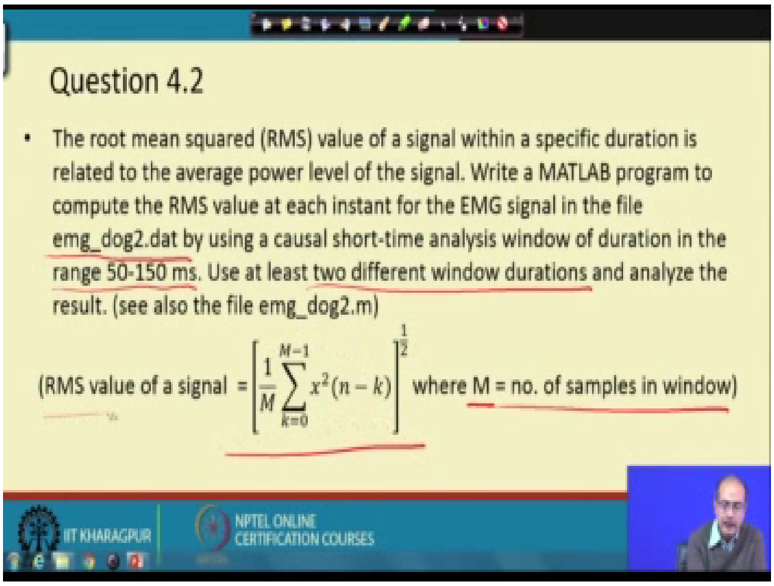
Biomedical Signal Processing
Prof. Sudipta Mukhopadhyay
Department of Electrical and Electronics Communication Engineering
Indian Institute of Technology, Kharagpur

Lecture - 58
Tutorial – IV (Contd.)

(Refer Slide Time: 00:20)



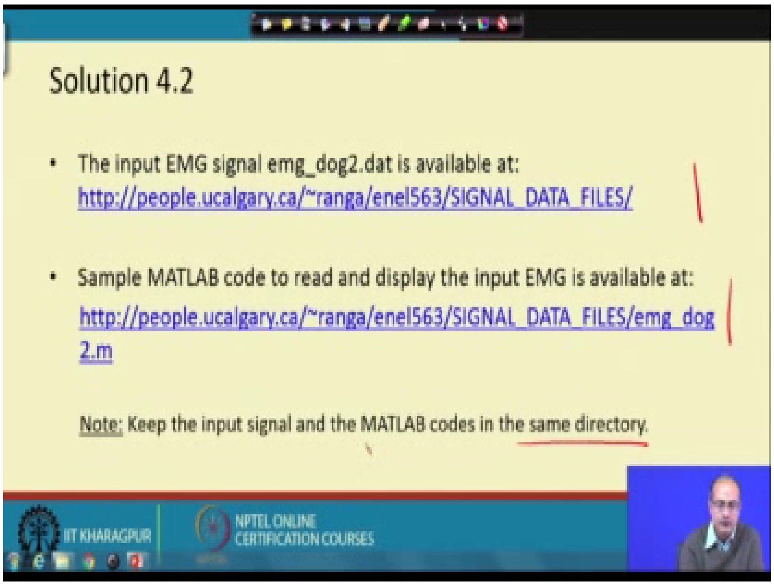
This is the second assignment of the tutorial 4. What we have to do is to find out the RMS value of a signal with a specific duration related to the average power level of the signal and for that we have to write MATLAB program to compute that RMS value at each instant of the EMG signal.

When you look at the EMG signal we know the EMG signal has a actually lot of high frequencies. So, it does not give us a nice shape. So, how we can get that activity one is that what is the frequency; another is that what is the amplitude of the signal. Here we are trying to find out the amplitude of the signal using the that RMS value and for that purpose we are provided with the signal that EMG dog 2 dot that and we have to do the analysis of that local RMS for the different durations starting from 50 to 150 millisecond.

We can take different windows 50, 100, so, 150 in that way and for each of these case we can see that how is the that RMS local RMS estimates and varying and here the that RMS that how to compute the RMS that is also given and what we are told that at least two different window duration we need to take. So, that we can compare and that window is giving us that how many sample should be there that within that window what is M for that what we are doing we are finding out the instantaneous energy taking the average of the instantaneous energy and while taking the average of the instantaneous energy we take the half of it rather we taking the square root of it.

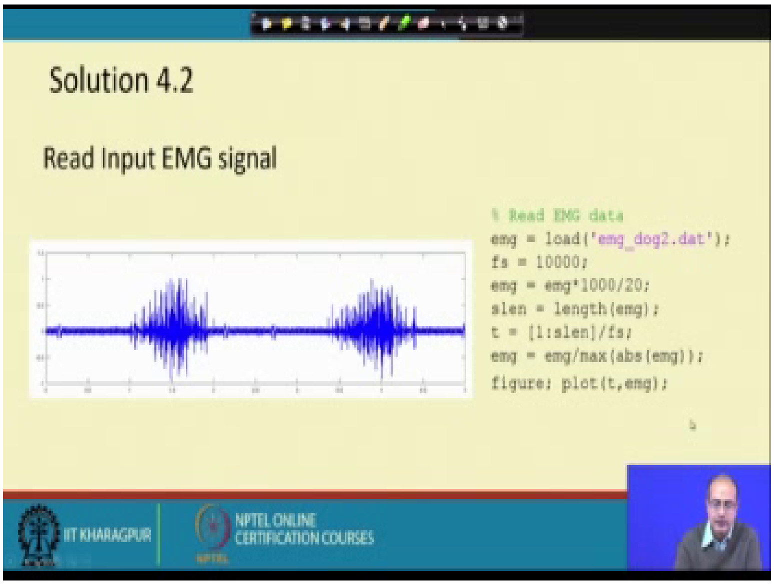
So, that the square root of the average of the instantaneous energy is gives us the RMS value ok. So, let us see that what we get out of this experiment.

(Refer Slide Time: 02:56)



As with the previous cases that we start with downloading the data and the MATLAB file to read them and keep them in the that same directory which is the working directory for our MATLAB and with that we start our exercise.

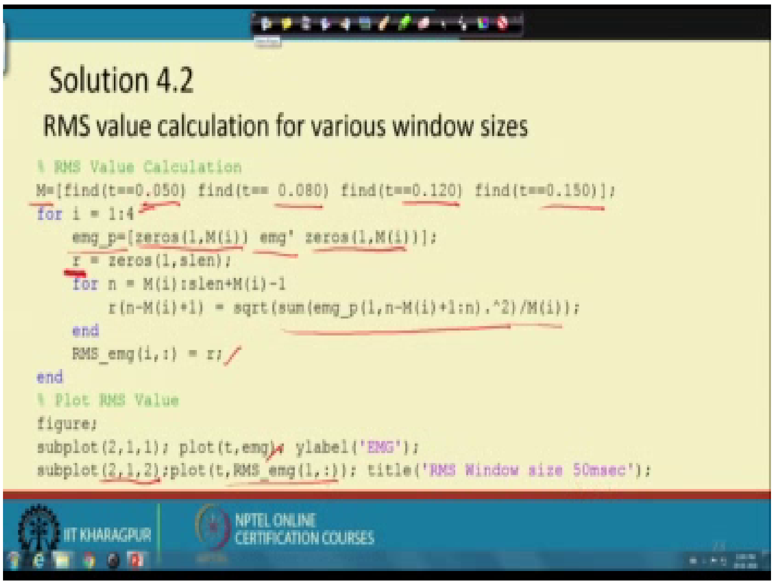
(Refer Slide Time: 03:20)



Here the first point is we have to read the EMG signal and we need to plot that ok. So, what we are doing? We are reading the that signal and that is taken as 10 kilohertz and we are taking the length of it to find out the time index and we are doing some normalization of it and we are taking the plot of it ok.

So, the job is to find out the that enveloped ok. Here is the EMG signal that is given that we have plotted here and next we go for the calculation of the RMS value ok.

(Refer Slide Time: 04:17)



Calculation of the RMS value that for that what we have done we need to find out the M that is the number of samples are there for different window length and here we have chosen actually four window length; first is 50 millisecond; second is that 80 millisecond; third is 120 millisecond; fourth is 150 millisecond.

Everything is expressed as that in terms of second because that time axis is actually given in second and here we have created a factor of M and here the point is that out of the that axis t or rather vector t it will find that what is the index of the t when it is becoming 50 millisecond.

So, that value will come at the first place ok, next one will give us the value when it is becoming same as the 80 millisecond. So, in other word the first one will give us how many samples are there from starting point 0 to 50 millisecond; the next one will give us the number of samples up to 80 millisecond; the third one will give us that number of samples have to 120 millisecond and fourth one will give us the number of samples with 150 millisecond.

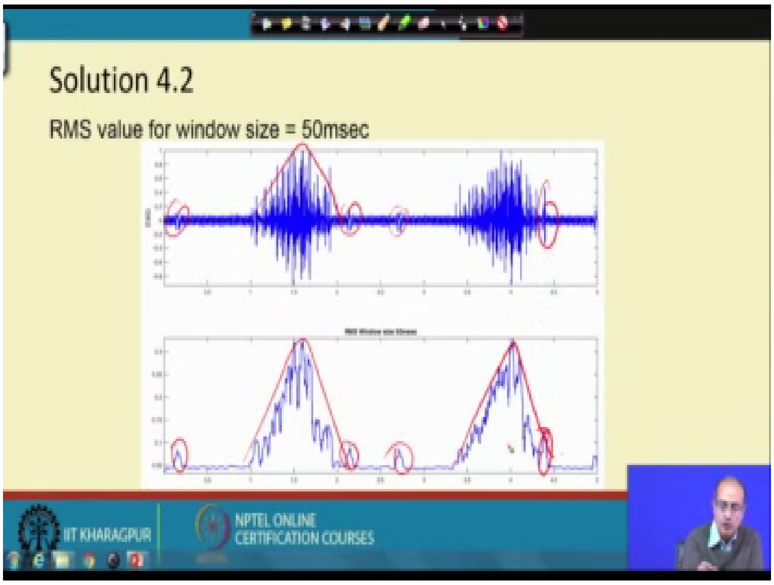
So, it is a compact representation, but we could do the same thing with more number of actually lines though it will have been make actually it easy to understand we could have got that way also, here just for the compact representation we have put in that way. Next is that we are going through all the four different windows. So, we are taking a for loop going for 1 to 4 and each of these case we have to pair the EMG signal. So, for that padding that a column signal that here emg p the padded signal is a rho signal.

So, we have taken the transpose and both the sides we are taking that same number of actually zeros as the that signal that window size ok. So, we are padding it both the sides with that same number of zero. So, that we do not have any problem of actually the case that we are not getting the data and if you look carefully that here the number of that windows that is actually going to decide that what would be the amount of averaging on the RMS value ok.

So, what degree of low pass filtering will be applied on the RMS. So, once we take that then within that window we are computing the value r that we are taking the that the sum of the energy divided by the that window side; I am taking the square root out of that. So, we get the RMS output. So, we get the RMS output first, we are showing the EMG and below that in the subplot that 1 2 2 1 sorry 2 1 2 we are getting the that RMS value for a particular window ok.

First we start with the 50 millisecond that is the first value here. So, we go for seen that plot.

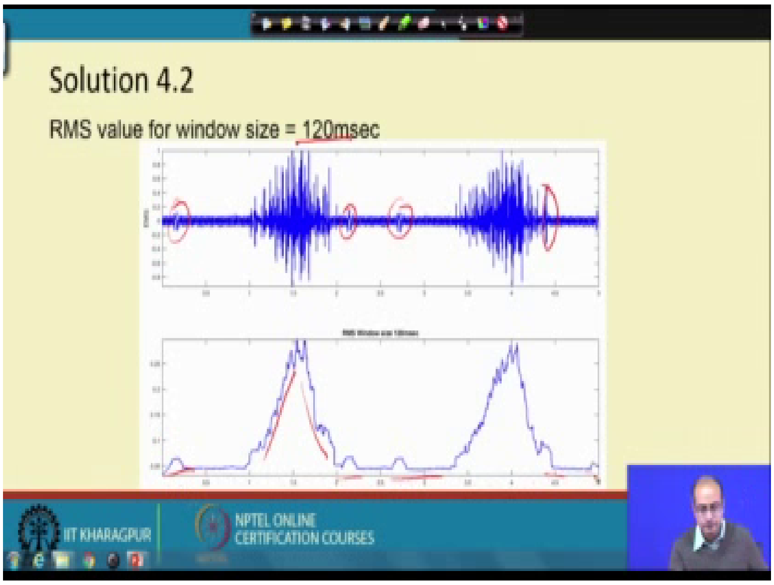
(Refer Slide Time: 08:40)



So here for 50 millisecond we get the output. We get that it is the way it is actually going up and down it is following the same trend, however it has lots of actually juggled points and in between them when there are perturbation that is also giving rise to some increase; here we are getting that those things.

So, they are also getting reflected as actually small peaks or like see it here that it is coming as a separate peak. So, all those things are there.

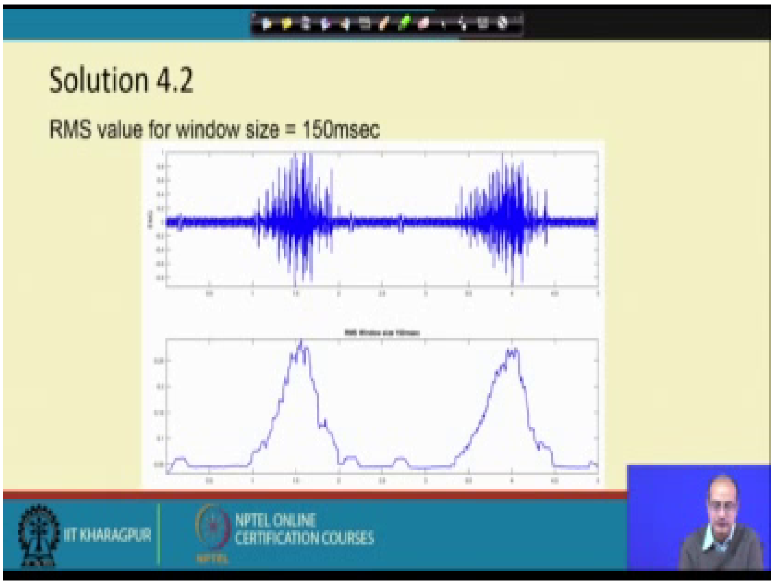
(Refer Slide Time: 09:21)



Now next is we go for 80 millisecond, with 80 millisecond what we get that the jaggedness of the output it has reduced. If you look at here that it is less jagged, if you go back I think it would be easier to get that that previous case 50 millisecond compared to that 80 millisecond we have less of actually jaggedness.

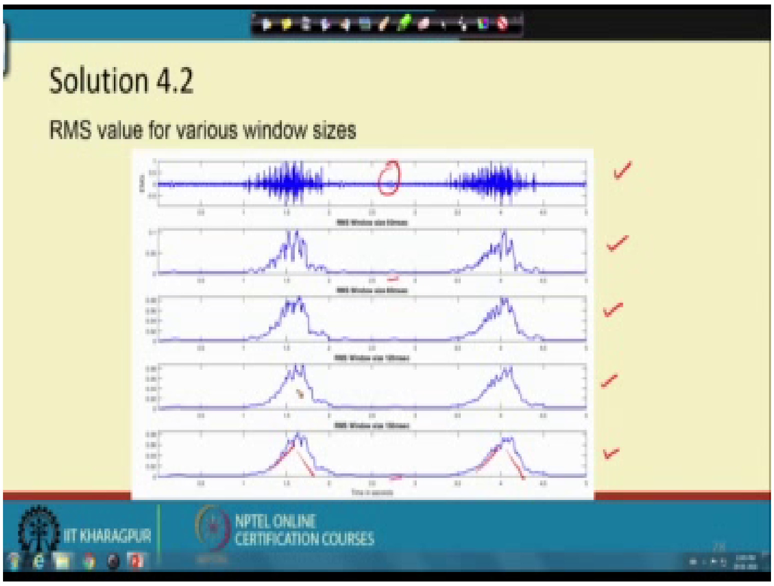
So, it has become much more smooth and when you go for the 120 millisecond it is even better and another thing you note that the small that perturbations all of them their magnitude have also reduce a bit. Then it also getting smooth (Refer Time: 10:25). So, that is another interesting point to note that it is becoming smooth and also that small perturbations they are getting eliminated.

(Refer Slide Time: 10:40)



Now, will go for 150 millisecond and with that we get the 150 millisecond. This one is giving us the best output as it appears from the smoothness of the curve and the that separation of the small perturbations. Now, we go for the that comparison of all of them together.

(Refer Slide Time: 11:09)

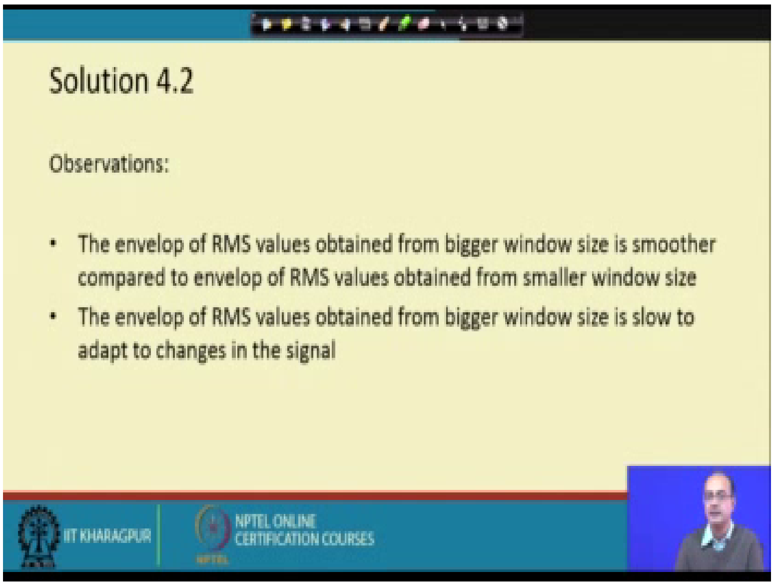


Here we put all of them side by side that first starting with the EMG signal, then 50 millisecond, 80 millisecond, 120 millisecond, 150 millisecond.

As the window is small it is actually fast in giving actually responding to the small fluctuations. For example, that if we look at this fluctuation it is visible here, but not so prominently here in 150 millisecond ok.

So, the changes are slow that is the downside when we are increasing the window length but upside is here the envelope is much more smooth that the envelope is much more smooth compared to the that lower window size ok.

(Refer Slide Time: 12:26)



So, that is the thing we observe here and at the end we conclude it like this that envelope of the RMS value obtained from bigger window size is smoother compared to the RMS value obtained from smaller window size and envelope of RMS value obtain from bigger window size is slow to adopt to change in the signal.

So, there is a trade off we cannot keep on increasing the window size if you do that then the change in the that signal envelope it many not follow exactly but so long it is not actually effecting that the tracking of that change of the envelope. We should keep on increasing the window size to get a smoother envelop.

Thank you.