Computerized control - Homework 4

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Polynomial design of integrating controller (RST incremental)

The task is to design a controller for the same system as in homework 3, i.e. the discrete-time harmonic oscillator

$$H(z) = \frac{\big(1 - \frac{\sqrt{3}}{2}\big)z - \big(\frac{\sqrt{3}}{2} - 1\big)}{z^2 - \sqrt{3}z + 1}.,$$

but this time using a feedback controller with integral action (a.k.a. incremental control). That the feedback controller has integral action means that it has a pole in $z = 1$. The structure of the closed-loop system is given in figure 1.

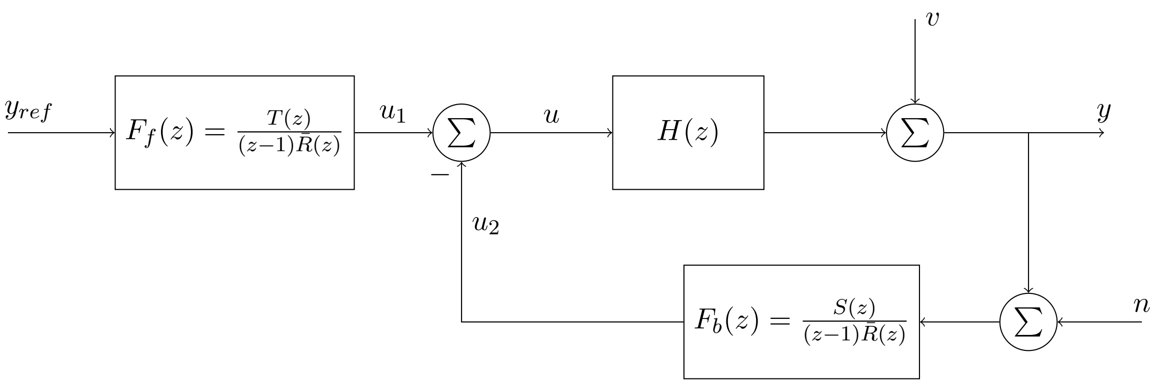

Figure 1: Two-degree-of-freedom controller

Criteria

1. The closed-loop system from reference signal to output should have unit static gain, i.e. $H_c(1) = 1$, and poles in $z = 0.6 \pm i0.3$. **Determine the damping ratio of**

this set of complex-conjugated poles by calculating the corresponding continuous-time poles.

2. The observer poles should be twice as fast as the closed-loop poles (twice as far from the origin in the s-plane), and critically damped. **Determine the discrete-time observer poles.**

Design a 2-DoF controller

Design a discrete-time controller with the structure given in figure 1. The controller is given by

$$(\mathrm{q}-1)\bar{R}(\mathrm{q})u = -S(\mathrm{q})y + T(\mathrm{q})u_c$$

and the the plant-model is

$$A(\mathrm{q})y = B(\mathrm{q})u.$$

Assume a suitable order (as low as possible) of the controller polynomials $\bar{R}(\mathrm{q})$ and $S(\mathrm{q})$ and calculate the controller coefficients.

Simulate the closed-loop system

Implement your controller and closed-loop system in matlab (or simulink), and test step plots both from the reference signal $y_{ref}(k)$ and from the disturbance $v(k)$. **Discuss the performance of the closed-loop system in 3-4 sentences. Compare to the result you obtained in homework 3. Is the result what you expected?**.

Some code to help you

```
% The coefficients of the controller
h = 1;
Rbar_coeffs =
R_coeffs = conv([1, -1], Rbar_coeffs)
S_coeffs =
T_coeffs =

% The forward part of the controller
TR = tf(T_coeffs, R_coeffs, h);
% The feedback part of the controller
SR = tf(S_coeffs, R_coeffs, h);

% The closed-loop system from reference to output
Hc =

% The closed-loop system from disturbance to output
Hv =
```

```
figure(1)
clf
pzmap(Hc) % Verify that the closed-loop poles are as desired

figure(2)
clf
step(Hc, Hv) % Expected performance?
```