NRI: Adaptive wearable robots for movement assistance via bio-inspired sensorimotor integration

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Project Goal: develop an upper-limb wearable robot (exosuit) that amplifies the functional independence of children with motor impairments

Key Challenges

Actuator design: Exosuits require variable joint impedance but such technology is lacking, in particular for soft actuators.

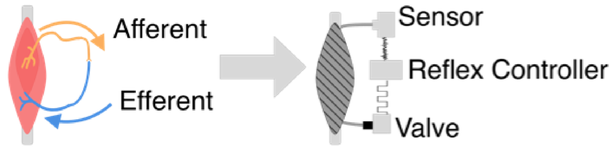
Control for human-robot interaction: Impedance control does not exist for soft actuators (impedance modulation).

Human volitional control: EMG-based (proportional) controllers required careful tuning and recalibration.

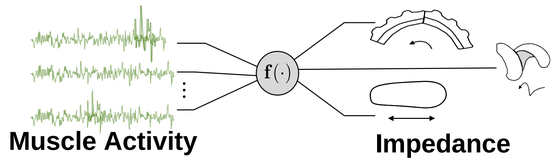
Solutions

1. Soft actuators integrated with smart material for impedance modulation.

2. Proprioceptive reflexes and equilibrium-point control for physical interaction.

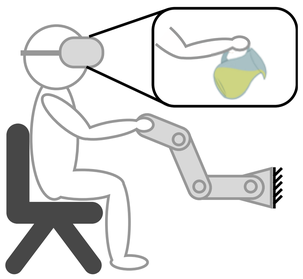


3. Human-in-the-loop regulation of impedance through a neural interface.



Evaluation Platform

Human-robot experiments will leverage a simulation environment in VR with a manipulator for rendering haptic information, which will be capable of simulating everyday tasks



Central Hypothesis: The wearable robot will reduce the required effort and increase the movement accuracy, measured through motion analysis, during manipulation.

Scientific Impact

Embodied intelligence for robotics: We aim to co-design impedance variable actuators with (bio-inspired) reflexive control structures to simplify the physical interaction problem. Our work provides a new direction towards neuromorphic perception-action integration for robotic embodiments.

Human motor control: Through our human-robot experiments, we will gain insight into muscle coordination, skill acquisitions, and object manipulation , with/without exosuit assistance

Education and Outreach Impact

Workshops with stakeholders: We will hold three workshops with community stake-holders at CHOC

Education and training: We will train students in soft robotics, smart materials, control, and human-robot interaction

Societal Impact

Although designed with the pediatric population in mind, the technology will be adaptable to general use cases, e.g., provide physical assistance to the elderly, and for deployment in manufacturing, nursing, and industrial sector.

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