# Seyed Mohammad Amin Atyabi - 830402014

**Biomedical Signal Processing - Homework 5**

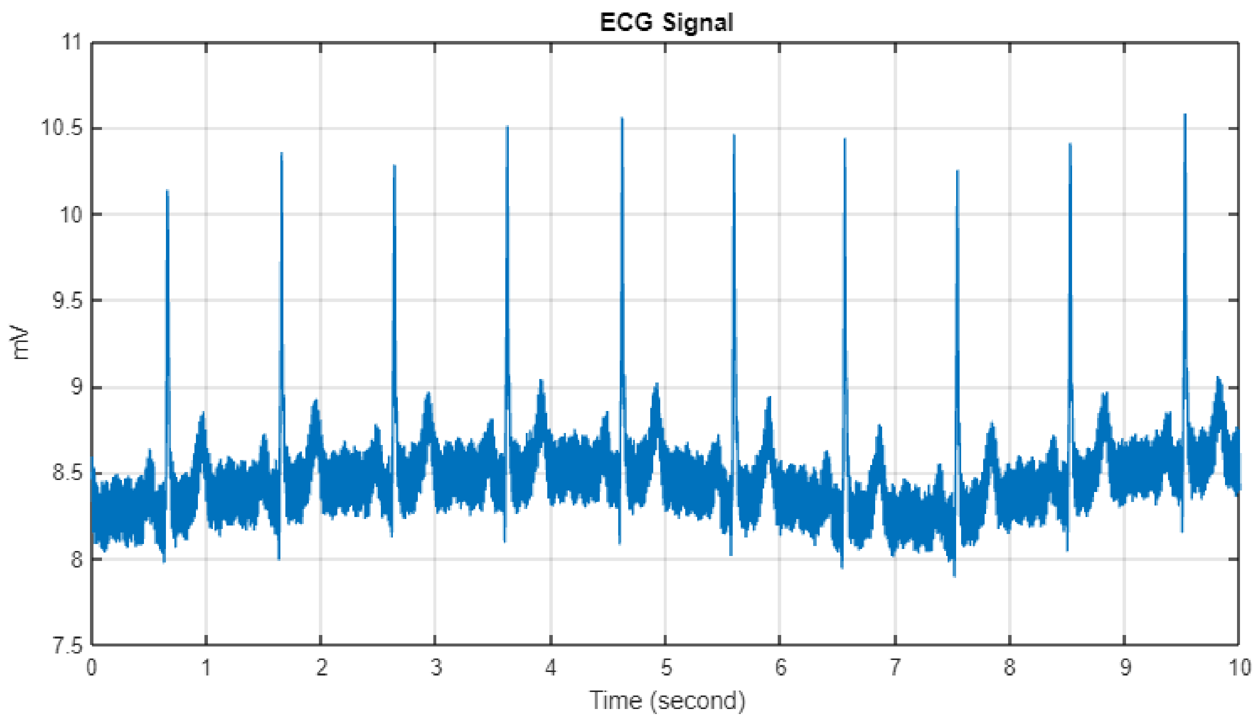
# Fantasia Database

## f1o01

Directly plot ECG signal from .dat file

According to 250Hz sampling rate, the fist 2500 samples show the first 10 seconds of signal

```
FS = 250;
[sig, ~, tm] = rdsamp('Data/f1o-01/f1o01.dat', 2, 10 * FS);
fig = figure();
fig.Position(3:4) = [3000, 1500];
plot(tm, sig);
title('ECG Signal');
xlabel('Time (second)');
ylabel('mV');
grid on;
```



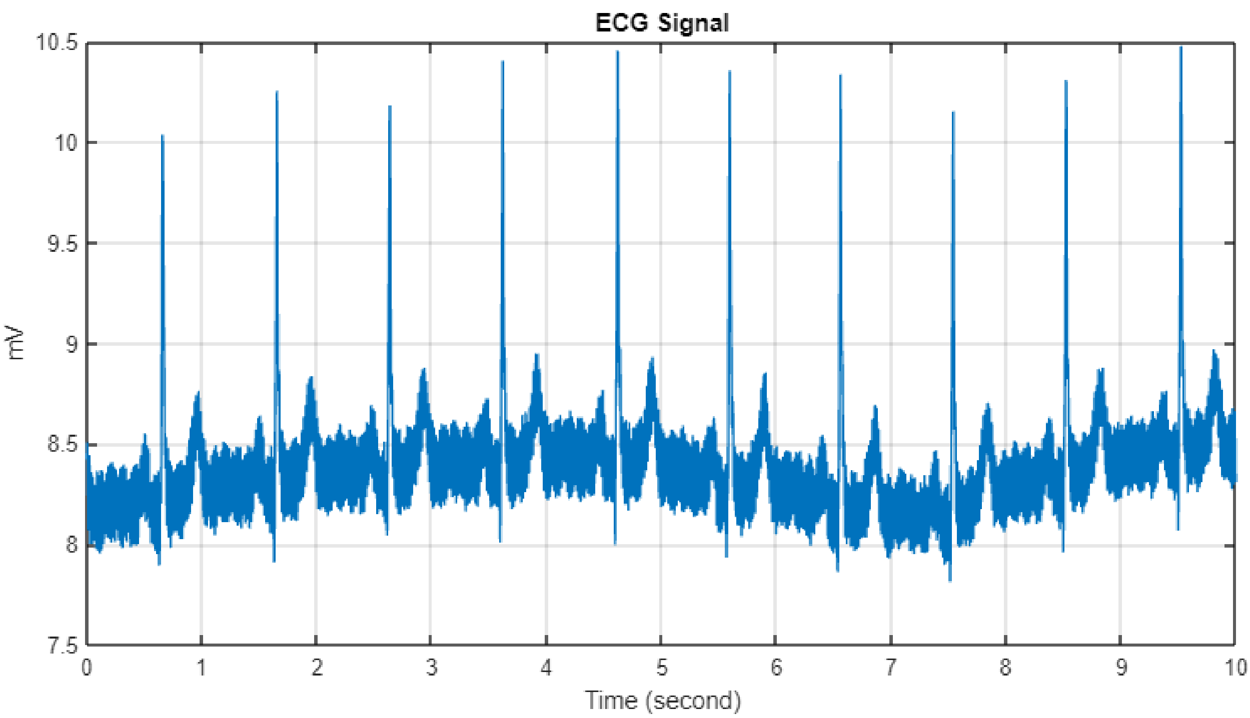

$$y(n) = \frac{1}{T}[x(n) - x(n-1)] + 0.995y(n-1)$$

Given time domain filter is a **LTI** system. It can be rewrite in format below:

