

P 3-102

Kinematic measures of upper-limb functional impairments in stroke patients using a robotic device

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Objective

To evaluate kinematic measures of upper-limb functional impairments in stroke patients using a robotic device, and construct database.

Methods

Subacute and chronic stroke patients with hemiparetic arm in Brunnstrom 3, 4, or 5 stage were enrolled. Hemiparetic arm function was evaluated and trained with 3 kinds of tasks (free exploration, point-to-point reaching, and round shape drawing) using RAPAE Smart Board™ (Neofect). The device has 2-axis planar board and position sensors. The 11 kinematic measures were included as follows: range of motion, normalized jerk, zero crossings in acceleration, mean arrest period rate, mean and maximum velocity, time to velocity peak, reaction time, hand path ratio, bias, and variability.

Results

The database was constructed for robotic measures, demographic data, and clinical scales such as Fugl-Meyer assessment score, box and block test, and Pegboard test. Processing metrics for 11 kinematic measures were developed, and raw kinematic data could be automatically drawn by Python program. The maximum speed in free exploration and bias in the round shape drawing task have negative correlation with Fugl-Meyer assessment score.

Conclusion

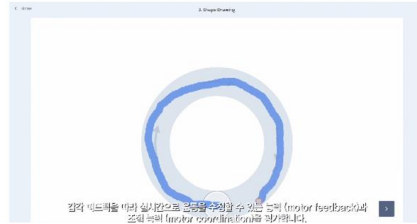
Various kinematic measures may be correlated with clinical parameters. The study Results can be further applied to patients classification, and robotic biomarkers investigation for prognostication of functional arm recovery. An accurate machine learning algorithm needs to be drawn with larger sample size.



Free exploration

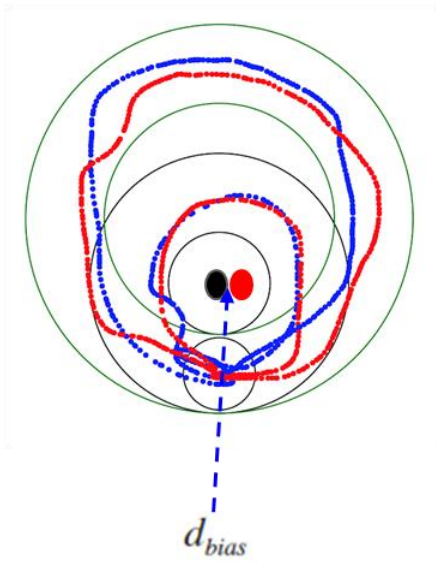


Point-to-point reaching

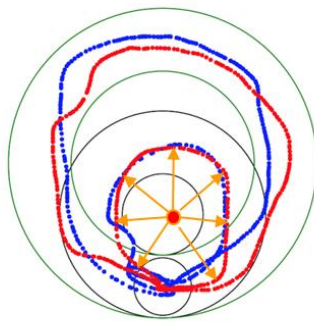
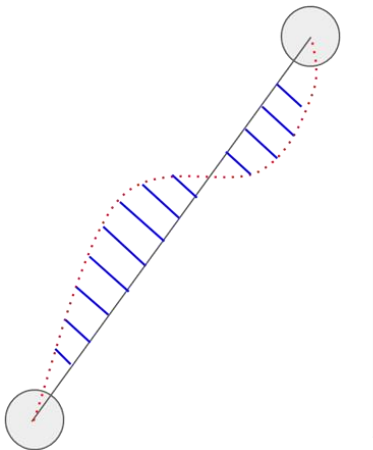


Round-shape drawing

The three tasks in a robotic device



Bias for accuracy evaluation



Variability in reaching and shape drawing tasks