Tactile Feedback Device for Transradial Amputees

Hasan Al Salloum ● Jack Sarmiento Emms ● Martin Sergo ● Dozie Ubosi

FUNDED BY LAB FUND ENGINEERING STUDENTS

Background

Current myoelectric arm prosthetics primarily focus on motor control providing a user with advanced functionality but often lack real-time sensory feedback. This absence reduces the user's ability to enact precise movements and increases the cognitive effort required for control. This absence of feedback is a major factor in prosthetic rejection, as it prevents intuitive use. Research indicates that incorporating sensory feedback improves both embodiment and user agency, highlighting the potential of real-time feedback systems to effectively tackle these challenges.

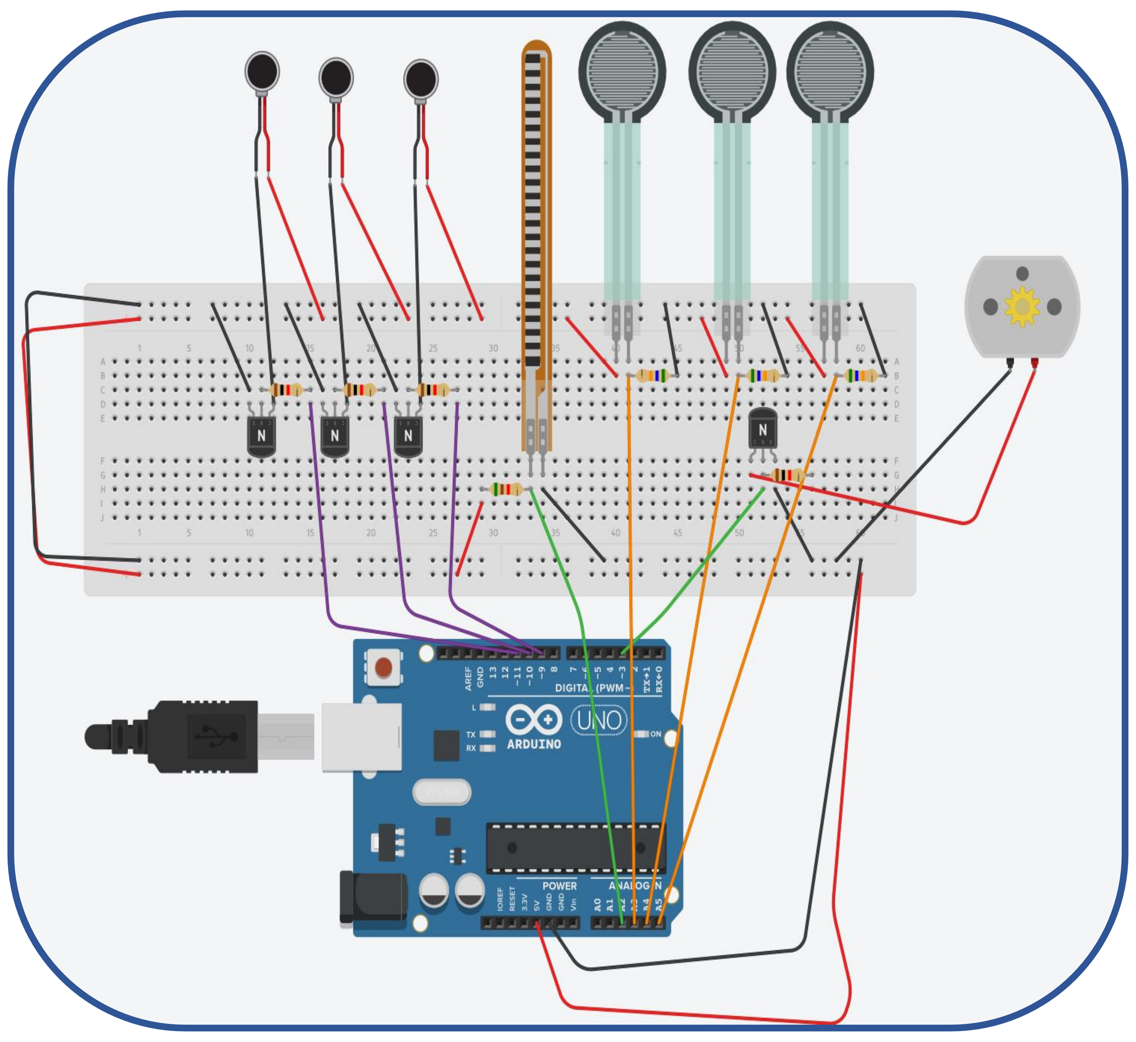
Objectives

- The primary objectives of this design are to:
  - Measure a user's grip force (within 100 lbf) and perceived object hardness (within 50 GPa).
  - Output real-time feedback within 300 ms.
  - Evaluate the intuitiveness of the device by conducting tests involving participants.

Design Scope

- This design's focus is on creating a proof-of-concept feedback system rather than complete prosthetic integration.
- The target audience for the design is transradial amputees.
- The feedback system will only apply to gripping tasks that utilize the index finger of the right hand.