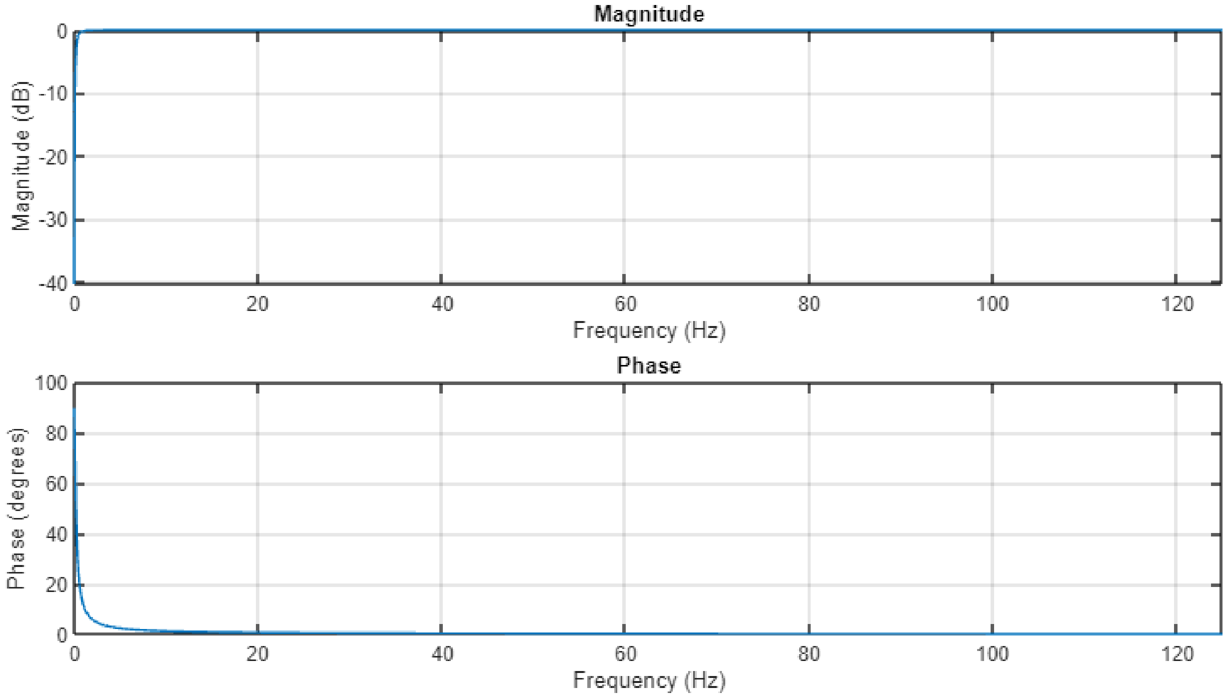
$$y(n) = \frac{1}{T}\left[0.995x(n) - 0.005x(n-1)\right]$$

This filter eliminates the low frequency noise witch in our case is the base line drift.

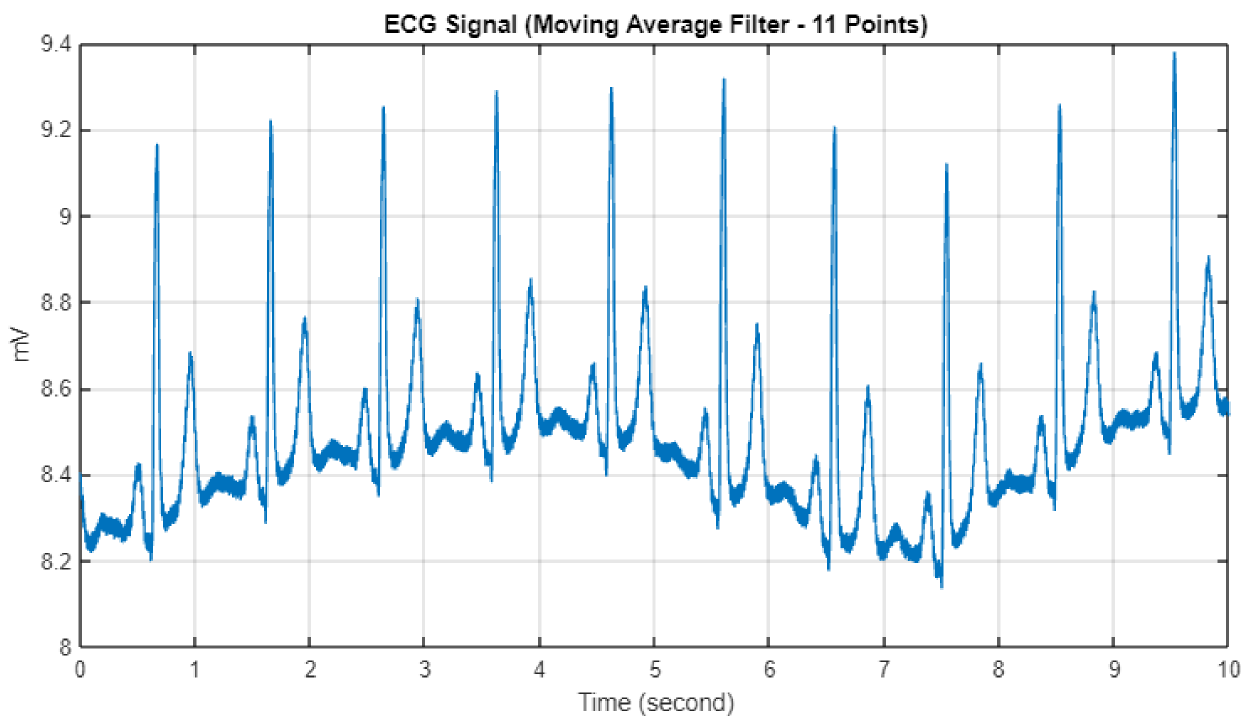
```
T = 1/FS;
filter_coeff = [0.995, -0.005];
sig_filterd = filter(filter_coeff, 1, sig, T);

fig = figure();
fig.Position(3:4) = [3000, 1500];
plot(tm, sig_filterd);
title('ECG Signal');
xlabel('Time (second)');
ylabel('mV');
grid on;
```




```
freqz([1 -1], [1 -0.995], 2^16, FS);
```

