Analysis of Subject Specific Grasping Patterns for a Self Calibrated Haptic Feedback Device

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Introduction

Virtual Reality (VR) and Augmented Reality (AR) are both rapidly developing fields related to the creation of vivid and lifelike simulations.

VR and AR can be used through haptic feedback for purposes of rehabilitation. A computerized system, for example, can train finger range of motion, finger flexion speed, independence of finger motion, and finger strength using specific VR simulation exercises [1].

Particle Jamming

Jamming describes a state in which granular material gets packed together to make a one solid-like material with different properties. Recent studies on jamming show great promise for jamming in the field of soft robotics [2].

In order to design our haptic feedback glove, we need to go through two steps:

1. Measure the different grasping patterns of people to check whether our glove needs to be customized.
2. Understand the different aspects of what parameters are relevant to how the jamming principle works [3-6].

Objectives

Prove that the haptic feedback glove must be personalized for each user.

Make a haptic feedback glove-based interface for VR, AR, and rehabilitation purposes.

Methods

1. Use a Vicon motion capture system to measure different people against the same stimuli.

   The measurement system is composed of (Figs 1+2.):

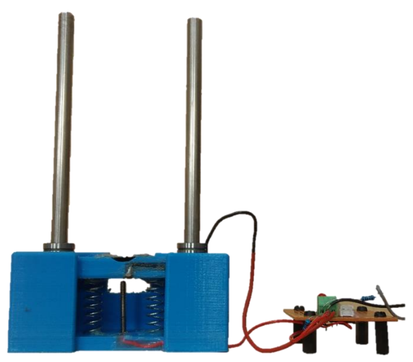
   - Force sensitive resistors (FSR).
   - Motion tracking system.
   - Electromyography (EMG).

   The protocol (Fig. 3) for the measurements includes:

   - The calibration of the Vicon system.
   - The calibration of the force sensors.
   - What tasks the patients need to do in what order.
   - How to extract information from the Vicon Nexus.

   We have chosen activities that demonstrate different types of grasping behaviors to find a trend that can be detected and analyzed by the Vicon system.
2. Analyze data to look for trends and patterns.

Figure 1: Left panel: Markers placement diagram, Middle panel : The experiment room with the Vicon cameras, Right panel : The Myo Band EMG sensor.



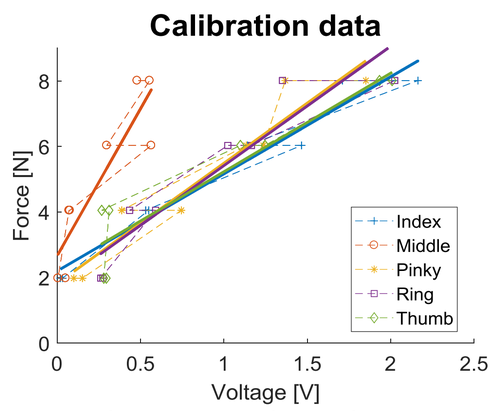


Figure 2: The FSR calibration mechanism and results

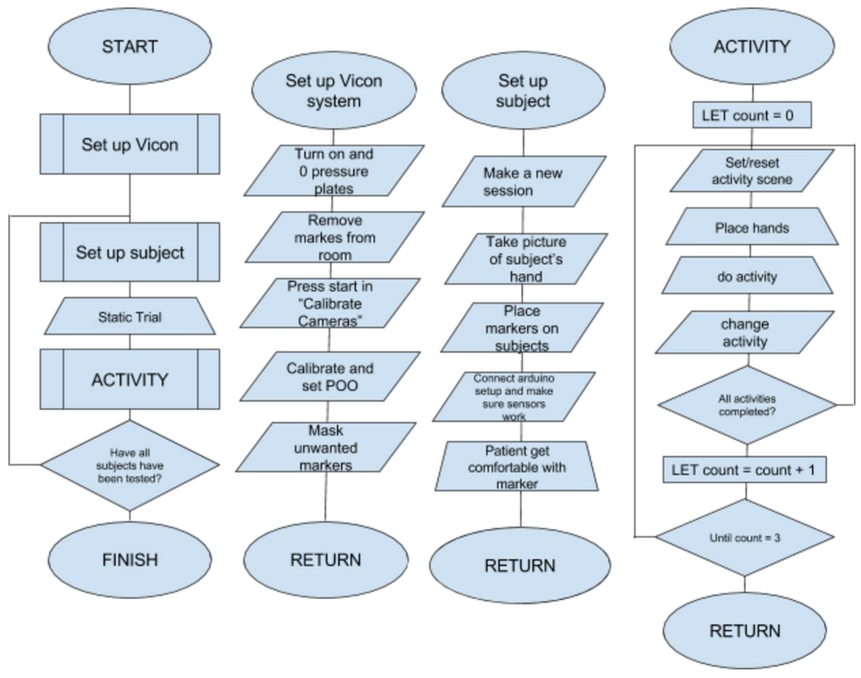


Figure 3: The experiment's protocol workflow

Results

As seen in Fig. 4, our protocol for the measurements is standardized and therefore we have successfully minimized the amount of degrees of freedom. Now that the protocol is working, more data can be gathered.

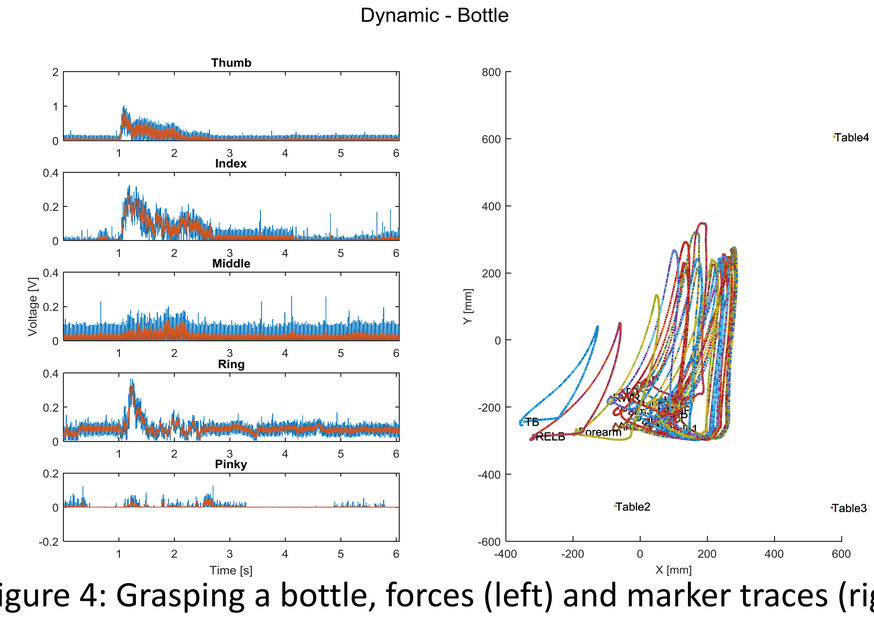


Figure 4: Grasping a bottle, forces (left) and marker traces (right)

Conclusions and future work

We have successfully created a measurement protocol to measure and collect kinematic data of grasping pattern.

We have established from our data collection that we need to customize the haptic feedback glove for the individual user according to their grasping patterns.

Future work:

- Use data on particle jamming to construct a mathematical model for how different parameters affect the jamming properties
- Adapt model to each individual user.

The same measurement protocol (with slight changes) can be used for other research goals such as evaluating and testing low-cost 3D printed prosthetic hands.

References

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