Biomedical Signal Processing
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Lecture - 59
Tutorial - IV (Contd.)

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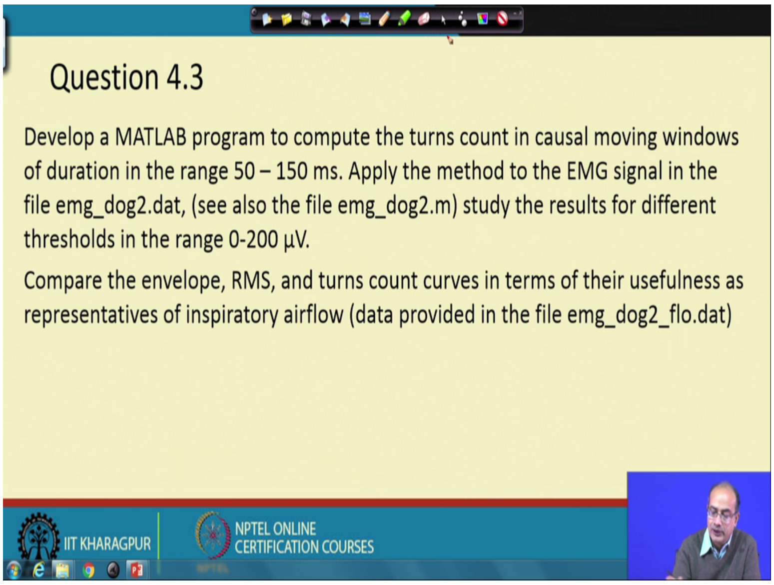

Now, we will take the third assignment of the fourth tutorial. Here what we have to do that, we have to look at that compute the turns count in a causal window ok. Between the range that 50 to 150 millisecond and apply the method of the on the EMG signal, same EMG signal and study the effect of different thresholds ok. That compare the envelopes envelope RMS and turns count in their from the usefulness of it and along with the inspiratory air flow ok, which is giving the amount of activity that is done first thing to note here that why the turns count is actually compared with the envelope or RMS ok.

That envelope or the RMS they are giving the amplitude of the signal, same way turns count is giving the number of the frequency of it or number of times the that same the muscle fibers are activated on engaged for the job. So that is also gives us that and index that amount of as a force exerted by those muscles ok. So they should be comparable in some way which is actually proportional to the, that the air flow. And here another thing we need to actually look at that casual moving window. Causal moving window means if this is the signal say and this is the time and we are looking at a particular instant, our window should be that the present and the past value.

If we take a window starting from here to here, we are taking some samples in the future which makes it non causal. So we need to restrict into the signals of the present and in the past ok. So moving window or m a filter should be taking care of that, that it is they casual one ok so that is actually we need to that that will help us to have a real time implementation because in real time you cannot expect that the future sample should be available.

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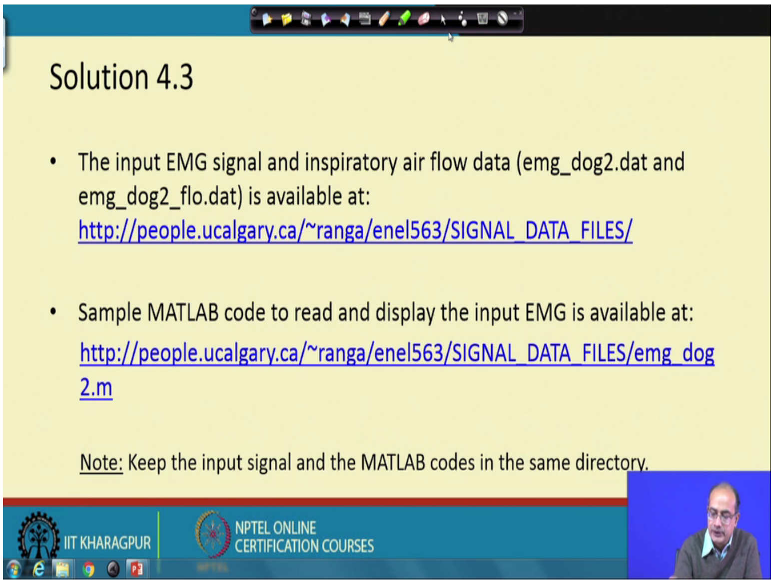

So it starts again with the same job of collecting the data, and the corresponding the, that the MATLAB read file to read that EMG signal and we put them the signal and the MATLAB code in the same working directory of MATLAB and we proceed with the task.

