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

Lecture – 23
Event Detection (Contd.)

So, now we look at another at another similar technique to find the rhythms and the waves of that EG signal it is called as match filter ok.

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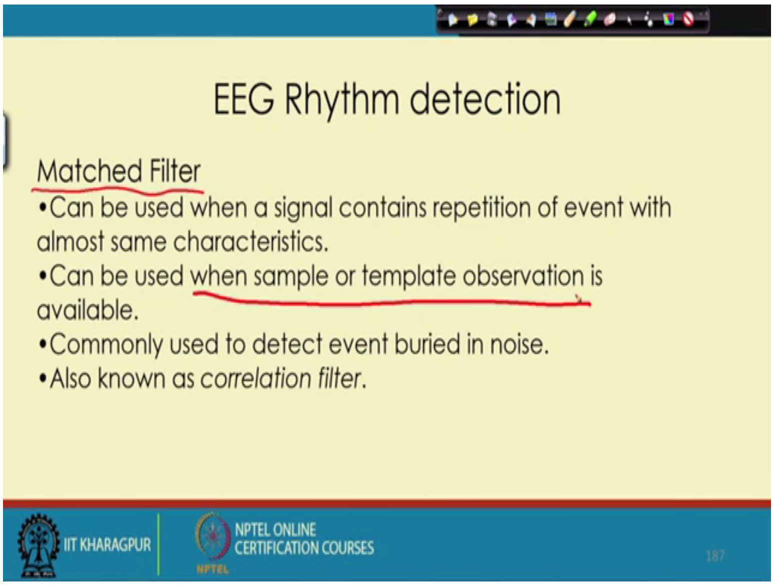

That the match filter that it can be used when there is a reputation of the same wave form, which is exactly the same the same or very similar. So, only then we can use the match filter and one of the requirement of the match filter is that we should have the sample or the template the template of the observation; that means, it is not good enough that to have that knowledge. For example, that if you are an expert then looking at that wave forms; you may tell that this is alpha wave this is beta wave.

So, that kind of qualitative description is not enough in this case we need those sample values to actually take advantage of the match filter. The third key that that we it is actually primarily used when there is the noise or artifacts. In fact, sometimes the situation could be so, the signal is buried in noise; that means, the noise is so much that hardly we can observe the event. But if we have that the template of that event stored earlier which is clean then in that case still we can find out the occurrence of that event, even if it is buried in noise. And this match filter has another name it is also known as correlation filter will see as we proceed that; why is this name has come.

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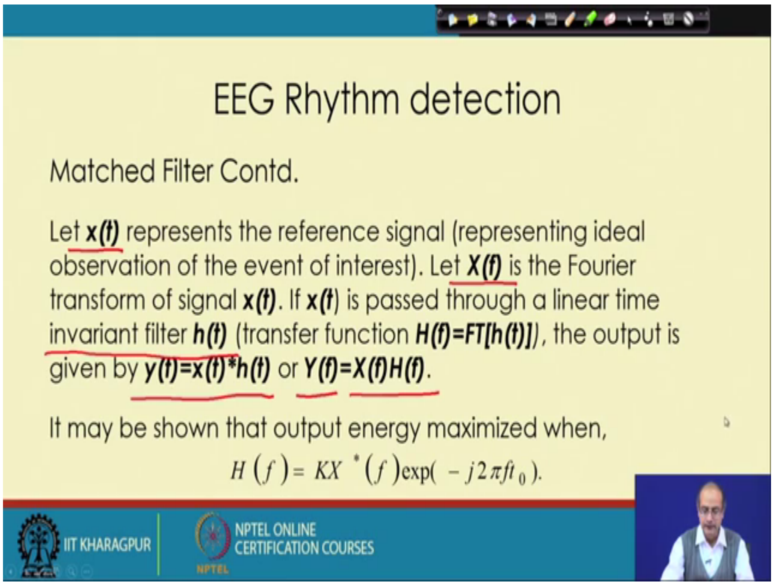

So, if we take a signal that is xt in the continuous domain in the frequency that discrete domain we can write xn; if this is the reference signal; that means, the event or the waveform that what we are interested in.

So, in the frequency domain we can represent that as xf; now if we pass this signal xt through a that linear time invariant filter that is ht the output would be the convolution of xt and ht, and we write that as yt or if we want to describe the this phenomena in the frequency domain, then the output yf would be the product of xf and hf. So, this is the that the description we get here, and here the point to note that if we take that hf the if hf becomes the scaled and conjugated version of that the input signal, then we get actually maximum output of that y. So, this K is giving a scaling and this part is giving dealing.

