
MAE5803 - HW#5 Part 2 Adaptive Controller

```
function HW5P2(D)

% Choose parameters
a1 = 2;
a2 = 5;
P = 5*eye(2);
lambda = 3;
eta = 1;
% D = 0.5;
d = @(t) D*sin(t);
phi = 0.1;
sat = @(x,delta) min(max(x/delta,-1),1);

tspan = [0 20];
X0 = zeros(1,5);
[t,X] = ode45(@EOM,tspan,X0,[],a1,a2,P,lambda,eta,D,d,phi,sat);
% Plot
for i = 1:length(t)
    [~, u(i)] = EOM(t(i),X(i,:),a1,a2,P,lambda,eta,D,d,phi,sat);
end
xd = sin(0.8*t);
x1 = X(:,1);
a = [a1 a2];
a_hat = [X(:,4) X(:,5)];
fh = figure(1);
set(fh,'Position',[0 0 799 1089])
suptitle(['HW5 Problem #2 D = ' num2str(D)]);
% Dynamics
subplot(311)
plot(t,xd,t,x1,'--')
legend('Desired','Sumulated','location','southeast')
xlabel('Time'); ylabel('Position'); ylim([-1.5 1.5]);
% Parameter Estimate
subplot(312)
hold on
plot(t,a1*ones(size(t)), 'b')
plot(t,a2*ones(size(t)), '--r')
plot(t,a_hat(:,1), 'b')
plot(t,a_hat(:,2), '--r')
title('Parameter Estimates'); xlabel('Time'); ylabel('Value'); ylim([0 7]);
% Control Input
subplot(313)
plot(t,u)
title('Control Input'); xlabel('Time'); ylabel('u'); ylim([-7 7]);

end
```

EOM

```
function [dx, u] = EOM(t,x,a1,a2,P,lambda,eta,D,d,phi,sat)
dx = zeros(size(x));
x1 = x(1);
x2 = x(2);
x3 = x(3);
a1_hat = x(4);
a2_hat = x(5);

xd      = sin(0.8*t);
xd_d    = 0.8*cos(0.8*t);
xd_dd   = -0.64*sin(0.8*t);
xd_ddd  = -0.512*cos(0.8*t);

xt      = x1 - xd;
xt_d    = x2 - xd_d;
xt_dd   = x3 - xd_dd;

s = xt_dd + 2*lambda*xt_d + lambda^2*xt;
xr_ddd = xd_ddd - 2*lambda*xt_dd - lambda^2*xt_d;

gamma = [x2^2 sin(2*x1)];
a_hat = [a1_hat a2_hat]';
k = D + eta;

u = xr_ddd + gamma*a_hat - k*sat(s,phi);    % I have no guess for
d_hat
s_delta = s - phi*sat(s,phi);
da_hat = -P*transpose(gamma)*s_delta;

dx(1) = x2;
dx(2) = x3;
dx(3) = u - a1*x2^2 - a2*sin(2*x1) - d(t);
dx(4) = da_hat(1);
dx(5) = da_hat(2);

end
```

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