Sharif University of Technology

Medical Signal Processing LAB

Assignment 05

Amirmohammad Marshalpirghebi

Parnian Taheri

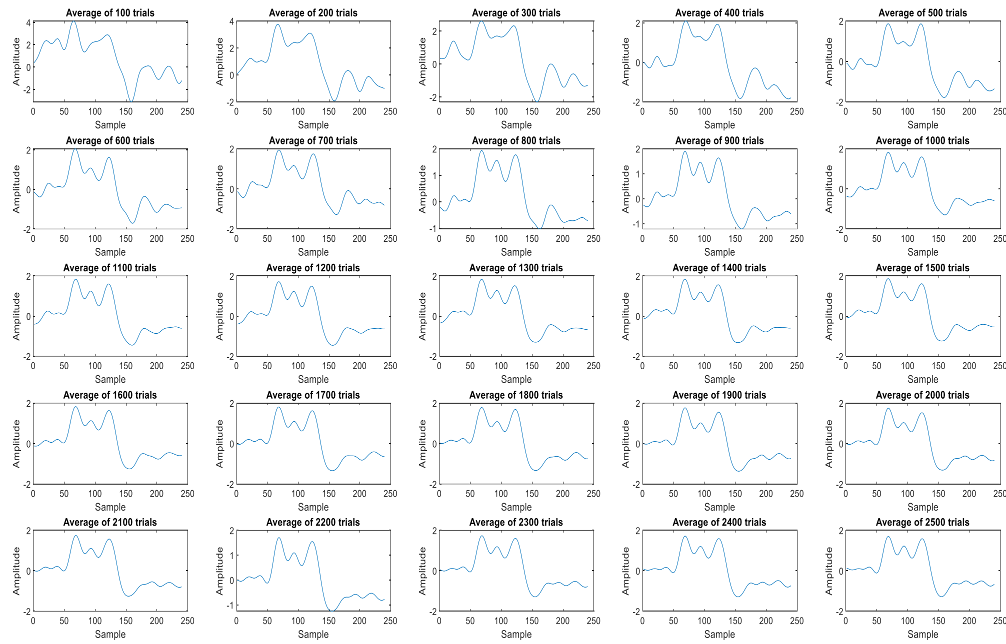
Amirali Razi

Contents

Section 1.

Part 1.

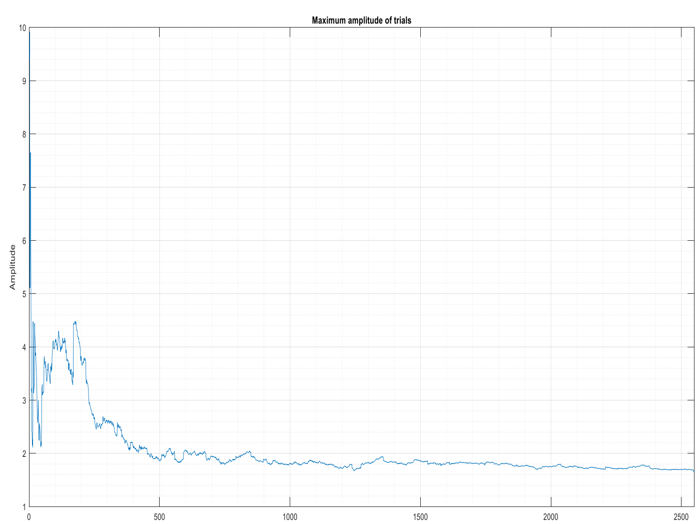
The result for this part is shown in the following figure.



As you can see, as N gets bigger and bigger, the average signal doesn't change that much and somehow we can see that for large enough N, the average signal converges to a particular signal.

Part 2.

