Estimating the Quality of Reaching Movements in Stroke Survivors

Juhyeon Lee, Hee-Tae Jung, and Sunghoon Ivan Lee
University of Massachusetts Amherst

Summary
This study proposes an analytic method to estimate the quality of individual reaching movements in stroke survivors using a single wrist-worn inertial sensor.

Background and Objective
- Stroke survivors need to perform therapeutic exercises in their home settings for recovery. However, they often practice exercise movements in a therapeutically undesirable manner, especially when therapists' supervision is not available.
- While wearable sensors have been investigated to monitor patients' exercise movements, it remains as a challenge to accurately and objectively estimate the quality of at-home exercise movements.

Methods

- **19 stroke survivors** performed averaged 45 trials of reaching movements with stroke-affected arm.
- The quality of each reaching movement was labeled into two classes (Therapeutically Desirable vs. Undesirable) based on clinician-scored Functional Ability Scale.
- Time/Frequency features were extracted from velocity and acceleration magnitude.
- Various machine learning models were trained and evaluated using Leave-One-Subject-Out Cross-Validation.

Results

- The best-performed model is a gaussian process model with the Area Under the ROC Curve is **0.94**.
- The extracted temporal and frequency features demonstrate that significant differences exist between the two classes.
- The three most correlated features show the variable and irregular kinematic characteristics of therapeutically undesirable movements from the affected arm's reaching.

Conclusion
- The proposed methods can estimate accurately the quality of each reaching movement based on single inertial sensor data.
- We envision our estimation results enable monitoring the quality of reaching or other goal-directed movements in at-home exercise and personalizing rehabilitation therapy.