RBDL and MUSCOD-II: Example 2: Cart Pendulum

Debora Clever, Manuel Kudruss (debora.clever@iwr.uni-heidelberg.de)

This is a simple example that should get you started with MUSCOD and RBDL. It is devoted to the introduction to forward dynamics and one-phase optimal control problems. To this end we consider a cart pendulum, see Figure 1.

The cart pendulum consists of two rigid bodies, the *Cart* and the *Pendulum*. The pendulum itself consists of two elements, a spherical mass and a massless link. The model has two degrees of freedom:

- q_0: the x-translation of the body *Cart*.

- q_1: the rotation around the y axis of the body *Pendulum*.

Figure 1: Cart Pendulum

The movement of the pendulum can be controlled by a force u_0 acting in horizontal direction on the cart.

Cart:

- Cuboid

- x-length= 0.5m, y-length = 0.2m, height = 0.2m

- mass = 10.0kg

Pendulum:

- Massless link: length = 0.5m
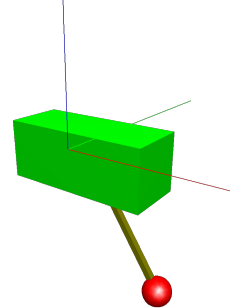
- Sphere: radius = 0.1m, mass = 1.0kg

Tasks

At initial time $t_0 = 0$ the pendulum is hanging down. Determine an optimal control, such that at final time t_f, the pendulum is standing up. To this end:

1. Set up a feasible lua model, describing the cart pendulum model.

2. Complete source and data file.

3. Optimization 1: Minimize energy consumption.

4. Optimization 2: Minimize final time.