Towards an automated rating of the MDS-UPDRS motor scores.

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Introduction and Motivation

In PD, the gold standard to evaluate the severity of the motor and non-motor symptoms is captured with the MDS-UPDRS scale. However, the precision of the PD motor signs evaluation remains constrained by subjectivity and inter-examiner variability.

This study aimed at developing an automated and more objective rating method for the MDS-UPDRS motor scores using inertial measurement units (IMUs).

Study Designs and Patients

The pilot study including 14 PD subjects was single-site, non-randomized, observational with no treatment intervention.

An IMU-based device (SensorMotor) was used to record movements during 4 motor tasks of the MDS-UPDRS Part III:

- Finger Tapping (FT),
- Pronation/Supination of Hands (PSH),
- Postural Tremor of the Hands (PTH),
- Kinetic Tremor of the Hands (KTH).

SensorMotor device

The SensorMotor device was developped by Tools4Patient and uses IMU sensors placed on the tip of the index finger and thumb bilaterally.

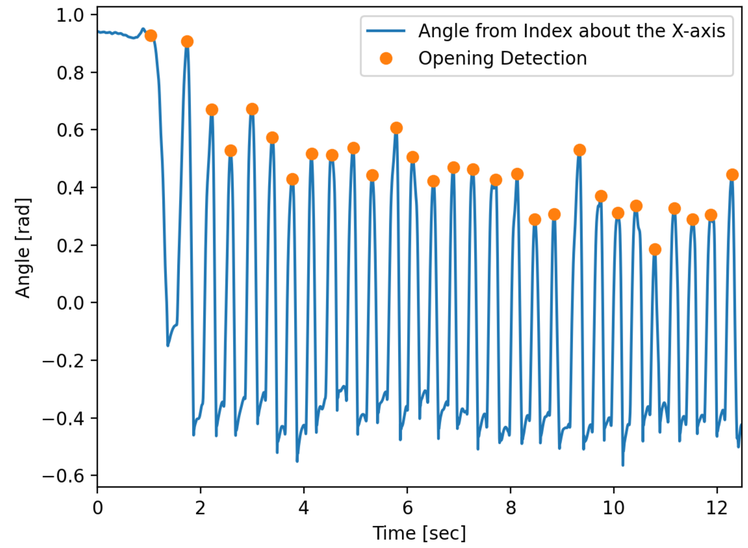
Figure 1: A SensorMotor installed on a patient's right arm.

Automated movement characterization

Features quantifying the movement were extracted for each task using IMU-recordings, such as:

- Period of movement and its evolution,
- Amplitudes (Mean, SD, decrease, ...),
- Signal spectrum,
- Root mean square of the signal.

Figure 2: Automated detection of the finger tapping periods and amplitudes.



Modeling the MDS-UPDRS part III score

A machine-learning model (rank ordered logit) was used to associate the extracted features with the scores given by a MDS-UPDRS certified examiner.

One model was trained for each of the four tasks.

The performances of the ML models were estimated in cross-validation with the concordance index (C-index).

C-index measures the concordance between the scores given by examiner and the automated scoring on a scale from 0 to 1.

Automated scoring performance

The correlation (C-index) between the ML-based model and scores assigned by a MDS-UPDRS certified examiner were significant for all four tasks examined: FT, PSH, PTH and KTH.

Table 1: Performances of the automated scoring models.

MDS-UPDRS III Task		C-Index Estimate	95% CI	P-value
FT	3.4	0.803	[0.711 , 0.895]	<0.001
PSH	3.6	0.772	[0.613 , 0.931]	<0.001
PTH	3.15	0.892	[0.871 , 0.914]	<0.001
KTH	3.16	0.798	[0.72 , 0.877]	<0.001

Inter-raters performance

The MDS-UPDRS part III inter-raters concordance was estimated with several MDS-UPDRS certified examiners evaluating the same motor tasks using video recordings of patients.

The concordance (C-Index) between their evalutions was similar or lower to the concordance of the automated rating method.

Table 2: Inter-raters consistency on the 4 MDS-UPDRS tasks.

MDS-UPDRS III Task		C-Index Mean	Min	Max
FT	3.4	0.73	0.68	0.77
PSH	3.6	0.73	0.71	0.76
PTH	3.15	0.82	0.76	0.88
KTH	3.16	0.65	0.59	0.67

Conclusion

Tools4Patient has developed an IMU-based device that more precisely measures Parkinson's patients' motor tasks.

This device combined with machine-learning can automatically and objectively measure the MDS-UPDRS hand motor scores (FT, PSH, PTH and KTH tasks).

This automated rating may help assess motor tasks in PD patients with greater accuracy. This method might eventually be improved to provide motor scores on a continuous scale.