QRS Detection

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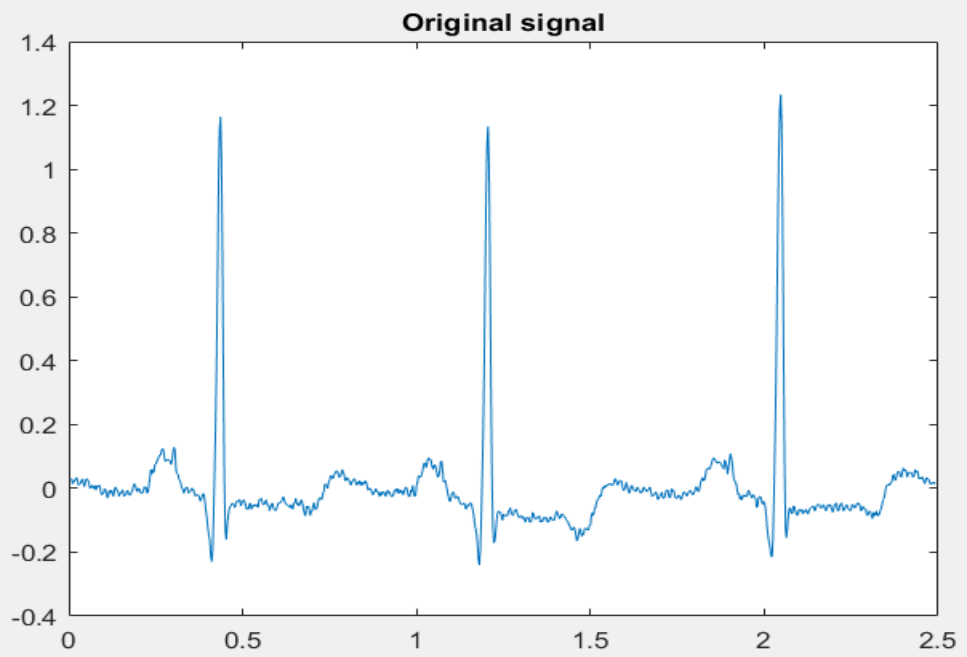
1)Display ECG signal:

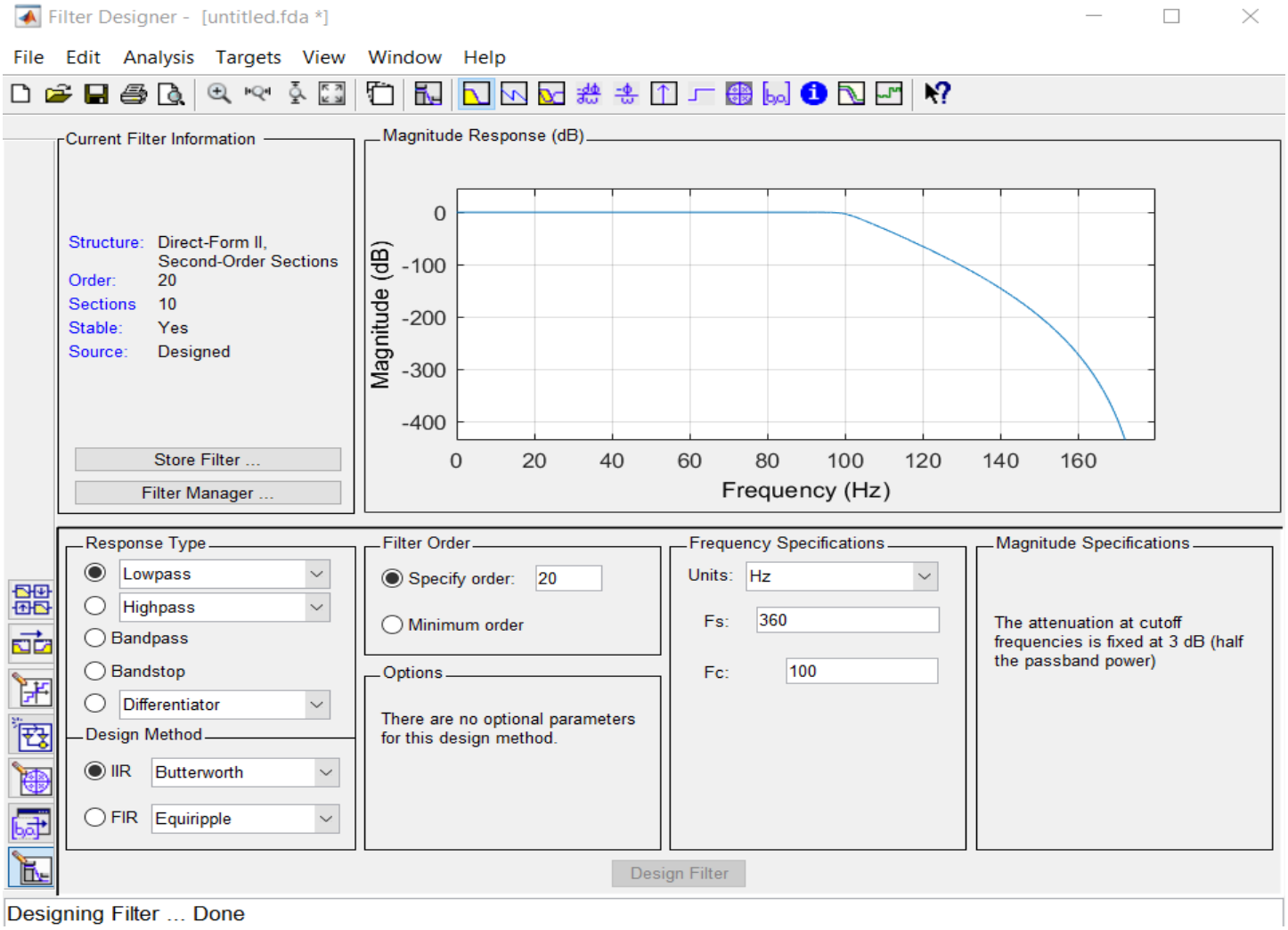
```
data=xlsread("ECG_SR360hz.xlsx");
signal=data(:,1);

%%%draw data
t=1:1:897;
fs=360;
time=t/fs;
```

