Step Initiation by Humans and Robots.
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Abstract:

Many neurologic diseases, such as Parkinson's disease (PD), associate with gait impairments that limit function and independence. Understanding the biomechanical, environmental, intentional, and task-related variables that affect the planning and control of step initiation is a paramount challenge that is required to effectively direct treatment strategies and improve clinical outcomes.

In the field of autonomous robotics significant progress has been achieved in producing robots of varying complexity that can walk on flat surfaces without direct control. Robotic technologies, however, are still unable to develop a minimally complex robot that learns how to autonomously walk in dynamic conditions nor have models been developed to represent neuropathological conditions.

Therefore, the objectives of our planned studies are to evaluate how predictability of limb choice and step placement, risk of harm, availability of sensory feedback and mechanical degrees of freedom affect step initiation in humans with and without disease or injury, and also test these outcomes in a controlled virtual environment on a minimally complex human model.

Human subjects, both healthy and with PD, will perform tasks of step initiation under varying conditions (predictable vs. unpredictable environment, with or without vision, etc.). A computational model of a human body will be developed in a 3D physics engine to (1) robustly reproduce healthy human behavior, and, (2) when lesioned, will behave similarly to people with PD.

The outcome of this study will be understanding of how each of the variables affects step initiation. This model will provide insight into how to improve treatment strategies for PD, perhaps providing a proxy for experiments involving patients with PD. For autonomous robotics, the model will yield a minimally complex design of a robot controller on which effects of various lesions can be studied, or for use in industrial stress testing or autonomous robotic exploration in dynamic environments.