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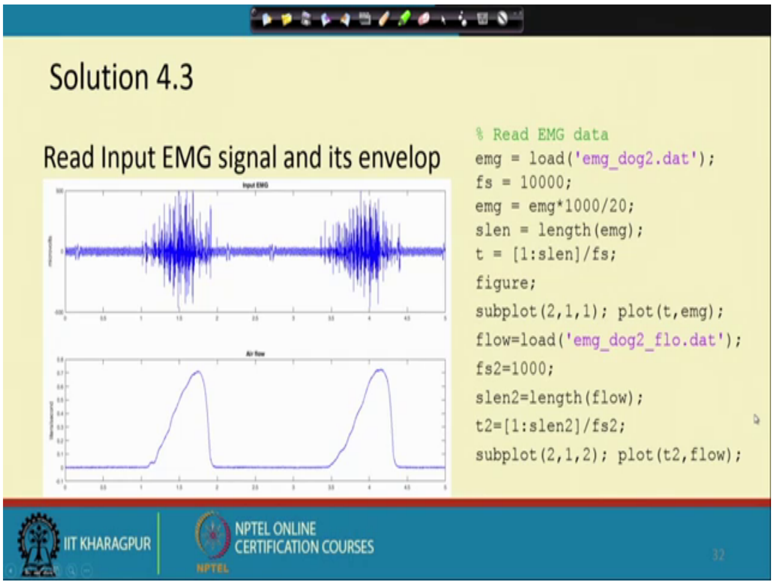

So, first we read the signal and the task we load the EMG data node that our that sampling frequency, and we create the time index from the sampling frequency and we use the comment sub plot the upper part of the plot we put the EMG signal, then we load that the flow of air that is the result of that movement of these muscles, put it in the variable flow the corresponding that our that time index, and we use again sub plot command 2 1 2 to take the lower half of it, to plot that output. So here we get the signal and the airflow.

So, that is gives us the input as well as the reference, which we are trying to actually measured with the help of the turns count, and the other 2 techniques that envelope detection and the RMS what we have learnt in the previous 2 assignments.

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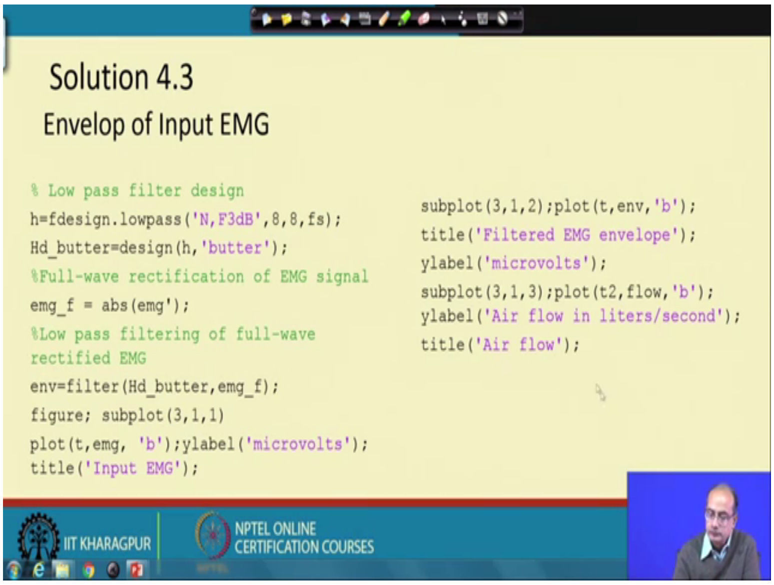

So first is we calculate the envelope we have already done that. So we would not go into the detail that here what it is done that, we have used the that envelope that after the filtering using the that absolute value; that means, we are having the full wave rectification we have applied the low pass filter, that the same butter worth filter and we get that signal and we get the air flow what gives us the index of it.

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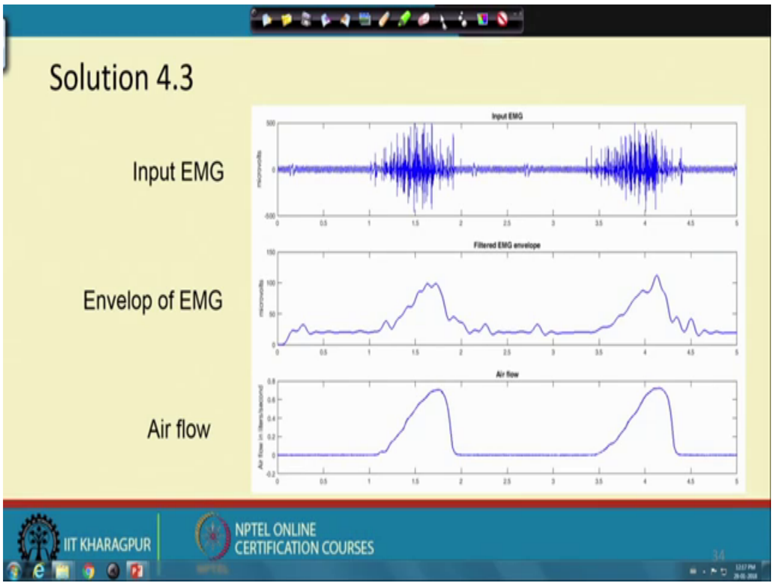

So, here we are showing the at the top we are showing the EMG signal what is the input; then envelop of the EMG using full wave rectification and here the that air flow. We see that EMG envelop it is similar to it especially when we are actually starting that air flow, but wind while it is decreasing, that I think the air flow it is going down faster compared to the that effort exerted by the muscles. That is moving in a slower phase as it is apparent from that EMG output as well as the envelop.

