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Contribution to the Study of Automatic Epileptiform Pattern Recognition in Long Term EEG Signals

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Abstract : Electroencephalogram (EEG) is a record of the electrical activity of the brain that has many applications, such as monitoring alertness, coma and brain death; locating damaged areas of the brain after head injury, stroke and tumor; monitoring anesthesia depth; researching physiology and sleep disorders; researching epilepsy and localizing the seizure focus. Epilepsy is a chronic condition, or a group of diseases of high prevalence, still poorly explained by science and whose diagnosis is still predominantly clinical. The EEG recording is considered an important test for epilepsy investigation and its visual analysis is very often applied for clinical confirmation of epilepsy diagnosis. Moreover, this EEG analysis can also be used to help define the types of epileptic syndrome, determine epileptiform zone, assist in the planning of drug treatment and provide additional information about the feasibility of surgical intervention. In the context of diagnosis confirmation the analysis is made using long term EEG recordings with at least 24 hours long and acquired by a minimum of 24 electrodes in which the neurophysiologists perform a thorough visual evaluation of EEG screens in search of specific electrographic patterns called epileptiform discharges. Considering that the EEG screens usually display 10 seconds of the recording, the neurophysiologist has to evaluate 360 screens per hour of EEG or a minimum of 8,640 screens per long term EEG recording. Analyzing thousands of EEG screens in search patterns that have a maximum duration of 200 ms is a very time consuming, complex and exhaustive task. Because of this, over the years several studies have proposed automated methodologies that could facilitate the neurophysiologists' task of identifying epileptiform discharges and a large number of methodologies used neural networks for the pattern classification. One of the differences between all of these methodologies is the type of input stimuli presented to the networks, i.e., how the EEG signal is introduced in the network. Five types of input stimuli have been commonly found in literature: raw EEG signal, morphological descriptors (i.e. parameters related to the signal's morphology), Fast Fourier Transform (FFT) spectrum, Short-Time Fourier Transform (STFT) spectrograms and Wavelet Transform features. This study evaluates the application of these five types of input stimuli and compares the classification results of neural networks that were implemented using each of these inputs. The performance of using raw signal varied between 43 and 84% efficiency. The results of FFT spectrum and STFT spectrograms were quite similar with average efficiency being 73 and 77%, respectively. The efficiency of Wavelet Transform features varied between 57 and 81% while the descriptors presented efficiency values between 62 and 93%. After simulations we could observe that the best results were achieved when either morphological descriptors or Wavelet features were used as input stimuli.

Keywords : Artificial neural network, electroencephalogram signal, pattern recognition, signal processing
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