Classification of brain activity rate based on electroencephalographical signal on smokers using learning vector quantization

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Abstract. There are several harmful substances contained in cigarettes, one of which is nicotine. Nicotine is one of the additives that makes addiction that is why smokers want to continue smoking cigarettes regularly. Nicotine is bound to the brain receptors and in other organs. Increased activity in the orbitofrontal cortex area occurs when smokers want cigarettes, while in the prefrontal cortex the activity increases when smokers smoke cigarettes. Increased activity in the area will produce electricity along the scalp which can be measured using Electroencephalography (EEG). The difference in ion current voltage will provide information on the level of addiction to cigarettes so that they can be classified. Classification is done in 3 classes, namely low dependence, moderate dependence and high dependence. According to the results, it was found that the level of accuracy of the introduction of the decency level reached 50.63%.

1. Introduction
Indonesia as a country that has 255,182,144 inhabitants [1] with the number of smokers reaching 46.16 percent [2] ranks third with the largest number of smokers in the world after China and India. Research results of the Ministry of Health's Research and Development Agency in 2010 showed that deaths from tobacco-related diseases occurred 190,260 people or around 12.7% of all deaths in the same year in Indonesia. The number will continue to increase where the WHO predicts 10 million deaths due to smoking in 2030 as smoking consumption increases.

Based on Government Regulation No. 109 of 2012 concerning safeguarding materials containing additives in the form of tobacco products for health, cigarettes are one of the tobacco products intended to be burned or smoked, including kretek cigarettes, white cigarettes, cigars or other forms produced from nicotiana tabacum or its synthetic plants. The smoke contains nicotine and tar. Nicotine is an addictive additive [3], which is why smokers want to continue smoking cigarettes regularly. Nicotine is bound in brain receptors and in other organs of the body [4] some of these parts are Cardiovascular system, Gastrointestinal system, Peripheral nervous system, Adrenal medulla, Exocrine glands dan Central nervous system.

Central nervous system or the central nervous system is a part of the nervous system located in the cheek and spine. In the case of cigarette addiction, the part of the central nervous system that most influences is the orbitofrontal cortex and prefrontal cortex [5]. Increased activity in the orbitofrontal cortex area occurs when the smoker wants a cigarette, while in the prefrontal cortex the activity increases when the smoker smokes a cigarette[6]. Increased activity in these areas will produce...
electricity along the scalp that can be measured using Electroencephalography (EEG). EEGs can record and measure voltage fluctuations produced by ion currents in brain neurons [7]. The difference in ionic current voltage will provide information on the degree of addiction to smoking so that it can be classified.

Addiction level classification is done by applying the Neural network learning vector Quantization (LVQ) method. Classification is done in 3 classes, namely low dependence, moderate dependence and high dependence. The LVQ classification results will be validated by applying the Fagerström Test for Cigarette Dependence (FTCD) instrument[8]. FTCD is a measuring instrument for dependence on cigarettes which is widely used clinically [9].

2. Materials and Methods
2.1. Samples
In this study, the data is taken from a sample of smokers that are measured using EEG, the number of samples is 25 smokers with the categories of low dependence, moderate dependence and high dependence that have been previously measured using FTCD. The condition of each smoker is set with the condition without cigarettes, wanting smoke, smoking is shown in figure 1.

2.2. Properties measurements
In this study, the observed variables were alpha wave signals, beta waves, delta waves, theta waves and gamma generated by brain activity patterns in the prefrontal cortex. The research stage consisted of several stages, the first stage was sampling brain signals in all participants. All participants were conditioned into 3 conditions: no cigarettes, wanted to smoke by showing a visualization of people smoking and smoking at the time of data collection. The second step is to separate the signal into 5 signals namely apla, beta, theta, gamma and delta signals. The next stage is the classification of signals using the LVQ Neural network which will be grouped into low dependence, moderate dependence and high dependence.

3. Result and discussion
3.1. Features of EEG signal
The measurement of brain activity level is done in two conditions, namely the condition before smoking and smoking. Data is taken for 1 minute for each sample. The pre-smoking graph is shown in figure 2 and the graph when smoking is shown in figure 3.
From the results of previous studies an increase in brain activity by 52% when compared between before and after smoking. Data comparison of gamma signals in one sample is shown in figure 4.
Data from the EEG signal results, the classification is done using the LVQ method with the provisions of hidden layer 2 parameters, Epoch 100 and learning rate 0.1.

![LVQ parameters](image)

The test was conducted as many as 79 samples consisting of 40 categories of high dependence, 20 samples from the category of low dependence and 19 samples from moderate dependence. The level of accuracy is influenced by the validity of data retrieval. The high level of sensitivity of the tool is very influential.

![Training Performance](image)

| Class               | Number of Samples | Prediction | Error prediction |
|---------------------|-------------------|------------|-----------------|
| Low dependence      | 20                | 6          | 14              |
| Moderate Dependence | 19                | 0          | 19              |
| High dependence     | 40                | 30         | 10              |

From the results of experiments with a sample of 79, the accuracy of prediction obtained by LVQ only reached 50.63%. Classification errors occur in each class with a large number. The largest number of moderate class dependencies reached 19 errors or all testing data experienced prediction errors.

4. Conclusion

Based on research that has been done, increased brain activity during smoking reached 52% between before and after smoking. In the classification process using LVQ by taking the alpha, beta, delta, theta and gamma wave signal features the accuracy results reached 50.63%. Further research can be done to improve accuracy by collecting more data and using other classification methods.
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