Signal and Image Processing Lab.

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Electronics
Computers
Communications

Technion Israel Institute of Technology

Midterm Presentation

User Interface Design for Low Cost 3D Printed Prosthetic Hand

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In Collaboration with: Haifa 3D

Outline

- Background
- Project goal
- Literature survey
  - Prosthetic hand types available
- Chosen Solution & Intermediate Result
- Conclusion & Future Work

Background

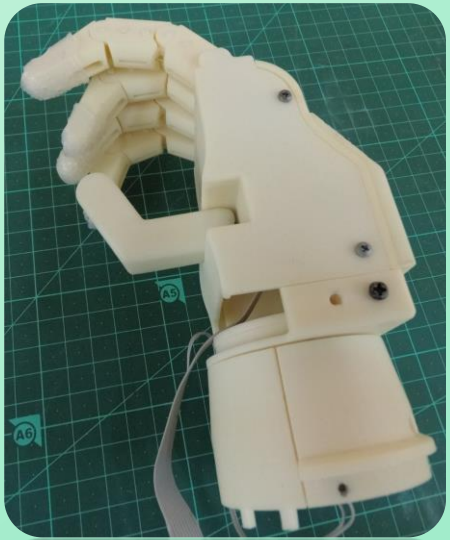
- Aspects impaired by hand loss:
  - Ability to perform daily life activities
  - Work
  - Social activities
- Drawbacks of current commercial solutions
  - Expensive
  - Not intuitive & long training
  - required the residual limb muscle activation

➔Thus a need for a practical, reliable & intuitive hand prosthesis arises.

Project Goal

- Control of 3D printed electro-mechanical prosthetic hand through signals acquired from the leg.
  - Setting up a sensor system
  - Collecting data
  - Classification of at least three gestures