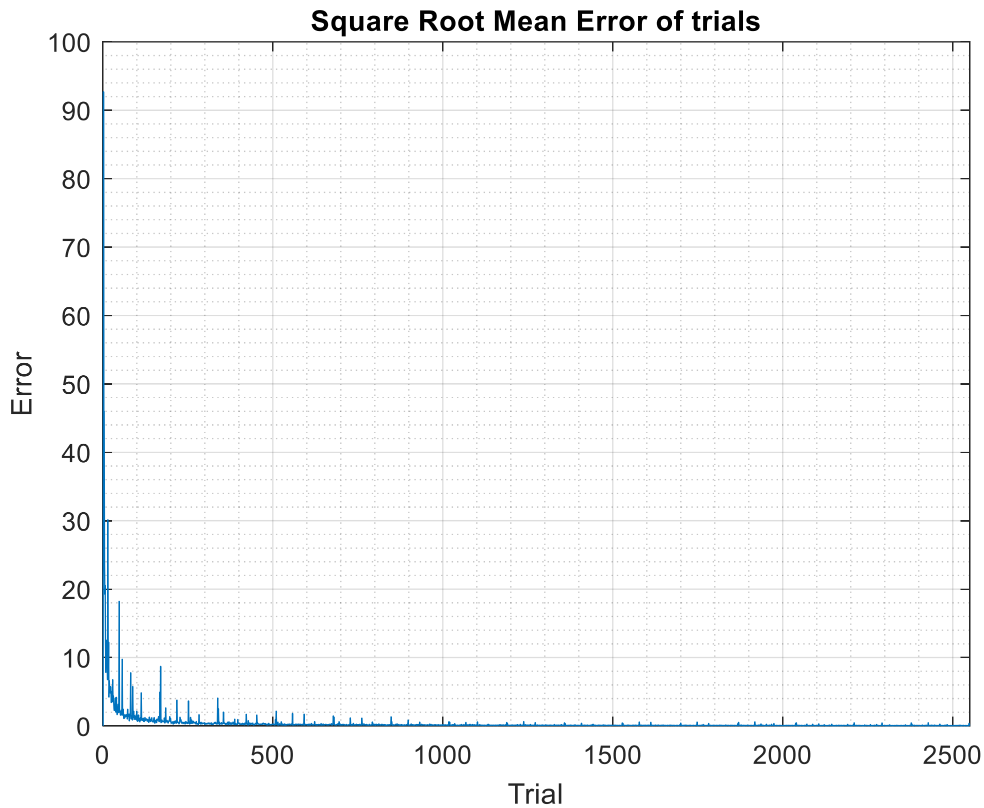
We can see the result of this part in the following figure.



As you can see, the maximum absolute value of the signal would remain constant as N passes 500. This shows some kind of convergence of the average signals to the original P300 signal.

Part 3.

The result of this part is shown in the following figure.



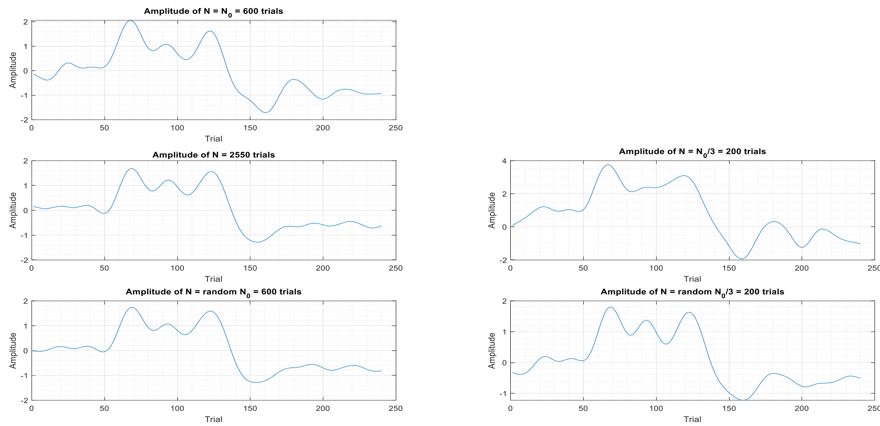
As you can see, the square root mean error of the average signal from the previous one decreases almost surely monotonically.

Part 4.

Based on our observation, the choice $N_0 = 600$ would be much considerable since the signal bears little difference if N increases more than that.

Part 5.

The result of this part is shown in the following figure.



As you can see, the result of $N_0 = 600$ average signals have captured the information of the P300 signal more accurately as obvious from the ups and downs of the signal. Whereas in other settings, the complexity of signals is not captured much compared to the first setting.

