Assigned: 8/25/10
Due: 8/30/10

Convolution

Getting Started

1. To start MATLAB on a PC, simply go to Start->Programs and start MATLAB from the menu.
2. To become familiar with some of the "gee-whiz" capabilities of MATLAB, try running `echodemo xfourier`. The text shows the MATLAB commands that were used to generate the examples. You may also wish to explore some of the other examples by running `demo` and exploring the options.
3. Run `echodemo intro` to get an idea of the basic capabilities of MATLAB.
4. You can type `doc` at any time to get a hypertext version of the MATLAB Reference Guide or `help <cmd>` to get help on specific commands (assuming this is installed on the machine where you are).
5. If you need help on a MATLAB function and the hyperlink doesn't work, simply type `help <function>` at the MATLAB prompt.

Exercises

1. Write a MATLAB function to generate a periodic waveform of total length L. Each period must be a truncated, decaying exponential $A\exp(-bn)$ with decay rate b that begins with amplitude A and lasts a total of M samples. The result should look something like a series of waves. By learning from the triangular waveform function example in MATLAB for DSP, it is possible to write this function without loops. (This is **not** necessary for full credit.) Include a listing of your function.
2. Create two signals:
   (a) Create a length-12 vector representing an impulse (`delta1 = [1 zeros(1,11)];`). Note that this is an impulse with some of the zeros shown, not a pulse.
   (b) Create a wave `s1` with $L = 80$, $A = 2$, $b = 0.08$, and $M = 20$.
3. Use conv to convolve `s1` and `delta1`, and plot the result using `stem`.
4. Examine another convolution:
   (a) Create another vector of length 12 representing an impulse at 0 and 11. (`delta2 = [1 zeros(1,10) 1];`).
   (b) Convolve `delta2` with `s1` and plot the result.
   (c) Explain the relationship between this plot and the previous one.
5. Examine another type of impulse response:
   (a) Create a flat impulse response `hn3` that is three points long and normalized by the length (`hn3 = 1/3*[ones(1,3)];`).
   (b) Convolve `hn3` with `s1`.
   (c) Increase the length of the impulse response to 5 and 10 and redo the convolution.

(d) What happens to the result as the length of the impulse response is increased? Explain.

6. Let $x[n] = \mu[n] - \mu[n-5]$. Let $h[n] = \delta[n] + 2\delta[n-3]$. Determine $x[n] * h[n]$ analytically, explaining each step. (Keep $x[n]$ in the form of a difference of two step functions and not a list of numbers. Your answer should be a functional expression, not an explicitly written sequence of numbers.) Check your result using MATLAB. Explain how you checked the result.

7. **6410 only:** Write two MATLAB functions that calculate a square root using the following recursive systems:

$$y[n] = \frac{1}{2}\left(y[n-1] + \frac{x[n]}{y[n-1]}\right) \tag{1}$$

$$y[n] = x[n] - y^2[n-1] + y[n-1] \tag{2}$$

Set $y[-1] = 0.5$. The input should be $x[n] = \alpha\mu[n]$, where α is the number whose square root is desired. For this system, α must be between 0 and 1. Plot the output as a function of n for $n \in [0, 100]$. Try several different input values, and report the result. About how many iterations are required to get the result accurate to four digits? Compare the two systems in terms of steps to convergence.

Write a **concise** report describing your findings following my format instructions. The report should contain a concise description of your results and all plots you were required to generates. *Be sure to answer all questions.*

NOTE: All out-of-class work is to be done independently. Sharing of programming tips and discussing general concepts is ok. Collaborating on experiments or code-writing is not. Any such collaboration on these assignments will be considered an act of dishonesty and will be treated accordingly.
For further help:

- MATLAB Primer
- MATLAB Help Desk