Motion Capture Analysis & Plotting Assistant:
An Opensource Framework to Analyse Inertial-Sensor-based Measurements

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Introduction

- Lack of widespread clinical adoption of motion capture-based (mocap) objective evaluation, especially for upper limb (UL) prostheses
- Such analyses require coding skills in computing languages that an average clinician might be unfamiliar with
- Opensource applications for marker-based mocap data – MoKKa, Biomechanical ToolKit, biomechZoo, GaitViewer, C3Dserver, MOtoNMS, pyCGM, etc.
- No similar packages exists for inertial-sensor based measurements to facilitate translation of mocap *beyond the lab*
- Potential hindrance in reproducibility of results and collaboration, consequently, slowing advancement of this field
- Objective: ***M**otion **C**apture **A**nalysis & **P**lotting **A**ssistant* (**MCAPA**) was developed to offer an opensource framework for user-friendly data post-processing and visualisation involving inertial-sensor-based measurements

Motion **C**apture **A**nalysis & **P**lotting **A**ssistant

Steps involved

1. Following Standard Operating Procedure
2. Performing anthropometric measurements
3. Placement of Xsens sensors as per manual
4. Task instructions to participants; practice trials
5. Subject calibration with MVN Analyze software
6. Functional Data capture (Three trials of any chosen task of interest with the custom-built test rig); Export to *.mvnx format; rename data files
7. Data analysis/interpretation using MCAPA App (Opensource **M**otion **C**apture **A**nalysis & **P**lotting **A**ssistant

Types of evaluation

1. Qualitative comparison (i.e. ensemble/average graphs)
2. Quantitative comparison (i.e. maximum angles, minimum angles, joint range of motion, bar graphs, etc.)

Evaluation scenarios

1. *Normative* data vs Patient data *(Quantifying functional differences)*
2. Patient1 vs. Patient2 vs. Patient3 vs. Patient4 vs. Patient5 *(Comparing different prostheses/terminal device/new prosthetic design → Inter-patient/case assessments)*
3. Patient vs. Old data 1 vs. Old data 2 vs. Old data 3 vs. Old data 4 *(Longitudinal assessments → Intra-individual change with time)*