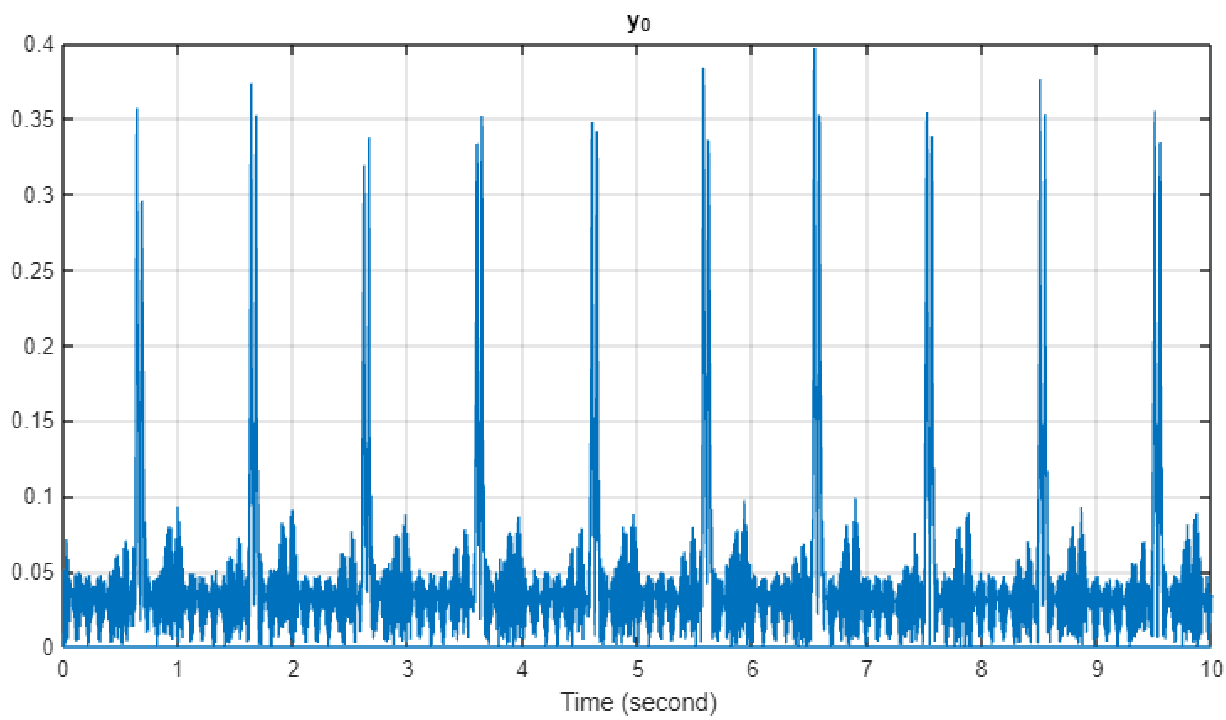



```
movingAverageFilter = movmean(sig, 11);
plot(tm, movingAverageFilter);
title('ECG Signal (Moving Average Filter - 11 Points)');
xlabel('Time (second)');
ylabel('mV');
grid on;
```

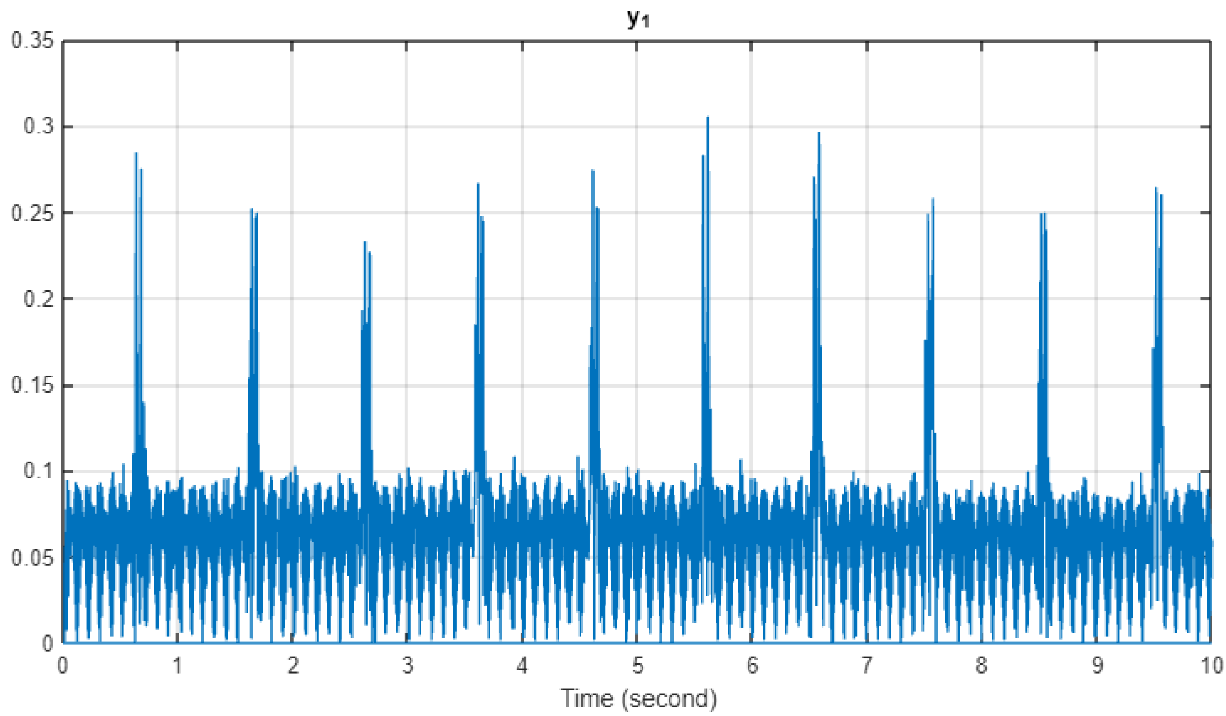



```
y0 = zeros(length(movingAverageFilter));
```

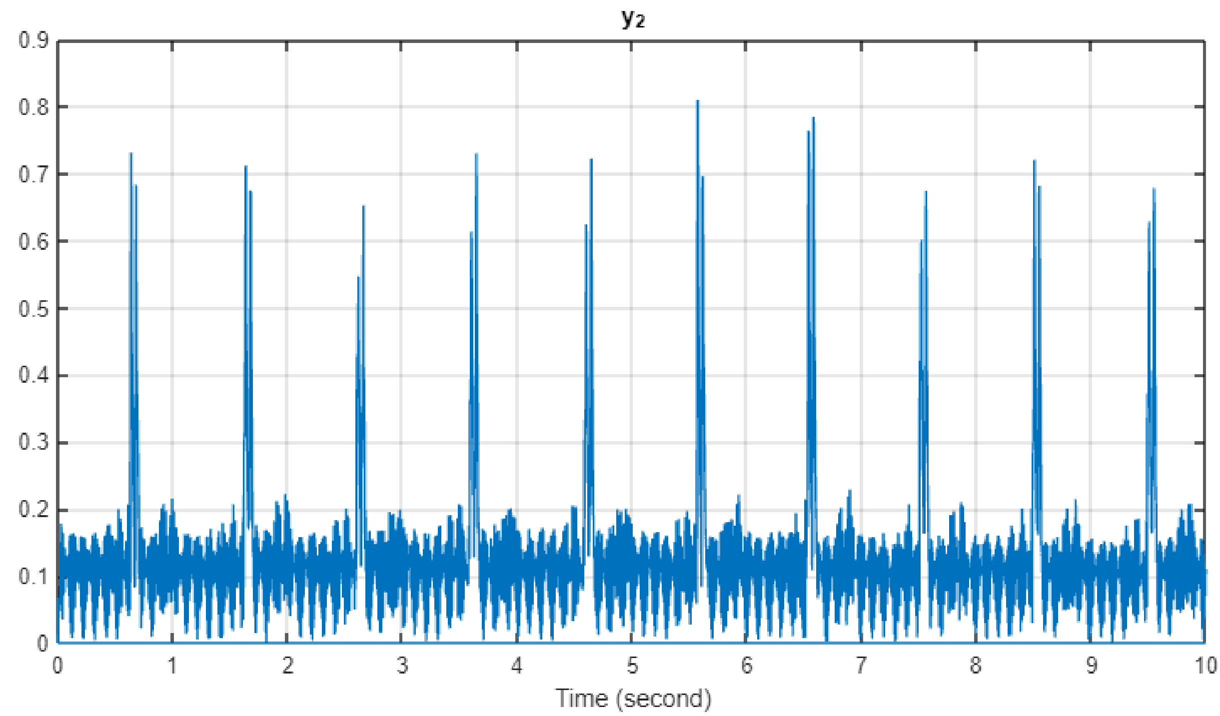
```
for n = 3:length(movingAverageFilter)
    y0(n) = abs(movingAverageFilter(n)-movingAverageFilter(n-2));
end
plot(tm, y0);
title('y_0');
xlabel('Time (second)');
grid on;
```



