HOMEWORK ASSIGNMENT #7

Due Fri. Feb. 29, 2008 (in class)

Reading:

1. Ch. 6.1–6.7, 9.1–9.3

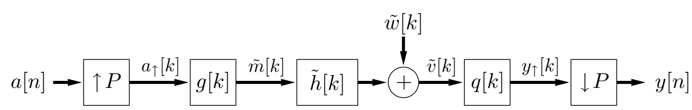
Problems:

1. Here you will use the discrete-time baseband model to simulate a real-valued digital communication system and then plot an eye diagram to interpret the outputs. The programs `pam.m` and `srrc.m` are available on the course webpage.

   (a) Using `pam`, generate a 4-ary PAM symbol sequence with length $N = 100$ and variance 1.

   (b) Using `srrc`, generate $\{g[k]\}$, a sampled SRRC pulse shape with total time span $4T$, rolloff parameter $\alpha = 0.5$, and oversampling factor $P = 16$.

   (c) Implement the discrete-time complex-baseband system below assuming a noiseless and trivial discrete-time channel (i.e., $\tilde{w}[k] = 0$ and $\tilde{h}[k] = \delta[k]$).



   Remember than upsampling can be accomplished via

```
a_up = zeros(1,P*N);
a_up(1:P:P*N) = a;
```

   and that downsampling can be accomplished via

```
y = y_up(1:P:P*N);
```

   But, before downsampling, you will need to remove the effect of causal filtering delay via

```
y_up = y_up(dly+[1:P*N])
```

   for appropriately chosen `dly`. (See the plot on the next page.)

   (d) Plot the oversampled outputs $y_\uparrow[k]$ and superimpose the recovered symbols $y[m]$ using dots. Because $y_\uparrow[k]$ and $y[m]$ correspond to the same signal at different sampling rates, you need to plot them on different time grids. This can be done via

```
plot([0:N*P-1]/P,y_up,'r',[0:N-1],y,'.');
```

   Note that we do not use `plottf` because we are not plotting continuous waveforms.
   Question: Do the recovered symbols $y[m]$ closely match the transmitted symbols $a[m]$?

   (e) Finally, you will plot the eye diagram. For this, I suggest to leverage the fact that, when given a matrix, `plot` generates a superimposed plot of every column of the matrix. Notice that the matrix

```
Y_up = reshape(y_up,P,N);
```

contains (a $\frac{T}{P}$-sampled version of) each T-wide segment of $y(t)$, which are what we want to plot in the eye diagram. This is the basic technique; you may have to adjust the start point of `y_up` to get the eye diagram properly centered.

Questions: Is the eye open? With smaller α, explain what happens and why. Do the same with larger α.

The plots that you generate for this problem should look something like the following. Notice that, because the causal filtering delay was removed, the first recovered symbol appears at time 0 on the left plot.

