Homework #5

Author: Guryev Boris
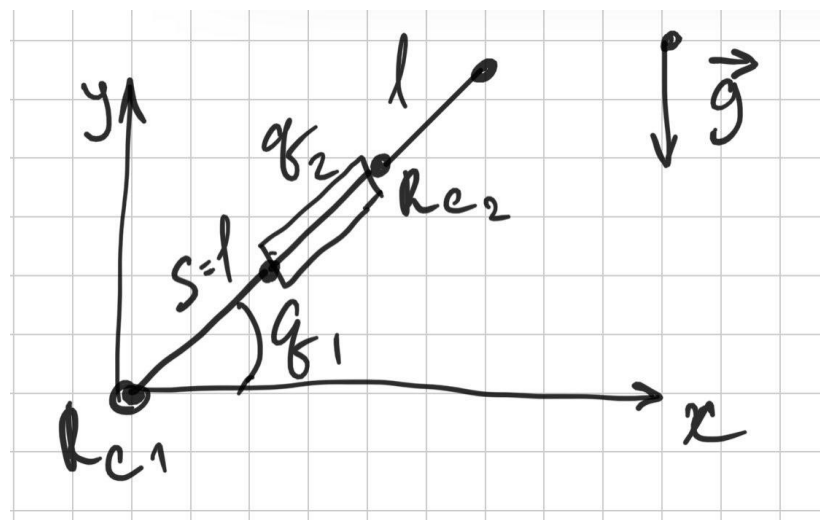
Github link: github.com/BorisAnimal/RP-robot-dynamic

Robot
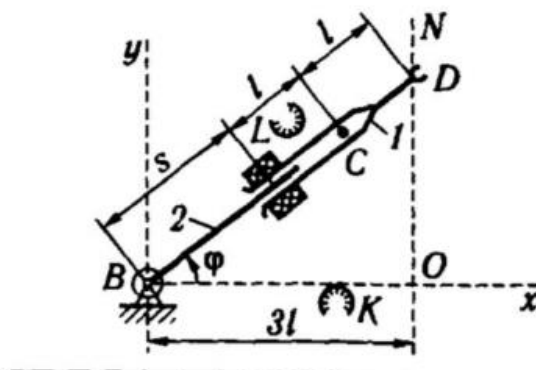
m1 = 2 kg (C – center mass)
m2 = 2 kg (B – center mass)
I1 = 1 kg*m^2
I2 = 2 kg*m^2
L = 0,2 m

For simplicity, I reordered joint's numeration. Also, watching schema, I decided that $S = l_1$ and l_1 is fixed. That means the distance right after l_1 that follows to R_{c2} is the variable parameter q_2 (prismatic joint, #2). Resulting schema looks like:

Consequently, I got following values for keypoints:

$O_{c1} = [0, 0, 0]^T$

$O_1 = [s \cos(q_1), s \sin(q_1), 0]^T$

$O_{c2} = [(s + q_2) \cos(q_1), (s + q_2) \sin(q_1), 0]^T$

Lagrange solution

$D =$

$$\begin{pmatrix} m_2 q_2^2 + 2 m_2 q_2 s + m_2 s^2 + I_1 + I_2 & 0 \\ 0 & m_2 \end{pmatrix}$$

$G =$

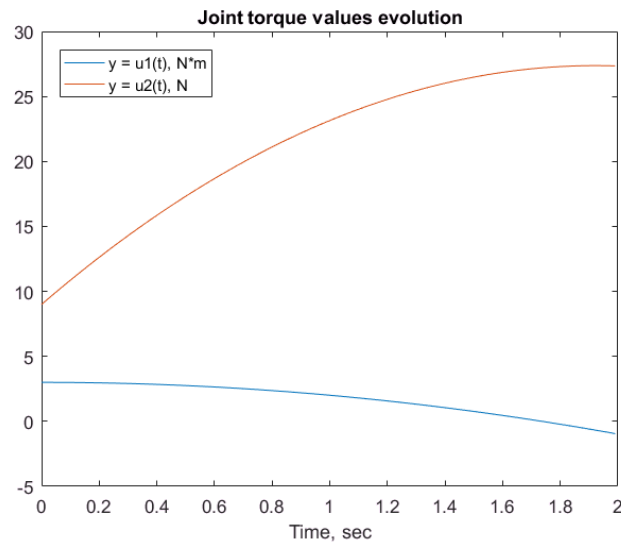$$\begin{pmatrix} g m_2 \cos(q_1) (q_2 + s) \\ g m_2 \sin(q_1) \end{pmatrix}$$

