2017 NSF CYBER-PHYSICAL SYSTEMS PRINCIPAL INVESTIGATORS' MEETING

Multi-Robot Cyber-Physical System for Assisting Young Developmentally-Delayed Children in Learning to Walk

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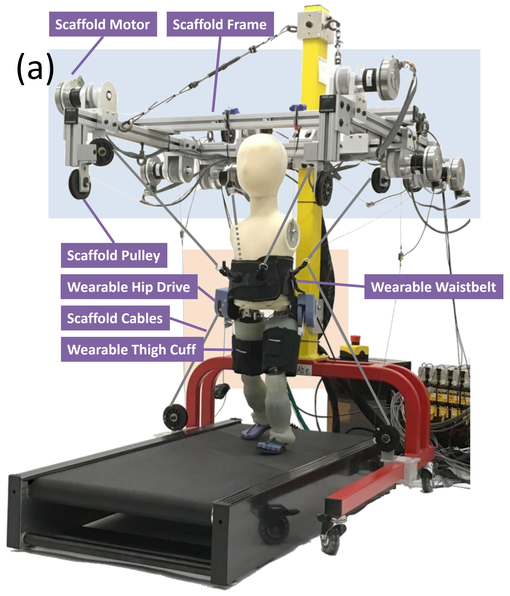
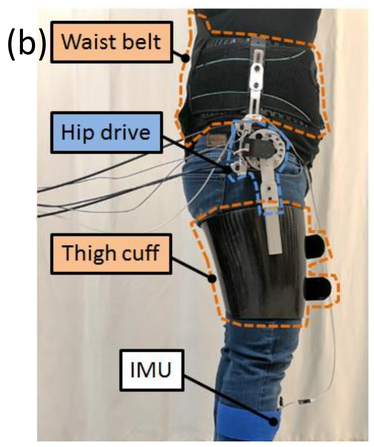
Challenges of Assisting Young Developmentally-Delayed Children Learn to Walk:

- Stabilizing medio-lateral body sway while promoting opportunities for exploratory behavior
- Developing gait that exploits exchange of potential and kinetic energy

Solution: A Modular Multi-Robot Cyber-Physical System (CPS)

- Wearable robot module
  - Applies assistive torques to the hip joints to assist limb movement
- Scaffold module
  - Applies forces to the pelvis via cables to modulate and stabilize center of mass movement

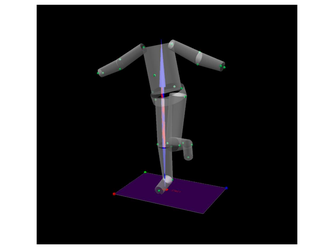


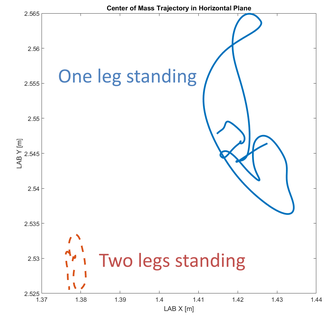


(a) Overview of the multi-robot system, consisting of the wearable robot module (orange rectangle area) and scaffold module (blue rectangle area)
(b) Scaled module for adult testing

Experimental Perturbation to Emulate Developmental-Delay:

- Gait Initiation and subsequent steps
  - Experiments demonstrate that standing on one leg introduces instability into center of mass behavior
  - The scaffold will be used to stabilize center of mass mediolateral sway
  - The wearable robot will assist elevation of the swing leg during gait initiation and subsequent steps





Scientific Impacts:

- Modular, computationally distributed design
  - Modules may be used individually or in combination
  - Tailors assistance to the specific needs of a developmentally-delayed child
- Interoperability of modular components
- Safe environment for exploring body sway

Broader Impacts:

- Designed for children with cerebral palsy (CP) or stroke
- Potentially applicable for clinical populations of adults
- We are currently assessing the safety and efficacy of the system
- Design and fabrication has provided learning opportunities at all levels of education, and for a diverse group of students

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