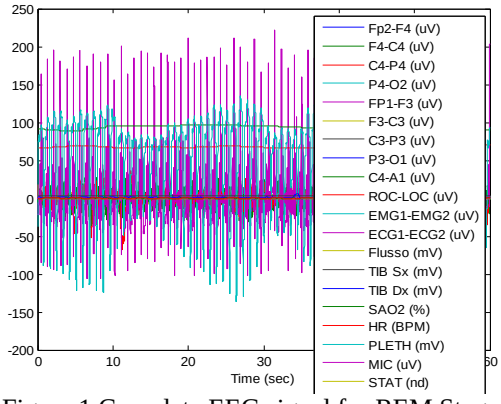

Figure 1 Complete EEG signal for REM Stage

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4.2 Extraction of Channel

As discussed in the previous topic, we took the EEG signal where all the channels are interwoven in a single signal. Now from that figure 1 we extracted different common channels of all insomnia patients:

ROC-LOC, C4-P4, C4-A1, F4-C4, ECG1-ECG2, EMG1-EMG2, P4-O2.

The channels shown here are C4-P4.Figure 2 is based on frequency basis. Here the frequency is 256 Hz.
C4-P4

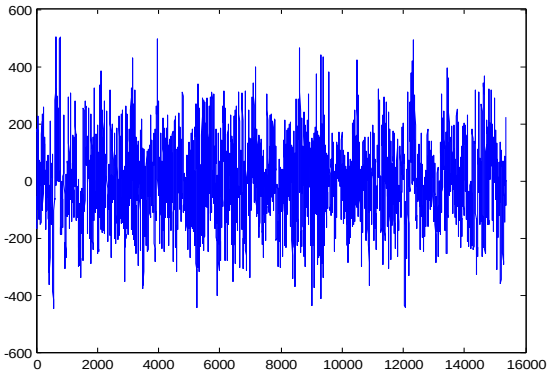

Figure 2 Different extracted signals on frequency basis

Now the figure 3 is based on time respect. The duration of clipped signal is 1 min (60 seconds) consisting of EEG signal of respective channel for S0 sleep stage.
C4-P4

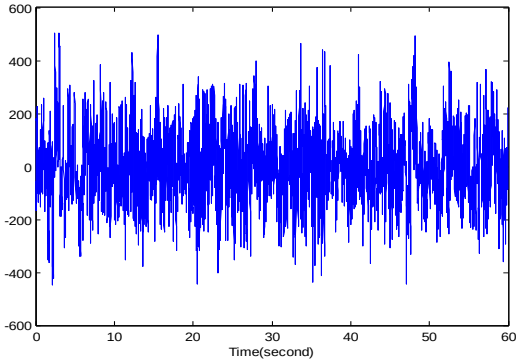

Figure 3 extracted different signals on time basis for REM stage

4.3 Filtering of EEG Signals

C4-P4

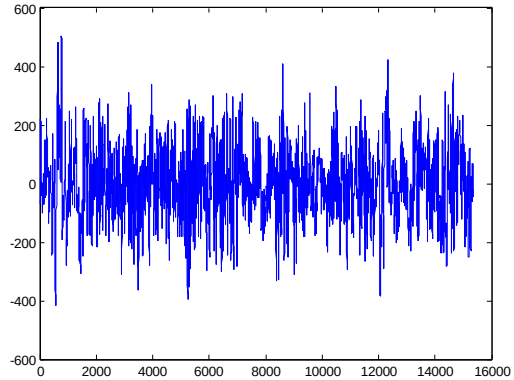

Figure 4.Extracted different filtered signals for REM stage

Now each clipped signal is pre-processed and then passed through the Hanning window low pass filter for removing the high frequency component that eventually indicate noise because major proportion of EEG signals are limited within the range of 25 hz. Hence, the filter based in FIR filter design of order 200 with cut off frequency of 25 Hz with shape of hanning window is designed for low pass filtering of each sleep stage.

