Is it the same when we go outside? - Measuring real world stability

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I. RESEARCH CONCEPT

The current standard for biomechanical gait research uses optical motion capture in a controlled gait research lab. However, healthy humans are able to successfully navigate much more complex scenarios. During daily commutes by foot, humans might contend with a wide range of challenges, including traffic, ice, uneven sidewalks, and other pedestrians. The disconnect between walking in a gait lab and in real environments begs the question whether the behavior captured in the lab is representative of how healthy humans behave when navigating the real world. Maintaining stability is a key task during walking that is dependent on the perturbation experienced. Previous in-lab studies have concluded that the primary strategy to overcome these perturbations is corrective stepping to alter the base of support [1]. When we move out of the lab into the real world, ground conditions may limit the possibility for corrective stepping. Other stability strategies, such as ankle torques or upper-body momentum, may play a larger role in overcoming perturbations.

II. APPROACH

The goal of this study is to investigate how healthy humans adjust their stability strategy when walking in different outdoor conditions. A significant problem in moving to out-of-lab experiments is collecting accurate stability measures without standard gait lab equipment. To collect data of humans walking in uncontrolled settings, we plan to use an IMU suit (XSENS, Netherlands) for full-body kinematics and smart insole sensors to measure center of pressure. Equipped with these sensors, we plan to have subjects walk in a simulated daily commute around the university campus with no instruction other than the path to walk. In Canada there are drastic changes in ground conditions between summer and winter months. Collecting data in both seasons will allow for the winter to supply an increased set of obstacles compared to the summer. This will provide us with significantly differing perturbation conditions, possibly forcing the subjects to elicit different strategies for maintaining stability.

III. PRELIMINARY DATA COLLECTION

So far we have completed a preliminary analysis of some common gait features that are relevant for gait stability from a single healthy, adult subject walking on five separate spring days (Fig. 1). Although no conclusions can currently be drawn from these results, they demonstrate that the system does allow for similar stability analysis that would be done during in lab experiments. Additionally, even if certain measures like stride width are inaccurate in magnitude, the system is capable of detecting the variability that may occur between days based on the external factors such as subject fatigue and traffic.

![Fig. 1. Preliminary results of a single subject walking a 1.3 km route around campus on five different days during spring with the IMU suit only.](image)

IV. EXPECTED OUTCOMES

The realization of the proposed research may reveal that humans might adopt differing balance strategies in real environments than those captured in gait labs. In particular, we might begin to understand the relationship between the environment and the choice of stability strategy, along with implications for energetic cost. Additionally, the methods presented can be translated into various applications that cannot be studied in the lab, such as real-time monitoring of fall risk, allowing for broader research topics to be explored.

REFERENCES