Example 8-5: Comb Filter Design.

Purpose:

A 30-Hz sinusoidal signal is corrupted by zero-mean 60-Hz periodic interference from a motor. The interference is bandlimited to 180 Hz. Using a DSP system with a sampling rate of 480 samples/s, design a comb filter that keeps the sinusoid and rejects the interference. Use $a = 0.95$.

Inputs:

f1=frequency in Hz of sinusoid to keep.
T=period in s of interference to reject.
fmax=maximum harmonic of interference.
fs=sampling rate in sample/s used.
aa=a=radius of poles.

Outputs:

Original (left) and filtered (right) signals.
Two-sided gain (left) and pole-zero diagram.

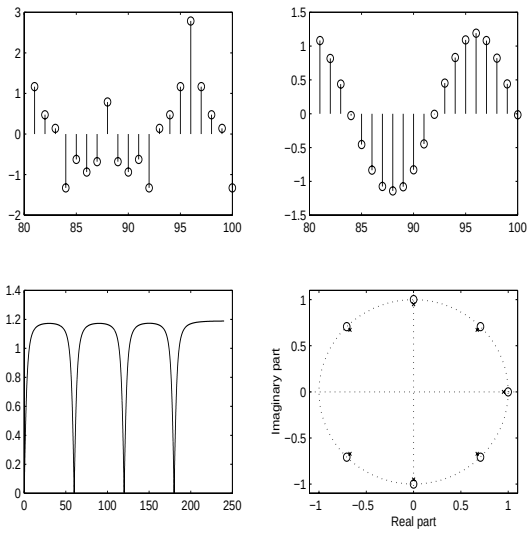

Figure 1: Comb filter.

Comments:

- It is clear that only the sinusoid remains.
- Duration of the transient response is 80.
- Periodic interference is generated using harmonics with random amplitudes.

Program:

```
f1=30;T=1/60;fs=480;aa=0.95;
fmax=180;n=fmax*T;
N=1:100;%Computation interval
M=[81:100];%Display interval
X=cos(2*pi*f1*N/fs);
%Random periodic interference:
C=rand(1,n);%random amplitudes
for I=1:n;%sinusoid+interference
X=X+C(I)*cos(2*pi*I/T*N/fs);
end;%Compute comb filter:
Z=exp(j*2*pi*[-n:n]'/T/fs);
P=aa*exp(j*2*pi*[-n:n]'/T/fs);
B=poly(Z);A=poly(P);
Y=filter(B,A,X);
subplot(221),stem(M,X(M))
subplot(222),stem(M,Y(M))
%Frequency response of comb:
F=linspace(0,fs/2,10000);
W=exp(j*2*pi*F/fs);
H=polyval(B,W)./polyval(A,W);
subplot(223),plot(F,abs(H))
subplot(224),zplane(B,A)
```