THE ANDREW & ERNA VITERBI FACULTY OF ELECTRICAL ENGINEERING

SIPL
Signal and Image Processing Lab

TECHNION Israel Institute of Technology

User Interface Design for Low Cost 3D Printed Prosthetic Hand

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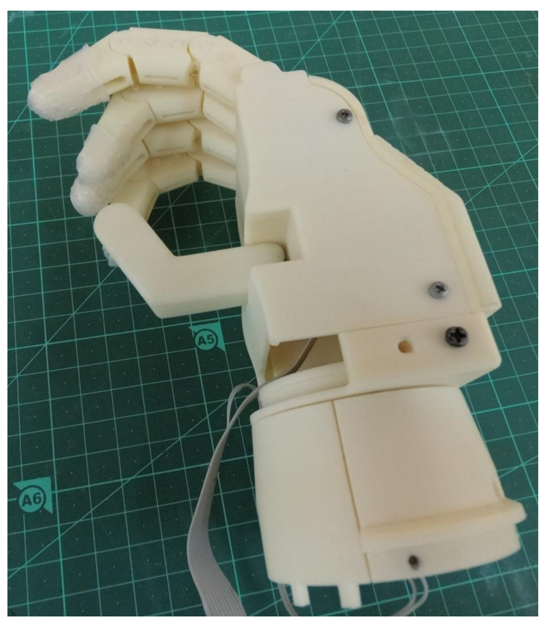
In collaboration with Haifa 3D

Introduction

- Day to day life aspects impaired by hand loss. Such as daily activities, social activities and work.
- Thus the need for a practical, reliable & intuitive hand prosthesis arises.
- The following users' needs are yet to be addressed by the current available solutions
  - Short training period
  - Reliability and steady grip
  - Light weight
  - low-cost
  - Controlling grip force
- A 3D printed prosthetic hand was designed to meet these needs



Low Cost 3D Printed Prosthetic Hand designed by Shunit

Prosthetic hand control

- Most available Electromechanical prosthetic hands are based on surface EMG which still introduces some challenges:
  - Noisy signal & unstable control
  - use of the residual limb muscles, which may cause phantom pain and unreliable signal.

Goals

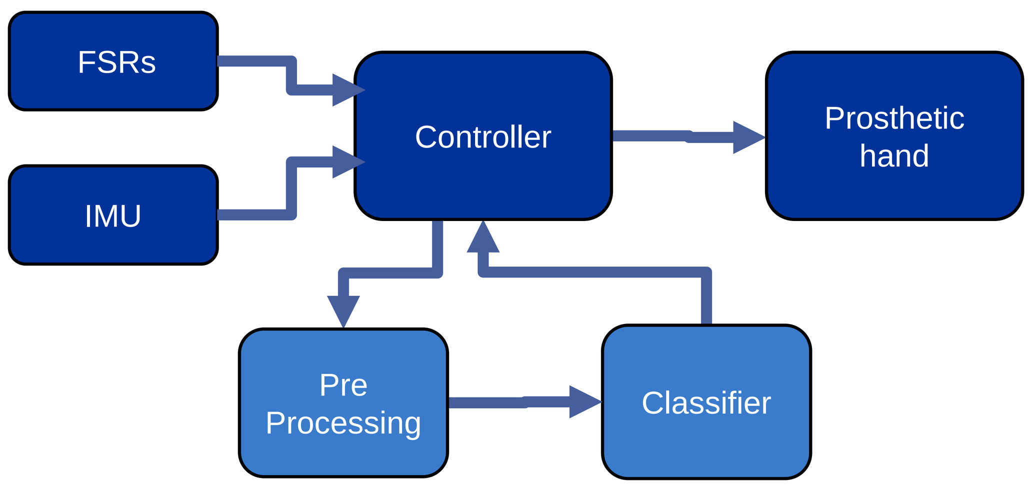
- Control of Electromechanical prosthetic hand through signals acquired from the foot:
  - Setting up a sensor system
  - Collecting data
  - Classification of at least three gestures