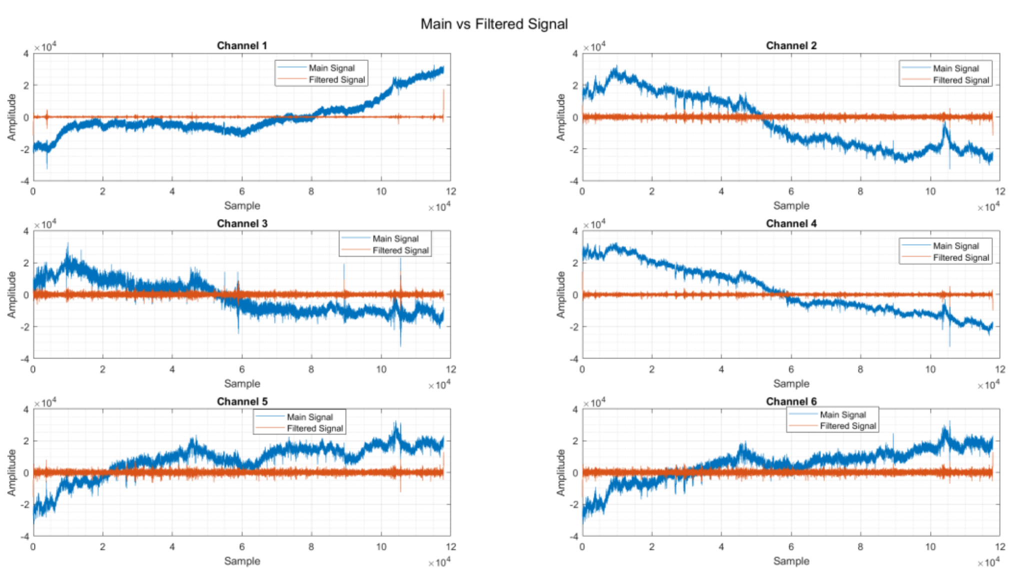
Part 6.

On a natural experiment, use very few trials than we reach in the previous section. We can't record 600 trials from one subject to detect P300 because it needs a long time to record that. So, it is quite absurd to talk about sampling 600 signals for our averaging because it took both our resources and time greatly.

Section 2.

Part 1.

The result of filtering the main signal in each channel with the given bandpass filter is shown in the following figure.

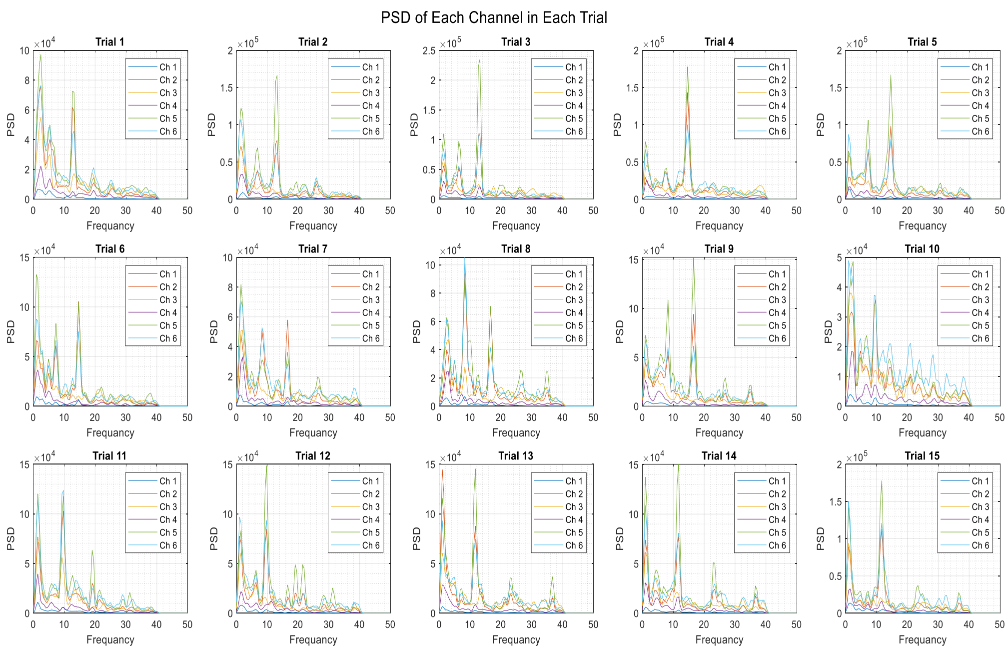


Part 2.

We have selected 15 signals with the given 5-seconds windows.

Part 3.

The result for this part is shown in the following graph.



Part 4.

No, the frequency response in each trial is different. That's because in each trial the brain's response is different and thus, the result of the frequency response is different.

Part 5.

For each trial, each channel with a more significant frequency is dominant. The frequency peak in each trial shows the stimulation frequency, and we can see a peak in the harmonics of these frequencies as well.

