Development of a novel gait perturbation system for the study of stumble recovery

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Falls due to stumbles and the related injuries are a major issue for populations with gait pathologies [1]. Previous studies have developed systems to introduce stumble-inducing gait perturbations, however none have been capable of introducing (1) realistic, (2) unanticipated, and (3) accurately-timed obstacle perturbations while (4) allowing for kinematic and kinetic analysis [2]. **PURPOSE**: The objective of this work was to develop a novel treadmill-based gait perturbation system that overcomes limitations of prior systems and has capabilities (1)-(4). **METHODS**: A ramp-based obstacle delivery apparatus was created to introduce an obstacle to a treadmill without the subject perceiving it. Additionally, a predictive targeting algorithm was developed to determine the required release time to produce a specifically timed perturbation. A seven-subject experiment was conducted on healthy individuals to validate the system by demonstrating the targeting accuracy and that subjects did not anticipate the obstacle. Ground reaction forces and motion capture data were collected. **RESULTS**: No subjects could perceive the obstacle entering the treadmill (i.e., anticipate the perturbation) (12 trials per subject). Additionally, the system demonstrated an absolute mean targeting error of 6.2% of swing phase, or 25 ms (28 trials per subject). **CONCLUSION**: Beyond achieving its goals (1)-(4), the system allows for quick collection of numerous trials while also providing a higher analytical resolution with respect to perturbation timing than previous studies. Next, the system will be used to aid in the design of a new stumble recovery control system for a robotic transfemoral prosthesis.

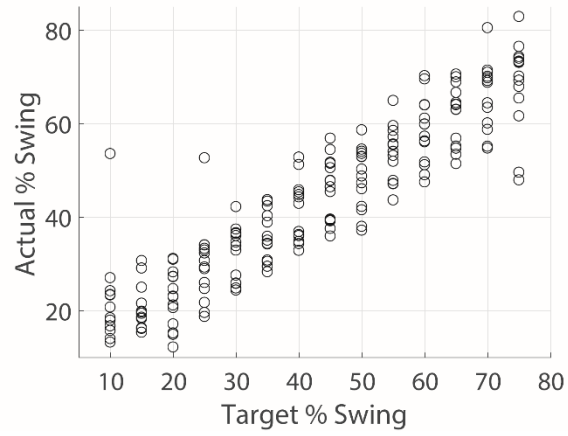

Figure 1. Targeted versus the actual perturbation percent swing. Absolute mean error of 6.2% swing or 25 ms.

References

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