Challenges

- Choosing short, different and intuitive movements
- Choosing classification method
- Implement robust acquisition system – wiring, choosing components, design on PCB

Chosen Solution

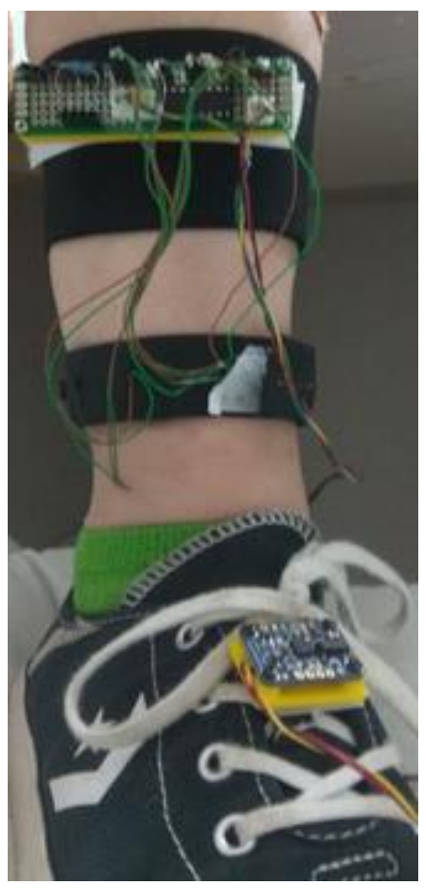
- Our system reads the ankle orientation and muscles movements around it
- FSR - pressure sensor that get data from the muscles
- IMU - orientation and acceleration sensor. For our purpose we used mainly the fused gyro data which is an angular velocity.



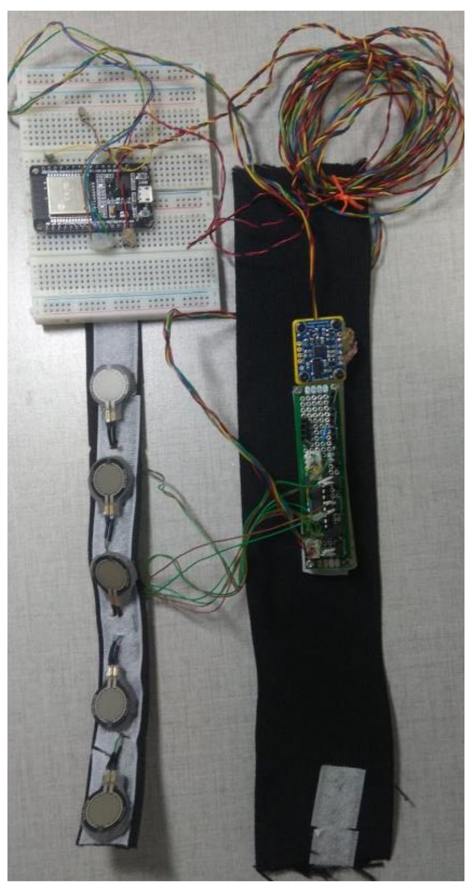
Block Diagram

Implementation

- A custom-made band was assembled for data acquisition:



System on leg



System layout

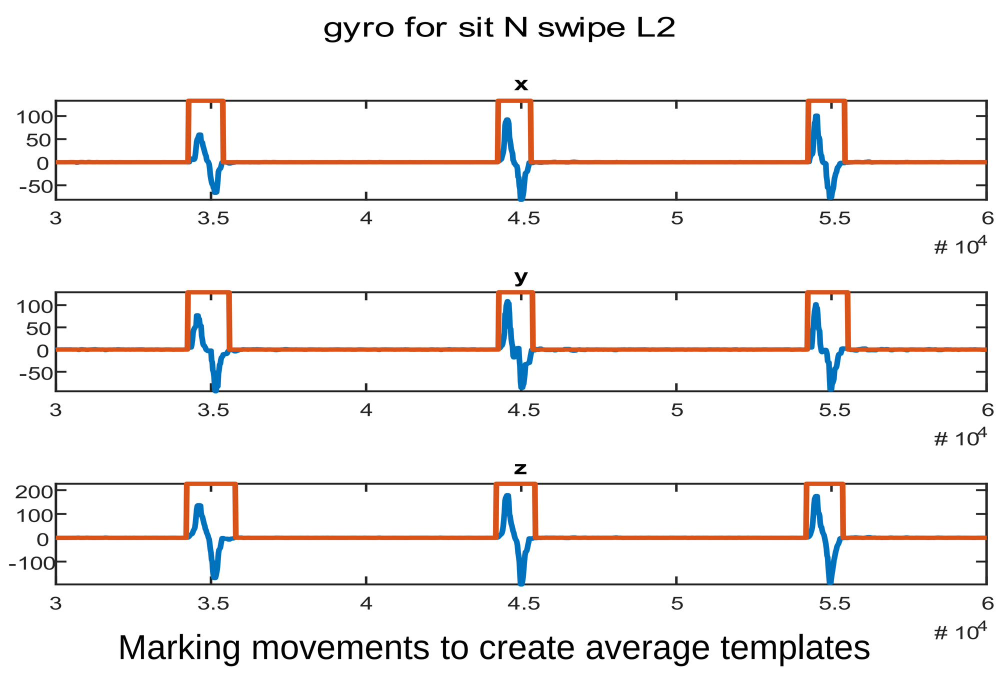
- IMU located on foot and read movements signals.
- FSR's located above ankle and read muscle pressure signals.

Data acquisition

- Arduino code was written to implement data acquisition and synchronize all sensors to produce measurements at approximately 50 [Hz] rate.
- A series of measurements was conducted for 4 movements - Tap, Swipe Left & right & side ankle flexion.
- Raw data was filtered using a median filter and resampled to a constant sample rate.

