Classification NREM in EEG Signal for Detection Depth of Sleep Using HJORTH Descriptor

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***Abstract*— Sleep is one of rest which is marked by decrease in physical activity, awareness, and decrease in respond for external stimulation. Sleep is important in returning body energy, maintain body resilience even cognitive function in the body. There is two kind of sleep that is Rapid Eye Movement (REM) and Non Rapid Eye Movement (NREM) that must be experienced by someone for reach depth of sleep. If one of that not achieved then it can disturbance in the body. Detection of NREM and REM can be done with analyze EEG signal. In this research has been successfully classify NREM and REM wave based on EEG signal for delta wave. A time series method analysis that is HJORTH Descriptor used to get signal feature of that. HJORTH activity, mobility, and complexity showing many value for each category. From simulation has been reach 70,9% accuracy using Fine Gaussian Support Vector Machine.**

Keywords—NREM, REM, HJORTH Descriptor, SVM

I. INTRODUCTION

At sleep, the brain moves, respond, and generate brainwave. There is also eye condition in open or close generate brainwave too with characteristic and certain value. Brainwave appear when neuron in brain activate to work and effect electric activities. Either way to detect and record brainwave is Electroencephalography (EEG) [1].

Research of sleep already a lot, there is about effect soporific[2], effect of age[2], [3], even effect of gender [4]. Which is get result depth of sleep cause effect of age and effect of soporific [2], [3], [4]. From the result, this research will classify depth of sleep from comparison of NREM and REM wave.

By reason of depth of sleep everyone is different cause effect of age [2], [4]. This research will see the comparison delta wave between early sleep(REM), when the lights off(NREM) and 60 minutes before waking up (NREM)[5].

II. METHOD

This research will take data from *Analysis of a Sleep-Dependent Neuronal Feedback Loop: The Slow-Wave Microcontinuity of the EEG* which is just take 39 sample consisting of two night. The first night correspondent normal sleep recorded and then the second night Temazepam were given to correspondent.

This data will process using EDFLoad in Matlab cause the data using EDF format. After that the data will divided into two parts. First parts is data delta wave (NREM) while correspondent starting sleep for the first five minutes in lights off. Second parts is delta wave (REM) while correspondent starting recorded for the first five minutes in lights on. Third parts is data delta wave (NREM) sixty minutes for the last record before wake up.

Then classified using HJORTH Descriptor which is HJORTH Descriptor is features extraction method used for analyze EEG signal in the time domain [6]. HJROTH Descriptor have three parameter, there is activity, mobility, complexity [6].

Activity is parameter to present power signal and variance in the time domain. This parameter can present power spectrum in the frequency domain. Equation of activity parameter :

$$Activity = var(y(t)) \tag{1}$$

Mobility is parameter to present average frequency or proportion of power spectrum standard deviation. Equation of Mobility parameter:

$$Mobility = \sqrt{\frac{var(dy(t))}{var(y(t))}} \tag{2}$$

Complexity is parameter to present transformation at frequency. This parameter divided signal similarity with sinusoidal wave, which is value approaching to 1 then the signal more similar. The equation of complexity parameter :

$$Complexity = \frac{Mobility\ (\frac{dy(t)}{dt})}{Mobility\ (y(t))} \tag{3}$$

After classification using HJORTH Descriptor the data will classified using SVM classifier. Support Vector Machine (SVM) is a supervised learning algorithm which addresses general problem of learning to discriminate between positive and negative members of given n-dimensional vectors [7]. The SVM has three kernel functions namely, there is polynomial kernel, linear kernel, radial basis kernel.

III. RESULT AND DISCUSSION

The first step is load data EDF and divided into three parts there is delta wave when lights off (NREM), delta wave when lights on (REM), and delta wave before wake up (NREM).

Then data was extraction using HJORTH Descriptor. In HJORTH Descriptor this research will divided 3 channel. First channel is five minutes when the lights off (NREM), the second channel is 60 minutes before waking up (NREM Last) and then the third channel is five minute start recording and the lights on(REM). Then data was classified using SVM.

TABLE. 1 : Confusion matrix of Linier Kernel in SVM

Class	**Predicted**

	Channel	NREM	NREM Last	REM
True	NREM	17	22	
	NREM Last	24	15	
	REM			39

This research use linier kernel to see variance data and to see data accuracy. The result is 70,9% accuracy data. In that table showing similarities signal between NREM when lights off and NREM Last before waking up.

IV. CONCLUSION

In the early sleep and the lights on categorized as not well sleep because seen form the signal characteristic and the result. When the lights off categorized as depth of sleep cause the signal characteristic is different from signal before the lights off. In the last sleep or sixty minutes before waking up categorized as sleep cause the signal has a similarity with signal when the lights off. The effect of lights and condition NREM and REM wave to depth of sleep is important.

The right method to extraction feature of this data is HJORTH Descriptor cause HJORTH Descriptor analyze EEG signal in the time domain. Will see the activity, mobility and complexity parameter of EEG signal.

Set aside time for sleep and manage time for sleep is very important. Cause the depth of sleep take effect to your health and decrease stress, worried, and also wrought-up. This research don't know yet about how long depth of sleep go on. So how long you sleep there is a little depth of sleep inside.

REFERENCES

[1] R. Oliver and D. Suendermann, "A First Step towards Eye State Prediction Using EEG," *Proc. of the AIHLS*, 2013.

[2] B. Kemp, A. H. Zwinderman, B. Tuk, H. A. C. Kamphuisen, and J. J. L. Oberyé, "Analysis of a sleep-dependent neuronal feedback loop: The slow-wave microcontinuity of the EEG," *IEEE Trans. Biomed. Eng.*, vol. 47, no. 9, pp. 1185–1194, 2000.

[3] V. V. Vyazovskiy and A. Delogu, "NREM and REM sleep: Complementary roles in recovery after wakefulness," *Neuroscientist*, vol. 20, no. 3, pp. 203–219, 2014.

[4] J. Carrier, S. Land, D. J. Buysse, D. J. Kupfer, and T. H. Monk, "The effects of age and gender on sleep EEG power spectral density in the middle years of life (ages 20-60 years old).," *Psychophysiology*, vol. 38, no. 2, pp. 232–242, 2001.

[5] A. L. Goldberger *et al.*, "PhysioBank, PhysioToolkit, and PhysioNet : Components of a New Research Resource for Complex Physiologic Signals," *Circulation*, vol. 101, no. 23, pp. e215–e220, 2000.

[6] B. HJORTH, "THE PHYSICAL SIGNIFICANCE OF TIME DOMAIN DESCRIPTORS IN EEG ANALYSIS," pp. 321–325, 1973.

[7] G. Mehmet, "Multiple Kernel Learning Algorithms," vol. 12, pp. 2211–2268, 2011.