Output:



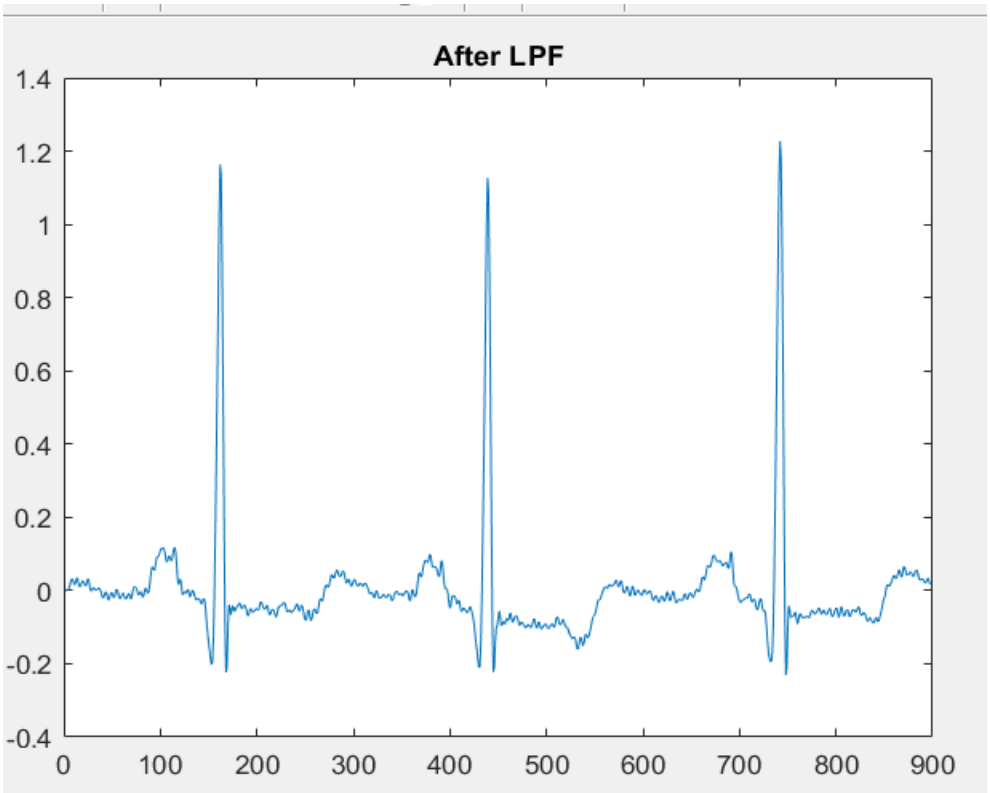
2) Design low pass filter:



It's designed at sampling frequency 360HZ for the signal and cut of frequency 100 HZ which indicates of end of ECG signal.

```
%%%lowpassfilter%%%%
l_p=lowfilt;
lpf_filtered_ECG = filter(l_p,signal);
subplot(6,1,2);
plot(lpf_filtered_ECG);
title('After LPF');
```

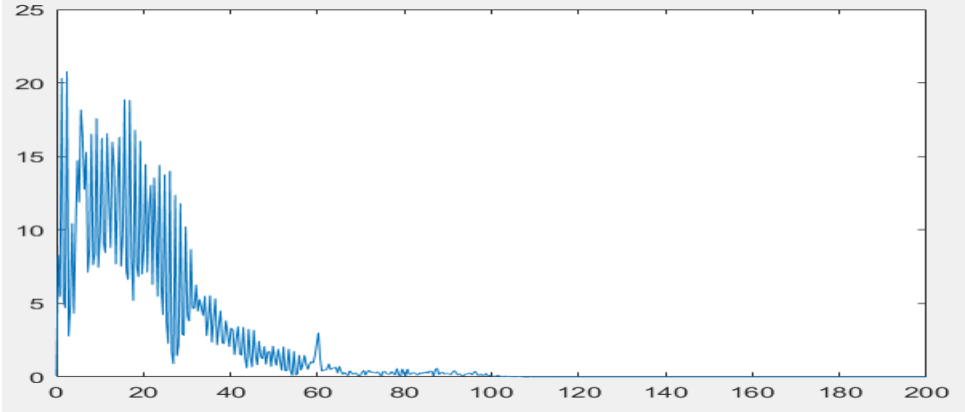
Output:



To observe the effect of LPF we display the frequency component of signal after low pass filter

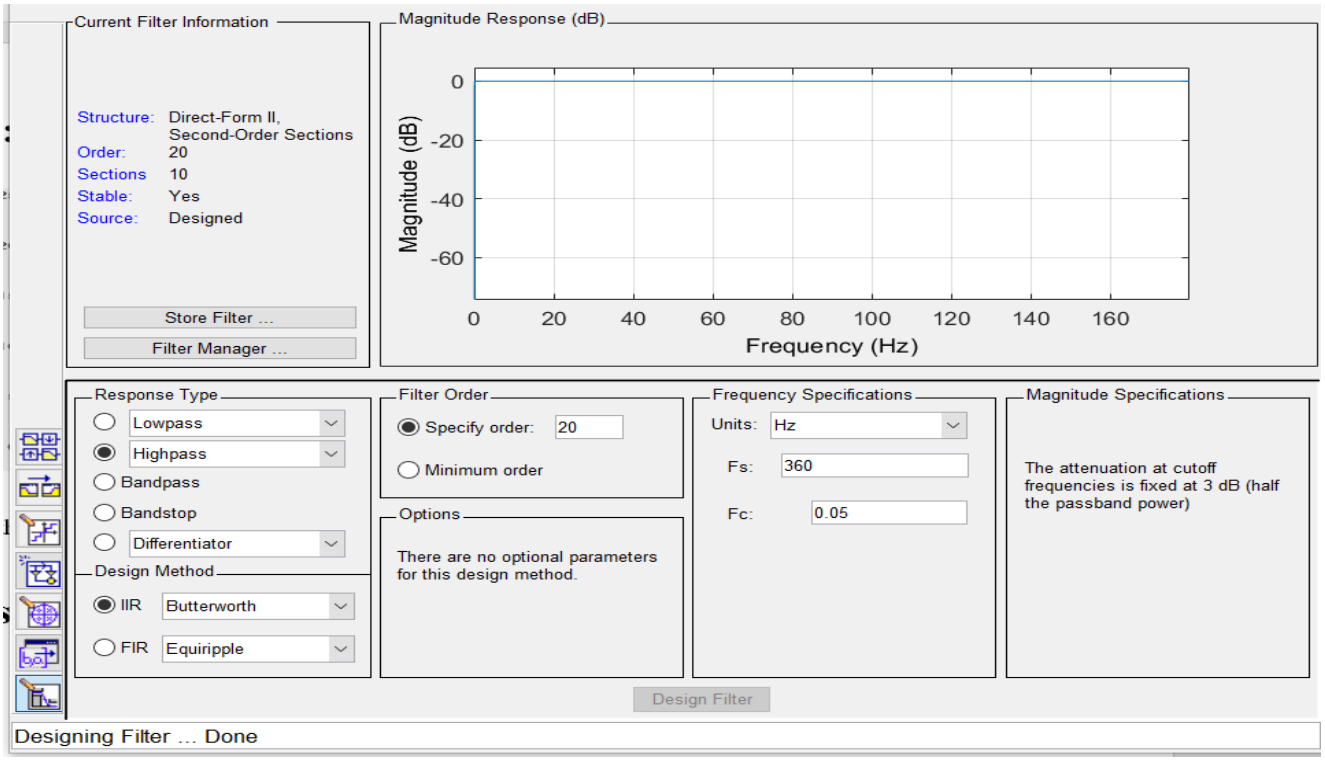
```
%%%%%%%%%%%%%%%%freq component after LPF%%
n=length(lpf_filtered_ECG);
y=fft(lpf_filtered_ECG);
f=(0:n-1)*(fs/n);
plot(f,abs(y));
axis([0 200 0 25])
```