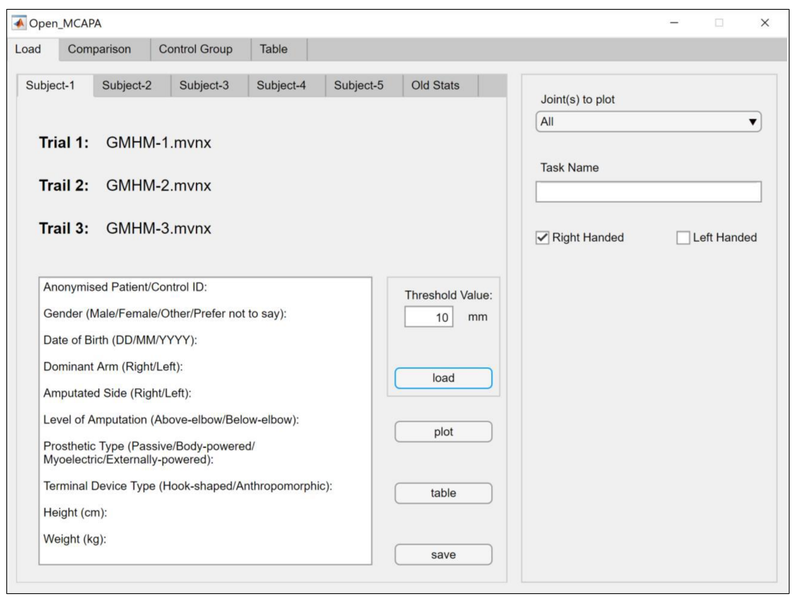

Fig. 1: Screenshot of the MCAPA GUI

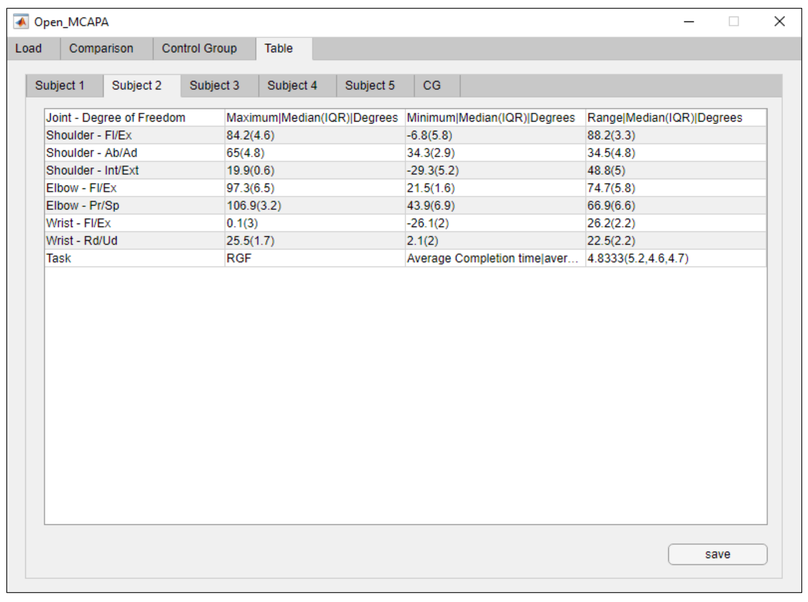

Fig. 2: Joint angle outputs for different UL joints

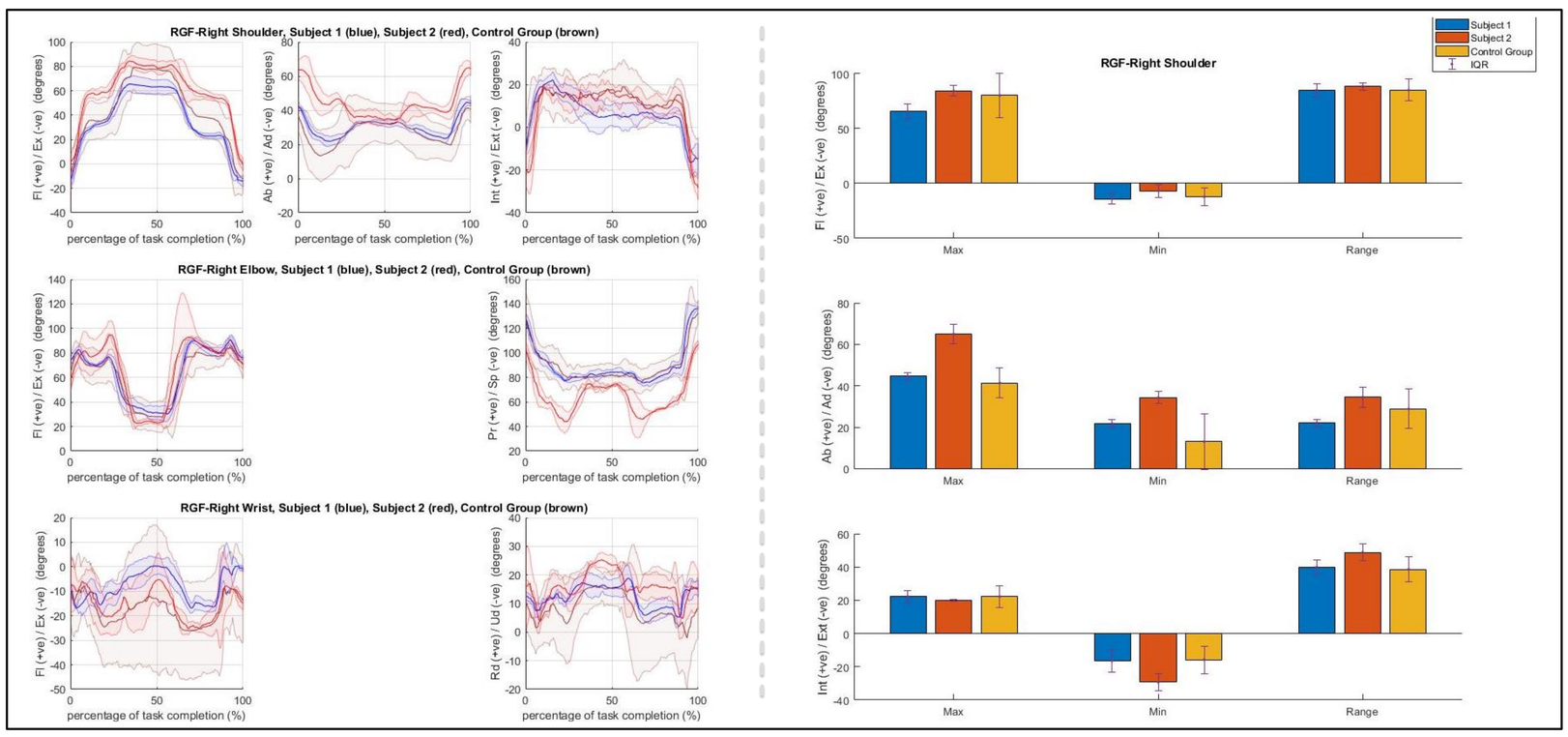

Fig. 3: Qualitative & Quantitative comparison plots (MCAPA extracts the joint angles from *.mvnx motion capture files) (Note: RGF - Reach-to-grasp to the Front task)

MCAPA is developed for *qualitative* and *quantitative* assessment of inertial-sensor based measurements of the UL by the Xsens Body Sensor Network via *MVN Analyze 2018 software* (Xsens Technologies, Enschede, Netherlands), and is powered by MATLAB® Runtime R2018b (Mathworks Inc., USA) .

The app has four different tabs, i.e. *'Load', 'Comparison', 'Control Group', and 'Table'* (Fig. 1).

- A threshold analysis is done by including all those frames when the study participant's hand (or prosthetic terminal device) is above a fixed location from the reference point (i.e. a threshold value of the user's choosing) at the beginning and the end of the trials to ensure each trial has the same starting and finishing points (in the task execution cycle).
- Up to three trials can be considered for each subject, which can then be saved as an *.m file for later comparisons.
- MCAPA can construct a quantitative table, listing the maximum, minimum angles, and movement range for every degree of freedom of the UL joints (Fig. 2).
- Control group management: new subjects can be added to existing tasks, and new tasks can be created for custom studies.

Future work

- Support for Vicon Plug-in Gait model (Vicon Plug-in Gait 2010) and marker-based data (*.c3d format) will come in future version for comparisons between the two mocap systems. This support would also include converting Vicon Plug-in Gait model outputs to ISB guidelines[1] recommended Euler angle sequence (Z-X-Y).
- Development of the app in Octave→ Opensource framework

Reference

1. Wu G, et al. ISB recommendation on definitions of joint coordinate system of various joints for the reporting of human joint motion—Part II: shoulder, elbow, wrist and hand, J Biomech. 2005 May; 38(5):981-992.

Scan this code for the GitHub link for the app and a copy of the poster

Acknowledgements

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