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MASTER'S THESIS PRESENTATION

The Hips as a Four-Bar Linkage System: Using Reinforcement Learning to Explore Compensation Patterns in Patients with Leg Length Discrepancies

WHEN
May 2, 2022
12:00PM

WHERE
Zoom Meeting

Ben Picker, MS candidate

Although mechanical modeling of human biomechanical systems has existed for years, few (if any) models have adequately described frontal plane motion of the hips. Mechanical models provide an important tool for describing human motion patterns and the absence of such a model for the hips limits the ability for medical professionals to help patients, in particular those with leg length discrepancies (LLDs). We present a four-bar linkage model of the hips to describe frontal plane hip motion and argue that the distance between the feet is a key determinant of hip geometry. We hypothesize that wider distances between the feet are capable of inducing hip hikes even in normal healthy patients. Furthermore, in patients with LLDs, we posit that patients will use the distance between their feet to regulate the lumbopelvic hip complex to optimize between uprightness and minimizing functional scoliosis. To test this hypothesis, we use a Proximal Policy Optimization (PPO) method to train a custom humanoid model with mobile spine with the goal of exploring how reward function design influences the distance between the humanoid agent's feet as well as the manifestation of hip hike and functional scoliosis. In general, we find that humanoid agents tended to use wider distance between the feet to maintain stability against gravity, resulting in hip hikes even in normal patients. Furthermore, we also find that humanoids agents with LLDs displayed functional scoliosis and used the distance between the feet to maximize uprightness, agreeing with the original hypotheses. We conclude medical professionals should consider the distance between a patient's feet as a possible predictor of hip hike pathologies and that the four-bar linkage model may offer useful insights generally for understanding LLDs.

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