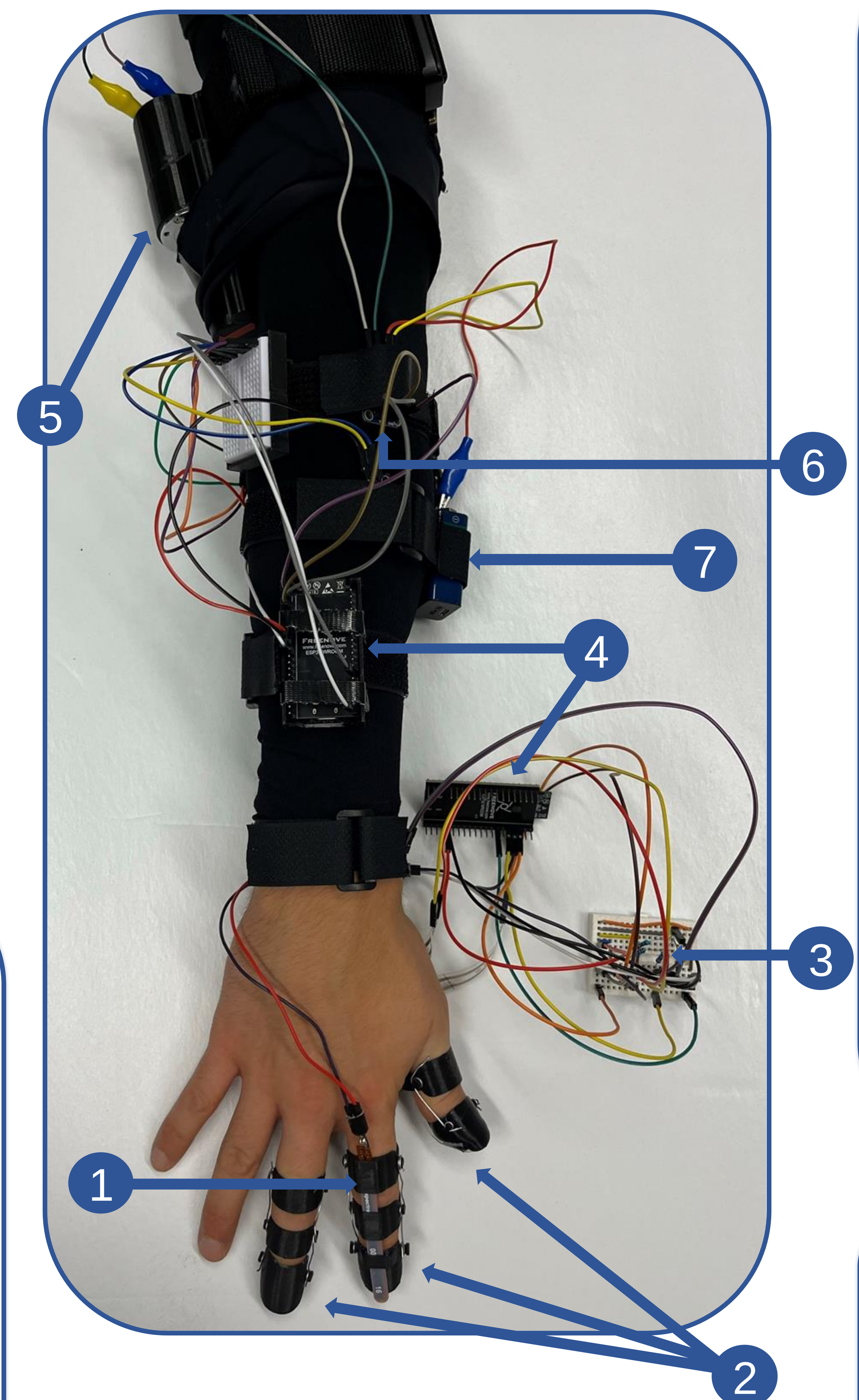
Circuit Diagram



This circuit diagram is a simplified version to display the components used and how the system was developed.

Implementation

- Minimum force and flex thresholds trigger a BLE notification from the server ESP32 to the client ESP32.
- Transmission takes 30-50 ms, then data processing begins.
- Maximum force reading maps to motor position, exerting force on the user's bicep.
- Perceived hardness is calculated from force/flex readings and their rates of change, then normalized and conveyed via vibration motors.



Design Components

1. Flex Sensor to measure bending angle.
2. FlexiForce A201 Force Sensitive Resistors for measuring applied force.
3. 56 KΩ Resistors to control FSR resolution.
4. Dual ESP32-WROOM microcontrollers use Bluetooth Low Energy (BLE) for the input and output system control.
5. DC 12V 60RPM Motor for applied force feedback.
6. Vibration Motors for object hardness feedback.
7. DC Motor Power Supply, 9V Lithium-Ion rechargeable battery.

Safety Features

- All design components can be quickly removed from the user, as they are attached via straps.
- Power to the system can also be removed by unplugging.

Future Work

- Improve design comfort and wearability with PCBs.
- Upgrade to DC motors with higher RPM for faster applied grip force feedback.
- Implement true closed loop control by measuring motor shaft position empirically (motor encoder) to eliminate errors with DC motor position/set point.
- Integrate the technology used with myoelectric prosthetics and test on amputees.

Faculty Advisor: Dr. Scott Brandon, PhD, P.Eng

UNIVERSITY of GUELPH ENGINEERING

BIOMEDICAL ENGINEERING · COMPUTER ENGINEERING · MECHANICAL ENGINEERING