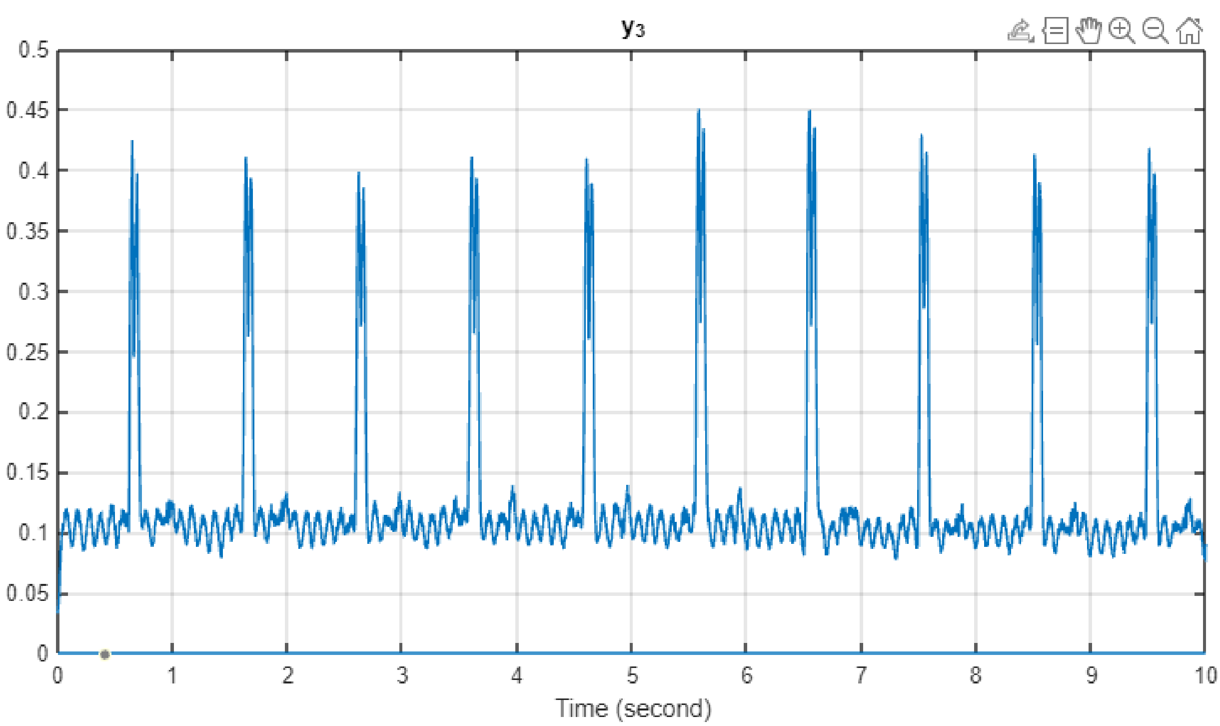

```
y1 = zeros(length(movingAverageFilter));
for n = 5:length(movingAverageFilter)
    y1(n) =
abs(movingAverageFilter(n)-2*movingAverageFilter(n-2)+movingAverageFilter(n-4));
end
plot(tm, y1);
title('y_1');
xlabel('Time (second)');
grid on;
```




```
y2 = zeros(length(movingAverageFilter));
for n = 1:length(movingAverageFilter)
    y2(n) = 1.3*y0(n)+1.1*y1(n);
end
plot(tm, y2);
title('y_2');
xlabel('Time (second)');
grid on;
```



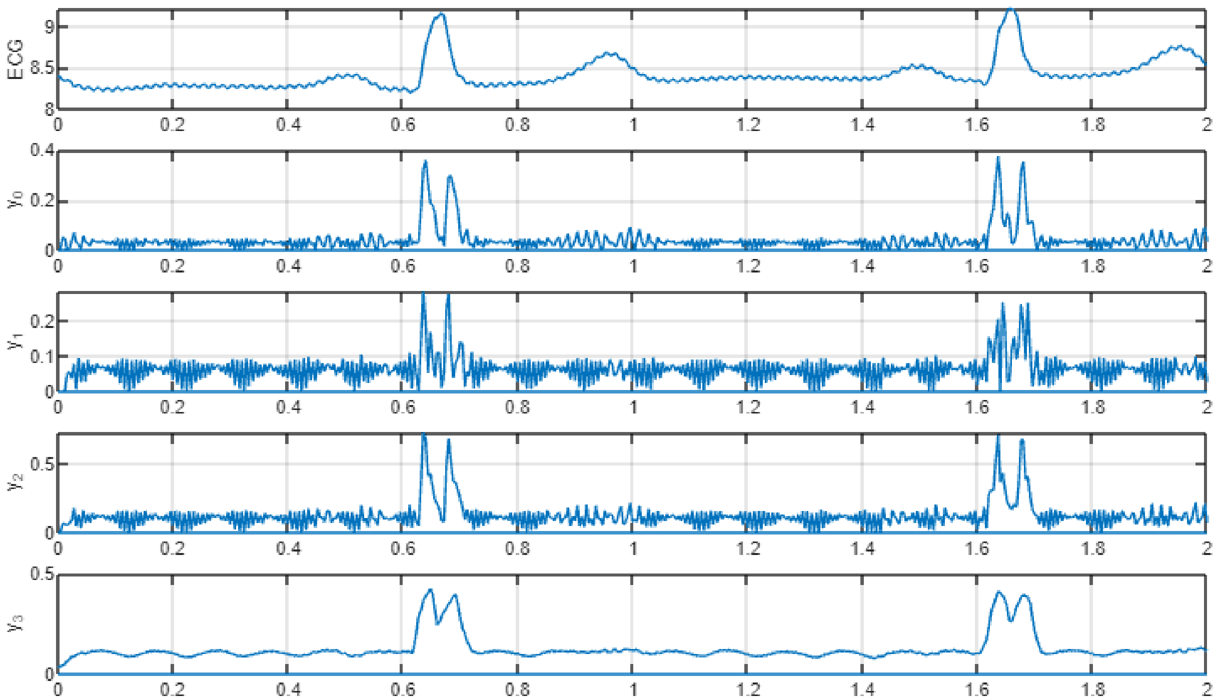

```
y3 = movmean(y2, 8);
plot(tm, y3);
title('y_3');
xlabel('Time (second)');
grid on;
```




For better view of five signals, we limit the time to the first two seconds.

