MULTI-ROBOT CYBER-PHYSICAL SYSTEM FOR ASSISTING YOUNG DEVELOPMENTALLY-DELAYED CHILDREN IN LEARNING TO WALK

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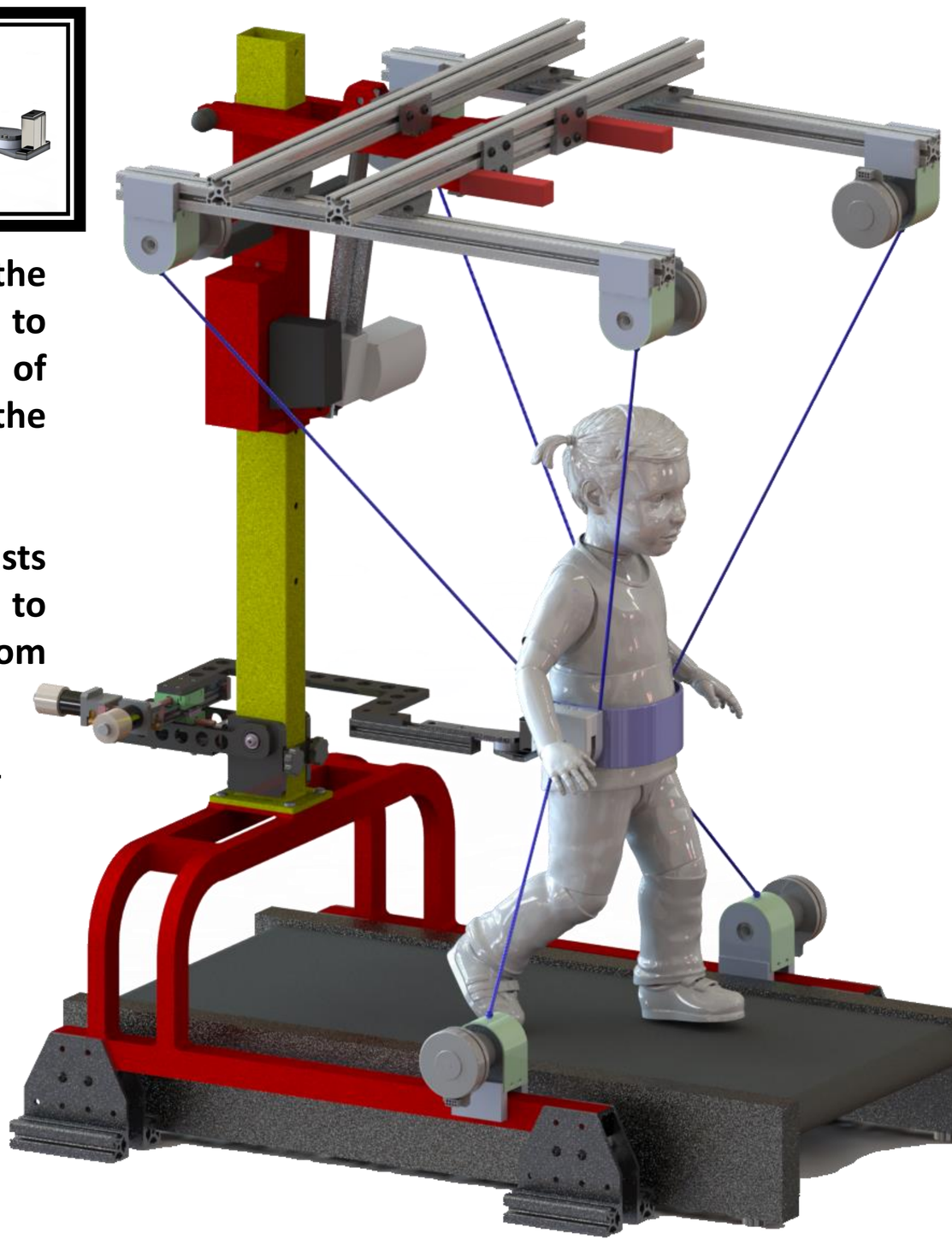
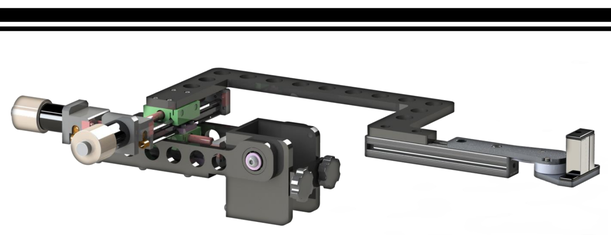
Introduction

This project is a modular, computationally-distributed multi-robot cyber-physical system (CPS) for assisting young developmentally-delayed children learning to walk. The challenges of assisting young developmentally-delayed children learning to walk are 1) stabilizing medio-lateral body sway, 2) developing gait that exploits energy exchange, and 3) coordinating multiple degrees of freedom. Adults assisting children learning to walk provides a "scaffold" of postural support that enables the child to safely explore the forces acting on its body. In order to capture the adaptability of the adult in responding to the child's learning, our CPS consists of 1) a support arm to dynamically sense and stabilize center of mass sway; 2) a wearable exosuit with embedded sensor and actuator to assist walking; and 3) a scaffold to modulate and stabilize center of mass sway.

