CoP location may serve as a temporal indicator for foot placement in bipedal walking simulation

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1 Motivation

The compliant walking models are often used for reproducing characteristic gait dynamics [1]. However, since they require the touchdown angles to be chosen independently, there is a limited explanation for the foot placement selection in relation to the state of the body. In this study, it is hypothesized that the foot placement is indicated by progression of the center of pressure (CoP) towards the forefoot during the single stance phase.

2 State of the Art

The proper foot placement location that would induce stable sequential steps was calculated by foot placement estimator in recent rigid legged bipedal model [2]. Whereas in compliant walking models [1], for a given state, a set of touchdown angles was tested to investigate which of them leads to steady solutions. However, the foot placement is a result of the forward progression of body, and thus, it should be decided as a dependent model parameter on the body state.

3 Own Approach

We hypothesized that the location of the center of pressure (CoP) within the base of the support may serve as a temporal indicator for foot placement. During the single stance, the CoP moved from the heel to toe by consistently showing bell-shaped speed profiles [3]. It was also reported that the heel-contact of the swing leg follows after the CoP suspension under the metatarsal-phalangeal joint [4].

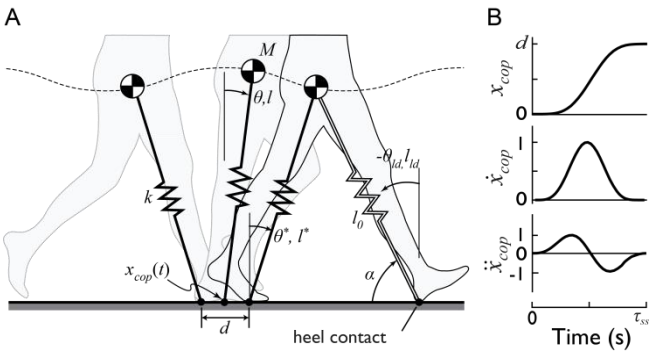

Fig1. (A) The bipedal walking model that uses proposed the foot placement criterion and (B) the CoP excursion profile

To reflect the empirical observation, a smooth, single sinusoidal function was proposed as the CoP excursion acceleration profile. Then the CoP continuously travels from the central heel to the metatarsal joint, which then serves as a novel gait shift criterion from single to double stance. The compliant bipedal model is used to test the hypothesized criterion.

As opposed to the previous bipedal walking model, this criterion does not require a pre-specified touchdown angle for simulation, but instead it is the result of the step transition triggered by CoP excursion.

4 Current Results

The proposed foot placement criterion achieved steady walking solutions that emulates empirical data and could predict the speed-dependent gait parameter change.

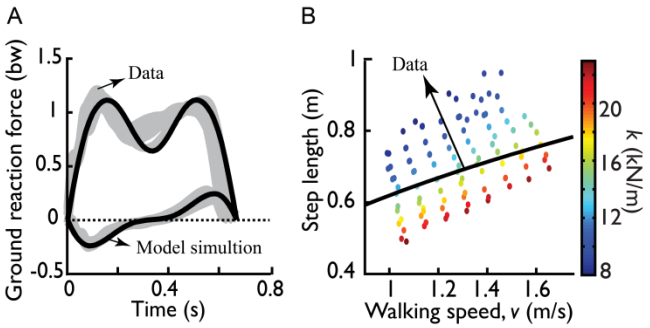

Fig2. (A) The walking domain (dots colored with corresponding leg stiffness) and (B) the ground reaction forces (GRF) along the preferred step length, l_{step}, with velocity, v, reported in [5].

5 Best Possible Outcome

We expect to be able to extend our study to describe step-to-step transition criterion of non-steady gait dynamics such as transient, asymmetric gaits.

Acknowledgement

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References

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