Automated classification of Parkinson's disease and Essential Tremor by combining electromyography and accelerometer signals

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Differentiating tremor characteristics in Parkinson's disease (PD) from Essential Tremor (ET) is clinically challenging but of substantial therapeutic relevance. Tremor is defined as a constant rhythmic oscillatory movement produced by alternating or irregularly synchronous contractions of reciprocally innervated muscles, although the amplitude and frequency of the movement may vary. There are numerous possible causes for tremor, but PD and ET are the two most important entities and differential diagnosis is highly relevant.

The purpose of this study was to automatically classify ET from PD tremor by combining muscular activity from electromyography (EMG) with motion information from accelerometers (ACC). Therefore an automatic classification system was developed using pattern recognition algorithms and multiple feature extraction methods to support diagnostic differentiation between tremor patients with PD and ET.

In total 16 subjects were included in this study: 8 subjects with PD (6 male, 2 female, age 65.1±9.9, UPDRS 16.3±8.5) and 8 subjects with ET (6 male, 2 female, age 65.3±8.5). Data acquisition was performed as part of the standard tremor test in the electrophysiology laboratory of the University Hospital Erlangen. EMG signals from flexors and extensors of both forearms were collected using surface Ag/AgCl electrodes. ACC signals were collected from sensors placed on the dorsal side of both hands. All signals were recorded at 1kHz during rest and hold exercises. Data was pre-processed and filtered, followed by a feature extraction step, where different sets of clinically relevant tremor features were extracted from both EMG and ACC signals to train the classification system and to also allow a descriptive analysis of the tremor. The feature set included frequency features, statistical features and coherence features describing the tremor characteristics and the relationship between sides and antagonists. Finally the features were used to train a Support Vector Machine (SVM) classifier, which was evaluated using leave-one-subject-out cross-validation.

The automated classification system was able to discriminate between patients with PD and ET with a sensitivity and specificity of both 87.5% based on the EMG and ACC signals. This pilot study suggests that an automated sensor-based analysis system which combines muscular activity with motion information will become a valuable tool for the differential diagnosis between PD and ET.

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