CPS System Overview



Part A. Dynamic Support Arm



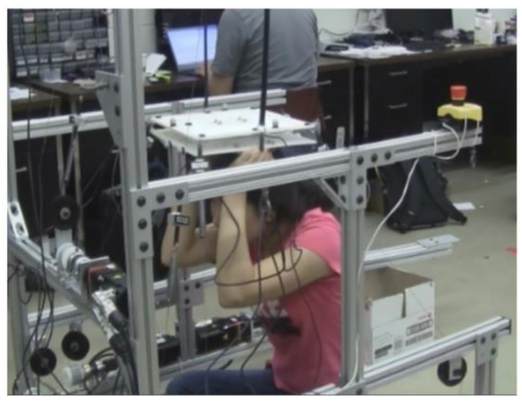
A support arm attached to the vest the child is wearing to sense and stabilize center of mass movement while the child is standing.

This support arm also adjusts center of mass movement to facilitate the transition from standing to walking.

Part B. Hip Drive Unit

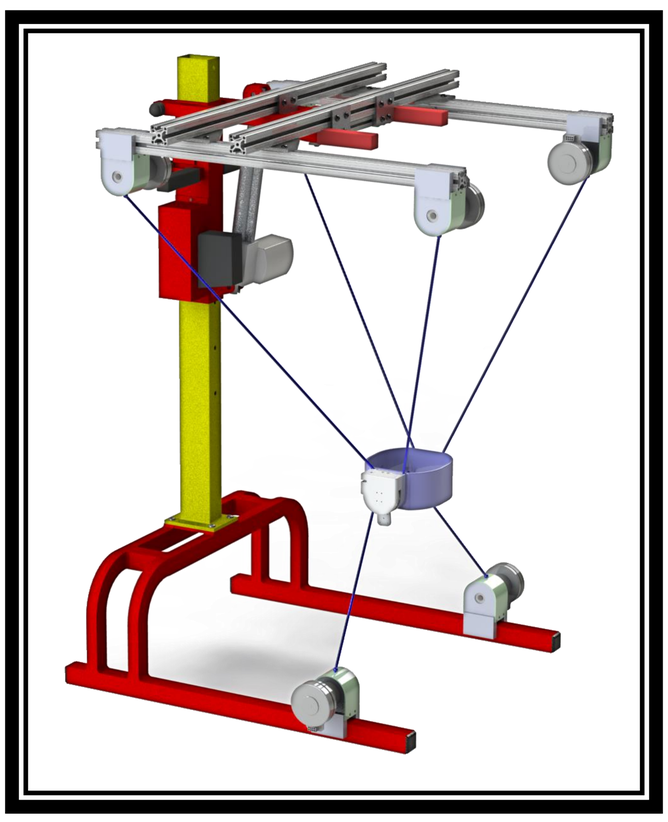
A hip drive unit attached to the waistband over the hip, and a thigh band that wraps around the thigh.

This drive unit senses hip joint angle and provides rotational torques to the thigh at critical moment to initiate and assist hip joint flexion during walking.



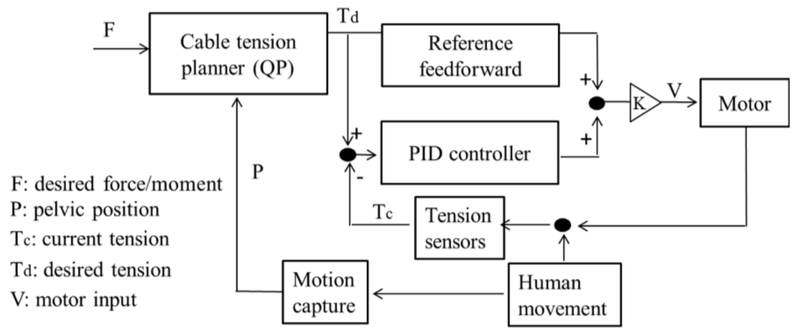
Preliminary results on a dummy pelvis (white rectangular object held from below) suggest that the pelvis is appropriately stabilized by the cabling system.

Part C. Scaffold System

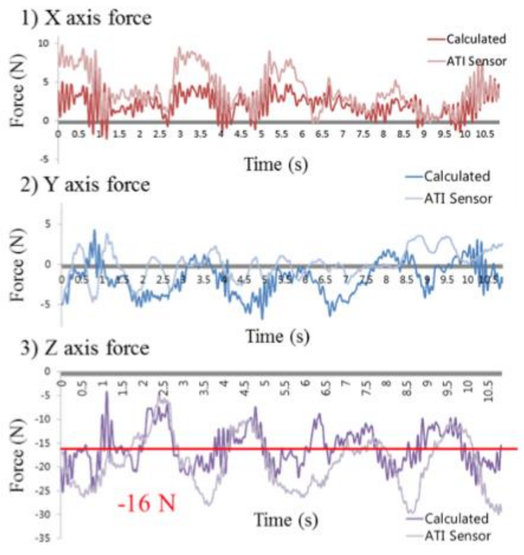


A scaffold system to modulate and stabilize center of mass movement during standing and walking.

Part C1. Design & Testing



The control system schematic for the actuated cable scaffold system takes input from the toddler's motion using various sensors and a motion capture system to stabilize the center of mass.



Initial testing and evaluation of the performance of 1) anterior-posterior, 2) medio-lateral, and 3) vertical motion has been conducted.

Acknowledgement

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