Mobile systems for monitoring Parkinson’s disease

av

Mevludin Memedi

Akademisk avhandling

Avhandling för teknologie doktorsexamen i informationsteknologi,

som kommer att försvaras offentligt

fredag den 14 februari 2014 kl. 13.00,

Clas Ohlsonsalen, Campus Borlänge, Högskolan Dalarna

Opponent: Docent Martin Gellerstedt

Högskolan Väst

Örebro universitet
Institutionen för naturvetenskap och teknik

701 82 ÖREBRO
Abstract

A challenge for the clinical management of Parkinson's disease (PD) is the large within- and between-patient variability in symptom profiles as well as the emergence of motor complications which represent a significant source of disability in patients. This thesis deals with the development and evaluation of methods and systems for supporting the management of PD by using repeated measures, consisting of subjective assessments of symptoms and objective assessments of motor function through fine motor tests (spirography and tapping), collected by means of a telemetry touch screen device.

One aim of the thesis was to develop methods for objective quantification and analysis of the severity of motor impairments being represented in spiral drawings and tapping results. This was accomplished by first quantifying the digitized movement data with time series analysis and then using them in data-driven modelling for automating the process of assessment of symptom severity. The objective measures were then analysed with respect to subjective assessments of motor conditions. Another aim was to develop a method for providing comparable information content as clinical rating scales by combining subjective and objective measures into composite scores, using time series analysis and data-driven methods. The scores represent six symptom dimensions and an overall test score for reflecting the global health condition of the patient. In addition, the thesis presents the development of a web-based system for providing a visual representation of symptoms over time allowing clinicians to remotely monitor the symptom profiles of their patients. The quality of the methods was assessed by reporting different metrics of validity, reliability and sensitivity to treatment interventions and natural PD progression over time.

Results from two studies demonstrated that the methods developed for the fine motor tests had good metrics indicating that they are appropriate to quantitatively and objectively assess the severity of motor impairments of PD patients. The fine motor tests captured different symptoms; spiral drawing impairment and tapping accuracy related to dyskinesias (involuntary movements) whereas tapping speed related to bradykinesia (slowness of movements). A longitudinal data analysis indicated that the six symptom dimensions and the overall test score contained important elements of information of the clinical scales and can be used to measure effects of PD treatment interventions and disease progression. A usability evaluation of the web-based system showed that the information presented in the system was comparable to qualitative clinical observations and the system was recognized as a tool that will assist in the management of patients.

Keywords: automatic assessments, data visualization, data-driven modelling, home assessments, information technology, mobile computing, objective measures, Parkinson’s disease, quantitative assessments, remote monitoring, spirography, symptom severity, tapping tests, telemedicine, telemetry, time series analysis, web technology.