



Full length article

Diagnosis of insomnia sleep disorder using short time frequency analysis of PSD approach applied on EEG signal using channel ROC-LOC

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ABSTRACT

Insomnia is a sleep disorder in which the subject encounters problems in sleeping. The aim of this study is to identify insomnia events from normal or effected person using time frequency analysis of PSD approach applied on EEG signals using channel ROC-LOC. In this research article, attributes and wave-form of EEG signals of Human being are examined. The aim of this study is to draw the result in the form of signal spectral analysis of the changes in the domain of different stages of sleep. The analysis and calculation is performed in all stages of sleep of PSD of each EEG segment. Results indicate the possibility of recognizing insomnia events based on delta, theta, alpha and beta segments of EEG signals.

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1. Introduction

The complexity of the human brain is one of the most well documented fields of academic study. Nowadays multiple technologies exist to record brain wave patterns, Electroencephalography being one of them. Through Electroencephalogram based signals, a better understanding of the complex inner mechanisms and their association with psychological and psychiatric disorders can be established [1].

Insomnia or sleeplessness is a sleep disorder in which there is an inability to fall asleep or to stay asleep as long as desired. Insomnia is characterized by:

1. Frequently waking up during the night.
2. Waking up early.
3. General feeling of exhaustion.
4. Deficit concentration prowess.
5. Feeling slow and not-refreshed during the day.

Insomnia cases have seen a rapid climb over the past few years and coupled with pain and fatigue is one of the most common

disorders in urban societies. Even though cases of insomnia are at alarming levels, awareness about it is at abysmal levels, both in victims and doctors. Compounding the issue is the fact that there are no widely accepted forms standard treatments [2].

DSM-5 criteria for insomnia contain the following:[13].

- Predominant grievance of dissatisfaction with sleep quantity or quality, associated with one (or more) of the following symptoms:
- Difficulty initiating sleep. (In children, this may manifest as difficulty initiating sleep without caregiver intervention.)
- Difficulty maintaining sleep, characterized by frequent awakenings or problems returning to sleep after awakenings. (In children, this may manifest as difficulty returning to sleep without caregiver intervention.)
- Early-morning awakening with inability to return to sleep.

General sleepless nights happen to everyone, leading to the misappropriation that insomnia is a natural reaction of an organism to tension or noise. However, insomnia is not symptom of other disorders but secondary to other medical conditions. The effects generated due to insomnia are:

1. Daytime sleepiness.
2. Irritable mood.
3. Increased possibility of workplace accidents.
4. Inability to effectively operate machinery.
5. Lapse in concentration while driving.

Abbreviations: EEG, Electro Encephalogram; ROC-LOC, Right of Central & Left of Central; PSD, Power spectrum Density

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2. Classification of insomnia

2.1. According to etiology

2.1.1. Insomnia disorder

When insomnia has no recognized physical (pain), affecting (depression/anxiety), Environmental (noise at night) or substance (drugs) cause, the condition is called Insomnia Disorder.

2.1.2. Comorbid Insomnia

This is when the victim has sleep problems because of something else, such as a fitness condition like asthma, depression, arthritis, cancer or stomachache; pain; drug being taken; or a material being used, like alcohol [3].

2.2. According to sleep pattern

2.2.1. Sleep-onset insomnia

When the victim takes a long time to get to sleep, but can sleep through the dark once sleep starts.

2.2.2. Sleep-maintenance insomnia

When sufferer wakes regularly during the night and sleep is fragmented [4].

2.3. According to duration

2.3.1. Transient insomnia

Durable less than a week. This is the most common and extensive form among the population.

2.3.2. Acute insomnia

Lasting between one and four weeks. It is connected to stress factors, but more longer-lasting than for transitory insomnia.

2.3.3. Chronic insomnia

Lasts for four or more weeks and may be due to essentially causes in the organism, eg a long-term physical or psychiatric sickness or it may have no obvious underlying cause [2].

3. Subject details and recorded data

Total twenty five volunteer subjects' were selected for this study [5]. Nine subjects were suffering from the sleep disorder of insomnia and sixteen subjects were referred to as the normal group. The subject's details like gender, age, sleep duration of each stage etc. were taken. The subject demographics of both groups are shown in Tables 1 and 2 Respectively.

