Actuated Passive Dynamic Walker Perturbation Control: Stable Walking with Varying Upper Body Mass and Ramp Angle

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Having started as a design for toys, the Passive Dynamic Walker (PDW) has been extensively studied with insightful breakthroughs. In this project, we plan to simulate a two-legged PDW in an environment with varying upper body mass and ramp angle. For our version of the PDW, we intend to add a single actuator at the hip to control the leg angle in order to facilitate continuous passive walking under a wider range of conditions. In combination with an altered weight and/or ramp angle, the actuator would provide minimal but sufficient torque to change the leg angle such that the system may return to standard passive walking without interruption. At the end of the project, we expect to have a working model of a two-legged PDW that is able to walk continuously with minimal torque in the face of various environmental conditions that would typically perturb the dynamics of the standard PDW model into a non-continuous motion.

We find this project to be worthwhile as it combines two concepts that we have investigated in this class: application of control laws and the dynamics of PDWs. Furthermore, we believe that this concept has interesting practical applications for real-life robots. For example, if our version of the PDW was used as a delivery robot, it would be able to carry packages of varying weights throughout its trip on a non-uniformly leveled land as simulated by our varying ramp angle. The ability to complete such a task would ultimately bring insights into other adaptive robot behaviors.

Our project would be based on research that has previously explored PDW models with the addition of upper body weight on a fixed-angle ramp. However, we believe it would be reasonable to expand these experiments to find a corresponding control law for tuning the leg angle of our PDW under different ramp angle conditions while still relying on the basic dynamics of the PDW. Ultimately, our project will be a more dynamic version of these models that actively calculates the best angle of a single actuator at the hip for a given weight and ramp angle in order to drive the system to its goal with the minimal intervention.

In order to have enough time to fine tune our model, we have set specific goals for each of the planned updates. By the first update, we intend to have two simple versions of our model catered to each of our changing conditions: one for varying weight and one for varying angle. By the second update, we expect to have a full working model that combines the results of the previous models. Following this plan, we will each be responsible for completing one half of the challenge and then work together to combine our approaches. We then expect to spend the rest of the time beyond the second update fine-tuning the model and writing the final report.

References

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