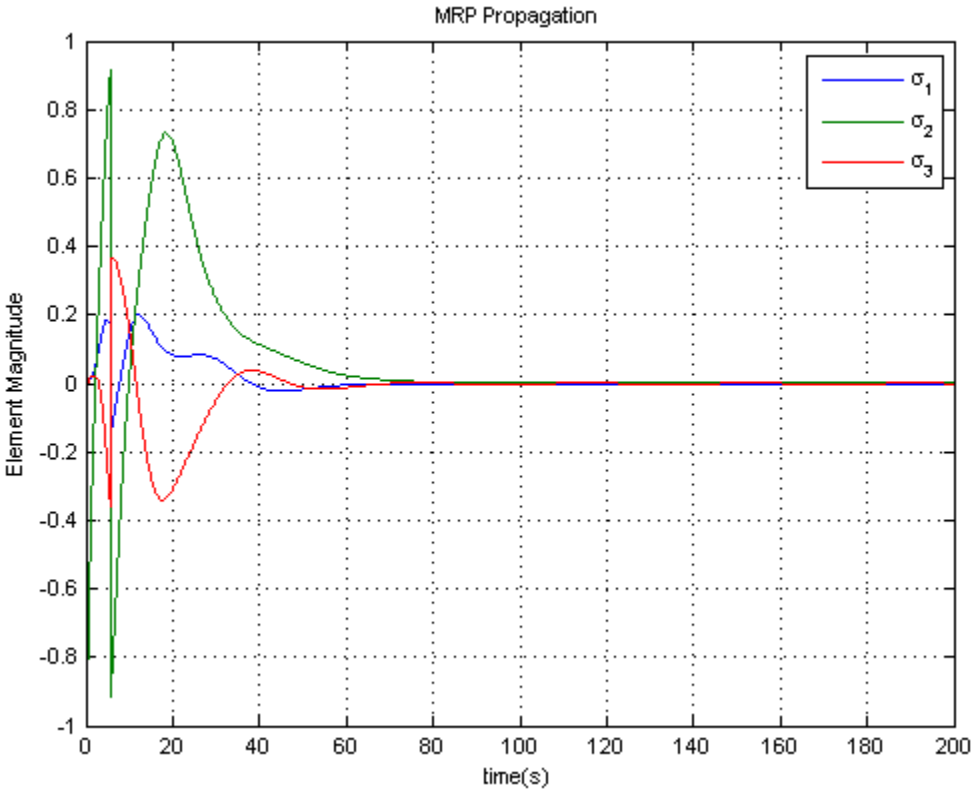
Simulation with PD control

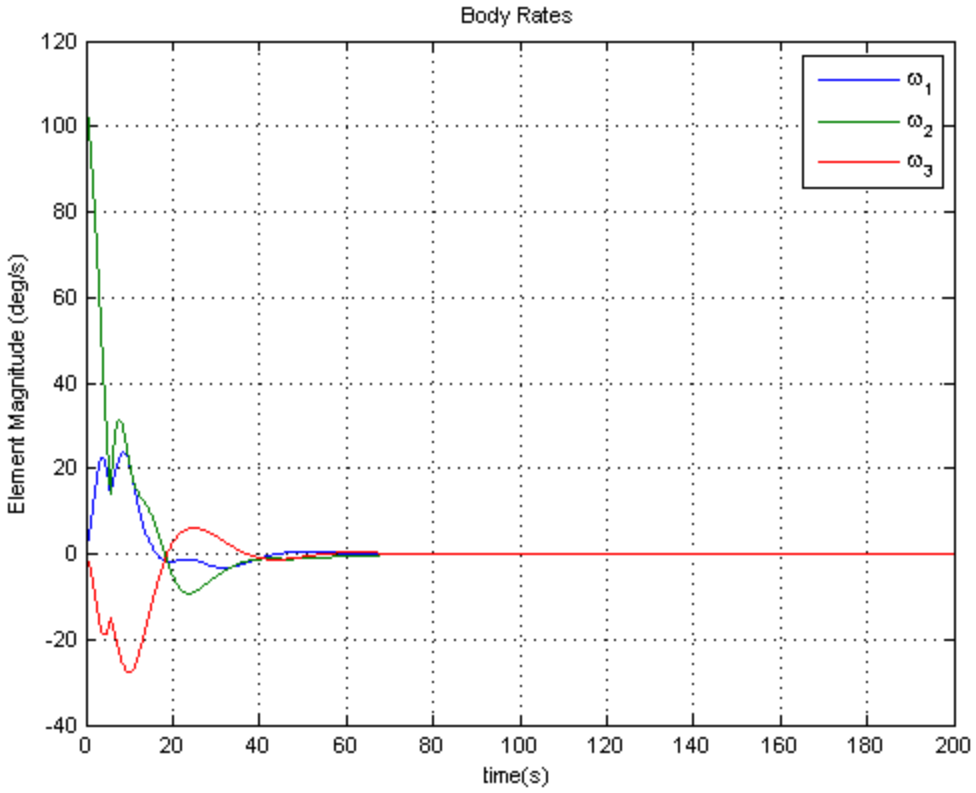
```
fprintf('\n');
clearvars -except function_list pub_opt
close all
MRP0=[0;0.8;0];%rad

fprintf('MRP vector:\n');
MRP = MRP0;
printVector(MRP, '');
omega_body0 = [0; 2; 0]; %rad/s
fprintf('Initial Body Rates:\n');
printVector(omega_body0, 'rad/s');
I_body=[10 0 0;0 20 0;0 0 30]; %kg*m2

%unit gains
scalar_K = 6;
scalar_P = 6;
K = eye(3)*scalar_K;
P = eye(3)*scalar_P;
Ki = 0.01;
cm_torque=[0;0;0];
disturbance_torque=[1;2;-1]; %Nm

delta_t = 0.01;
t_end = 200 - delta_t; % seconds

MRP = MRP0;
omega_body = omega_body0;
% Arrays for recording and plotting
t_mat = 0:delta_t:t_end+delta_t;
[rows, cols] = size(t_mat);
MRP_mat = zeros(3,cols);
omega_mat = zeros(3,cols);
EA_mat = zeros(3,cols);
mode_mat = zeros(3,cols);
CT_mat = zeros(3,cols);
MRP_mat(:,1) = MRP;
omega_mat(:,1) = omega_body;
mode_mat(:,1) = 0;
CT_MAT(:,1) = cm_torque;
idx = 2;

% RK4 integration
state = [MRP; omega_body];
control_int = 0;
for t = 0:delta_t:t_end

    control_int = control_int + state(1:3)*delta_t;
    control_torque = -K*state(1:3) -(P+P*Ki*I_body)*state(4:6) - Ki*P*K*control_in

%     control_torque = -K*eps -P*state(4:6);
```