4. Analysis of EEG signal

4.1. Load EEG data

Load EEG Signals from physionet.org [5] in MATLAB workspace and the name of various signals Load (matName) command gives a signal in workspace named as 'val'.

Fig. 1 shows the full signals and is on time basis. The signal is of one minute [6].

4.2. Extracting EEG signals

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

ROC-LOC, C4-P4, C4-A1, F4-C4, ECG1-ECG2, EMG1-EMG2, P4-O2 [6,7].

The channels shown here are C4-A1 and ROC-LOC. Fig. 2 is based on frequency basis. Here the sampling frequency is 256 Hz.

4.3. Extracting stage of sleep from EEG signal

Now the Fig. 3 is based on time respect. The duration of clipped signal is 1 min (60 s) consisting of EEG signal of respective channel for S0 sleep stage.

4.4. Filtering of EEG signals

Now each clipped signal is preprocessed and then passed through the Hanning window low pass filter for removing the high frequency components that eventually indicate noise because major proportion of EEG signals are limited within the range of

Table 1

Normal person recorded data.

S. NO.	SUBJECT	SLEEP TIME DURATION OF S0 SLEEP STAGE		SLEEP TIME DURATION OF S1 SLEEP STAGE		SLEEP TIME DURATION OF S2 SLEEP STAGE		SLEEP TIME DURATION OF S3 SLEEP STAGE		SLEEP TIME DURATION OF S4 SLEEP STAGE		SLEEP TIME DURATION OF REM SLEEP STAGE		
		G	P ID A	START TIME	END TIME	START TIME	END TIME	START TIME	END TIME	START TIME	END TIME	START TIME	END TIME	START TIME
1	F N1	37	22:09:33	22:10:33	06:19:33	06:20:33	23:29:33	23:30:33	00:35:03	00:36:03	22:40:33	22:41:33	23:36:33	23:37:33
2	M N2	34	22:19:06	22:20:06	00:44:06	00:45:06	23:20:06	23:21:06	22:47:06	22:48:06	22:52:06	22:53:06	00:20:36	00:21:36
3	F N3	35	23:10:42	23:11:42	04:57:42	04:58:42	23:55:12	23:56:12	23:20:42	23:21:42	23:25:12	23:26:12	01:00:42	01:01:42
4	F N4	25	22:36:37	22:37:37	06:41:37	06:42:37	23:54:07	23:55:07	03:33:07	03:34:07	00:29:07	00:30:07	01:07:37	01:08:37
5	F N5	35	22:49:48	22:50:48	22:53:18	22:54:18	00:01:18	00:02:18	00:52:48	00:53:48	01:05:48	01:06:48	01:18:48	01:19:48
6	M N6	31	22:38:39	22:39:39	NA	NA	23:03:39	23:04:39	01:03:39	01:04:39	00:34:39	00:35:39	23:58:09	23:59:09
7	M N7	31	22:21:11	22:22:11	06:27:41	06:28:41	00:00:41	00:01:41	03:21:41	03:22:41	23:04:11	23:05:11	00:31:11	00:32:11
8	F N8	42	22:17:41	22:18:41	05:58:41	05:59:41	00:00:41	00:01:41	22:56:41	22:57:41	23:06:41	23:07:41	00:23:41	00:24:41
9	M N9	31	22:56:13	22:57:13	23:15:43	23:16:43	23:43:13	23:44:13	23:49:13	23:50:13	23:52:43	23:53:43	00:38:43	00:39:43
10	M N10	23	23:24:52	23:25:52	NA	NA	23:58:22	23:59:22	01:34:22	01:35:22	00:04:52	00:05:52	01:12:52	01:13:52
11	F N11	28	22:37:16	22:38:16	NA	NA	23:08:46	23:09:46	00:38:16	00:39:16	23:36:16	23:37:16	00:17:16	00:18:16
12	M N12	29	15:14:22	15:15:22	NA	NA	15:30:52	15:31:52	15:38:52	15:39:52	15:55:22	15:56:22	16:34:22	16:35:22
13	F N13	24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14	F N14	35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15	M N15	34	22:00:22	22:01:22	22:14:52	22:15:52	22:28:52	22:29:52	22:34:52	22:35:52	NA	NA	23:46:22	23:47:22
16	F N16	41	22:35:17	22:36:17	NA	NA	23:58:17	23:59:17	NA	NA	NA	NA	23:50:17	23:51:17

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