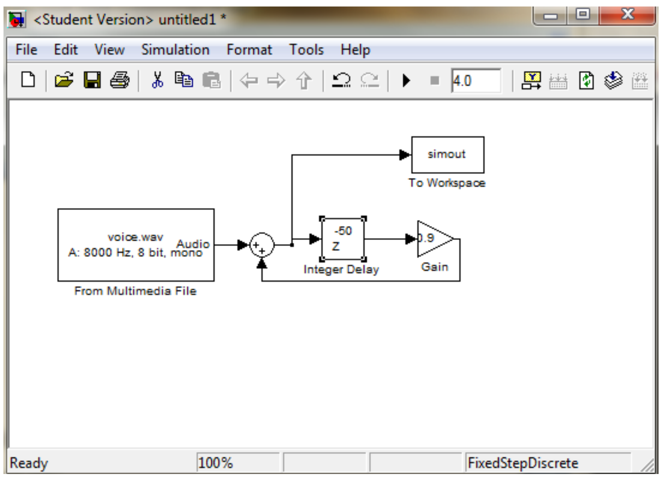
Thomas Boynton Lab 8 CET 346 4/13/2010

1. The system S2 has an input of y:Integers →Reals and has an output z: Integers →Reals and this is given by ∀ n ∈ Integers, $z(n) = \alpha y(n - N)$. So we can say:

$y(n) = x(n) + z(n)$ This equation says that this is a feedback system, scaled, delayed.

2. If we put this system into simulink, we have the system shown below.



So we have a gain of 0.9 and an N value of 50. If we use a N value of 2000, it tends to echo. If we use N = 50 it's kind of a changed, kind of amplified sound, it is reflecting the sound. The delay bounces around some energy is lost each time it does this. When alpha is greater than 1 it is an unstable system. When alpha is 0, the sound sounds the same as it is the same. When alpha = 1 the sounds echoes forever.

The commands in Matlab

plot([0:1/8000:4], simout)

xlabel('time'); ylabel('amplitude')

will plot this unstable system

3. If we plot the impulse response with N = 40 and alpha = 0.99, we use the commands

subplot(2,1,1); plot([0:1/8000:1], simout)

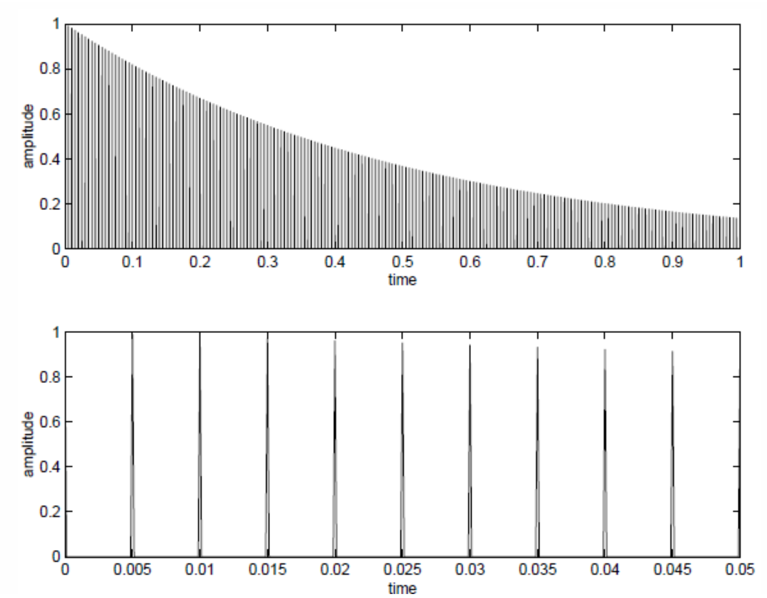
xlabel('time'); ylabel('amplitude')

subplot(2,1,2); plot([0:1/8000:0.05], simout(1:401))

axis([0, 0.05, 0, 1]);