As we can see, we are very close to a good peak detection.

```
subplot(5,1,1);
plot(tm, movingAverageFilter);
ylabel('ECG');
xlim([0 2]);
grid on;

subplot(5,1,2);
plot(tm, y0);
ylabel('y_0');
xlim([0 2]);
grid on;

subplot(5,1,3);
plot(tm, y1);
ylabel('y_1');
xlim([0 2]);
grid on;

subplot(5,1,4);
plot(tm, y2);
ylabel('y_2');
xlim([0 2]);
grid on;

subplot(5,1,5);
plot(tm, y3);
ylabel('y_3');
xlim([0 2]);
grid on;
```




## ECG-ID Database

### person 1 - rec 14

Directly plot ECG signal from .dat file

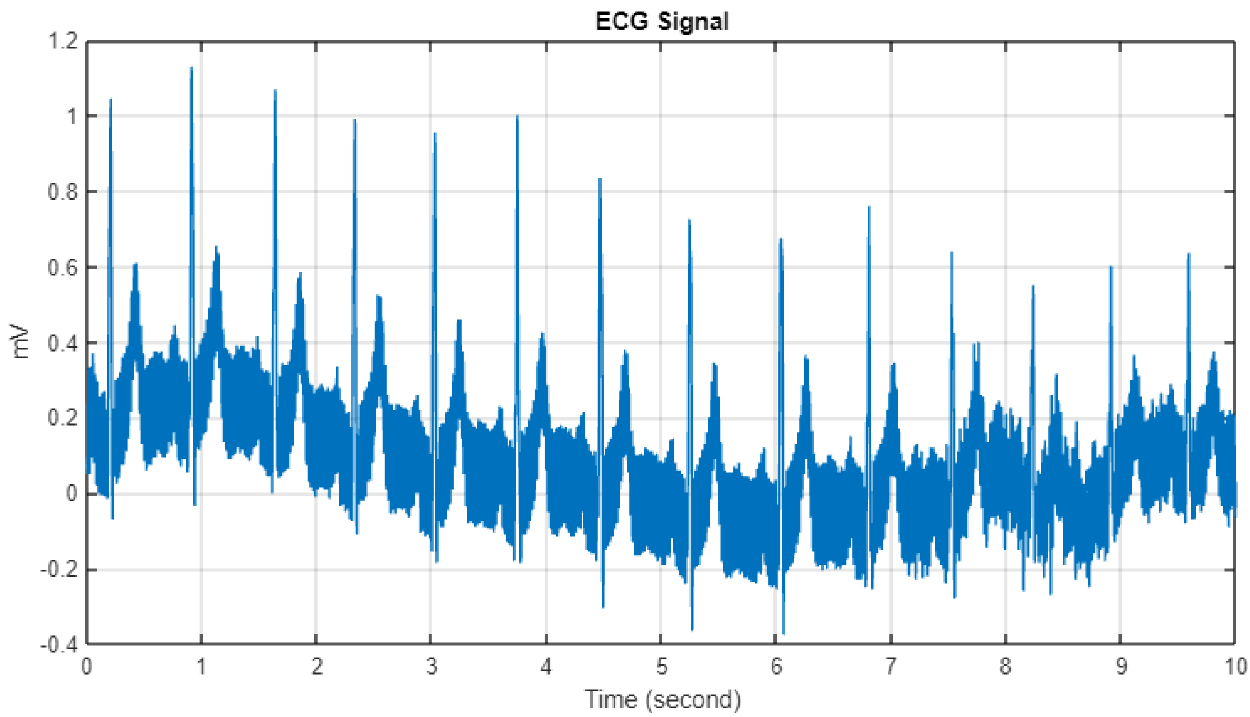
According to 500Hz sampling rate, the fist 5000 samples show the first 10 seconds of signal

```
FS = 500;
[sig, ~, tm] = rdsamp('Data/person 1 - rec 14/rec_14.dat', 1, 10 * FS);
```

```
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
Warning: Replacing blank spaces with %20
```

```
Warning: Replacing blank spaces with %20
```

```
fig = figure();
fig.Position(3:4) = [3000, 1500];
plot(tm, sig);
title('ECG Signal');
xlabel('Time (second)');
ylabel('mV');
grid on;
```




$$y(n) = \frac{1}{T}[x(n) - x(n-1)] + 0.995y(n-1)$$

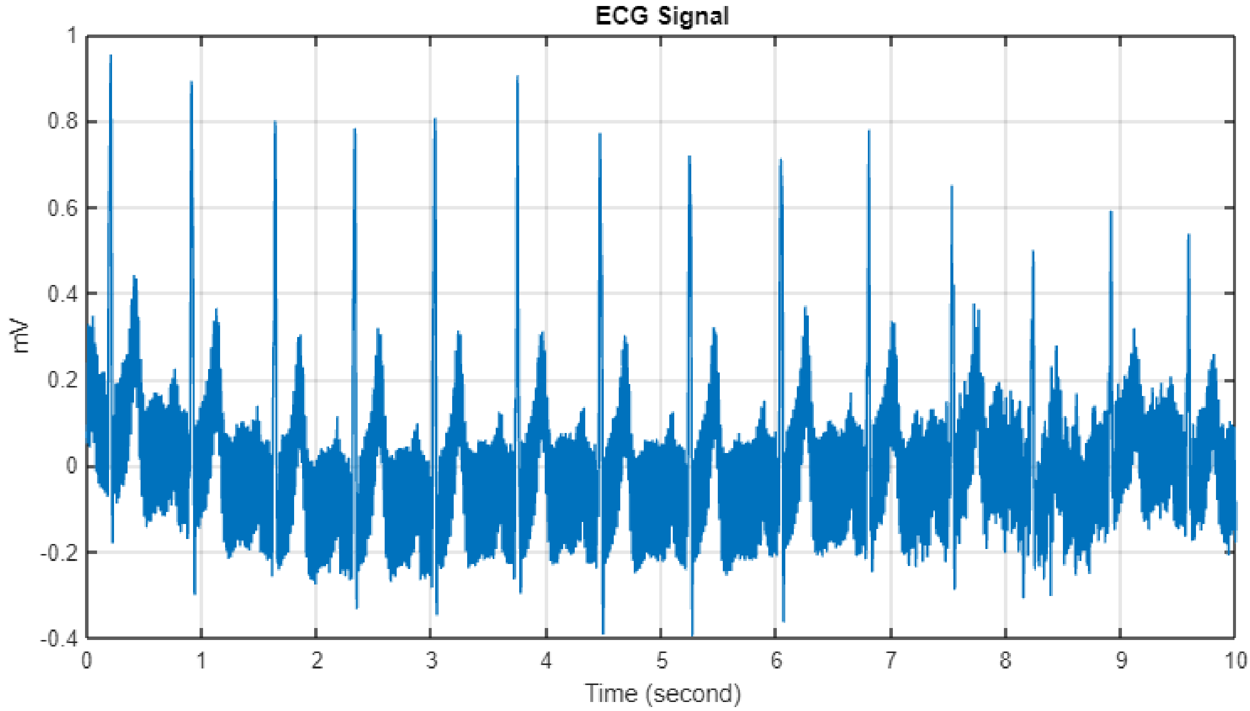
Given time domain filter is a **LTI** system. It can be rewrite in format below:

$$y(n) = \frac{1}{T}\ [0.995x(n) - 0.005x(n-1)]$$

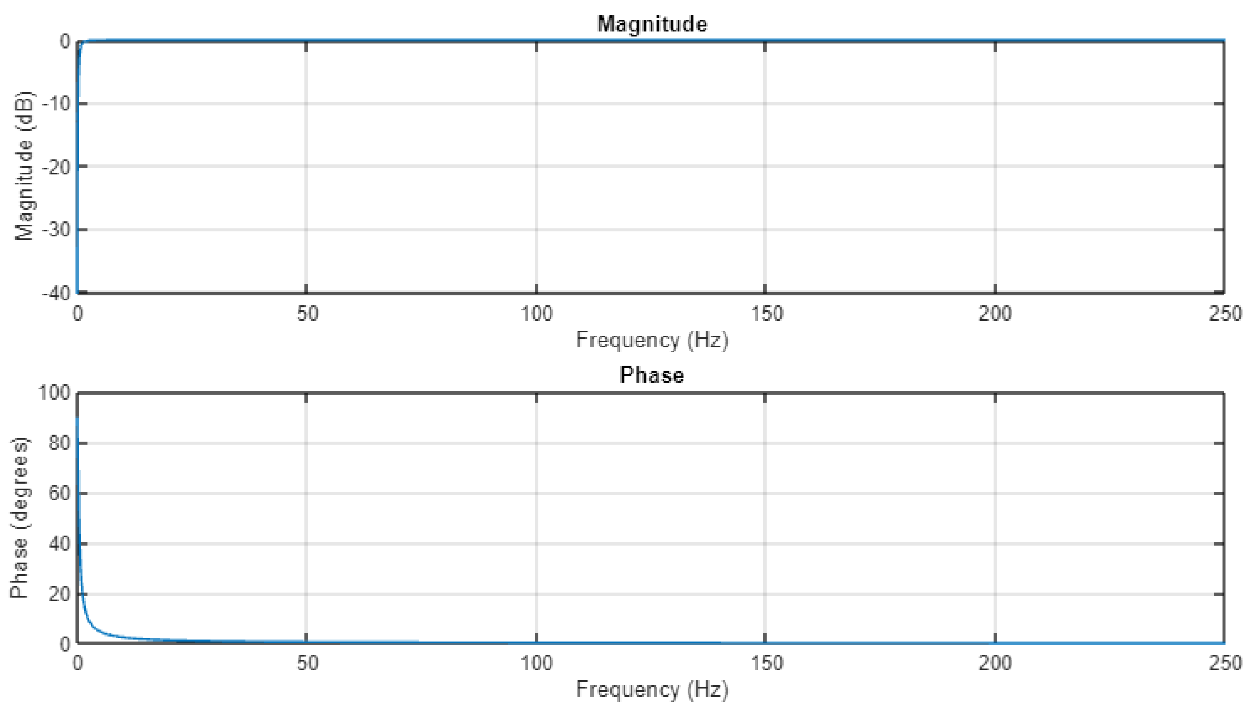
This filter eliminates the low frequency noise witch in our case is the base line drift.

```
T = 1/FS;
filter_coeff = [0.995, -0.005];
sig_filterd = filter([1 -1], [1 -0.995], sig, T);

fig = figure();
fig.Position(3:4) = [3000, 1500];
plot(tm, sig_filterd);
title('ECG Signal');
xlabel('Time (second)');
ylabel('mV');
```

```
grid on;
```

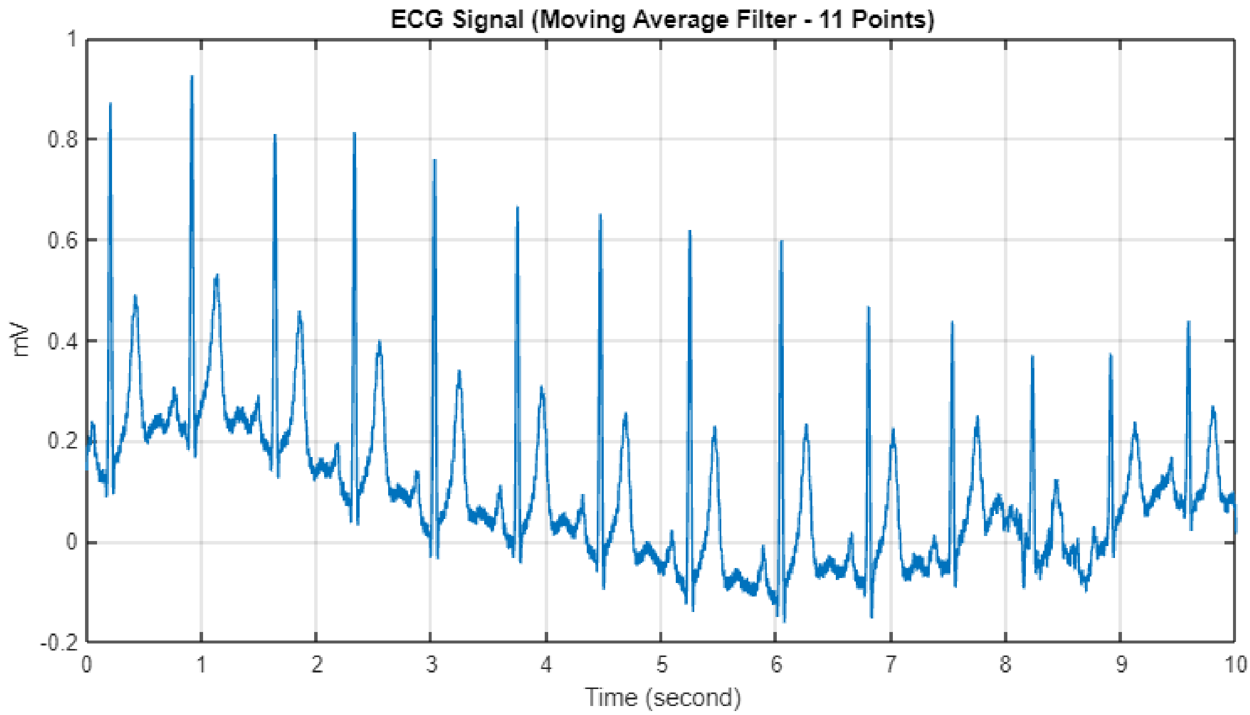



```
freqz([1 -1], [1 -0.995], 2^16, FS);
```