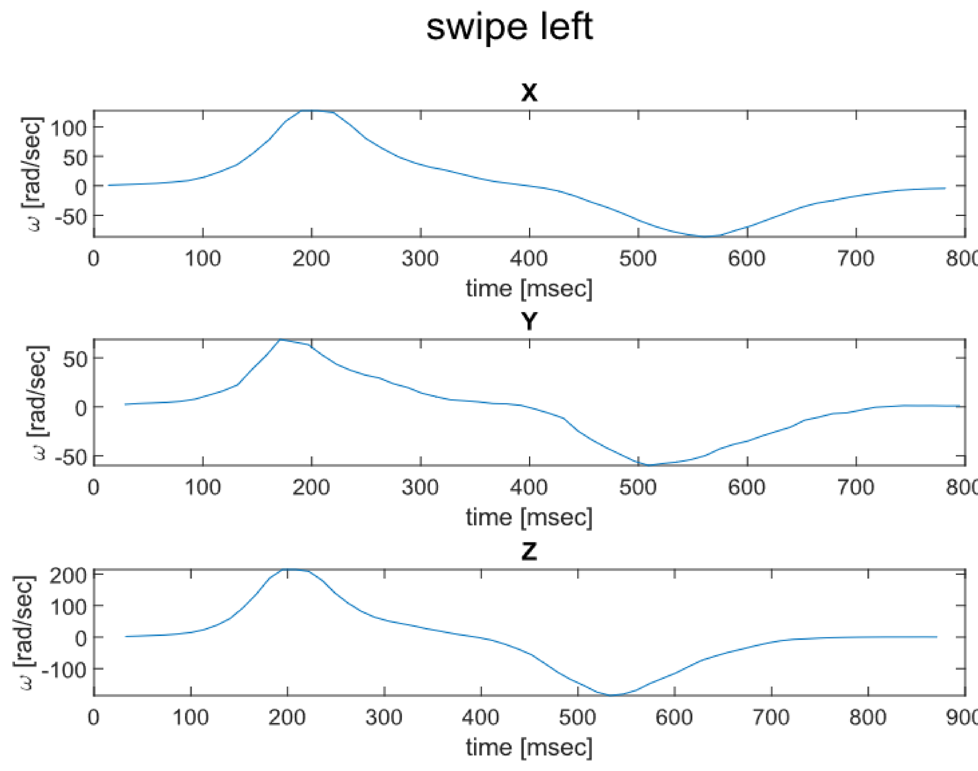
Classification

- Template matching method was chosen for the purpose of classification due to the pattern exhibited by the gyro measurements
- Movements were extracted to create average templates of each movement at each axis:



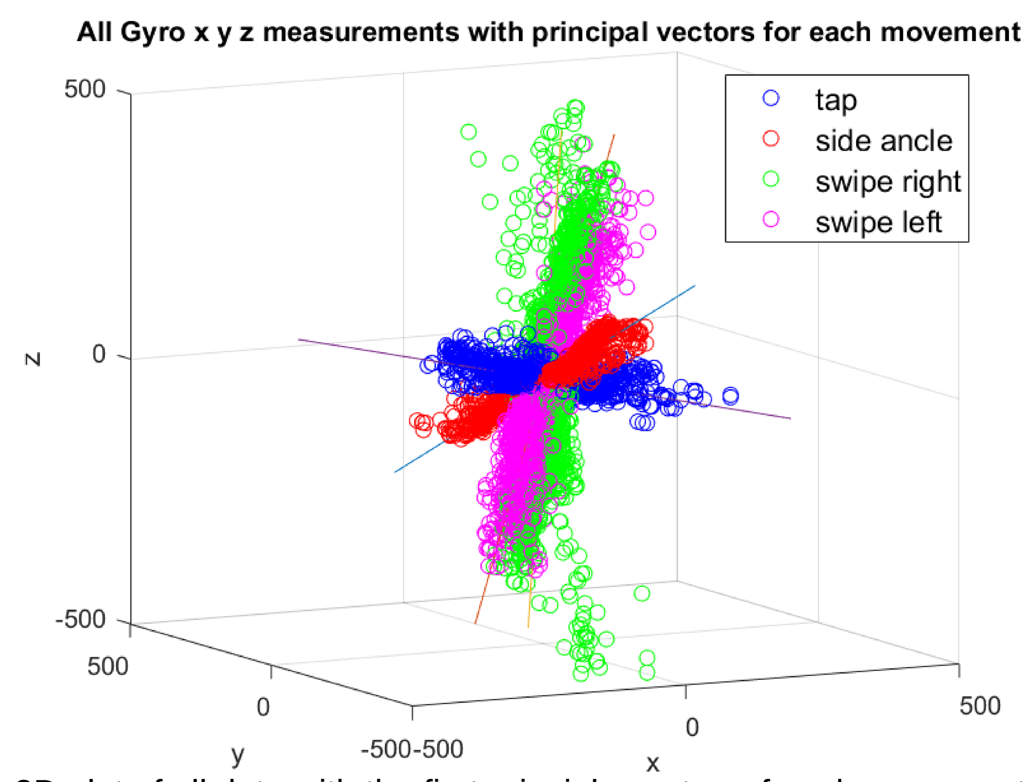
Marking movements to create average templates

- Movements were aligned and clipped to create average templates of each axis for each movement:



Average template of swipe with 3 channels –x,y,z

- PCA analysis was used to extract 3D principle vectors for each movement



3D plot of all data with the first principle vector of each movement

- The principle vectors were used as weights applied to highlight the difference in the patterns.
- Classification is based on the highest movement-template correlation

Future Work

- Improving classifier
- Implement real time on-board algorithm
- Test with real user to measure algorithm success and user's satisfaction.

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