EC380 Mini Project 4 – PeZ

Work alone for this mini project. You are free to discuss ideas with others. This MATLAB project is part of a sequence of mini projects.

Approach

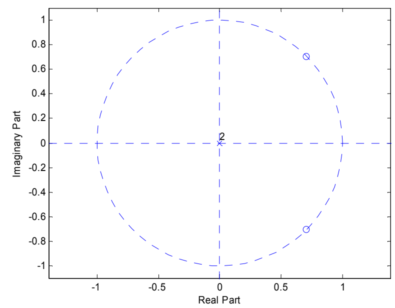
Do Lab 11: **PeZ - The z, n, and $\hat{\omega}$ Domains** from the CD-ROM.

Due Date:

This assignment is due Tuesday 20-Jan-2004 at the start of class. Turn in a paper copy of the Instructor Verification.

Redo Tone Removal using Zeros

Redo your tone removal project, this time thinking of placing zeros to remove the tone. You will get the same answer, however your approach is more general which will allow you to do more complicated filters in the future. For example, suppose you want zeros as shown in the figure. The zeros appear to be located at $e^{j\pi/4}$ and $e^{-j\pi/4}$, therefore $H(z) = (z - e^{j\pi/4})(z - e^{-j\pi/4})$. In MATLAB you can use the `poly` command (enter `helpwin poly` for more information) to convert from the roots of a polynomial to the coefficients of that polynomial. For example `poly([2, -2])` returns `1    0    -4`, which says the polynomial $1x^2 + 0x - 4$ has the roots 2 and -2.



Therefore `bb = poly([exp(i*pi/4) exp(-i*pi/4)])` would assign bb to the polynomial that as the roots we are looking for. Finally, the command `zplane(bb,1)`, will give the plot shown.

You can notch out more frequencies by adding more roots to the `poly` command. What is plotted by:

```
bb = poly([exp(i*pi/4) exp(-i*pi/4) exp(i*pi/2) exp(-i*pi/2)])
```
?

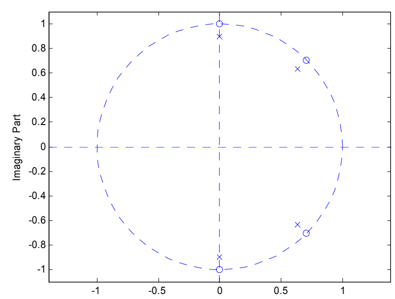
The frequency response can be plotted by using:

```
ww = -pi:pi/100:pi;
HH = freqz(bb,1,ww);
plot(ww,abs(HH));
```

What should the frequency response look like?

Redo Tone Removal using Poles and Zeros

Now that you've seen how to position zeros where you want them, you'll see that it is also easy to position poles. For example, let's place some poles right behind the zeros from above. Like this:



The poles are at $0.9e^{\pm j\pi/4}$ and $0.9e^{\pm j\pi/2}$. In MATLAB use:

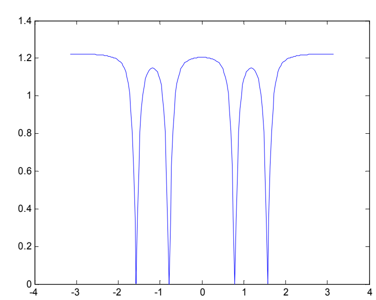
```
aa = poly(0.9*[exp(i*pi/4) exp(-i*pi/4) exp(i*pi/2) exp(-i*pi/2)]).
```

The figure at the right was created with `zplane (bb,aa);`

The frequency response can be found with: `HH = freqz(bb,aa,ww);`

Notice the frequencies between the zero'ed frequencies are not attenuated as much. In fact, they are amplified slightly (times 1.2). The only issue left is for you to figure out how to create a filter that amplifies by 1 rather than 1.2.

The Assignment



Redo the tone removal project using poles behind the zeros. Plot the frequency response for both approaches on the same axis. Describe how the sound has changed. Can you tell what the DC gain of your filter will be based on the *a* and *b* coefficients?