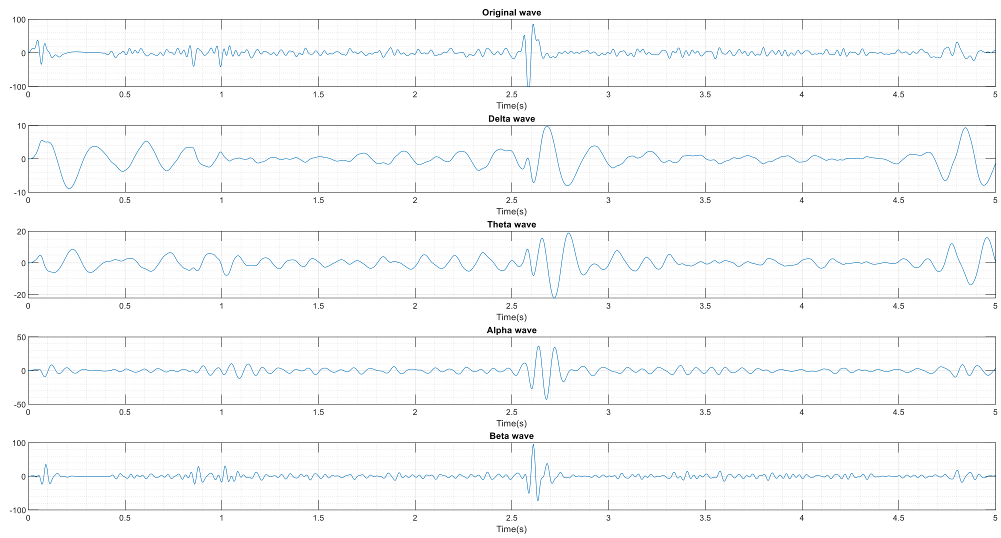
Part 6.

The other methods which we have found includes EMD, CCA, SSVEP encoded-phase & freq. For example, we can use the correlation of the signals to find the dominant frequency component in the signals.

Section 3.

Part 1.

The result of this part is shown in the following figure.



Part 2.

We have separated the trials of signals as requested with length of about 10 seconds.

Part 3.

Now we calculate the square of the amplitudes for each trial in each band and channel to calculate the power in each point.

Part 4.

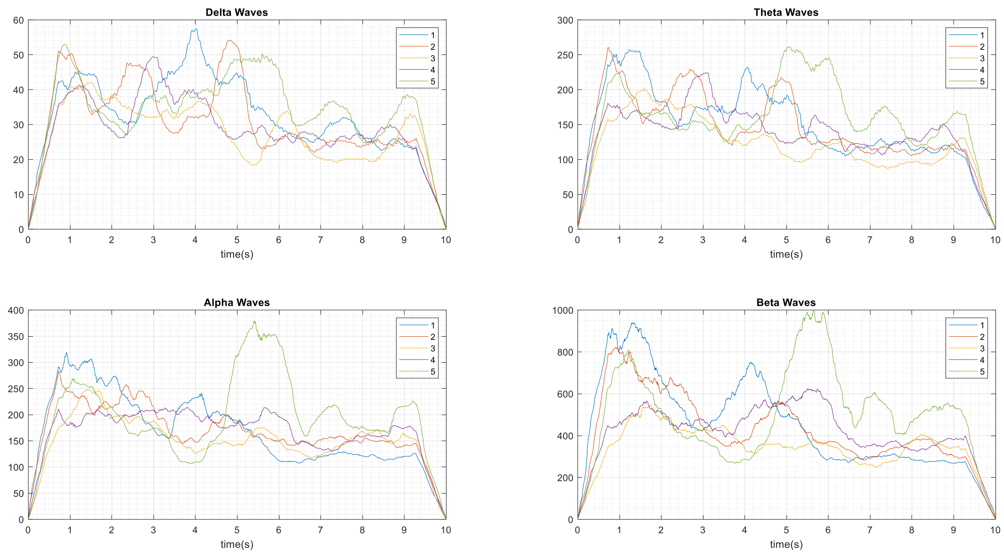
In this part, we separate data from each class and for each band, we calculate the mean of the channel signals from different trials.

Part 5.

Now, we convolve each signal in each band and channel with the given filter to obtain a smoother version of the signals

Part 6.

In this part, for each frequency band, we plot the average signal for each class as follows.



Part 7.

In this part, we want to discuss about the dominant frequency of the signals. For the alpha wave, we spot that at $t = 6$, we spot that the 5th channel we saw the dominant frequency peak which shows the main activity for this part. For beta waves, the same argument applies as well here. For theta waves we spot the main activity in the 5th channel at $t = 5$. Finally, for delta waves, we spot the peak of 1st channel at $t = 4$ which shows the main activity in this part.