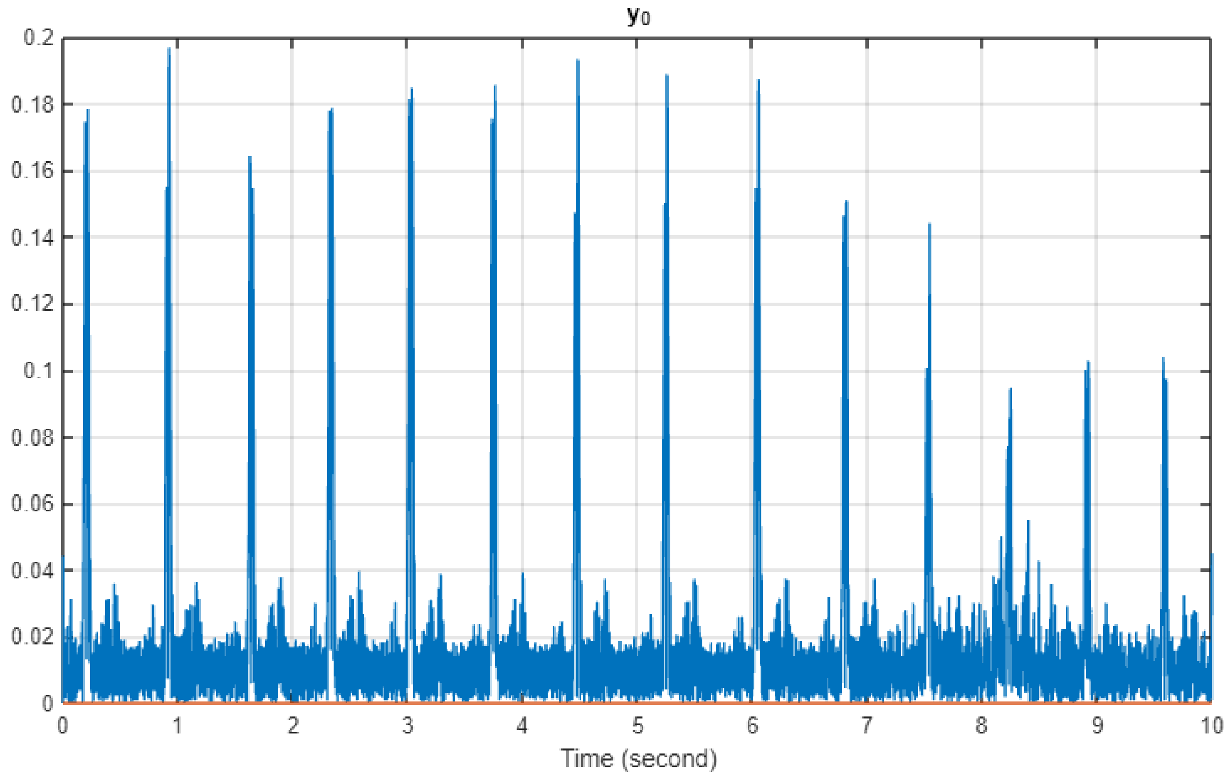

```
movingAverageFilter = movmean(sig, 11);
plot(tm, movingAverageFilter);
title('ECG Signal (Moving Average Filter - 11 Points)');
xlabel('Time (second)');
```

```
ylabel('mV');
grid on;
```

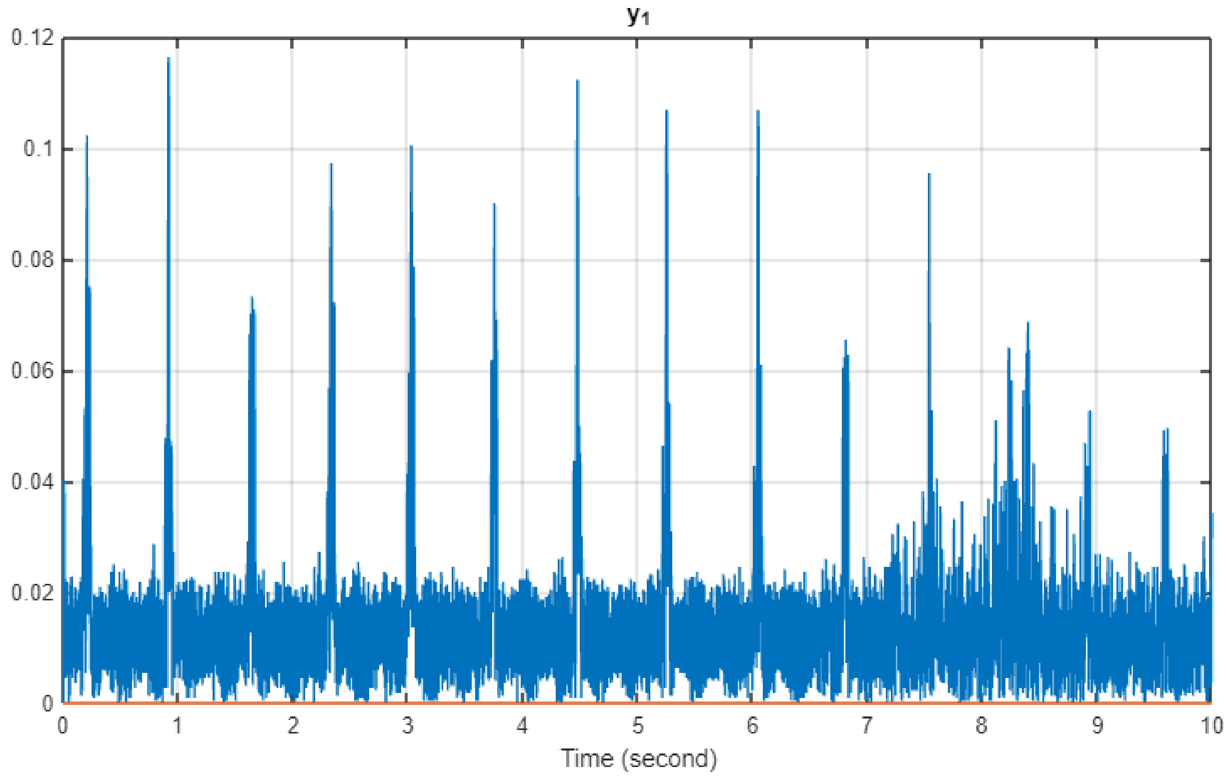



```
y0 = zeros(length(movingAverageFilter));
```