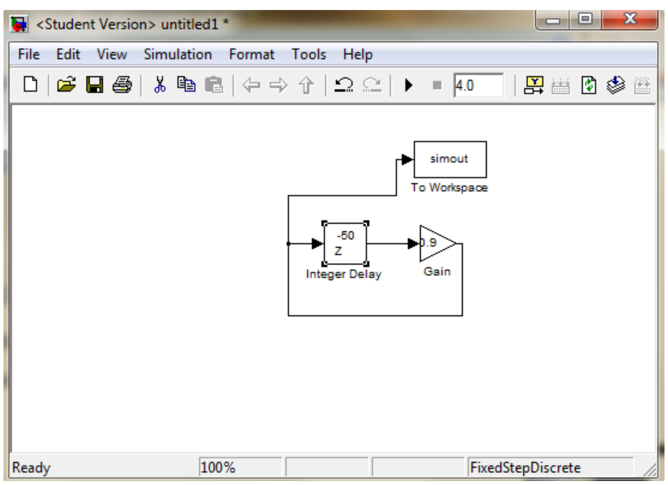
xlabel('time'); ylabel('amplitude')

and we get the plots



This has a period of 0.005 seconds and a frequency of 200 Hz.

4. Our model with a random initial value for our delay values is shown below



It is a richer sound.

5. If we use an input of $x(n) = e^{i\omega n}$, then we will have an output of $y(n) = H(\omega)e^{i\omega n}$. This will give us $H(\omega)e^{i\omega n} = e^{i\omega n} + \alpha H(\omega)e^{i\omega(n-N)}$

$$= e^{i\omega n}(1 + \alpha H(\omega)e^{-i\omega N}).$$

And then we can simplify and get

$H(\omega) =$

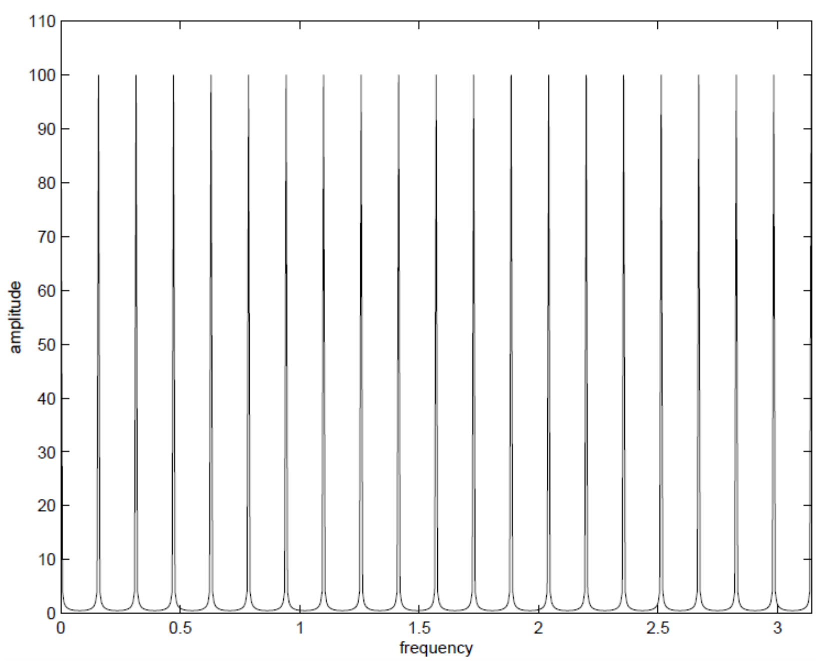
$1/(1 - \alpha e^{-i\omega N})$.

Then this can be plotted from 0 to 4 KHz and our omega will vary from 0 to 2π x 4000/8000 = π.

Then choosing samples or 500 for our amount of samples, we put our commands into Matlab

```
omega = 0:pi/500:pi;
alpha = 0.99;
N = 40;
magnitude = abs(1./(1-alpha*exp(-i*omega*N)));
plot(omega, magnitude);
xlabel('frequency');
ylabel('amplitude');
axis([0, pi, 0, 110]);
```

This gives us the plot



This frequency response tells us our output has a fundamental frequency of 200 Hz with multiples of 200 Hz being our harmonics.