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Increasing accuracy of the epilepsy signal classification

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Increasing accuracy of the epilepsy signal classification

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Abstract. Epilepsy is a condition that can cause a person to experience seizures repeatedly. Epilepsy can attack someone when there is damage or changes in the brain. This study researchers tried to use sampling techniques as a feature of extracting epilepsy signal features and the K-NN method to identify epilepsy signal patterns. The data of this study took epilepsy signal data from the University of Bonn's Epileptologie clinic which consisted of data set A, open eye normal signal, set B normal closed eye signal, set C in epilepsy zone, set D enter epilepsy, set E seizure epilepsy. In this study, researchers tried to classify data set A, data for normal people and data set E, data for people who have epilepsy. Data set A consists of 100 EEG signals and data set E consists of 100 EEG signal data. The data used are data for the training process as much as 50 Epilepsy signal data and data for the trial process as many as 50 Epilepsy signal data. In the trial process the classification results reach 100% accuracy. The trial process uses the value of K = 1 to the value of K = 9.

1. Introduction

Recurrent seizures are the main symptom of epilepsy. The characteristics of seizures will vary and depend on the part of the brain that is disturbed first and how far the disorder occurs. Types of epileptic seizures are divided into two based on disorders of the brain, namely Partial Seizures and generalized seizures. in partial or focal seizures, the brain is only partially disturbed. In generalized or generalized seizures, symptoms occur throughout the body and are caused by disorders that affect all parts of the brain. Epilepsy is a type of neurological disorder. Epilepsy is the second most common neurological disorder in humans after a stroke. Around 40 or 50 million people in the world suffer from epilepsy [1].

Repeated seizures are the main symptom of epilepsy. The characteristics of seizures will vary and depend on the part of the brain that is disturbed first and how far the disorder occurs. Types of epileptic seizures are divided into two based on disorders of the brain [2,3]. Epilepsy is characterized by a long-term risk for recurring attacks. This attack can occur in several ways depending on which part of the brain is involved and the patient's age.

In partial or focal seizures, the brain is only partially disturbed. Partial seizures are divided into two categories, namely: Simple partial seizures, i.e. seizures whose sufferers do not lose consciousness. Symptoms can be in the form of jerky limbs, or arising sensation of pins and needles, dizziness, and flashes of light. The part of the body that experiences seizures depends on which part of the brain is disturbed. For example, if epilepsy interferes with the functioning of the brain that regulates the movements of the hands or feet, then only the two limbs will experience seizures. Partial seizures can also make the sufferer experience emotional changes, such as feeling excited or scared suddenly. Complex partial seizures. Occasionally, focal seizures affect the sufferer's awareness, making them appear confused or semi-conscious for a few moments. This is what is called a complex partial seizure. Other characteristics of complex partial seizures are empty vision, swallowing, chewing, or rubbing hands [3].

Electroencephalogram (EEG) is a test to detect abnormal electrical activity in the brain [4,5]. Meanwhile according to dr. Darmo Sugondo distinguishes between Electroencephalogram and Electroencephalography. Electroencephalography is the procedure of recording the electrical activity of the brain with a sensitive recording device while the resulting graph is called an electroencephalogram. So, brain activity in the form of electrical waves, which can be recorded through the scalp is called Electro-Encephalography (EEG).

The amplitude and frequency of EEG varies, depending on the recording location and brain activity during recording [6]. When the subject is relaxed, eyes are closed, the EEG picture shows moderate activity with synchronous waves of 8-14 cycles / second, called alpha waves. Alpha waves can be recorded well in the visual area in the occipital region [7]. Synchronous and regular alpha waves will disappear if the subject opens his closed eyes. The waves that occur are beta waves (> 14 cycles / second). Beta waves are well recorded in the frontal region, a sign that people are awake, alert and have mental activity. Although the EEG wave originates from the cortex, its modulation is influenced by reticular formation in the subcortect. The reticular formation is located in the brain ash substance from the medulla to midbrain and thalamus regions. Reticular formation neurons show diffuse relationships. Stimulation of the midbrain reticularis formation gives rise to beta waves, as if the individual is awake and awake [8]. Lesions in the midbrain reticular formation result in people in a coma stage, with a delta wave EEG picture.

So the midbrain reticularis formation stimulates the ARAS (Ascending Reticular Activating System), a diffuse fibrous projection towards the area in the forebrain. The reticular thalamus nuclei are also included in ARAS, which also sends diffuse fibers in all areas of the cerebral cortex. ARAS has non-specific projections with global depolarization in the cortex, as opposed to projections of specific sensations from the thalamus that have a cortical excitation effect specifically for certain places. General ARAS excitation facilitates specific cortical responses to specific sensory signals from the thalamus. Under normal circumstances, when heading to the cortex, sensory signals from afferent sensory fibers stimulate ARAS through the axon collateral branch. If the afferent system is fully aroused (loud noises, cold showers), ARAS projections trigger general and awake cortical activation. EEG can be used to diagnose and classify epilepsy [9-11].

