**BACKGROUND**

In the paced finger-tapping test (PFT), subjects attempt to reproduce a sequence of stimuli by pinching their index finger and thumb together with a (near) constant time interval. The varying amplitude in tapping and the series of inter-tap intervals are important clinical features for symptom assessment. Typically, the PFT is visually assessed in clinical practice. In order to avoid cost and effort of applying wearable sensors, a computer-vision method is introduced for non-invasive PFT evaluation.

**OBJECTIVE**

To define and evaluate a Computer-Vision (CV) method for scoring PFT in Parkinson’s disease (PD) using quantitative motion analysis of index-fingers and to compare the obtained scores to the UPDRS (Unified Parkinson’s disease Rating Scale) finger-taps (FT).

**METHODS**

A database consisting of 221 PFT videos from 6 PD patients was processed. The subjects were instructed to position their hands above their shoulders besides the face and tap the index-finger against the thumb consistently with speed. The subjects were facing towards a pivoted camera during recording. The videos were rated by two clinicians between the symptom severity levels ‘0: normal’, ‘1: mild’, ‘2: moderate’ and ‘3: severe’ using UPDRS-FT.

The CV method (figure 1) incorporates a motion analyzer [1] and a face detector [2]. The method first detects the face of testee in each video-frame (figure 2b). The frame is split into two images from face-rectangle centre. Two regions of interest are located in each image to detect index-finger motion of left and right hands respectively (figure 2c). The tracking of opening and closing phases (figure 3) of dominant hand index-finger produces a tapping time-series (figure 4). This time-series is normalized by the face height (figure 2a). The normalizing factor hand index-finger produces a tapping time-series (figure 4). This time-series is normalized by the face height (figure 2a). The normalization calibrates the amplitude in tapping signal which is affected by the varying distance between camera and subject (i.e. farther the camera, lesser the amplitude).

**RESULTS AND DISCUSSION**

The Guttman correlation coefficient (g2) between PFT features and the averaged UPDRS-FT ratings was strong, i.e. g2 was 0.51, 0.57, 0.57, 0.57, 0.57, 0.57, 0.57, 0.57, 0.57, and 0.5 for Tn, T1, T6, VA, WA, TA, AvgCCNP and FS respectively. A 10-fold cross validation [5] in KNN classified the selected features between 3 UPDRS-FT levels with an accuracy of 78%. An average area under the receiver operating characteristic curves of 82.6% supports feasibility of the obtained features to replicate clinical assessments. The classification results obtained from the KNN algorithm are shown in table 2. Each matrix row represents the actual class instances while each matrix column represents the instances in a predicted class. Matrix (numbers in bold) depict high true positive rates in averaged symptom classes ‘0.5’ (83.2%), ‘1.5’ (80.1%) and ‘2.5’ (86.3%).

**CONCLUSIONS**

The system is able to track index-finger motion to estimate tapping symptoms in PD. It has certain advantages compared to other technologies (e.g. magnetic sensors, accelerometers etc.) for PFT evaluation to improve and automate the ratings. The uniqueness of this system is the utilization of facial features to normalize the tapping signal and to cope with camera calibration. Moreover, the method only requires a computer with a webcam. The subjects can perform the tapping task naturally in the same manner as instructed by movement disorder experts. An added advantage is that the subject’s face in a tapping video can be localized and blurred to avoid ethical issues in publishing and data sharing. The portability and ease of use makes it possible to perform the clinical assessments in the home environment.