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% Ryan Dewsnap
% CS403 Homework 6

% 1: Initial Value Problem

syms t th1 dth1 ddth1 th2 dth2 ddth2 real
syms c1 c2 l1 l2 m1 m2 real
syms I1 I2 g tau1 tau2 real

% theta coords and derivatives
q = [th1; th2];
dq = [dth1; dth2];
ddq = [ddth1; ddth2];

% controls and params
u = [tau1; tau2];
p = [c1 c2 m1 m2 l1 l2 I1 I2 g];

% unit vectors
ihat = [1; 0; 0];
jhat = [0; 1; 0];
khat = [0; 0; 1];

ahat = sin(th1)*ihat - cos(th1)*jhat;
bhat = sin(th1+th2)*ihat - cos(th1+th2)*jhat;

% position of link endpoints
linkA = l1*ahat;
linkB = linkA + l2*bhat;

% position of COMs
rA = c1*ahat;           %[c1*sin(th1); -c1*cos(th1)];
rB = linkA + c2*bhat;   %[l1*sin(th1)+c2*sin(th1+th2); -l1*cos(th1)-c2*cos
(th1+th2)];

% velocities of COMs
ddt = @(r) jacobian(r, [q; dq]) * [dq; ddq];

vA = ddt(rA);
vB = ddt(rB);

% kinetic
T1 = 1/2*m1*dot(vA, vA) + 1/2*I1*(dth1)^2;
T2 = 1/2*m2*dot(vB, vB) + 1/2*I2*(dth2)^2;
T = T1 + T2;

% potential
h1 = dot(rA, -(-jhat));
h2 = dot(rB, -(-jhat));
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49 V1 = m1*g*h1;
50 V2 = m2*g*h2;
51 V = V1 + V2;
52
53 w1 = [0; 0; dth1];
54 w2 = [0; 0; dth2];
55 M1 = [0; 0; tau1];
56 M2 = [0; 0; tau2];
57
58 Q_tau1 = jacobian(w1,dq(1)).'*M1;
59 Q_tau2 = jacobian(w2,dq(2)).'*M2;
60 Q = Q_tau1 + Q_tau2;
61
62 L = T-V;
63 g = ddt(jacobian(L, dq)') - jacobian(L, q)' - Q;
64
65 A = simplify(jacobian(g, ddq));
66 b = simplify(A*ddq - g);
67
68 z = [q; dq];
69 keypoints = [linkA; linkB];%[l1*sin(th1); -l1*cos(th1)];
70 E = T + V;
71
72 matlabFunction(A,'file',['C:\Users\Ryan\Documents\MATLAB\A_pend'],'vars',{z p});
73 matlabFunction(b,'file',['C:\Users\Ryan\Documents\MATLAB\b_pend'],'vars',{z u p});
74 matlabFunction(keypoints,'file',['C:↙
\Users\Ryan\Documents\MATLAB\keypoints_pend'],'vars',{z p});
75 matlabFunction(E,'file',['C:\Users\Ryan\Documents\MATLAB\energy_pend'],'vars',{z u↙
p});
76
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