DALHOUSIE UNIVERSITY
FACULTY OF ENGINEERING

Force Myography Interface

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Scope of Work

Build a system that can sense forces on the surface of the forearm to determine finger force and position, and investigate custom design of capacitive sensors.

Deliverable will be a proof of feasibility prototype including a sensor and necessary signal processing architecture to interface with customer device.

Requirements

Build a Measurement & Processing System

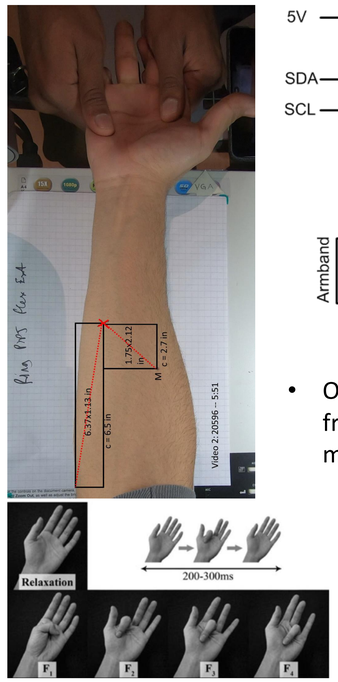
- Measures force signals from the surface of the arm
- Present streams of signal data to a computer/microcontroller
- Analyze signals in real time
- Display interpreted results to user showing individual muscle activation

Specifications to Consider

- Success rate: greater than 80% of gesture detection
- Detection time: 7.5 milliseconds
- Sensor bandwidth: 200 - 500 Hertz
- Spatial resolution: 1 centimeter
- Sensitivity: 0.1 Newtons
- Range: 0 – 1 Newtons

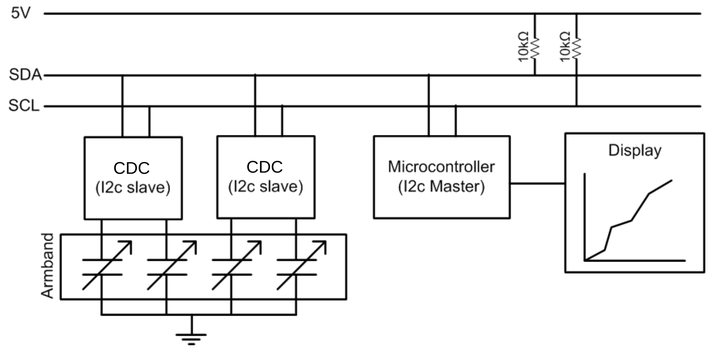
Details of Design

Motion Study



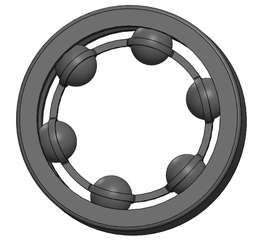
- The vital locations for sensor placement was determined by a motion study by monitoring activation sites of the forearm by doing different finger exercises.
- Using a consistent rig we could monitor what finger movements correlated to a skin deformation by muscle contraction and through this we could determine the optimal placements of the armband for all users.
- Creating a simple prototype we were able to measure the force that muscle generated when performing a pinch using the index and thumb.

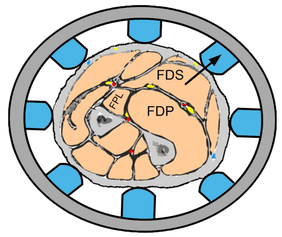
System Architecture



- Overview of components of the project and how data flows from sensor acquisition electronics and converted via microcontroller to a signal display.

Prototype Rendering of Armband



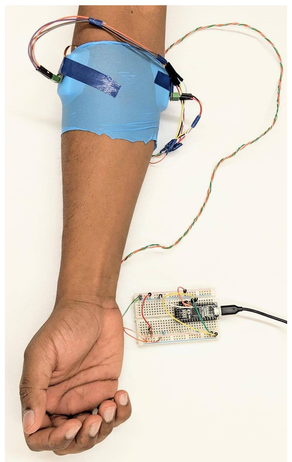


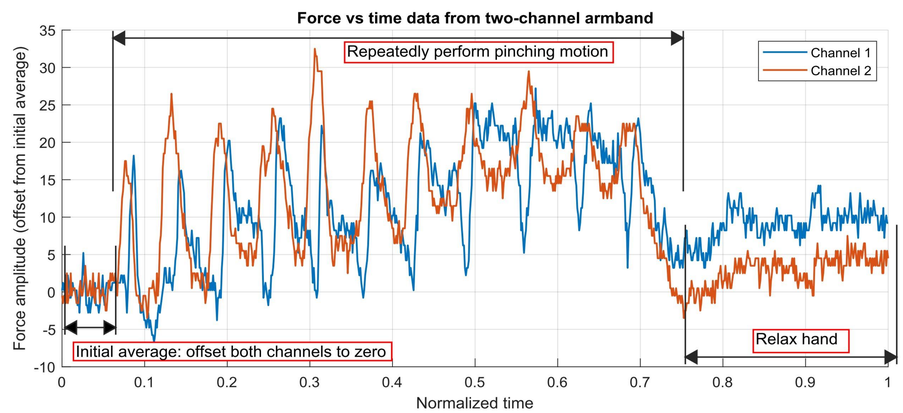
Forearm cross section with focused muscle groups:

- Flexor Digitorum Superficialis (FDS)
- Flexor Digitorum Profundus (FDP)
- Flexor Pollicis Longus (FPL)
- Extensor Digitorum Communis (EDM)
- Extensor Pollicis Longus (EPL)
- Abductor Pollicis Longus (APL)

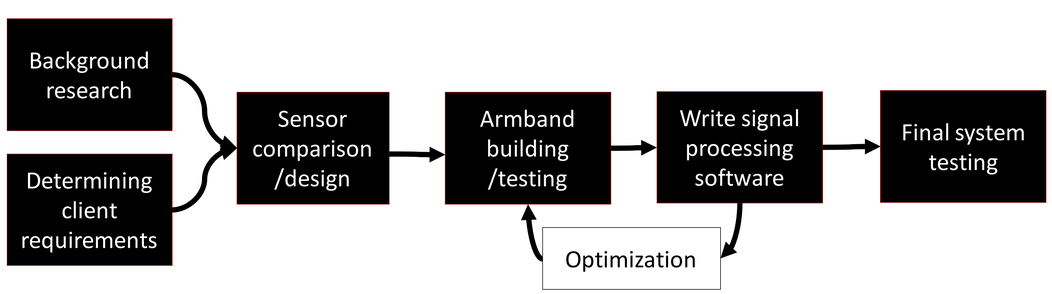
Sensor modules highlighted in blue with indicated force direction activating sensor.

Proof of Concept





Design Process



Future Work

- Building an expertise in capacitive sensing.
- Build a capacitive sensor.
- Sensor signal processing.
- Identifying individual muscles from activation signals.
- Demonstration routine: put on the device, move your fingers, watch the output printouts.
- Results report: can we reliably detect hand gestures from the force they generate?
- Design documentation: How did we build this system?
- Setup instructions for the client.
- User guide.

References

- Cho, E., Chen, R., Merhi, L. K., Xiao, Z., Pousett, B., & Menon, C. (2016). Force myography to control robotic upper extremity prostheses: a feasibility study. Frontiers in bioengineering and biotechnology, 4, 18
- You KJ, Rhee KW, Shin HC. Finger Motion Decoding Using EMG Signals Corresponding Various Arm Postures. Exp Neurobiol. 2010 Jun;19(1):54-61. https://doi.org/10.5607/en.2010.19.1.54