CAP SLEEP DISORDER IDENTIFICATION USING EEG ANALYSIS

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Abstract:

Cyclic Alternating Pattern (CAP) is a type of sleep disorder characterized by recurrent changes in sleep-wake states that occur in a cyclical fashion throughout the night. It is associated with other sleep disorders such as obstructive sleep apnea, insomnia, and restless leg syndrome. CAP is classified as a parasomnia, which is a type of sleep disorder that can occur during sleep or wakefulness. People with CAP often experience periods of deep sleep alternating with periods of shallow sleep, or brief awakenings during the night.

Keywords: CAP, sleep-wake, cyclic, apnea, insomnia.

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1. Introduction

CAP is believed to be caused by abnormal brain activity during sleep, which is often related to an underlying medical condition or sleep disorder. It typically affects people aged 30–50 but can also occur in children.

Symptoms of CAP can include frequent awakenings during the night, difficulty falling asleep, restlessness during sleep, and daytime fatigue. The diagnosis of CAP is based on a detailed sleep history, physical exam, and polysomnography (sleep study). Treatment options may include lifestyle modifications, medications, and cognitive behavioural therapy.[9]

2. Methodology

Sleep Disorders Center of the Ospedale Maggiore of Parma, Italy have made freely available data of 108 patients who are facing sleep disorder.[7]

Each data is available in. edf format including minimum 3 chs of EEG inclusive of F3 or F4, C3 or C4 and O1 or O2, also known as A1 or A2, two chs of Electro Occulo Gram, muscle signal EMG of the tibialis anterior, breathing signals and ECG. Standard arrangement used was IS 10-20. (Fp1-F3, F3-C3, C3-P3, P3-O1 and/or Fp2-F4, F4-C4, C4-P4, P4-O2).

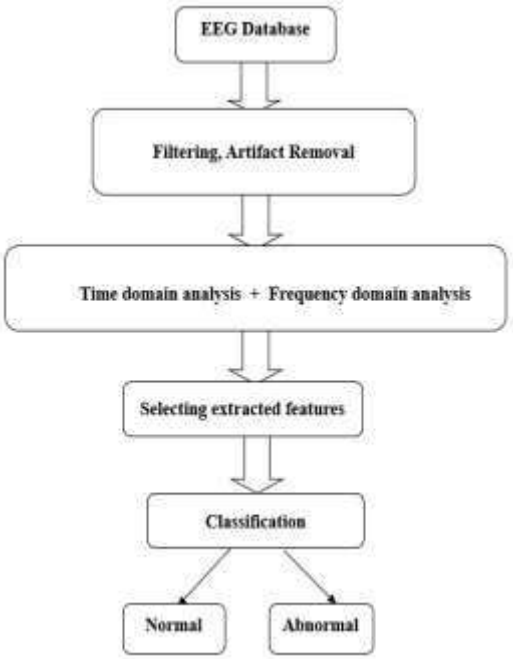

Figure 1 Flowchart

The study consisted of sixteen fit patients not presenting a little neural complaint and have not taken any CNS related medications. Remaining 92 compulsive copies included forty NFLE patients' samples, twenty-two with RBD, Ten PLM, nine having Insomnia, five having narcolepsy, four SDB and two Bruxism affected.

Each data signal is processed and filtered to get numerous features. Since it is not possible to get sufficient information in only time domain, signals are transformed in to frequency domain using wavelet decomposition.

3. Feature Extraction & Selection

Using wavelet decomposition, acquired signals are decomposed into sub bands and for every sub band, some features are calculated.

1.1. Mean

Central tendency of signal is calculated by adding all values divided by total number of values.[5]

1.2. Variance

Variance signifies characteristic score toward which distinct value differs with respect to mean.

1.3. Kurtosis

$$\text{Kurtosis} = \frac{M4[x(n)]}{M_2^2[x(n)]} \quad (1)$$

1.4. Skewness

$$\text{Skewness} = \frac{E[(x(n)-\mu)^3]}{\sigma^3} \quad (2)$$

1.5. Standard Deviation

Square root of variance gives standard deviation.

1.6. Band Power

It shows intensity of the EEG and measured in dB. Relative band power is calculated.

1.7. Entropy

It gives unpredictability of signal.