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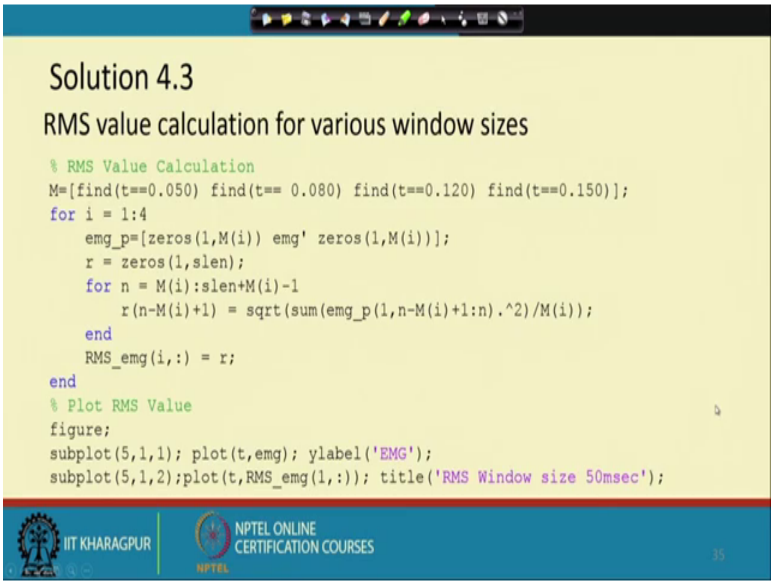

Now next part that we have to do the RMS calculation that as we have done in the previous assignment, we are taking 4 different window values that 50 millisecond, 80 millisecond, 120 millisecond, 150 millisecond, and after padding the that input with appropriate number of zeros in beginning and at the end we are computing the RMS value within that, and we are taking that in the these variable RMS under whole underscore that EMG. And we plot that thing that after the, that EMG that we are putting all of them together. So that first one is our EMG followed by that our RMS output.

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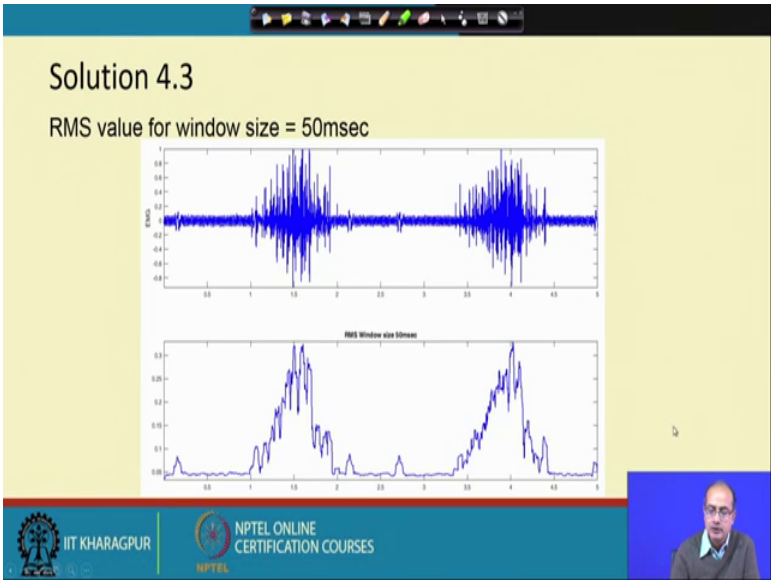

Here he has showing that output that, we have the EMG signal given and here is the RMS output. So, we get that for the 50 millisecond, then we get it for 80 millisecond, then we get it for 120 millisecond, then we get for 150 millisecond and we know that as we are increasing the window that envelop is becoming more and more smooth and looks like a real envelop.

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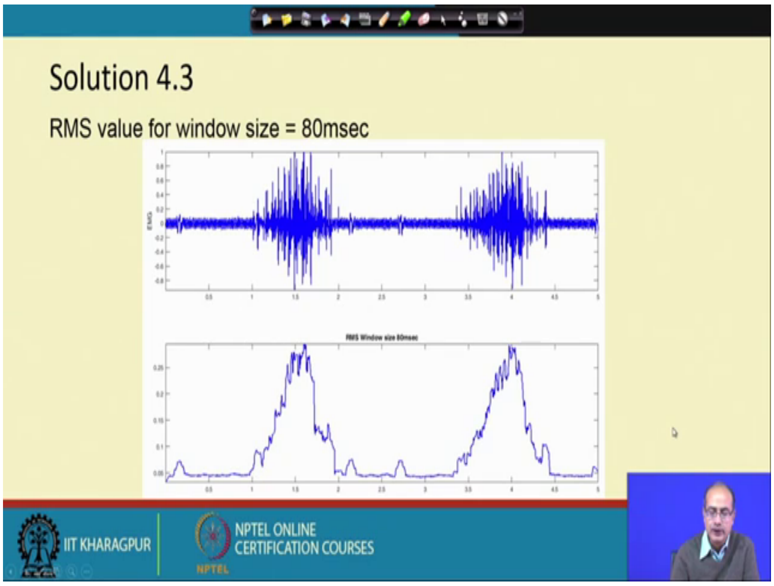

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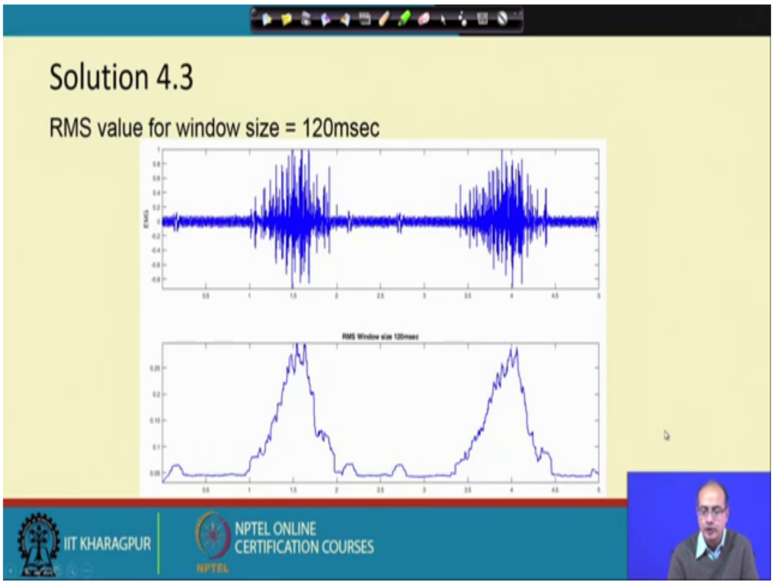

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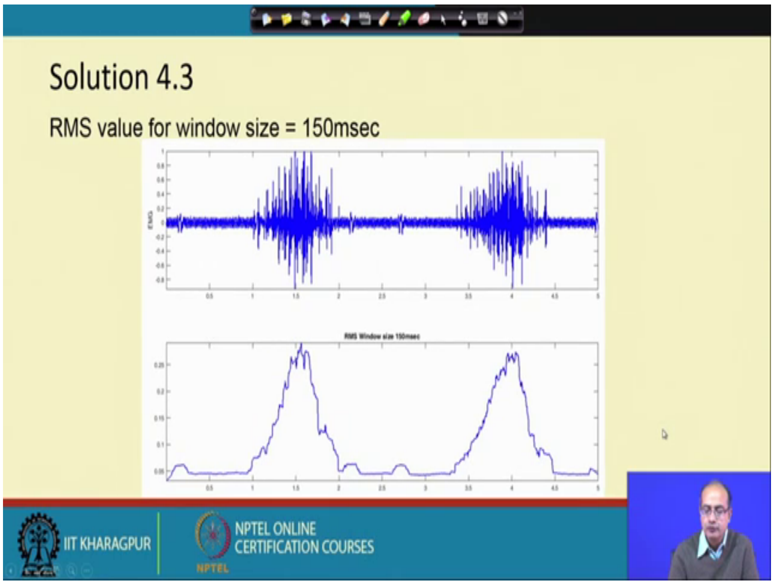

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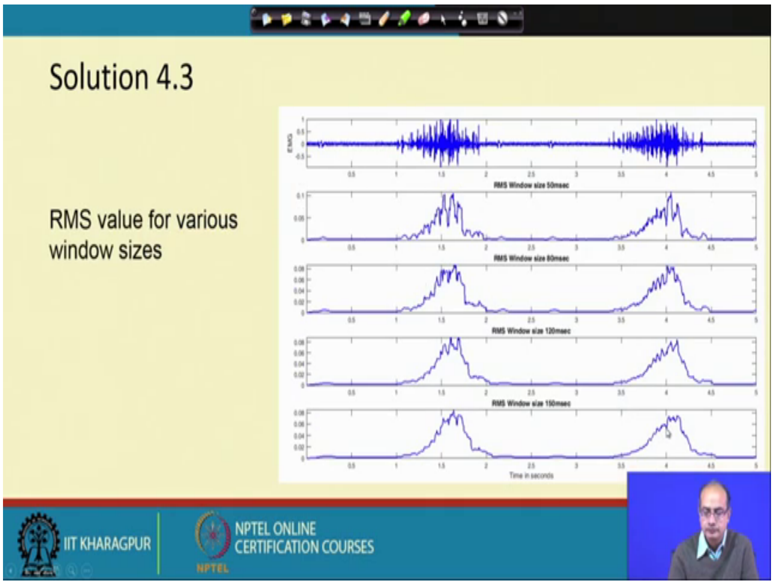

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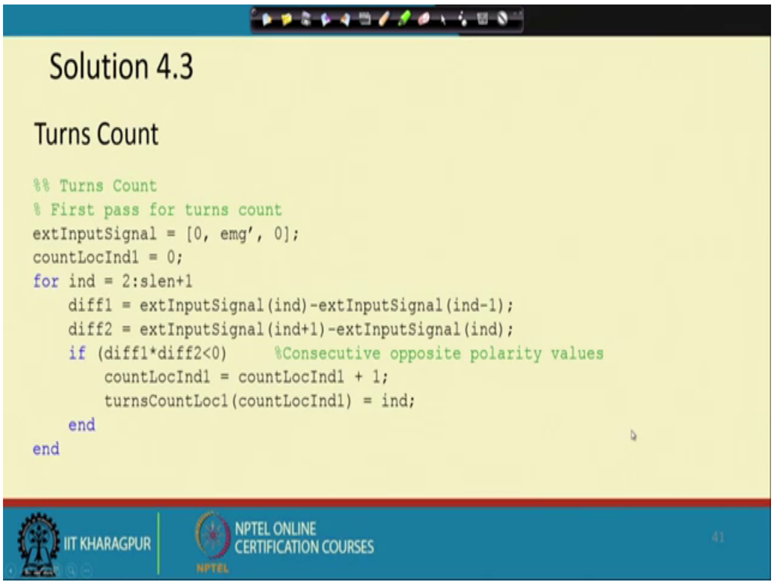

And here we are showing all the actually values together in fact, that is actually help helps us to get understand that their impact better we are putting all of them together the first one is the EMG signal this is 50 millisecond, 80, 120 and 150 millisecond that is why that in the code we have used that 5, that in this way 5, 1, 1, 2 in this in that way we started with 5 we are making actually 5 rows here.

Next we go for the turns count. Here we need to tell that what is the turns count in case of turns count what we do? If the signal is EMG signal is jagged signal like this, we would like to find out that where the slope is changed from positive slope it is going for negative slope, but negative slope to positive slope. So these are the points we would like to capture. Now what happens because of presence of noise we may get some perturbations here and there. To avoid that what is told that we should use a threshold that after finding out that we should take that it should have whenever we are getting a chain say this is one turn, we should check that next turn is below this at least this difference should be there that is the threshold from one turn to the next turn. If any turn comes in between then; that means this is a false peak that is the way that it is defined.

So, first we check that the first phase of turn; that means, all the turns we get then we go for that the thresholding operation

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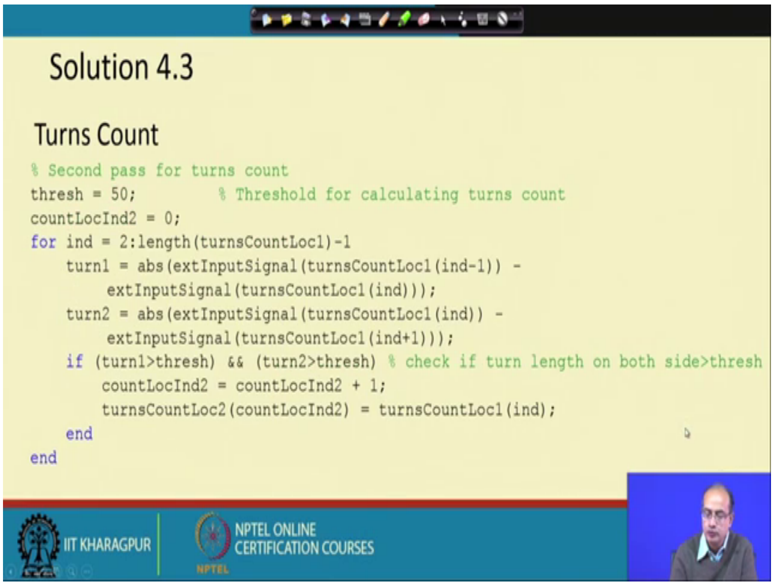

We look for that the threshold that we are taking that threshold here in this case as 50 and we are checking that difference in the highest should be at least 50; that means, when the signal would be presence say for example, for the EMG signal, if we look into that situation that sometimes the EMG signal is present and then there is no activity, then again EMG signal is present in this case that this region there would be some noise.

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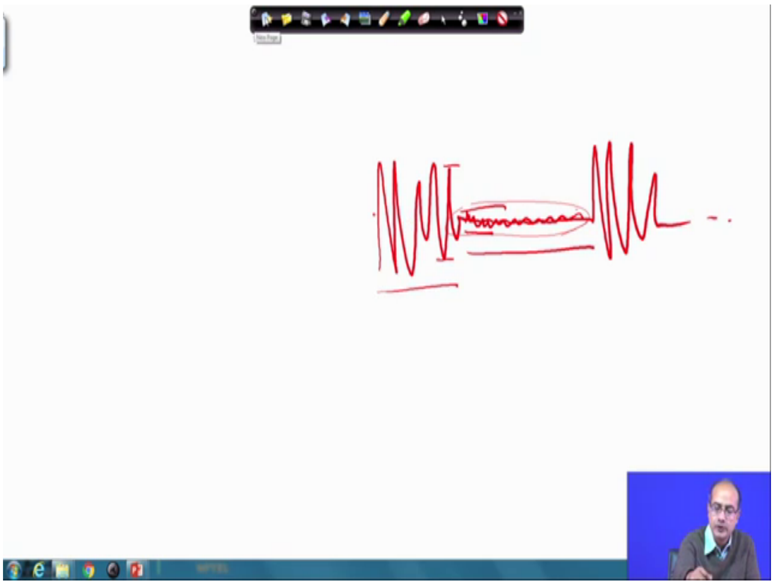

So, some small noises would be there, our threshold should be actually bigger this than this noise, but much smaller than the actual actually the wave form of the EMG signal or the signal under consideration ok. So threshold should be selected like that, so that we can avoid the that noise not only in this portion where actually no signal activity is there, but those noises are there here also in this period there also it will give us actually false turns count we would like to avoid that ok. So that is the intention of this that threshold and we are taking only those, which are having that amount of difference in both the sides if it is not you simply throw them out and at the final stage we get that output that here that we are showing that if we change that threshold how that that output varies.

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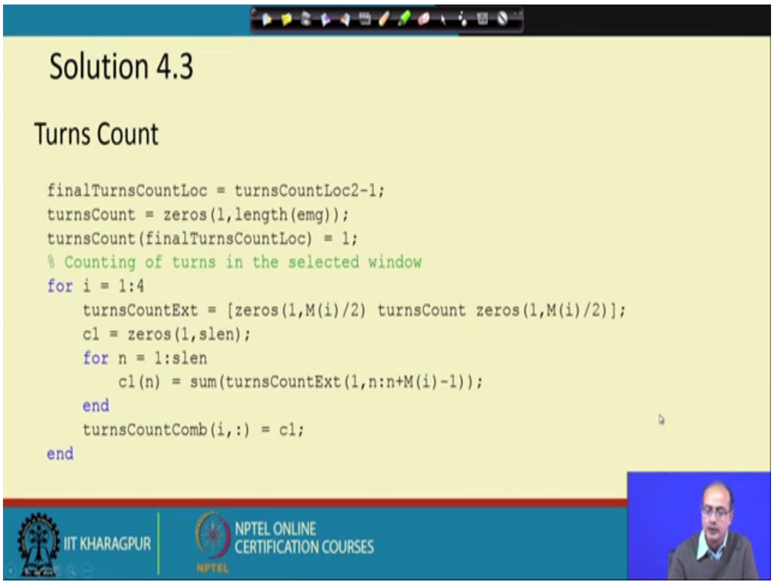

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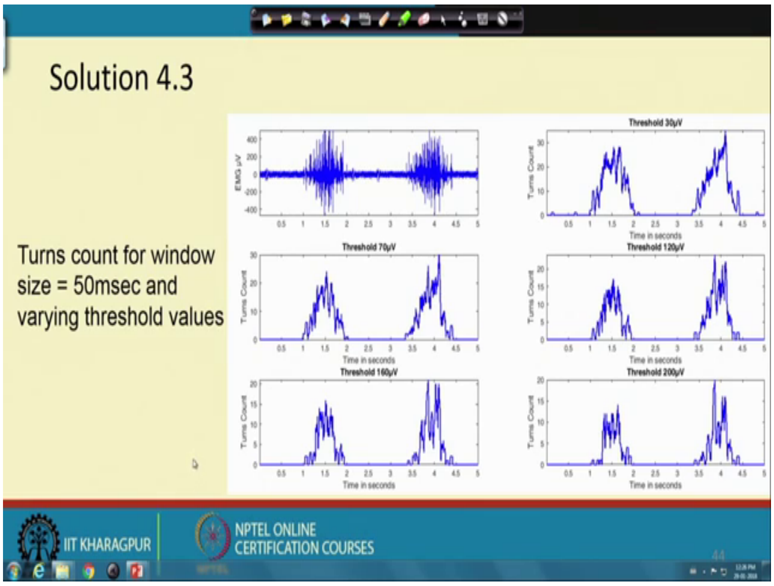

So, here we are showing that that how the output varies, first we are showing here that EMG signal then if we take it as 30 micro volt, this is the that output we get we increase that to 70 micro volt, this is the output with 120, this is the output then 160 this is the output, then 200 this is the output. Now if we look carefully then what we get that by changing the threshold the shape is not actually changing very fast. In fact, for 30, 70, 120 the shape we can say more or less that remains to be the same again in between 70, 120, 160 the shape remains to be the same. Again the same thing we can talk about threshold 120, 160 and 200 what is happening when we are changing the threshold.

Where we are calculating the turns count first of all another part, we have kept same that we have taken a actually time window of 50 millisecond that is kept fixed. With that when we are changing the threshold we are having a reduction in the amplitude ok that if the initial amplitude was say for 30 when the turns count, it was more than 30 micro volt here more than 30 then it has come down to 30 in this case then here we see it is below 30, here it is around 20, here it is even lower than that ok. So we see that over all there is a reduction in the peak, why that is happening that, more and more turns are getting rejected some of them they are noise peaks. So at the lower threshold the noise peaks are eliminated to some extent.

But sometimes that there are some spurious signals are there which are maybe because of some volition that is actually depicted here as small signal which are completely eliminated at higher peaks see that they are completely absent. So we remove them completely that spurious peaks and the noise. So those depositions are not there, but as we are going for that we must be missing some of the real peaks also which is actually causing the reduction of the amplitude. So if you are interested that at what period that the signal is present or having sufficient energy, I think each one of them would be successful. But if we want to follow that change more carefully, I think going for a lower threshold maybe 70 or 30 would be better in this case and we need to select that with manual intervention I would say ok.

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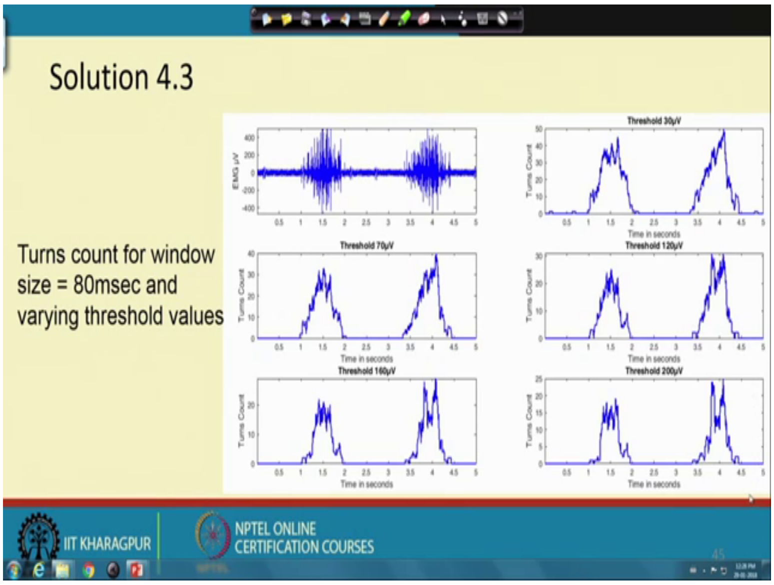

So, next what we do? We keep the threshold the same, but the time window for calculation of the, that turns count is changed ok. That if we change the time window then what we find each of this signal they become much more smooth, and because the time window is increased we are integrating over more time. So the total count also if you see that it was little above 30, now it has gone up to 50, so overall that there is an increase and what we get here in this case also that as we are increasing the threshold, that the peaks are actually reducing we are getting read off more and more actually noise peak, but at the end when we go for the higher state we get that it is getting actually separated as multiple peaks.

The signal the envelop looks like this, but here in the output it does not look in the same way because we are missing some low value probably the signal turns ok. Threshold has become higher than that or in between the noise has come which has actually affected the change, we are unable to get that the far away that turns and we have missing some signal turns.

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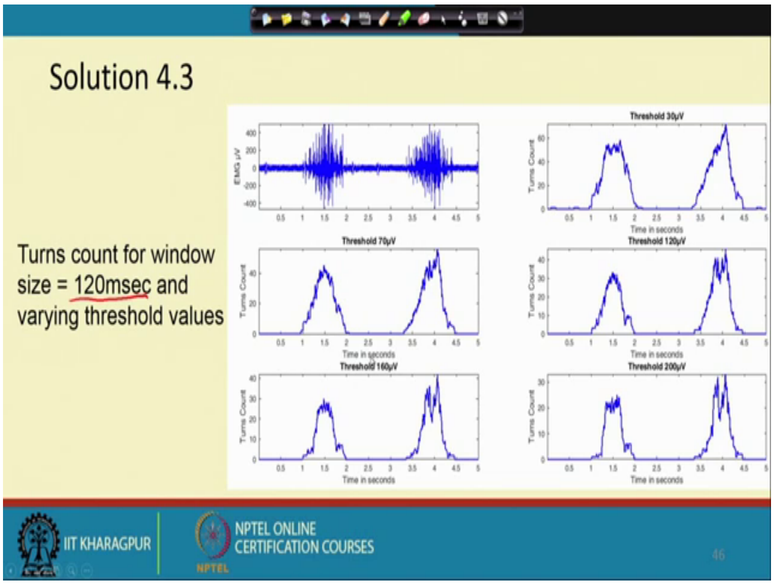

Next we go for another time window that is 120 millisecond, so 50, 80, 120 we are going in substation, and in this case we get that it has become much more smooth ok. If you look at that it has become much more smooth, I think it would be easier to actually understand that if we go back in time and see that what it was for 80 millisecond, what it was for the 50 millisecond we see that as we are increasing the time window.

The plots are for the turns count that becoming smooth, 120 millisecond it is smoother, and now the higher thresholds also are coming better. In fact, that we can say that instead of going for 30 millisecond, we can go for the 70 milli sorry 30 millivolt, we can go for the 70 millivolt, threshold also because we are not getting any that output when the signal is not present the spurious outputs are suppressed as well as it is skipping the shape pretty intact.

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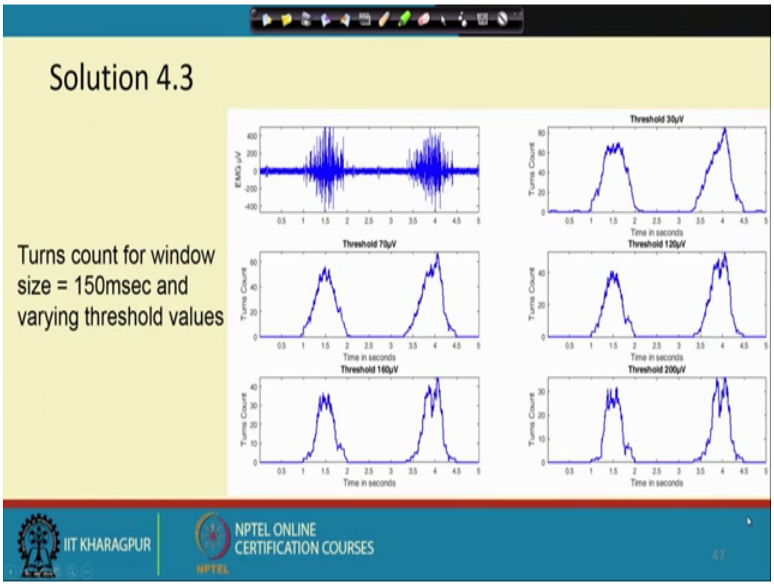

When we go for further 150 millisecond we get again some more improvement in the smoothness of the envelop, and here we get 120 millisecond also that that 120 microvolt, when the output is there this is also very close to the, that threshold of 70 microvolt output except that here.

That it has a actually a fault that instead of a single peak it is it has become 2 peaks, but if you look at the first one it looks very similar to that and what we get out of that, that a bigger window is doing actually better averaging and we need to choose that the threshold carefully to get a good output, we should not unnecessarily make it big.

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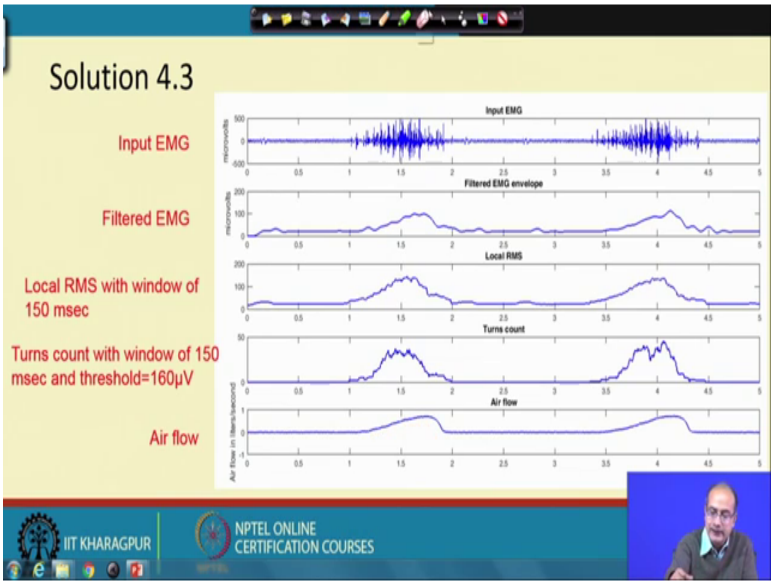

And here we are comparing each one of them; we are looking at the EMG output, first here the EMG output, followed by that the envelope with full wave rectification, then with the local RMS we get that very similar kind of output again we are getting an envelope out of that RMS that turns count also interestingly it is giving similar kind of variation.

We have taken 150 millisecond window which gives us smooth actually envelope or smooth turns count and we have taken threshold 160 to follow that because very stage we see that there are burst of energy and there is some actually king kind of thing that. It is not actually a single up and down there are small small changes are happening in the EMG signal, the bust of signal they are coming. And however, the air flow is very smooth compared to that that and it has a abrupt actually end this coming down very quickly.

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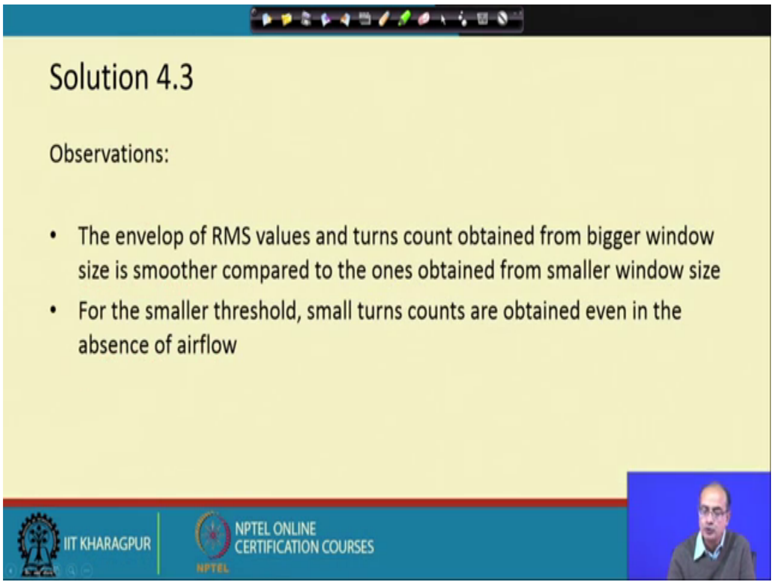

So that is the thing we get out of this comparison and let us conclude our findings what we get the envelope of the RMS value and the turns count obtained from vigor window is smooth compared to the one with the smaller window.

So, this is a common phenomenon what we get, and for the smaller threshold small turns counts are obtained even in the absence of noise flow, that that when there is no flow there are also some spurious signals are coming, and that is reflected in the output which is not desirable. So we need to take sufficiently high threshold to get a proper turns count or proper amount of volition of the muscle fiber.

Thank you.