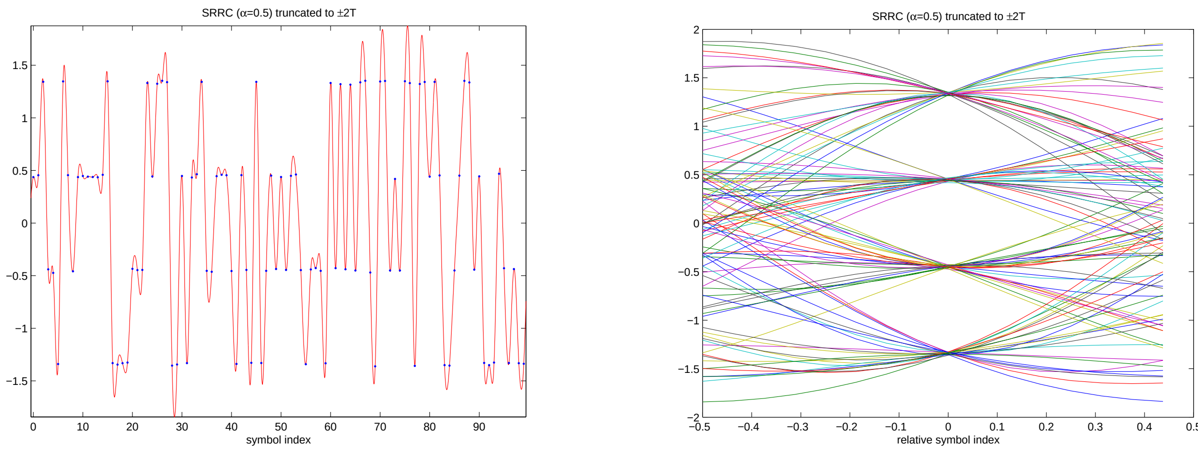


Figure 1: Example plots for problem 1.

2. Here you will use the discrete-time baseband model to simulate a complex-valued digital communication system and then plot constellation diagram to interpret the output.

   (a) Using `qam`, generate a 16-ary QAM symbol sequence with length $N = 100$ and variance 1.

   (b) Using the same $P = 16$ SRRC pulses and complex-baseband system as in problem 1, generate the oversampled output $y_\uparrow[k]$. As before, make sure to remove the causal filtering delay.

   (c) Plot the complex-valued signal $y_\uparrow[k]$ and the recovered symbol values $y[k]$ in 3D using

   ```
   plot3([0:N*P-1]/P,real(y_up),imag(y_up),'r',[0:N-1],real(y),imag(y),'.');
   xlabel('symbol index'); ylabel('I'); zlabel('Q');
   ```

   Typing `view(20,30)`, you can get a nice over-all view of the trajectory, but I suggest also trying `view(0,90)`, `view(0,0)`, and `view(90,0)`.

   (d) Plot the constellation diagram (superimposed on the received signal $y(t)$) using

   ```
   plot(real(y_up),imag(y_up),'y',real(y),imag(y),'.');
   axis('equal');
   ```

   Questions: Are the clusters tight? With smaller α, explain what happens and why. Do the same with larger α.

   The plots that you generate for this problem should look something like those on the next page.

3. Repeat problem 2 using an 8-ary PSK symbol sequence generated via `psk`.

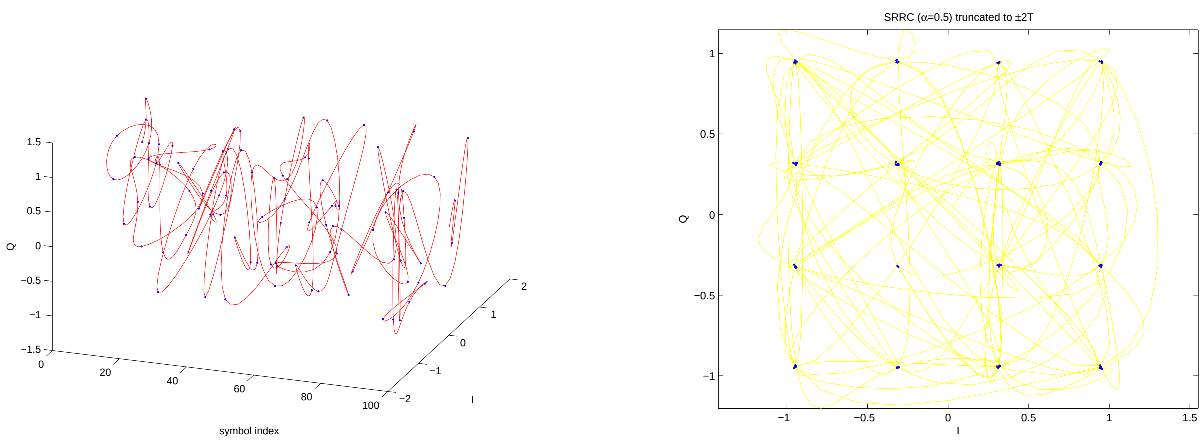


Figure 2: Example plots for problem 2.