4.4 Comparison between Filtered and Non filtered signals

The differences between original and filtered waveform is shown in figure 5. The MATLAB function 'filtfilt', which is a zero-phase filtering, is used as the filtering method. Now both the original and filtered waveform is cut in 1:1000 ratios which give the detail on the minute differences of both signals.
C4-P4

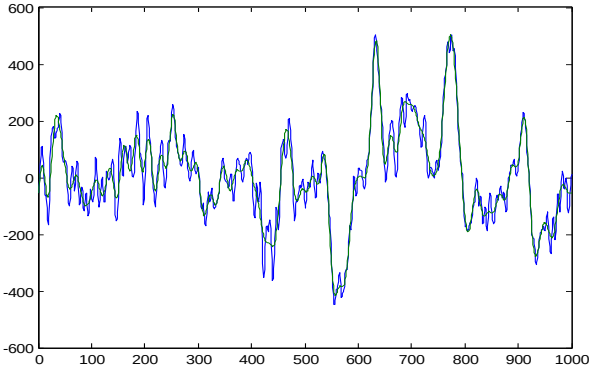

Figure 5 Differences between original and filtered signal

4.5 Estimation of Power Spectral Density

An enhanced estimator of the PSD is the one projected by Welch. The technique consists of separating the time series statistics into (possibly overlapping) segments, computing a modified periodogram of each section, and then averaging the PSD estimates.

The result is Welch's PSD approximation. Welch's method is implemented in the toolbox by the 'spectrum.welch' object. Since PSD gives signal power with admiration to the frequency spectrum, we require specifying the number of frequency slots to distribute the spectral power. It is called as number of FFT points (NFFT). The figure 6 is showing power spectral density (PSD) of different channels.
C4-P4

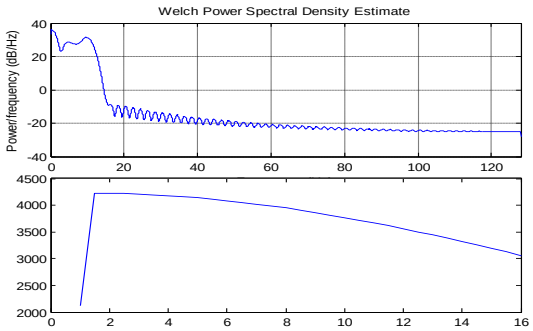

Figure 6 PSD Estimation

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5. RESULT & CONCLUSION

Normalized power of normal cases having no symptoms of sleep disorder is analyzed and compared with pathological cases. Normalized power indicates the percentage of a particular EEG activity out of complete power. So it is found a better indication of measurements of detection of features instead of taking average power of particular activity.

For delta activity normalized power for normal cases of C4-A1 channel is found in range of 0.34 to 0.35. Same calculations for cases under PLM disorder is found in range of 0.40 to 0.70 i.e. normalized powers for delta activity during S0 stage for PLM disorder is quite high in comparison to normal cases (see table 1).

Table 1:

StageS0	N1	N2	N4	PLM1	PLM2	PLM3	PLM5	PLM7
P_delta (normalized)	0.34611	0.34519	0.3553	0.70894	0.57799	0.67007	0.40326	0.46403
	LOW			HIGH				

For delta activity normalized power for normal cases of F4-C4 channel is found in the range of 0.30 to 0.44.

However average power cannot help in drawing such conclusion using data activity. The observation related to normalized power during theta, alpha and beta activity do not show any distinguishing values to recognize the detection features related to normal or related disorder.

We consider about 10 PLM disorder cases and 7 normal cases. Most significant figure is found in delta activity for PLM patients.

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BIOGRAPHIES

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[2]Dr. Geetika Srivastava received her M.Tech, Ph.D. (Electronics) She has very sound academic record with various awards and gold medals to her credit. She is having more than 10 years of teaching experience and written books on VLSI and Solid State electronics. Shehas published many reputed international journal research papers and qualified UGC-NET Examination in Electronics Science. She is working as Assistant Professor in AMITY School of Engineering and Technology, Amity University Uttar Pradesh.

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