4. Results

4.1. Normal and Abnormal EEG

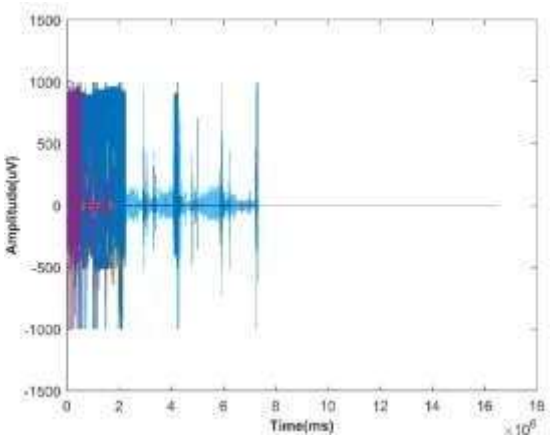

Figure 2 Normal EEG

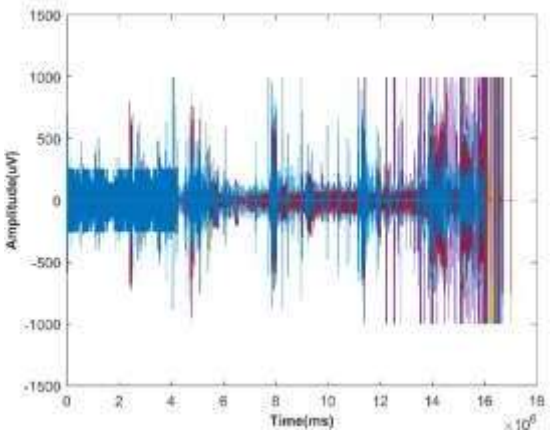

Figure 3 CAP EEG

4.2. Sub bands

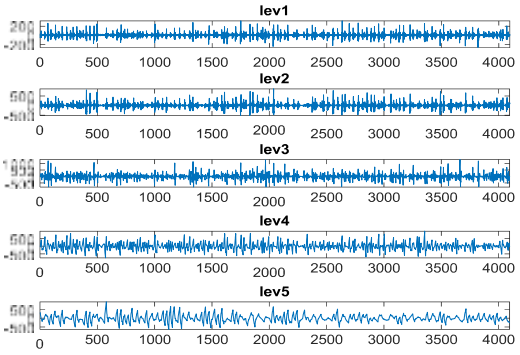

Figure 4 Sub bands of CAP Sleep EEG

a. Results

Table 1. Mean

Coeff	Mean Values	
	Normal	Abnormal
D1	0.002	-0.018
D2	-0.00	0.045
D3	-0.012	0.029
D4	-0.005	0.303
A4	-13.58	-8.233

Table 2. Variance

Coeff	Variance Values	
	Normal	Abnormal
D1	14.978	1996.40
D2	71.94	13709.519
D3	189.62	40100.419
D4	313.44	41782.079
A4	886.034	33438.79

Table 3. Standard Deviation

Coeff	Standard Deviation Values	
	Normal	Abnormal
D1	3.9	44.7
D2	8.5	117.1
D3	13.88	200.3
D4	17.7	204.4
A4	29.8	182.9

Table 4. Band Power

Coeff	Band Power Values	
	Normal	Abnormal
D1	15	1996
D2	72	13707
D3	190	40091
D4	313	41772
A4	1070	33498

Table 5**.** Entropy

Coeff	Entropy Values	
	Normal	Abnormal
D1	-2,18,417	-7.6E+07
D2	-1,58,5715	-6.3E+08
D3	-49,14,076	-2E+09
D4	-86,35,938	-2E+09
A4	-3.4E+07	-1.6E+09

Table 6. Kurtosis

Coeff	Kurtosis Values	
	Normal	**Abnormal**
D1	3.6	11.6
D2	5.1	10.9
D3	5.6	8.2
D4	4.7	4.6
A4	3.8	4.0

Table 7. Skewness

Coeff	Skewness Values	
	Normal	**Abnormal**
D1	0.037	0.702
D2	0.03	0.90
D3	0.04	0.68
D4	0.13	0.42
A4	-0.18	0.34

5. Conclusion

By using proposed algorithm signals are classified using hybrid CNN classifier which gave 95.65 with training percentage of 90. As k fold values are increased accuracy also increases.

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