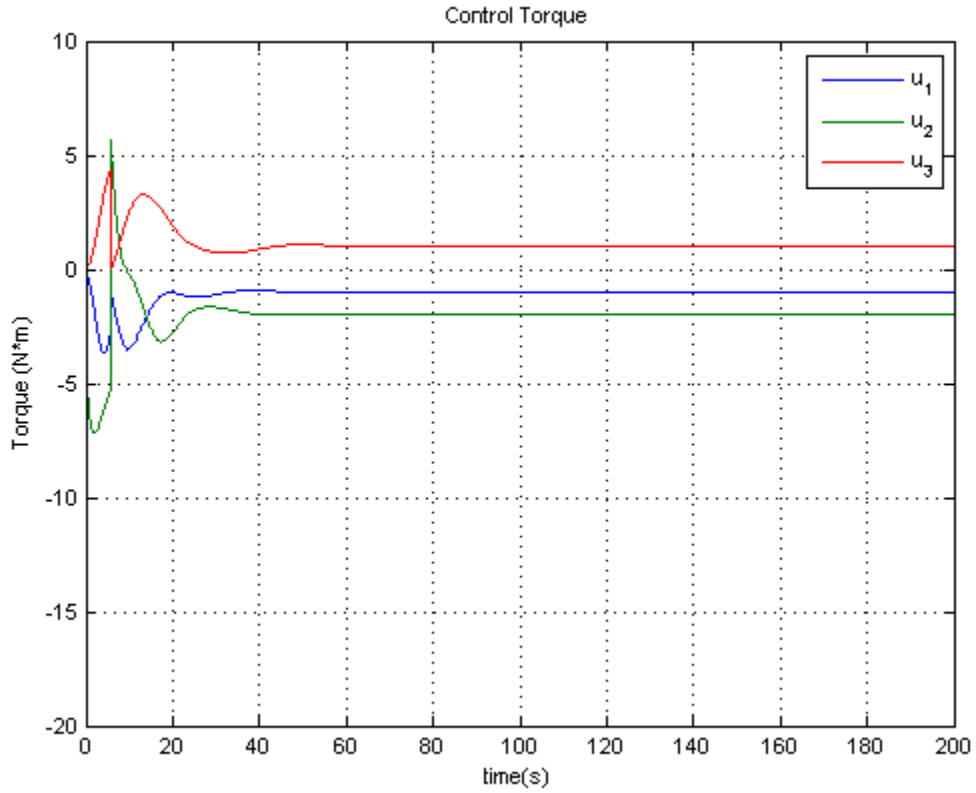
```
%

    cm_torque = control_torque + disturbance_torque;
  k1 = [derivMRP(state(1:3), state(4:6)); ...
      dBodyRatesRigid(state(4:6), I_body, cm_torque)];
  k2 = [derivMRP(state(1:3) + delta_t*k1(1:3)/2, ...
      state(4:6) + delta_t*k1(4:6)/2); ...
      dBodyRatesRigid(state(4:6) + delta_t*k1(4:6)/2, I_body, cm_torque)];
  k3 = [derivMRP(state(1:3) + delta_t*k2(1:3)/2, ...
      state(4:6) + delta_t*k2(4:6)/2); ...
      dBodyRatesRigid(state(4:6) + delta_t*k2(4:6)/2, I_body, cm_torque)];
  k4 = [derivMRP(state(1:3) + delta_t*k3(1:3), ...
      state(4:6) + delta_t*k3(4:6)); ...
      dBodyRatesRigid(state(4:6) + delta_t*k3(4:6), I_body, cm_torque)];

  state = state + delta_t/6*(k1 + 2*k2 + 2*k3 + k4);

  % Enforce |MRP| <= 1, switch to shadow set if needed
  if norm(state(1:3)) > 1
      state(1:3) = -state(1:3)/dot(state(1:3), state(1:3));
  end

  % Updating array

  MRP_mat(:,idx) = state(1:3);
  omega_mat(:,idx) = state(4:6);
  CT_mat(:,idx)=control_torque;
  idx = idx + 1;
end

font_size=8;
figure
plot(t_mat, MRP_mat);
mytitle = strcat('MRP Propagation');
title(mytitle,'FontSize',font_size)
xlabel('time(s)','FontSize',font_size)
ylabel('Element Magnitude','FontSize',font_size)
legend('\sigma_{1}', '\sigma_{2}', '\sigma_{3}')
grid on
set(gca,'FontSize',font_size)
fprintf('\n\n\n');

figure
plot(t_mat, omega_mat*180/pi);
mytitle = strcat('Body Rates');
title(mytitle,'FontSize',font_size)
xlabel('time(s)','FontSize',font_size)
ylabel('Element Magnitude (deg/s)','FontSize',font_size)
legend('\omega_{1}', '\omega_{2}', '\omega_{3}')
grid on
set(gca,'FontSize',font_size)
fprintf('\n\n\n');

figure
```

```
plot(t_mat, CT_mat);
mytitle = strcat('Control Torque');
title(mytitle,'FontSize',font_size)
xlabel('time(s)','FontSize',font_size)
ylabel('Torque (N*m)','FontSize',font_size)
grid on
set(gca,'FontSize',font_size)
legend('u_{1}', 'u_{2}', 'u_{3}')
```

MRP vector:
[0.000000; 0.800000; 0.000000]
Initial Body Rates:
[0.000000; 2.000000; 0.000000] rad/s




Body Rates
Element Magnitude (deg/s)
time(s)
ω1
ω2
ω3
120
100
80
60
40
20
0
-20
-40
0
20
40
60
80
100
120
140
160
180
200


Control Torque
Torque (N*m)
time(s)
u1
u2
u3
10
5
0
-5
-10
-15
-20
0
20
40
60
80
100
120
140
160
180
200

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