The prosthetic hand in use

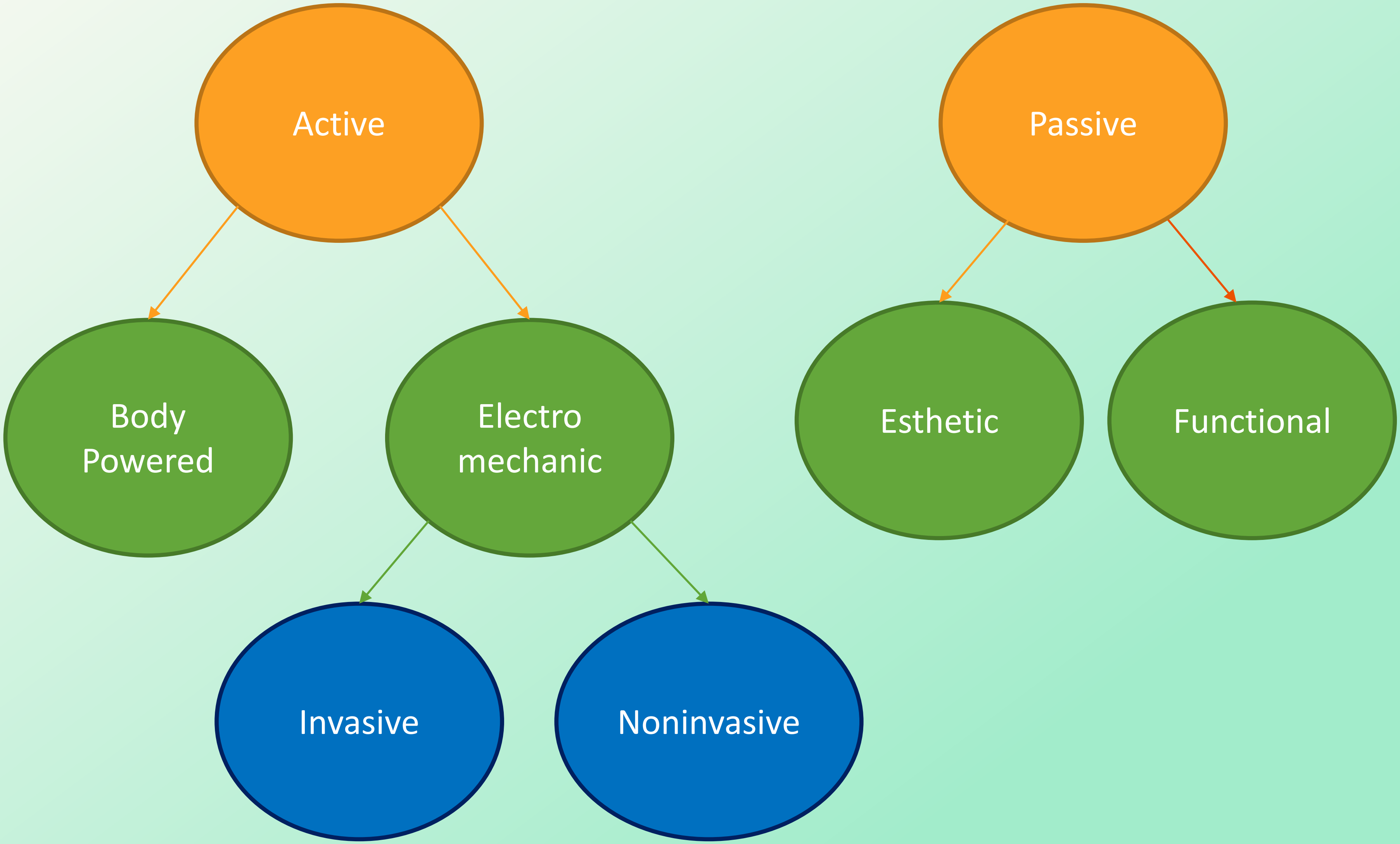


Literature Survey

Major needs of hand prosthesis users:

- Reliability of detection –Stable grip
- Intuitive control:
  - Short training period
  - Controlling grip force
  - Feedback
- Light weight

Prosthetic hand types



Prosthetic hand types

Passive prostheses - esthetic or functional

Body powered – connecting straps to the torso to control

opening and closing of a hand shaped gripper/hook.

- Requires a lot of power to actuate causing fatigue of the body.
- The use is uncomfortable.
- Restricted functionality - open and close gripper.

Ottobock®
Hand

Non - invasive electro mechanic

- FSM (Force Myography): measure the forces applied by muscles.
- Surface EMG (Electromyography) : read signals produced by muscular activity.
  - The most common commercially available solution.

Pros:

- Lots of research in signal processing and classification
- Identification of user's intentions-PNS

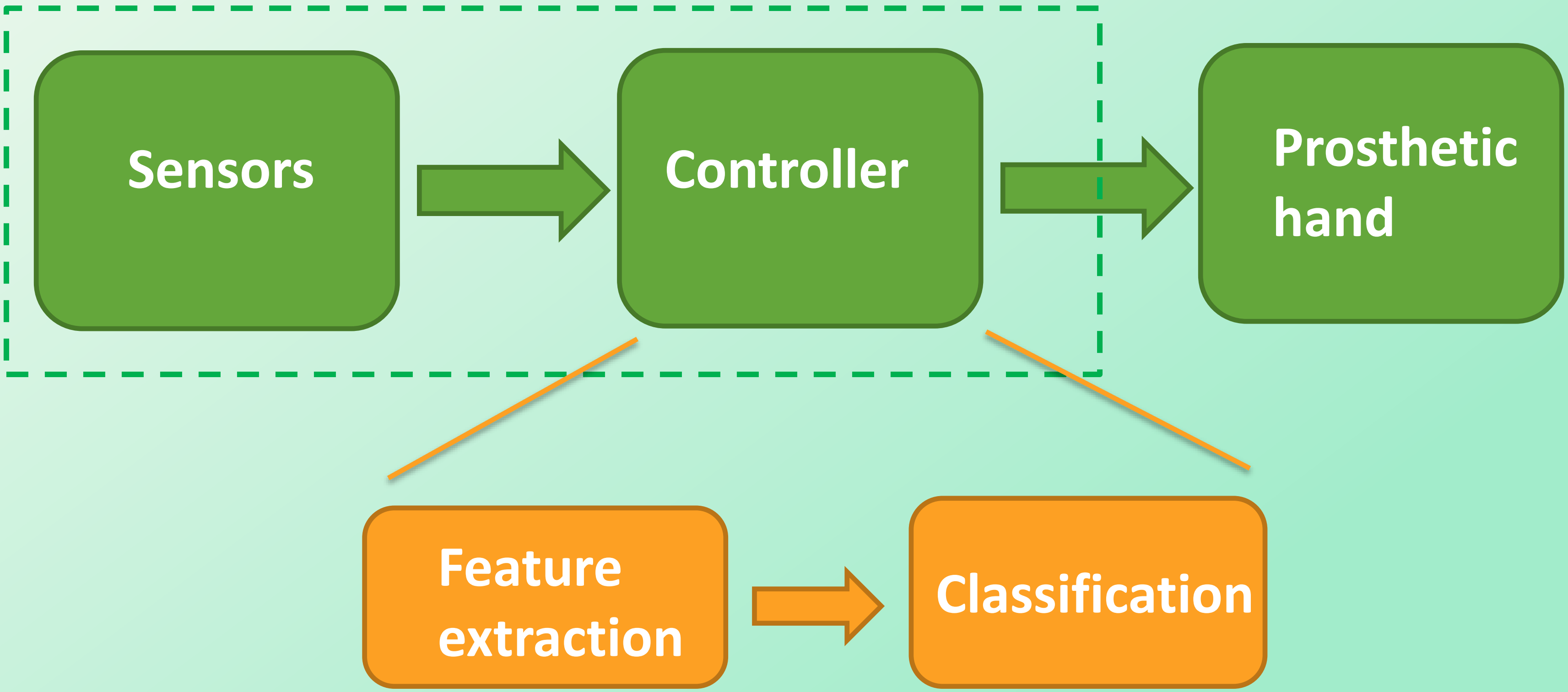
Cons:

- Very noisy signal , unstable control.
- Sweating and moving inside socked -lower signal quality.
- Use of muscles near amputation area- degenerated muscles, may cause phantom pain.

Deka® Arm

Chosen Solution

Block Diagram



Sensors

- FSR – force sensitive resistors

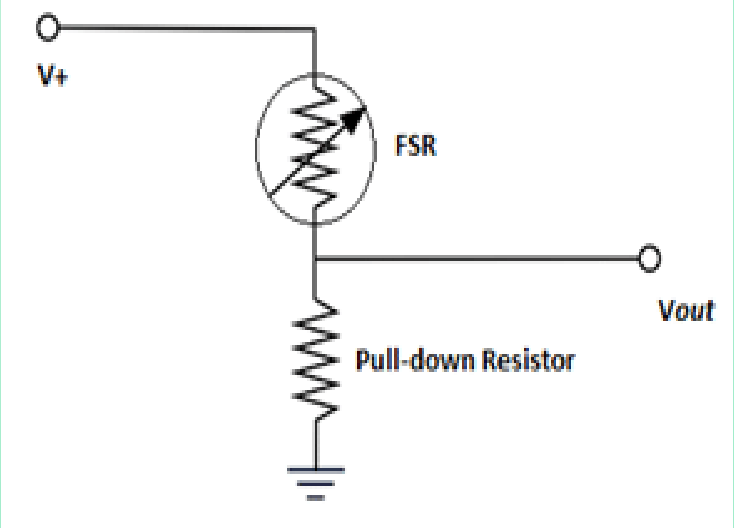
  Consists of two copper electrodes that contact a sheet of conductive polymer that decreases its resistance when pressure is applied.

  Specifications:

  – **Force Sensing Range** ≈0.2N – 20N

  – **No-Load Resistance** >10 MΩ

  – **Minimal resistance measured (by us)** ~2K Ω



Sensors

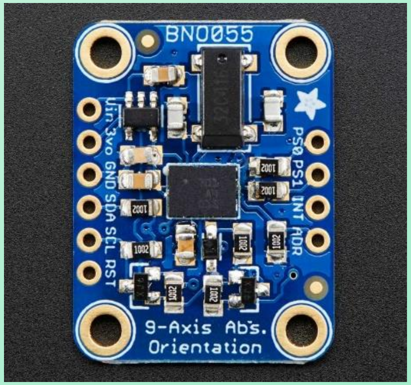
- BNO055 - Orientation and acceleration sensor

Adafruit©

Sensors

- BNO055 - Orientation and acceleration sensor

  Consists of three sensor units- accelerometer, gyroscope and magnetometer.

  Specifications:

  – **Orientation data : Quaternions**

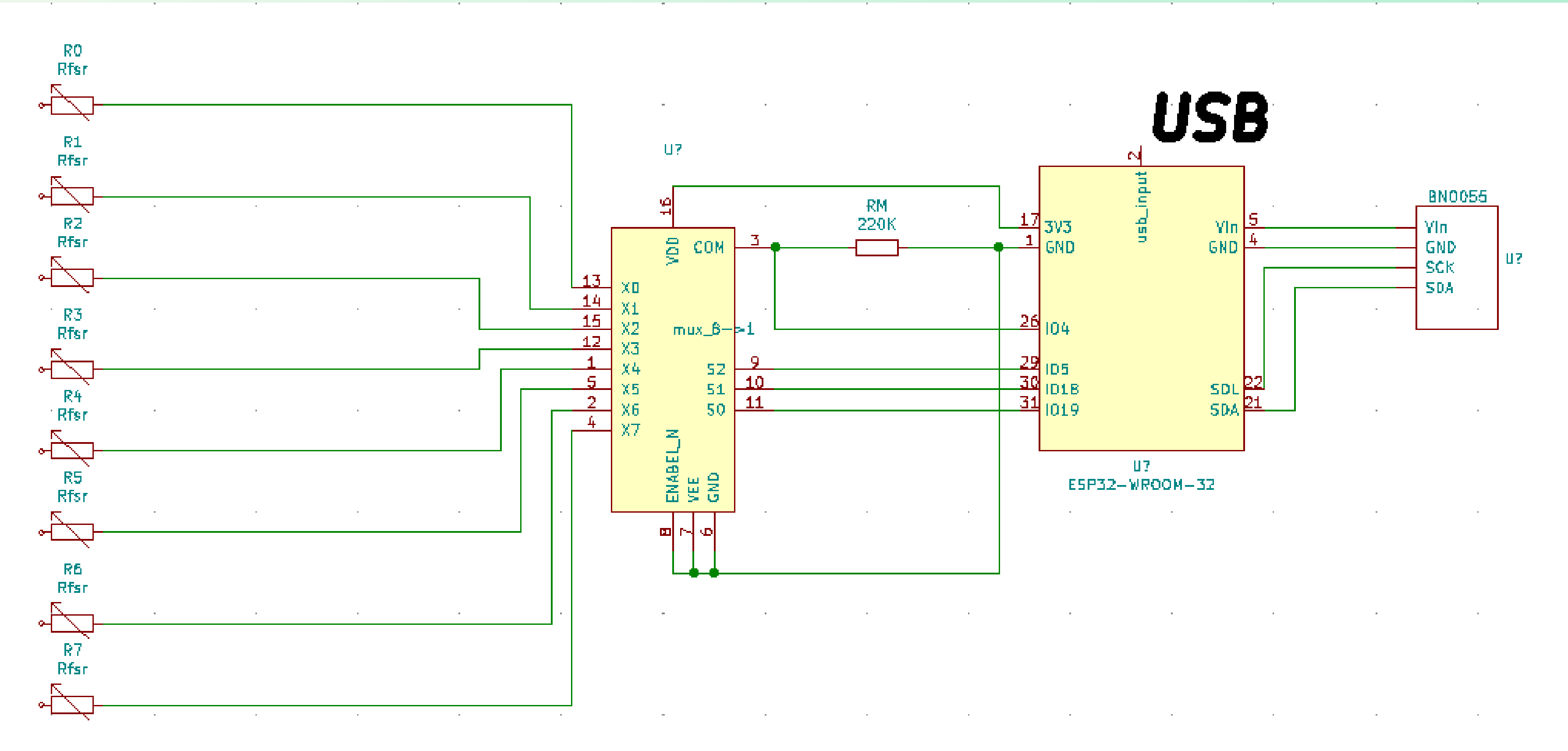
    Four-point quaternion output

    $$\left(\cos\left(\frac{\theta}{2}\right), \sin\left(\frac{\theta}{2}\right)\cdot i,\ \sin\left(\frac{\theta}{2}\right)\cdot j, \sin\left(\frac{\theta}{2}\right)\cdot k\right)$$

    Where (i, j, k) specify the axis of rotation & theta the angle of rotation.

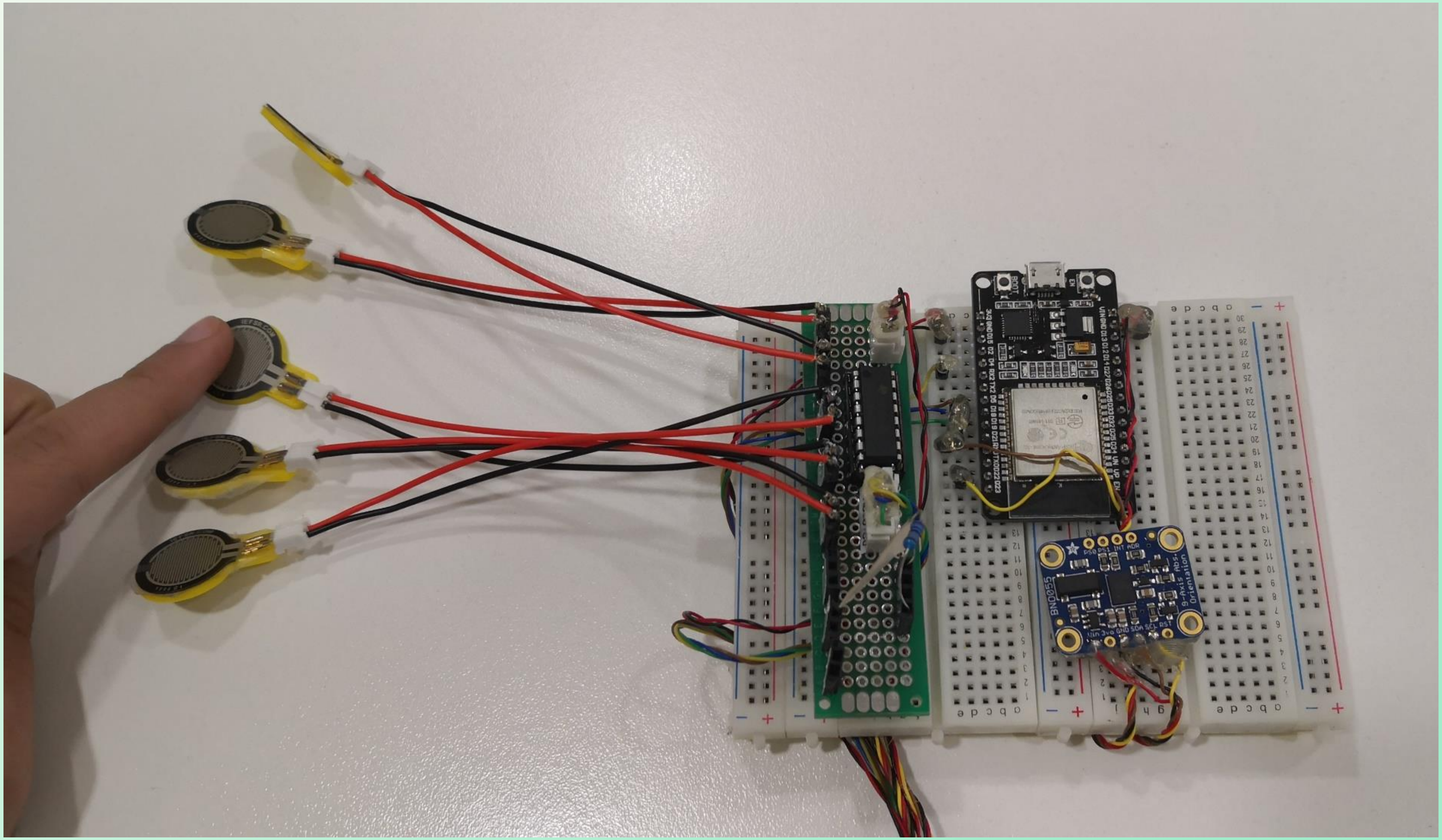
  – **Linear acceleration :** Three axis of linear acceleration data (acceleration minus gravity) in m/s^2.

Block diagram



SIPL

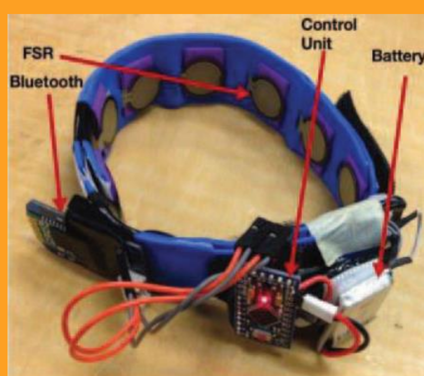
Intermediate Result



System's pros and cons

cons

1. Placed on foot- not intuitive
2. Cumbersome



pros

1. Not placed on the stump
2. Two independent sensors for more credibility
3. Low cost

System presented at [2]

Conclusion

- Characterizing user needs from literature review
- Choosing a sensor
  - Examining the use of a PNS sensor
  - Assembling custom-made sensor system
- Remaining goals to achieve

Future Work

- Fine tuning of system
- Collecting data
  - Movement selection
- Implementation of classifier
  - selecting features
  - Extracting from data
  - Choosing & implementing model for learning

References

1. Francesca Cordella 1, Anna Lisa Ciancio 1, Rinaldo Sacchetti 2, Angelo Davalli 2, Andrea Giovanni Cutti 2, Eugenio Guglielmelli 1 and Loredana Zollo 1 Unit of Biomedical Robotics and Bio microsystems, Università Campus Bio-Medicodi Roma, Rome, Italy, 2 Italian Workers' Compensation Authority (INAIL),Vigorsodi Budrio, Bologna, Italy "Literature review on needs of upper limb prosthesis users", 12 May 2016 doi : 10.3389/fnins.2016.00209
2. Artem Dementyev and Joseph A Paradiso. WristFlex: Low-power gesture input with wrist-worn pressure sensors. In Proc. UIST'14. pp. 161–166