

ECE-497/BME-491: Applied Biomedical Signal Processing
Laptop Day #4
Due at the end of class, December 21, 2006

Today we will implement the QRS detection algorithm of Murthy and Rangaraj.

At the end of class you should turn in four plots and your program.

1) Go to the class website and download the program *laptop4.m* and the data files *ecg5.dat* and *ecgpvc.dat*.

There are five **input** arguments to *laptop4.m*:

- alpha, the location of the pole in the filter used to remove the baseline wander
- N, the length of the window within which the first order differences are computed
- M, the order of the moving average filter
- fraction, the threshold is set at $\text{fraction} * \max(g)$
- the starting point (index) in the file, usually the first point in the file so this is usually a 1
- the number of sample points in the file to use

2) We first need to apply a filter of the form

$$H(z) = \frac{1 - z^{-1}}{1 - \alpha z^{-1}} \frac{1 + \alpha}{2}$$

to remove the baseline wander. You should have implemented this in *laptop3.m*, so you can copy it from there. The input to this filter should be *data* and the output should be *x*.

3) We need to determine the point at which the transients of the filter have died out. This occurs approximately at

```
n = ceil(log(0.02)/log(alpha));
```

and we need to normalize the signal by the maximum value after this point,

```
x = x/max(x(n:end));
```

If you run the code using the command

```
laptop4(0.8,16,16,0.3,1,800);
```

you should get a plot very similar to that in Figure 1.

4) We next need to implement the equation

$$g_1(n) = \sum_{i=1}^N |x(n-i+1) - x(n-i)|^2 (N-i+1)$$

We will start this by setting the array *g1* to zero, and then filling it in. Part of this has been done for you. When you have done this correctly, your results should look like those in Figure 1. (You will have to uncomment one of the plot commands to see this.)

5) We next need to plot an M^{th} order moving average (MA) filter to $g_1(n)$ to get $g(n)$.

6) Set the threshold, and put it in the variable *th*.

7) We are supposed to find the peaks in the signal $g(n)$ if $g(n)$ exceeds the threshold. This requires $g(n) > g(n-i), i = 1, 2, \dots, M$ and $g(n) > g(n+i), i = 1, 2, \dots, M$. This has been implemented for you, but you have to uncomment it.

8) If you uncomment the remaining plotting commands, you should get the results shown in Figure 1.

9) Turn in your plots and your code.

10) Run the code with for 3000 sample points (from 1 to 3000). Adjust the parameters if necessary to detect all beats. Turn in both plots.

11) Run the code with the data file *ecg5.dat*. The initial sample should be 1, and you should use 3000 samples. Modify the parameters so that all of the beats are detected. Turn in both plots.

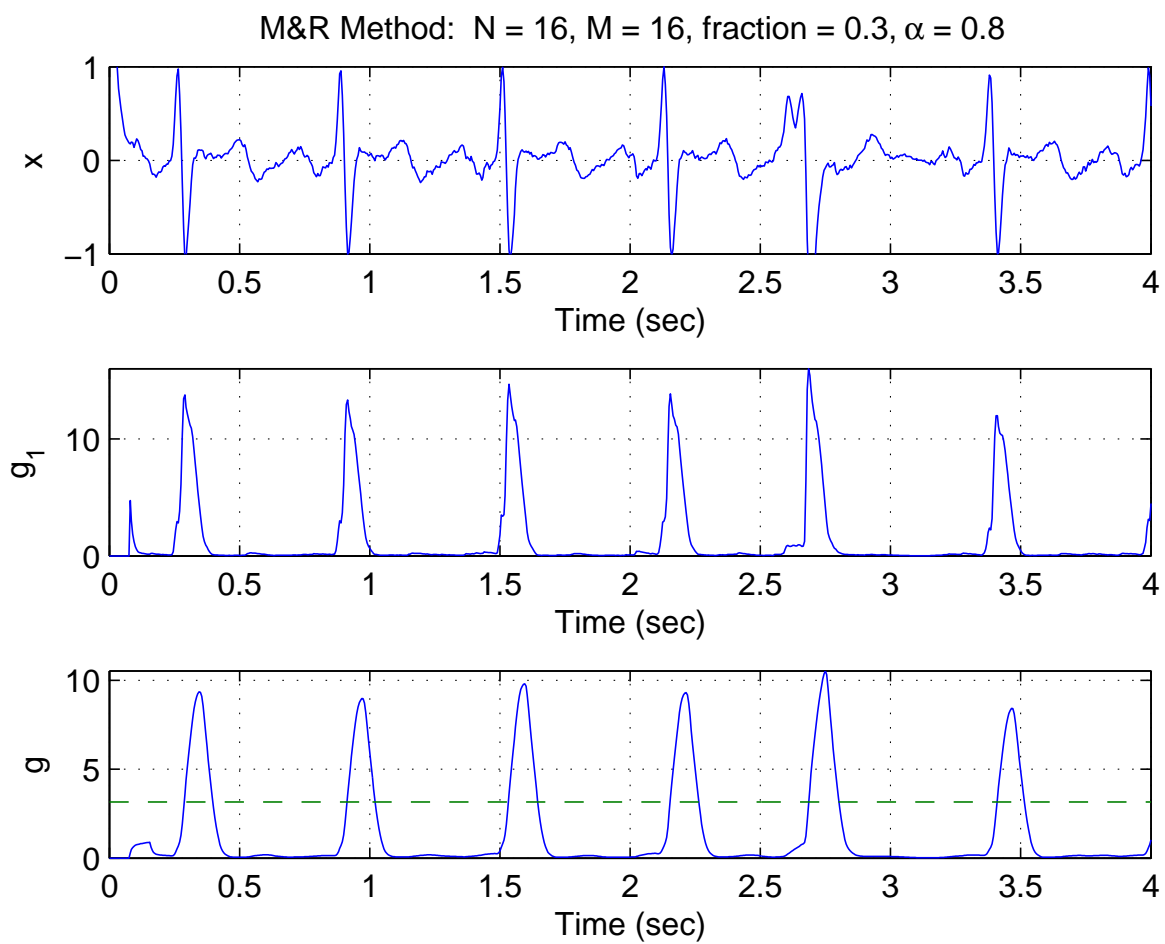


Figure 1: Results from processing data file *ecgpvc.dat* using $\alpha = 0.8$ and $N = M = 16$, *fraction* = 0.3.