EEG signals are very complex signals and are the main source of information for research into brain function and neurological disorders. The characteristic pattern of EEG signals in seizure conditions can enable health professionals to distinguish them from normal conditions. However, visual analysis is not possible routinely, because the EEG signal generated from the EEG monitoring system is very large and quite time consuming. Another problem that arises is the lack of clear differences in EEG signals between epilepsy and nonepileptic seizures [12].

The EEG signal model converted to another model is a good way to process the EEG signal classification. The EEG signal component consists of alpha, beta, theta and delta signals. of this component of the EEG signal, it is very useful to identify brain waves by referring to the frequency region of the EEG signal [13].

Automatically detect epileptic signals in EEG signals using artificial neural network algorithms and multistage nonlinear preprocessing filters [14]. Lyapunov feature extraction with Levenberg-Marquardt algorithm and classification using recurrent neural networks (RNNs) [15]. Classification of epileptic signals with multilayer perceptron neural network (MLPNN) [16]. Classification of epileptic signals with LS-SVM and AR [17].

With a variety of classification methods for epileptic signals, the researchers tried to use the K-NN classification method as a classification process and sampling technique methods for the process of finding features.

2. Materials and methods

The study used data from the Epileptology Clinic, University of Bonn, Germany. This data consists of five groups, each consisting of 100 single-channels, a duration of 23.6 seconds. The first two groups were recorded from five healthy subjects with open eyes (G1) and closed eyes (g2). The third and fourth groups are recorded before the seizures from parts of the brain with syndrome (g3) and from the opposite (healthy) hemisphere of the brain (G4). The fifth group (g5) is recorded from parts of the brain with syndromes during seizures [18].

2.1. Sampling technique

The epilepsy signal characteristic extraction used is the sampling technique method [19]. The sampling technique process in this study is as follows: first the data for each epilepsy signal is divided equally into four signals. second, from the divided signal, the maximum value, minimum value, average value and standard deviation are used to determine the characteristics of epilepsy signals. the sampling technique process as shown in Figure 1.

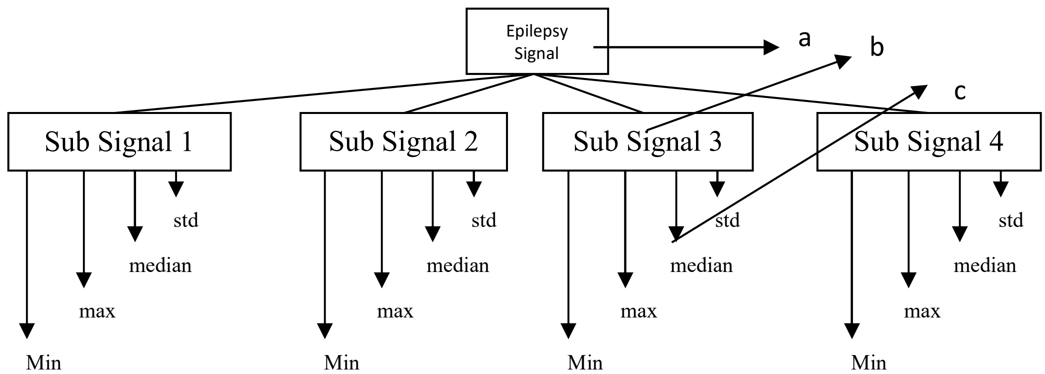

Figure 1. a. Epilepsy signal, b. Sub signal and c. Feature selection.

Research conducted using 100 Epilepsy signal file data. One signal consists of 4,097 data points. 4,097 data points are divided into 4, resulting in 1024 data points. 1024 data points which is one of the epilepsy sub signals, then the average value, minimum value, maximum value, and standard deviation value are produced. so that in this study obtained 16 feature values.

2.2. K-Nearest Neighbor Classification method

K-Nearest Neighbor (KNN) algorithm is an algorithm used to classify new objects based on attributes and training samples [20]. The working principle of KNN is to find the closest distance between the data used and the closest K in the training data [21]. The KNN method is used because it has several advantages, including being able to produce more accurate and effective data if there is a large enough training data [22]. However, this method also has several disadvantages, such as the high computational cost because it requires calculation of the distance of query instances in the entire training sample. Equation 1 below is the equation for calculating Euclidean distances. Euclidean distance is represented as follows:

$$j(a,b) = \sqrt{\sum_{k=1}^{k_n} (a_k - b_k)^2} \quad (1)$$

where J (a, b) is the distance between point a which is the class whose point is known and b is the new point.

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3. Results and discussion

The results of this study, for the sampling technique process can be seen in Figure 2. The process divides one signal into 4 signals with even distribution. the signal that has been divided, then obtained the average value, your maximum value, the standard deviation value and minimum value.

