A Modular Platform for Rapid Prototyping of Biosignal-Based Assistive Mobile Manipulator Control Schemes

Carson J. Wynn, Simon S. Padgen, Laura A. Hallock

BIOROB 2026 EDMONTON

THE UNIVERSITY OF UTAH®

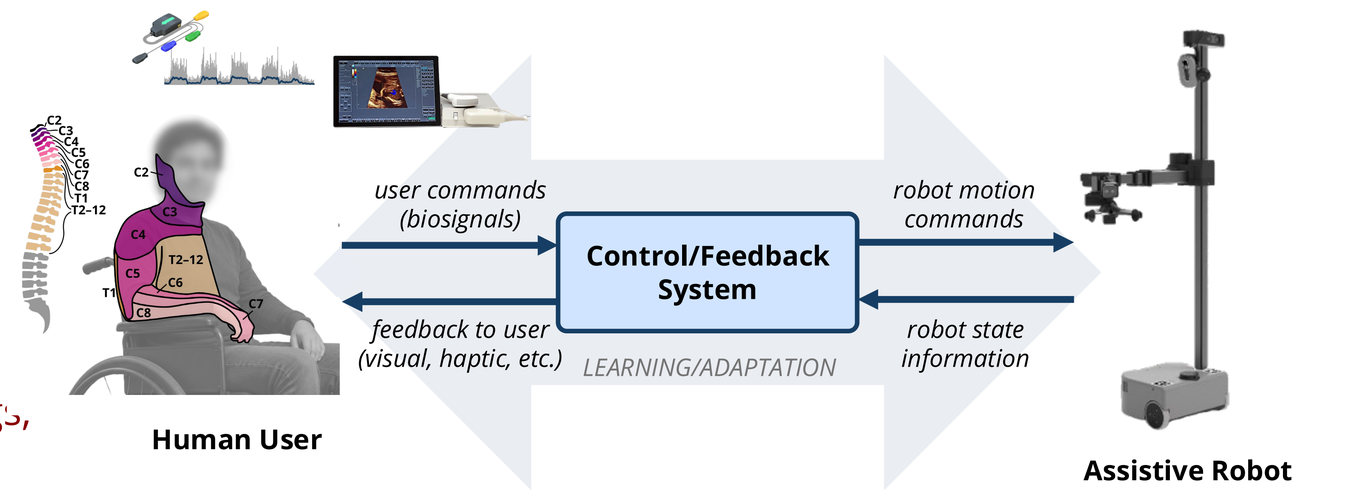
HRELab HUMAN–ROBOT EMPOWERMENT

We present a modular ROS 2–based platform that enables **rapid development and testing of biosignal-based control schemes** for an assistive mobile manipulator, toward discovering schema that enable users with tetraplegia to control complex devices.

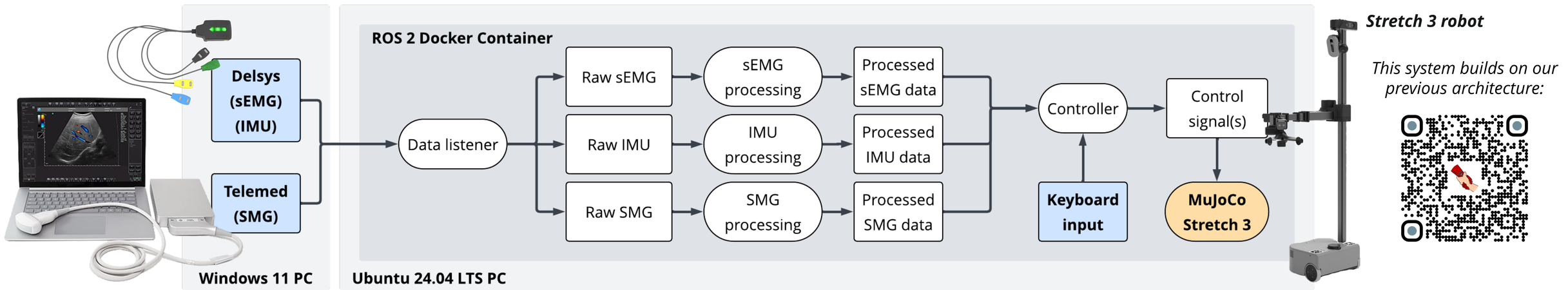
Motivation

- Spinal cord injury (SCI) survivors exhibit **heterogeneous capabilities** [1], but current assistive manipulator control schemes are slow, unreliable, and/or make assumptions about the user's level of motor function [2-4].
- Many control schemes are possible, but there is no consensus on what will work best for a given user.

→ **GOAL:** Develop a system for the **rapid iteration and testing** of different robot morphologies, control mappings, and feedback paradigms.



