システム工学実験 フレキシブルリンクの制御
パラメータ推定

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例

```
clear all
close all

load('data_flex.mat');% mat ファイルから，角周波数データとゲインデータを取得
omega = data_flex.omega;
gain = data_flex.G;

Ns = find(omega > 100);% 高周波数の線形部分のインデックス

% figure
% loglog(omega,gain,'b*');
% grid on;

% figure
% plot(log10(omega(Ns)),log10(gain(Ns)) + 2*log10(omega(Ns)))

% 同定に用いた PI ゲイン
Kp=3;Ki=1;



w0 = 19.97;%10^(1.225); % 目視で決定
b2 = (10^(mean( log10(gain(Ns)) + 2*log10(omega(Ns)) ) ) )/Kp;
b1 = w0^2*b2;

log_gain_prime = log10(gain) + log10(abs( 1./((Kp*1i*omega + Ki).* (- b2 *omega.^2 + b1)) ));

figure;
semilogx(omega,log_gain_prime,'b*')

%N_para = find(omega > 0.6);% パラメータ推定用インデックス

N_para = find((omega > 0.6& omega<15) | omega >21);% パラメータ推定用インデックス
```

```
figure;
semilogx(omega(N_para),log_gain_prime(N_para),'b*')

% figure
% plot(log10(omega),20*log_gain_prime,'b*');

%% parameter estimation
k2=1;
for k=1:100
    if k==1
        theta0 = 10 * rand(3,1) + 1;
        [theta1,fval] = fminsearch(@(x)
         cost_function1(x,b1,b2,omega(N_para),log_gain_prime(N_para),Kp,Ki),theta0);
        fval0 = fval;
        theta = theta1;
    else
        theta0 = abs(theta1) .* 3 .* rand(3,1);
        [theta1,fval] = fminsearch(@(x)
          cost_function1(x,b1,b2,omega(N_para),log_gain_prime(N_para),Kp,Ki),theta0);
        if fval < fval0
            % check stability for the case another PI controller
            kp = 1;
            ki = 1;
            P = tf([b2,0,b1],[1,theta(3),theta(2),theta(1),1]);
            C = tf([kp,ki],[1,0]);% PI controller
            G_cl = feedback(series(C,P),tf(1,1));
            if max(real(pole(G_cl))) < 0
                fval0 = fval;
                theta = theta1;
                k2=k2+1;
            end

%            if (theta(1)>0) & (theta(2)>0) & (theta(3)>0)
%                theta = theta1;
%            end
        end
    end
end
a1=theta(1);
a2=theta(2);
a3=theta(3);


G_est = tf([Kp*b2,Ki*b2,Kp*b1,b1],[1, a3, (a2+Kp*b2), (a1 + Ki*b2),Kp*b1,Ki*b1]);
pole_G_est = pole(G_est);
N_minus = find(real(pole_G_est)>=0);
pole_G_est(N_minus)=-pole_G_est(N_minus);
```

```
den = poly(pole_G_est);
G_est = tf([Kp*b2,Ki*b2,Kp*b1,b1],den);
P=tf([b2,0,b1],[1,theta(3),theta(2),theta(1),0]);


%% plot 確認用
figure;
bode(G_est,omega);
[gain_est,phase] = bode(G_est,omega);
gain_est = squeeze(gain_est)';

figure
loglog(omega,gain,'b*',omega,gain_est,'ro')



save P_theta P
```

コスト関数の例

```
function Y = cost_function1(x,b1,b2,omega,log_gain,Kp,Ki)


a1=x(1);
a2=x(2);
a3=x(3);
G = tf([1],[1, a3, (a2 + Kp*b2), (a1 + Ki*b2), Kp*b1, Ki*b1]);
[gain_est,phase] = bode(G,omega);
gain_est = squeeze(gain_est)';

%Y = norm( log_gain - log10(gain_est),2 );% H2
%Y = norm( log_gain - log10(gain_est),1 );% H1
Y = norm( log_gain - log10(gain_est),inf );% H_inf

Ki=1;Kp=1;
G = tf([1],[1, a3, (a2 + Kp*b2), (a1 + Ki*b2), Kp*b1, Ki*b1]);
pole_max = max(real(pole(G)));

Y = Y - sum(sign(x))*Y/4 + Y/2 * sign(pole_max) ;
% all parameters must be positive
% the real part of every eigenvalue of G with PI gain (Ki , Kp) = (1,1) must be negative
%
```