POCM²: Point of Care Mobility Monitoring Using Microsoft Kinect

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Introduction
- Motor evaluation done in the clinic uses subjective observation
- Patients are exposed to injuries during transportation to/from clinic
- Behavior deviation in the clinic leads to inaccurate evaluations
- POCM² allows monitoring in the natural setting of the home
- Possibly enhanced by wearable sensors data

Data
- Used MS Kinect V1 Shimmer & APDM accelerometers, video
- Acquired 7 tasks, demographic data from 15 subjects PD subjects in ON/OFF medication conditions 2 controls
- Conducted Focus Group
- Developed dedicated data sharing/browsing portal

Analysis
- We are in the process of analyzing the data
- Simple measures (e.g., total task time) cannot discriminate ON/OFF
- Large errors in Kinect skeleton pose estimation for turns
- Fine motor tasks difficult to capture with Kinect
- Very positive attitudes towards the system unchanged after use
- Concentrating on walking with cognitive task

Analytical Approaches
- Principal Component Analysis (PCA) used to count pauses – were able to discriminate PD/non-PD in pilot study
- Movement segmentation, temporal alignment and movement summarization (representative step)
- Graph Analysis to understand movement and enhance analysis

Segmentation, Temporal Alignment & Graph Analytics
- Segments the motion into units (e.g., walking into steps).
- Align temporally the units using a referenced one.
- Calculates averaged measurements from the aligned units.
- Extract Representative Skeletal Action Units on which metrics of mobility can be estimated.

Pause Extraction Using PCA
- Use PCA to find main axes of movement distribution, re-project in subspace and analyze movement to extract and classify pauses

Statistical Analysis
- Apply statistical analysis approaches to the data by:
  1. Segmenting the data into steps/strides.
  2. Calculating parameters of the data segments (Stride length, average angles of the body joints, angular speeds …)
  3. Then compare statistically the difference between the ON and OFF states parameters.

Machine Learning Approaches
- Segment the walking trails into steps/strides, calculate the joints angles of the body for each frame, extract parameters from these angles and the points (average, variance and speeds), then feed the parameter to a logit-boost classifier (with trees as a weak learner) and/or SVM (with RBF as kernel).

Related Research
- Health Informatics, human activity recognition with wearable sensors
- Motion capture data representation and analysis
- Infant mobility monitoring using accelerometers (Beth Smith et al.)

Conclusion and Future Work
- Finish statistical analysis
- Perfect machine learning techniques to characterize motor state
- Use of Kinect V2 and in conjunction to wearable sensors

POCM² mobility evaluation and monitoring

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