$C =$

$$\begin{pmatrix} dq_2 m_2 (q_2 + s) & dq_1 m_2 (q_2 + s) \\ -dq_1 m_2 (q_2 + s) & 0 \end{pmatrix}$$

tor = D*q'' + C*q' + G

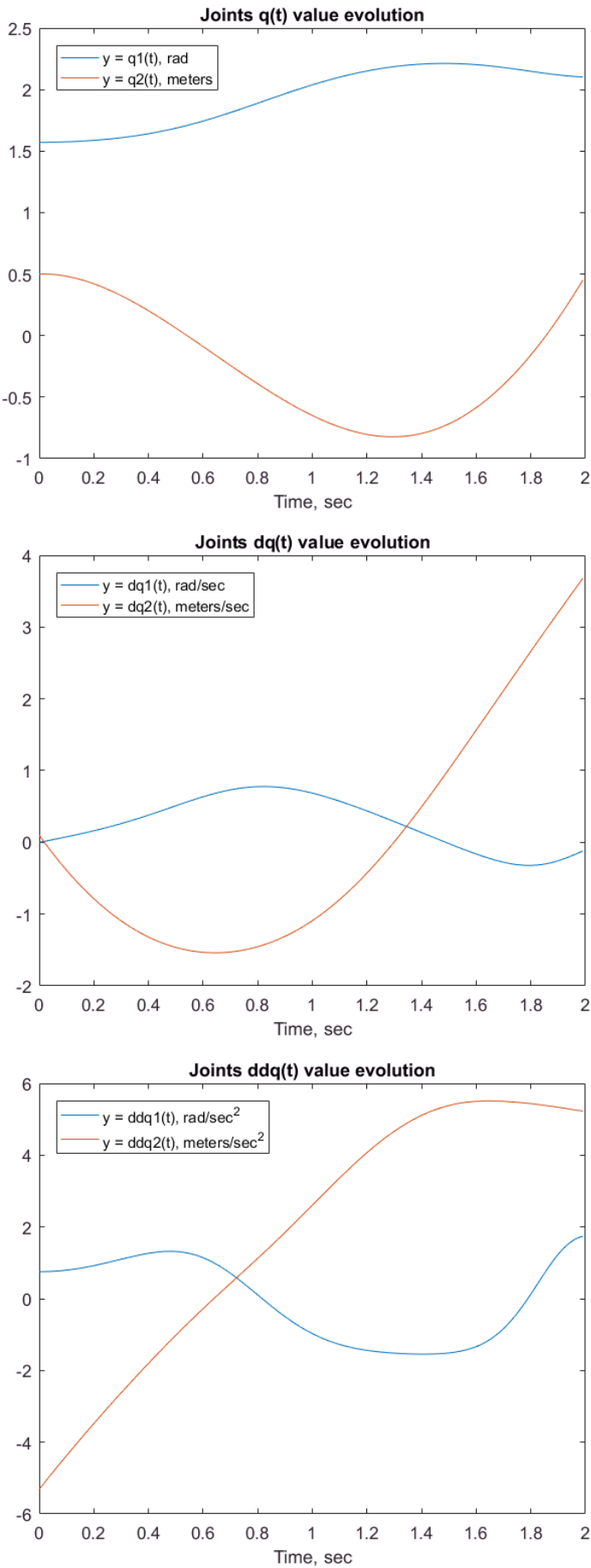tor =

$$\begin{pmatrix} ddq_1 (m_2 q_2^2 + 2 m_2 q_2 s + m_2 s^2 + I_1 + I_2) + g m_2 \cos(q_1) (q_2 + s) + 2 dq_1 dq_2 m_2 (q_2 + s) \\ - m_2 (q_2 + s) dq_1^2 + ddq_2 m_2 + g m_2 \sin(q_1) \end{pmatrix}$$

To test this equations, I used numerical expression for q, q', q'' and used u(t) values as follow:

And the motion of joints performed

Joints q(t) value evolution

- y = q1(t), rad
- y = q2(t), meters

Joints dq(t) value evolution

- y = dq1(t), rad/sec
- y = dq2(t), meters/sec

Joints ddq(t) value evolution

- y = ddq1(t), rad/sec^2
- y = ddq2(t), meters/sec^2

Time, sec

Considered model not include friction energy loss and joint limits, so result of q_2 easily limited to extreme values.