# Mechanical Engineering Thesis Defense

## Human Gait Entrainment to Soft Robotic Hip Perturbations Using Simulated Overground Walking

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## Abstract

Humans possess the ability to entrain their walking to external pulses occurring at periods similar to their natural walking cadence. Expanding the basin of entrainment has become a promising option for gait rehabilitation for those affected by hemiparesis. Efforts to expand the basin have utilized either conventional fixed-speed treadmill setups, which require significant alteration to natural walking biomechanics; or overground walking tracks, which are largely impractical. In this study, overground walking was simulated using an actively self-pacing variable speed treadmill, and periodic hip flexion perturbations (≈12 Nm) were applied about a subject using a Soft Robotic Hip Exoskeleton. This study investigated the effectiveness of conducting gait entrainment rehabilitation with simulated overground walking to improve the success rate of entrainment at high frequency conditions. This study also investigated whether simulated overground walking can preserve natural biomechanics by examining stride length and normalized propulsive impulse at various conditions. Participants in this study were subjected to four perturbation frequencies, ranging from their naturally preferred gait frequency up to 30% faster. Each subject participated in two days of testing: one day subjects walked on a conventional fixed-speed treadmill, and another day on a variable speed treadmill. Results showed that subjects were more frequently able to entrain to the fastest perturbation frequency on the variable speed treadmill. Results also showed that natural biomechanics were preserved significantly better on the variable speed treadmill across all accelerated perturbation frequencies. This study showed that simulated overground walking can aid in extending the basin of entrainment while preserving natural biomechanics during gait entrainment, which is a promising development for gait rehabilitation. However, a comparative study on neurologically disordered individuals is necessary to quantify the clinical relevance of these findings.

April 14, 2023; 11 AM; DH L1-07;
Zoom Link: https://asu.zoom.us/j/2864300543