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6.832 Final Project

For my final project, I aim to control a 2D Hopper. The project deliverable would be a simulation showing a functional and stable Hopper in various starting positions.

This is an interesting project because the 2D hopper can be used to model a leg, which can be very useful for walking robots. Because of the energy storage in the Hopper's springs, this method of movement can be very energy efficient. Getting trajectory optimization

I believe this project will use LQR and trajectory optimization. I will look into various methods of trajectory optimization, including iterative LQR, direct transcription, and possibly contact trajectory optimization.

Some related prior work includes Marc Raibert's Paper titled "Hopping in Legged Systems Modeling and Simulation for the Two-Dimensional One-Legged Case." In this paper he discusses control of the hopper by decomposing it into a horizontal speed, vertical hopping height, and body attitude. In this paper, the dynamics of the system are derived, making it easy for me to work with those.

Although I don't know an exact timeline, here's how I expect to proceed:

- 1) See if I can stabilize the system using LQR (x0 close to the origin, potentially only stabilizing the attitude and the jumping height, or attitude and horizontal position.)
- 2) Use trajectory optimization (exact method TBD) to control system and bring it back to the origin (x0 far from origin, multiple hops required. Nonlinear dynamics, so nonlinear solver is most likely required)
- 3) Add obstacles or altered terrain to the trajectory optimization from 2). Try to get the robot to climb steps, for example, or jump over or onto a box.

Keyword: trajectory