System Architecture



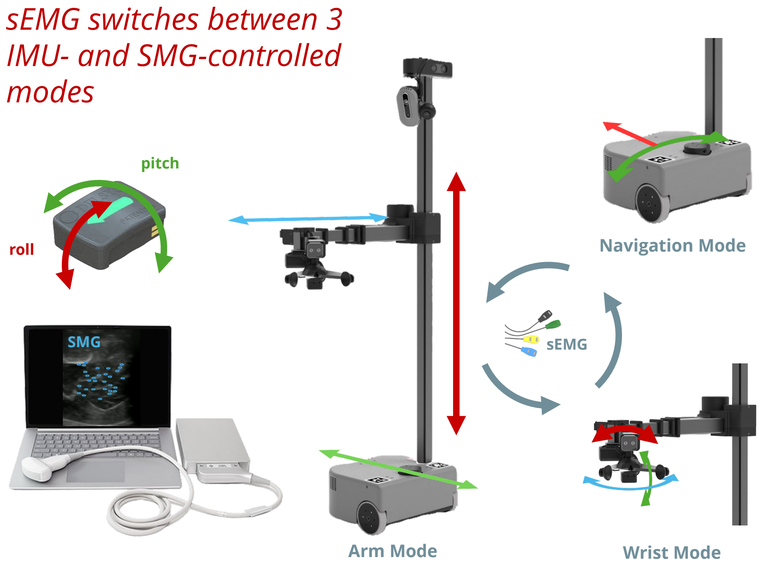
Control Mappings

Joint Controller

SMG controls each joint, sEMG switches between them

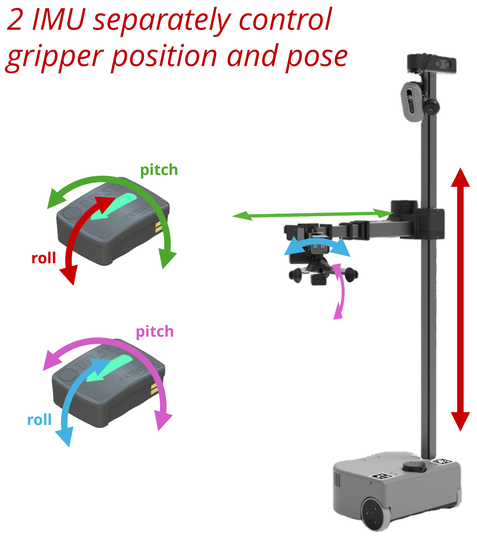
Switch Mode Controller

sEMG switches between 3 IMU- and SMG-controlled modes



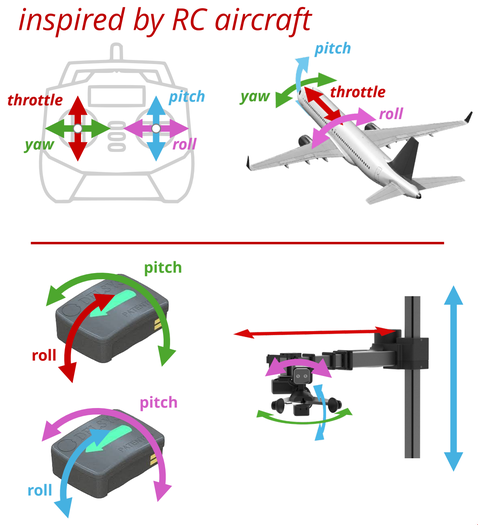
Gross/Fine Controller

2 IMU separately control gripper position and pose



"Mode 2" Controller

Non-holonomic control inspired by RC aircraft



Preliminary Results

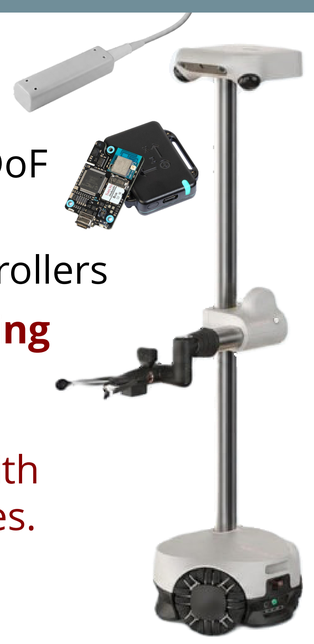
- Modular architecture enables **switching and remapping of control schemes in seconds**, enabling rapid exploration of many control interfaces.
- Early users find **"Mode 2" control most natural**; formal user studies in both healthy and SCI populations are forthcoming.

Current Extensions

Platform extensions:

- Hardware: additional ultrasound probes, 9-DoF IMUs, Stretch 4 robot
- Software: velocity controllers

Execute on our motivating goal: Investigate sensor placements and control mappings across users with heterogeneous capabilities.



Poster SuPO1P.12 *(Athithan et al. 2026)* — Researching **surface electromyography (sEMG) to reduce optical-flow-based sonomyography (SMG) signal drift**

Poster SuPO1P.13 *(Padgen et al. 2026)* — Extraction of **two continuous sonomyographic (SMG) control signals from a single B-mode ultrasound probe**

Paper TuO5T2.5 *(Sueltz et al. 2026)* — A **novel, ultrasound-based signal extraction method** that allows **users with tetraplegia** to continuously control devices

Acknowledgments / Sponsors

This work was supported by the University of Utah Department of Mechanical Engineering and the University of Utah Research Fund.

The authors thank Gabriel Parra, for his assistance with the Delsys API.

[1] Sheldon et al. (2025), *World Neurosurgery*.
[2] Nazari and Zheng (2023), *Sensors*.
[3] Henderson et al. (2013), *Technology Disability*.
[4] Mougharbel et al. (2013), *Science and Information Conference*.
[5] Sueltz et al. (2026), *BioRob*.