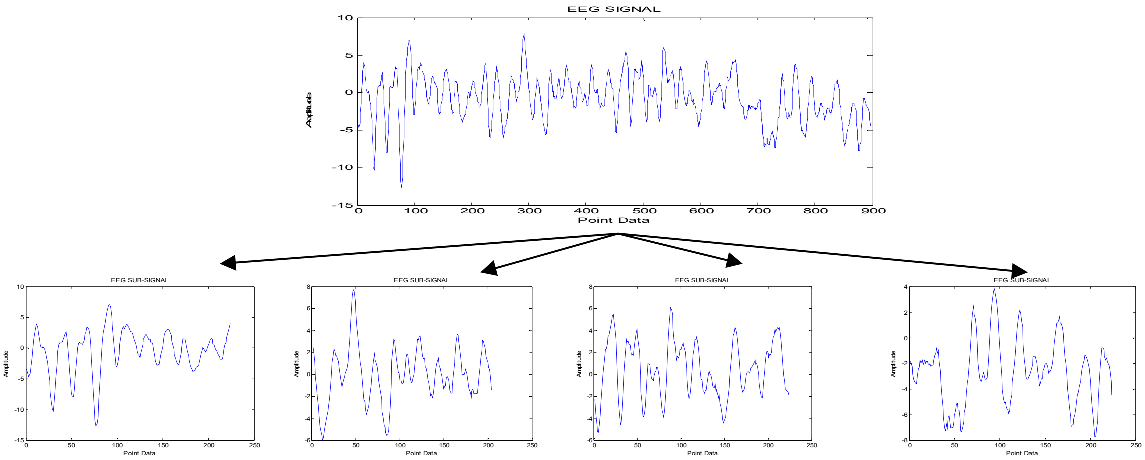

Figure 2. Sampling technique process.

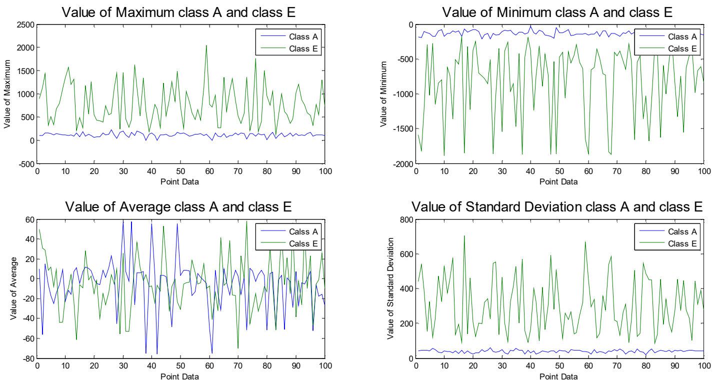

Figure 3. The results of the maximum value, average value, std value and minimum value on the sub-signal.

Figure 3 is a comparison of feature extraction values from class A and class E in experimental data. 16 features from these different classes will be classified using the K-NN method. The epilepsy data signal used 100 data, namely 50 training data and 50 experimental data. As shown in table 1, the distribution of each class.

Table 1. Sampling of class distribution on training data and trial data.

Class	Training set	Test set
Epilepsy Signals	50	50
Non Epilepsy Signals	50	50

The trial process uses the K-NN method using a different K value. In equation 2 is the accuracy formula of the process that has been generated in the trial using the K-NN method.

$$\text{Accuracy} = \frac{\text{The number of signals is correct}}{\text{Total amount of test data}} x\ 100\% \quad (2)$$

The classification process uses the KNN method using different K values. The K values used are 1, 3, 5, 7, 9, 11 and 13.

The results of the classification with different K values are shown in Table 2. The test results with K = 1, K = 3, K = 5, K = 7, and K = 9 obtain an accuracy value of 100%. Whereas K = 11 and K = 13 obtain 99% accuracy.

Table 2. Classification test results with different K values.

Value of K	The amount of training data	Amount of test data	Right	wrong	Accuracy
1	100	100	100	0	100%
3	100	100	100	0	100%
5	100	100	100	0	100%
7	100	100	100	0	100%
9	100	100	100	0	100%
11	100	100	99	1	99 %
13	100	100	99	1	99 %
		Average accuracy			99.99 %

Of all the tests for 100 experimental data with K values, the highest accuracy value of 100% was found at values K = 1, K = 3, K = 5, K = 7 and K = 9. Overall accuracy has a value close to 100%. this experiment is still using less data, not tried with more data.

4. Conclusion

By using the sampling method feature extraction method and the K-NN classification method for the detection of epilepsy signals, the accuracy value of 100% is obtained for the values of K = 1 to K = 9. Subsequent research, researchers tried to use other epilepsy signal data. From different data whether the accuracy is also good or not good.

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