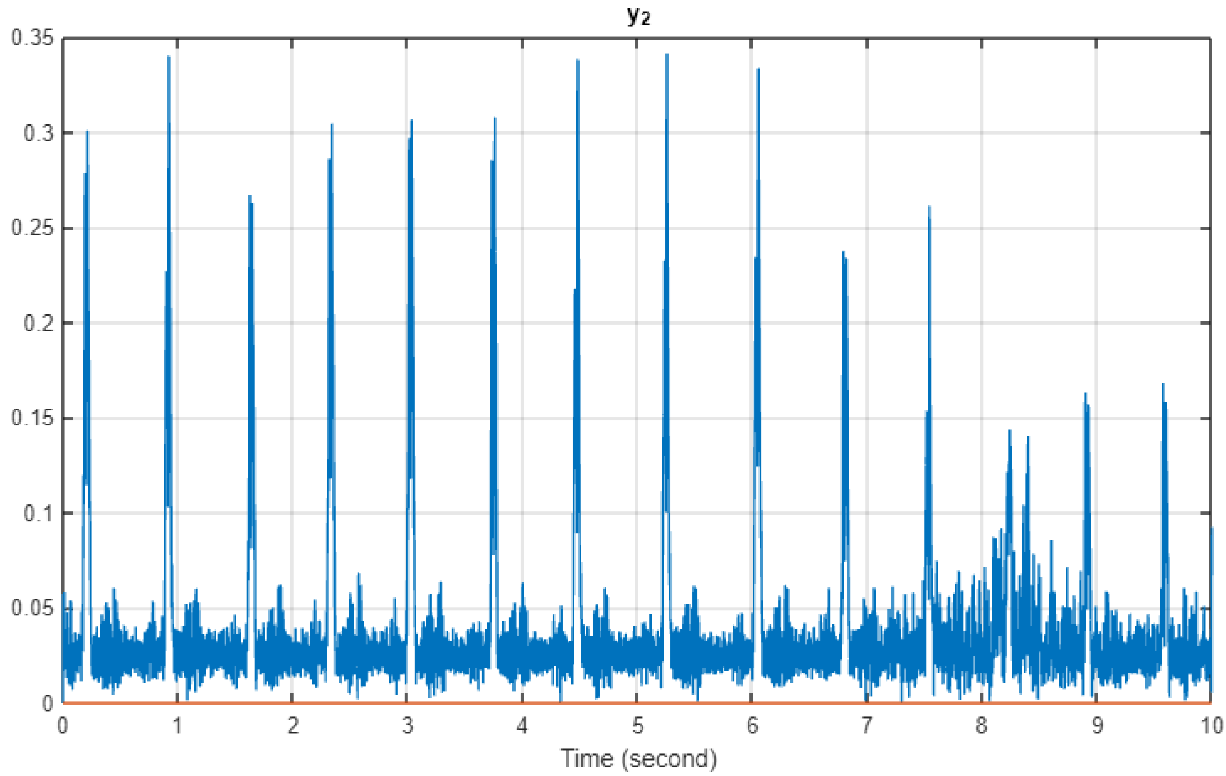
```
for n = 3:length(movingAverageFilter)
    y0(n) = abs(movingAverageFilter(n)-movingAverageFilter(n-2));
end
plot(tm, y0);
title('y_0');
xlabel('Time (second)');
grid on;
```



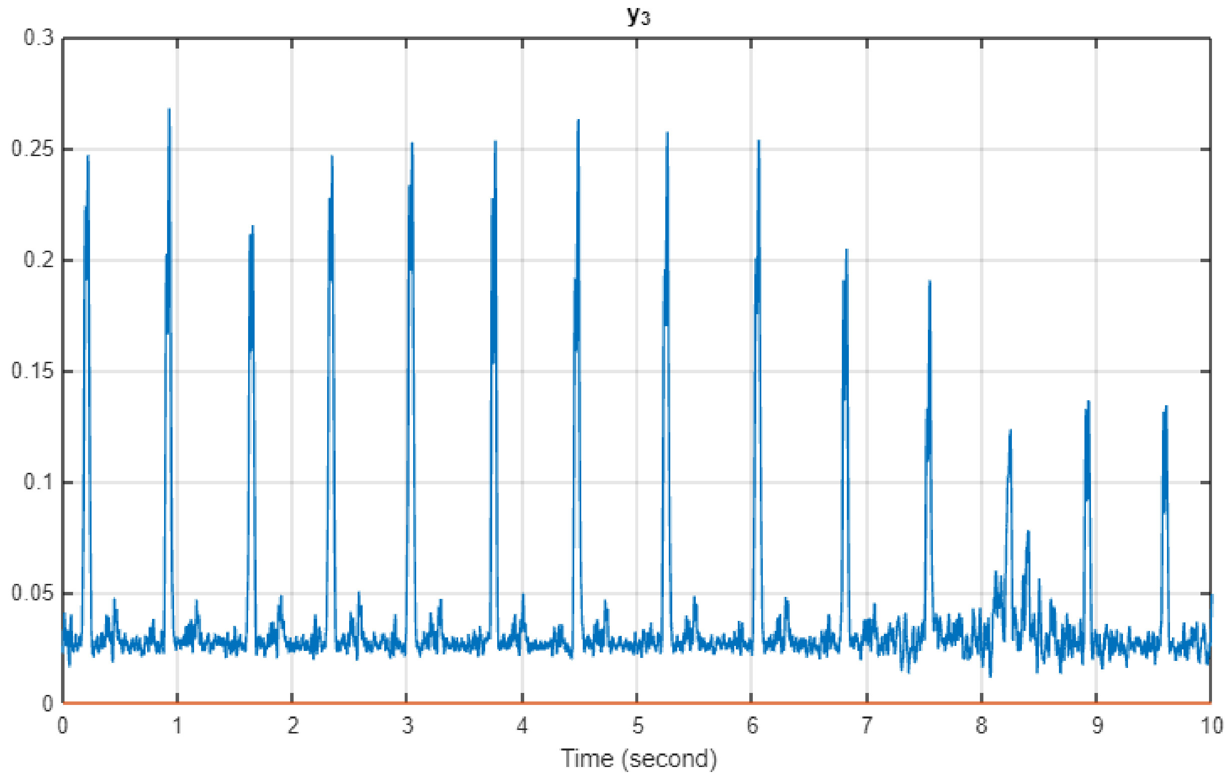

```
y1 = zeros(length(movingAverageFilter));
for n = 5:length(movingAverageFilter)
    y1(n) =
abs(movingAverageFilter(n)-2*movingAverageFilter(n-2)+movingAverageFilter(n-4));
end
plot(tm, y1);
title('y_1');
xlabel('Time (second)');
grid on;
```




```
y2 = zeros(length(movingAverageFilter));
for n = 1:length(movingAverageFilter)
    y2(n) = 1.3*y0(n)+1.1*y1(n);
end
plot(tm, y2);
title('y_2');
xlabel('Time (second)');
grid on;
```




```
y3 = movmean(y2, 8);
plot(tm, y3);
title('y_3');
xlabel('Time (second)');
grid on;
```




For better view of five signals, we limit the time to the first two seconds.

As we can see, we are very close to a good peak detection.

```
subplot(5,1,1);
plot(tm, movingAverageFilter);
uicontrol('Visible','off');
ylabel('ECG');
xlim([0 2]);
grid on;

subplot(5,1,2);
plot(tm, y0);
uicontrol('Visible','off');
ylabel('y_0');
xlim([0 2]);
grid on;

subplot(5,1,3);
plot(tm, y1);
uicontrol('Visible','off');
ylabel('y_1');
xlim([0 2]);
grid on;

subplot(5,1,4);
```

```
plot(tm, y2);
uicontrol('Visible','off');
ylabel('y_2');
xlim([0 2]);
grid on;

subplot(5,1,5);
plot(tm, y3);
uicontrol('Visible','off');
ylabel('y_3');
xlim([0 2]);
grid on;
```