Output:



We observe that the signal has frequency component in only range from 0 to 100 HZ.

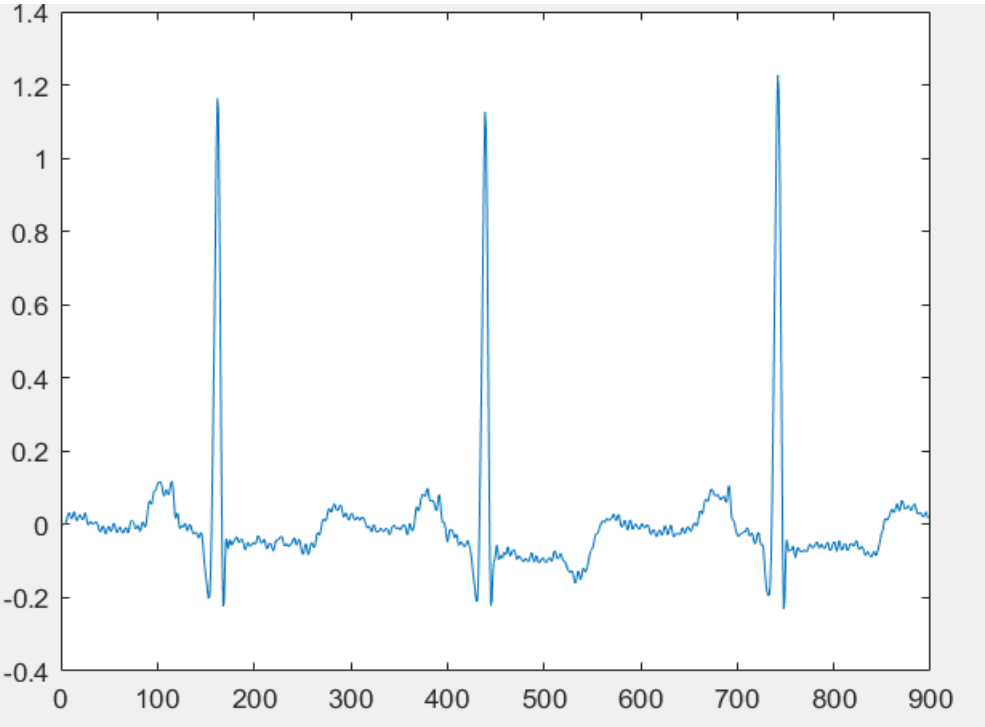
3)Design high pass filter:



It's designed at sampling frequency 360HZ for the signal and cut of frequency 0.05HZ which indicates of start of ECG signal.

```
%%%%high pass filter
H_p=highfilt;
hpf_filtered_ECG = filter(H_p,lpf_filtered_ECG);
subplot(6,1,3);
```

Output:



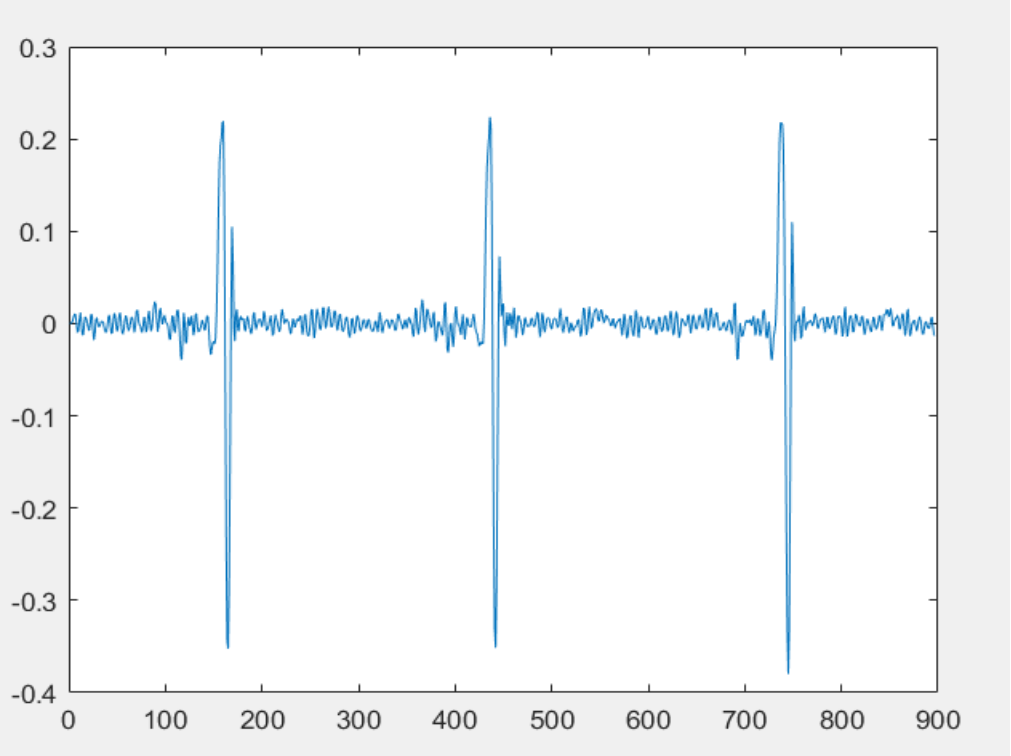
As high pass filter used to remove DC shift on signal and our signal has no DC shift so the plot doesn't changed.

4) Apply differentiator:

Used to detect fast transition in frequency which occur in ECG signal at QRS part.

```
%%%%%%%%%%%%differentiation%%%%%%%%%%%%%%%
DF_filtered_ECG=diff(hpf_filtered_ECG);
subplot(6,1,4);
plot(DF_filtered_ECG);
```

Output:

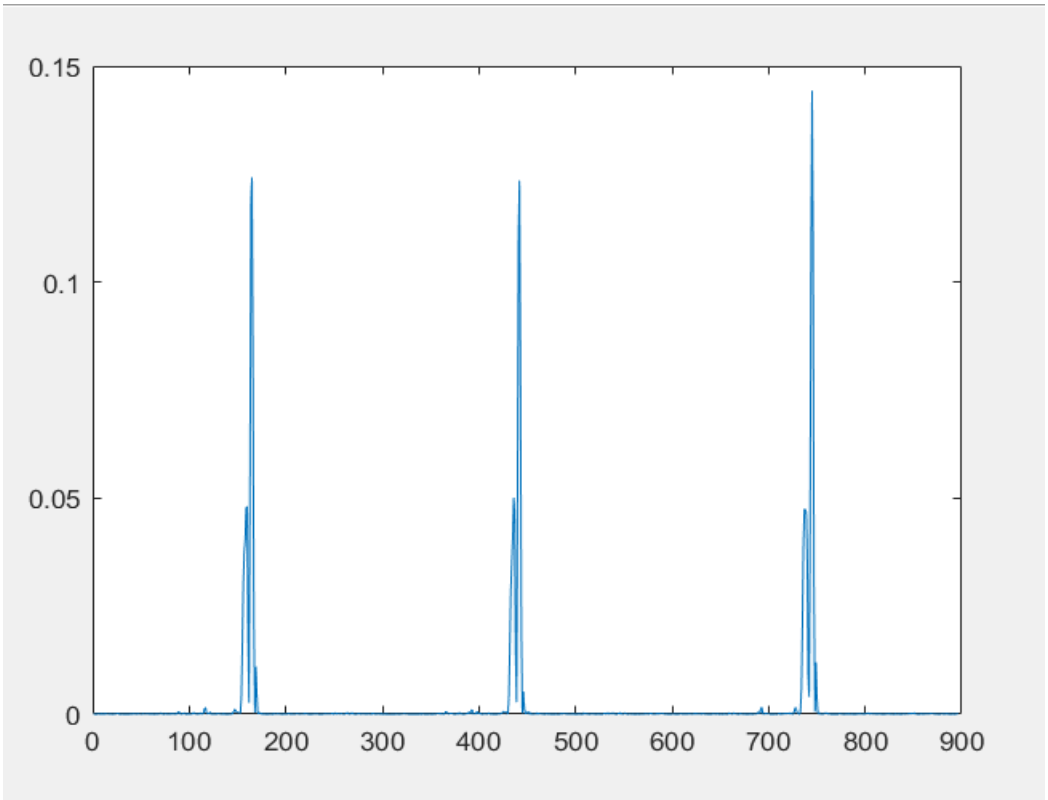


5) Square the signal:

1) To make all the signal in the positive domain
2) Small values (less than 1) will be squared and their values will be very small
3) Large values will be amplificated

```
%%%%%%%%%%%%%squaring%%%%%%%%%%%%%%%%%%
Sq_filtered_ECG=DF_filtered_ECG.^2;
subplot(6,1,5);
plot(Sq_filtered_ECG);
```

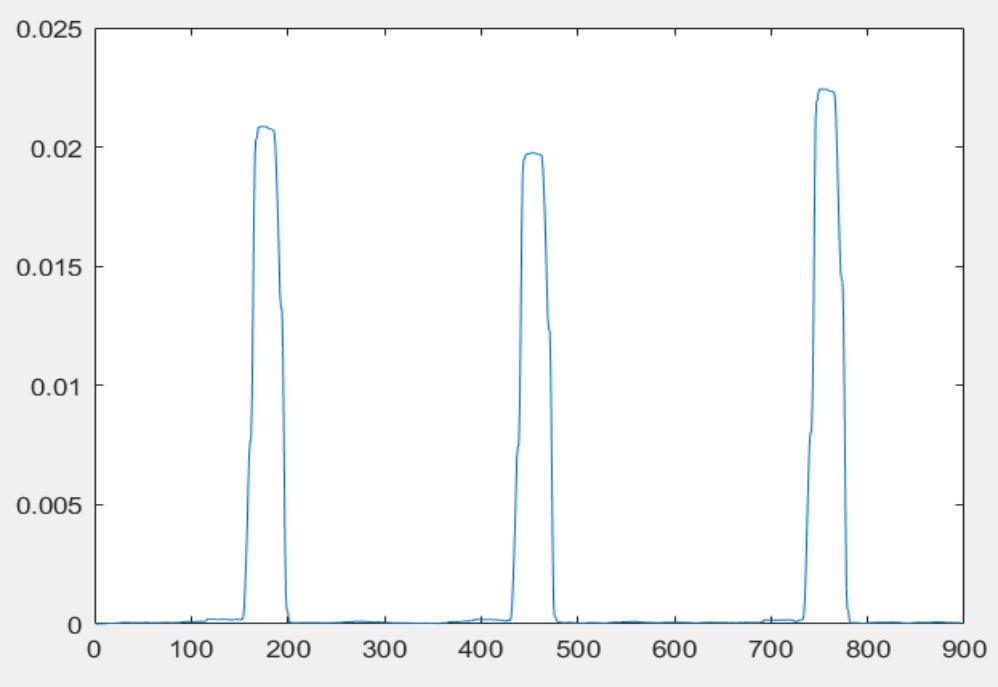
Output:



6) Apply moving average filter:

```
%%%%%%%%%%moving av%%%%%%%%%%
window= 1/32*ones(32,1);
AV_filtered_ECG = filter(window,1,Sq_filtered_ECG);
subplot(6,1,6);
plot(AV_filtered_ECG);
```

Output:



Overall output: