A LOW-COST PORTABLE AND INTUITIVE CONTROL SYSTEM FOR ASSISTIVE ROBOTIC DEVICES

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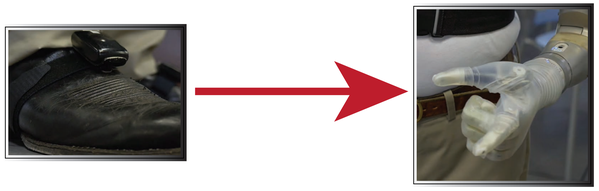
Background

Problem: Current control systems for robotics are expensive and utilize unintuitive inputs such as foot-mounted inertia measurement units (for prostheses) or oral sip-and-puff devices (for wheelchairs) which place unnecessary physical and mental strain on users — leading to the abandonment of assistive devices.

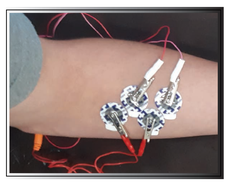
Standard foot-based control is unintuitive:



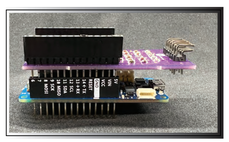
Goal: Develop a low-cost electromyographic (EMG) control system that performs comparably with a state-of-the-art research-grade control system (Ripple Nomad), while being portable, intuitive, and capable in a variety of control applications.

Low-cost System Provides Proportional Motor Control Based on Electromyography

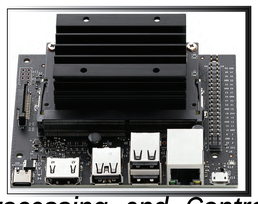
Sensing: Surface EMG detects voltage from muscle activity.



Data Aquisition: TI ADS + Arduino MKR amplifies and transmits EMG data.

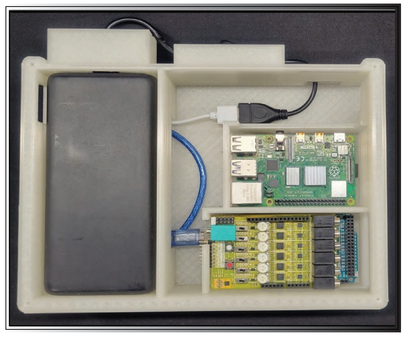


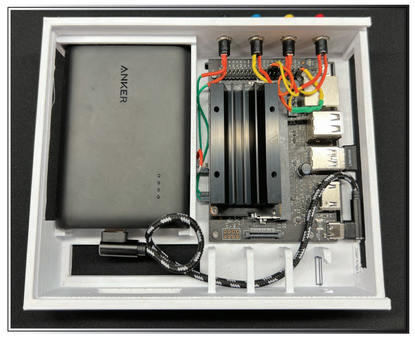
Processing and Control: Nvidia Jetson Nano filters EMG data and runs predictive control algorithm.



Actuation: Assistive robotic device completes commanded motion.

Hardware and Software Integration Improves Capabilities of Low-cost System





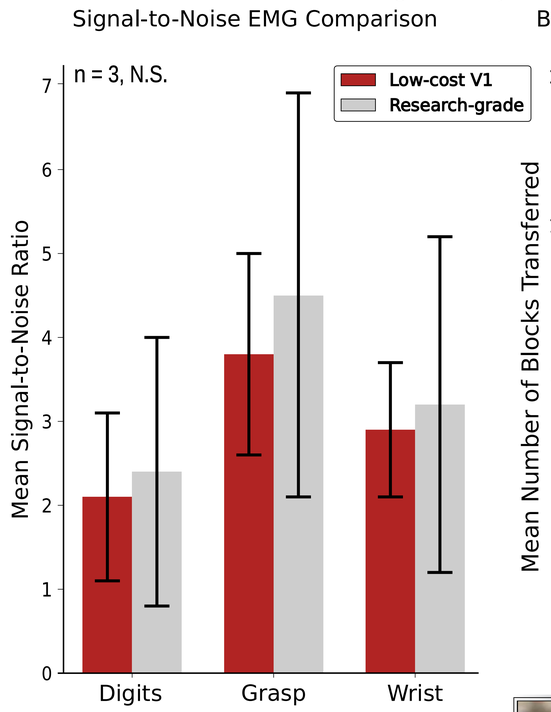
	V1	*V2*	
Cost	~$600	~$175	70% improvement
Volume	22.7 x 19.0 x 5.18 cm^3	13.5 x 19.0 x 4.0 cm^3	54% improvement
Weight	1132 g	586.8 g	52% improvement
EMG inputs	6	8	33% improvement

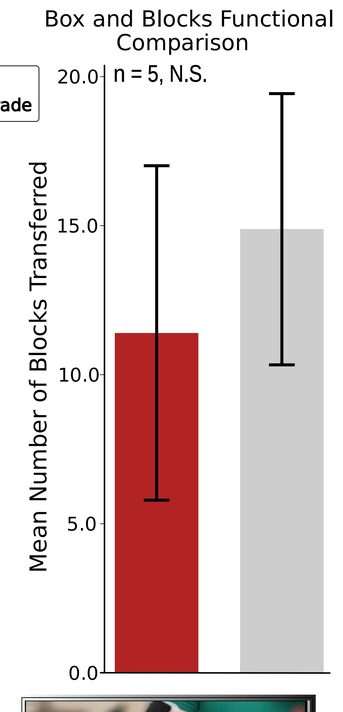
Research-grade: ~$60000, 9.5 x 18.3 x 3.6 cm^3, 700 g, 32 electrodes

Key Software Innovations:

- Wireless communication of EMG data from Arduino MKR to Nvidia Jetson Nano with UDP
- Control DEKA LUKE prosthesis by coupling communication CAN driver and data processing algorithm with C++/Python extensions
- Build prosthesis control driver and demonstration interface with Python

Low-cost System Provides Similar Performance to Research-grade System





Results: Compared to the research-grade system (Ripple Nomad), the V1 low-cost system displays similar signal to noise ratios and functional performance.

Current Work

Versatility: Integration with adaptive sports Tetra Ski, develope machine learning control algorithms utalizing Nvidia Jetson GPU.

Portability: Headless collection, training, and testing using push button inputs.

Validation: Conduct further functional comparisons to reasearch-grade system.

Acknowledgments

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