Comments on the ape swinging optimization

This folder contains MATLAB codes that find the optimal motions of a simple two limbed animal (an ape) swinging from one hand-hold to another on the ceiling.

The motion of the system is assumed to start and end at COMPLETE REST.

In the version of the MATLAB code given, the position of the hand-holds along the ceiling is NOT specified.

For the body mass and length parameters used, there is at least one energy-free collisionless motion starting from one point on the ceiling and ending at another. This motion is energy-optimal (for most reasonable energy functions) when the position of the hand-holds is NOT specified and the motion is allowed to have whatever stride-length (defined as the distance between consecutive hand-holds of the same hand).

Just running the program as is, will discover the above energy-free motion. You will notice that the joint torques are close to zero (in some scale) and the total energy of the system changes little.

So the first thing to do is to just run **root_swing.m .** Then you might consider making the following changes.

Some exercises

Please do not make all these changes all at once. Do them one at a time!

0) Start with different initial seeds to see if the convergence is as quick. Also increase/decrease param.ngrid -- the number of grid points defining the torque(t) -- to see how the answer changes, if at all. These apply to all the following. When the cost is substantially non-zero, increasing param.ngrid should decrease the objective function, typically.

1) Now add an equality constraint that ensures that the STRIDELENGTH is as desired. That is, the distance between where hand-2 starts and ends on the ceiling is equal to, say param.stridelength = 2.2.

How does the objective function change with the stridelength?

2) Now add another equality constraint that specifies the time taken for the motion.

Constraining the swing time and the stridelength constrains the forward velocity as well.

3) By systematically finding the optimal motions and the corresponding costs at various

stride lengths and swing times, we can get the cost contours as a function of speed and stride length. You will find that there is an optimal speed and stride length corresponding to the energy free motion.

4) Instead of starting and ending at rest, include the possibility of the hand approaching the ceiling with finite velocity, colliding with the ceiling, and the system undergoing a state-change due to the collision. See the folder "SwingingWithCollision" inside the current folder for comments on how to do this.

5) By changing the constraints and initial conditions, etc., make the swinging ape into a walking biped, albeit one with hip/ankle torques.

6) Try to see what changing the cost functions does.