

Topic Areas:	Design Optimization, Legged Robots, Simulation, CAD
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Responsible Professor:	Prof. C. David Remy
Prerequisites/Prior Knowledge:	Technical Mechanics III (Dynamics), Matlab, (ideally) CAD

Passive Dynamic Walkers (PDWs) are simple walking robots that can walk on their own using the natural motion of their legs and body. Unlike traditional robots, they do not rely on motors or complex controllers for each step. Instead, their movement comes from the mechanical design of the legs, joints, and body, which allows them to walk in a steady, repeating pattern.

In this project, you will build a PDW, as shown in Fig. 1, that can walk on a treadmill constrained to the sagittal plane. The goal of the PDW's design is to be maximally robust to disturbances and model inaccuracies.

Starting from an initial leg design (Fig. 1) and a MATLAB simulation environment (Fig. 2), you will extend the CAD model to vary hardware parameters such as mass, inertia, and dimensions.

These parameters will be integrated into the simulation to evaluate their effect on system robustness. Based on this, you will perform parameter optimization to identify the most robust design for hardware implementation. Your tasks include:

- CAD modeling and parameterization
- Mapping CAD parameters to simulation
- Defining robustness objectives (e.g., treadmill speed, disturbance rejection)
- Setting up gradient-free or gradient-based optimization
- Building and testing the hardware prototype

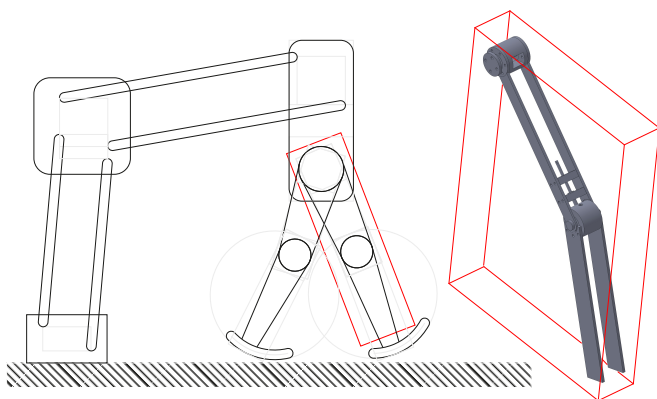


Figure 1: Schematic of the planar biped, highlighting the initial CAD model of a single leg.

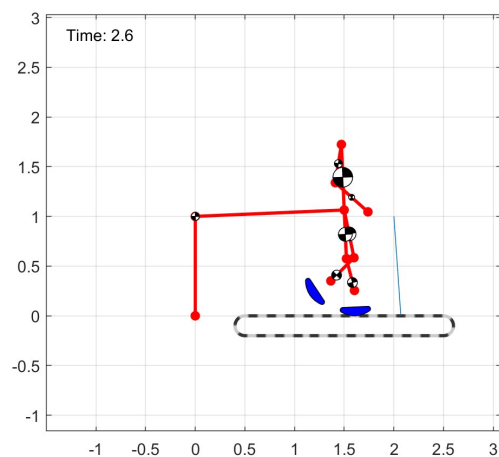


Figure 2: Animation of the simulated periodic walking motion.

[1] McGeer, T. *Passive dynamic walking*. The International Journal of Robotics Research, 1990