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16-711 HW2

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Part 1

The inputs needed for the symbolic dynamics program are gravity; the mass, position, and velocity of the cart; and the mass, length, moment of inertia, angle, and angular velocity of the pole. Although in this case the moment of inertia is required as an input, it could also be calculated within the program from the mass and length of the pole.

Part 2

The video of the cart and falling pole is called "part_2.ogv", and can be found online here. The simulation was done in Pymunk, and the code can be found in "cart_pole_sim.py".

Part 3

The manual gains were [10, 0.25, 10, 1], so the input force on the cart is f = 10x + 0.25dx + 10θ + 1dθ. The code for the balancing simulation can be found in "cart_pole_sim_manual_gains.py".

Part 4

The gains found using LQR were [1.4142, 0.0199, 2.2621, 0.0722], so the input force on the cart is f = 1.4142x + 0.0199dx + 2.2621θ + 0.0722dθ. The balancing simulation is coded in "cart_pole_sim_lqr.py".

Part 5

The swing-up uses the control f = k*cos(θ)*dθ*E_{err}, where k = 20 and E_{err} is the difference between the energy of the system at the upright configuration and the current calculated energy. This control was used to produce the swing-up in the video in part 6, and can be found in "cart_pole_sim_swing_up.py".

Part 6

The video of the cart-pole swing-up is called "part_6.ogv" and can also be found here. The code to perform the swing-up can be found in "cart_pole_sim_swing_up.py".