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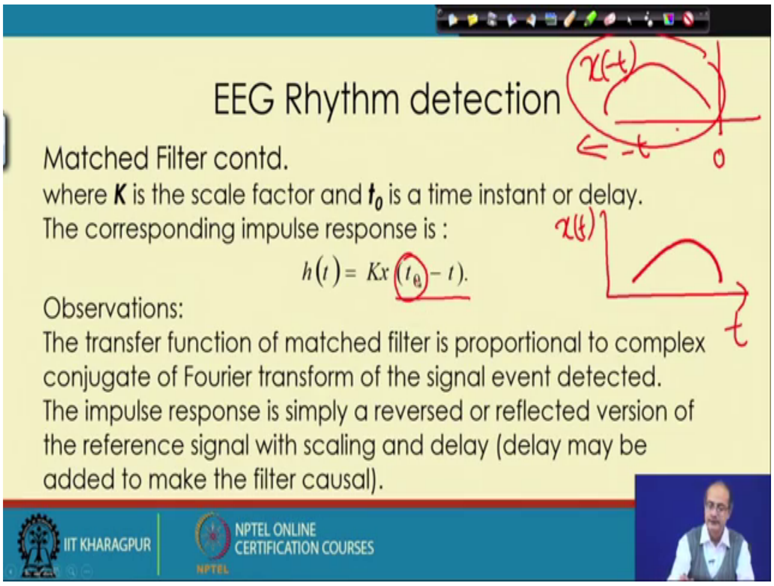

So, let us look at how the impulse response would be that, in this case the corresponding impulse response of that the filter ht would be K times x t 0 minus t. So, what we get here the first thing that that it is first of all scaled then because we have taken the conjugate. So, the time is reversed.

So, instead of being a function of t we are taking minus t and there is a delay that is t 0. So, we have actually flip the signal, and then we have taken the delay. So, this is the observation that the taking the complex conjugate of the Fourier transform, that what we are getting the flipped version of the signal flip flipping the that the time domain. That instead of x we are getting it is becoming function of that that x is earlier it was function of t now it is becoming function of minus t; that means, if we have a say wave form like this, for the t if this is the xt, now x of minus t would be just the opposite. It would be something like this, this direction is minus t and that t 0 actually is delayed this is just to make sure that if we want a casual signal what we need to do, we need to take this waveform and start from somewhere here from 0 and beyond that.

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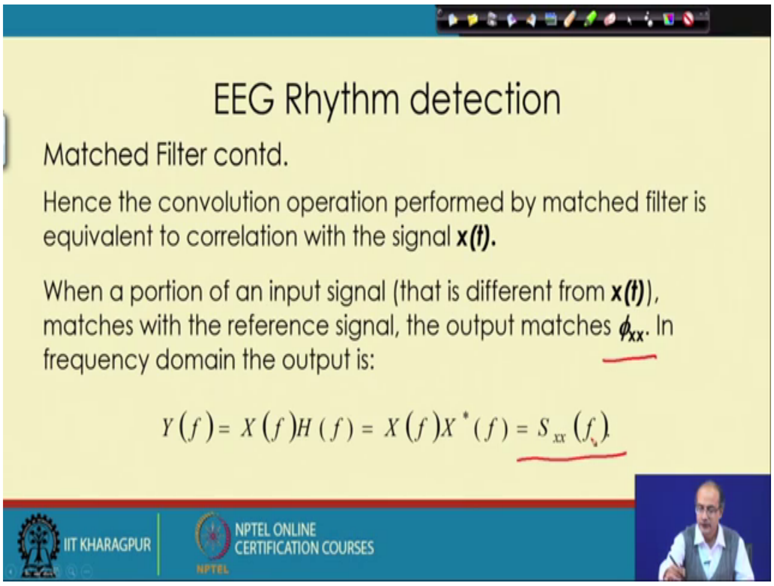

So, for that this delay is introduced. So, that is the main part purpose of it. If that is not a requirement the t 0 may not be required. So, in case of match filter we are having a convolution operation with that impulse response xt and this signal, in xt and what we notice actually this is nothing, but equivalent to the correlation. The correlation of the two components because we have already time reversed the signal to create that xt. So, if we take a part of the signal xt that and then we have a match. So, the output would be that our phi xxt and in the frequency domain if you look at that, we should get that the psd of that signal. So, what we get in a sense that match filter is also somewhat equivalent to what we are doing as auto correlation function in the previous case. Now let us see that what kind of output we can expect out of it.

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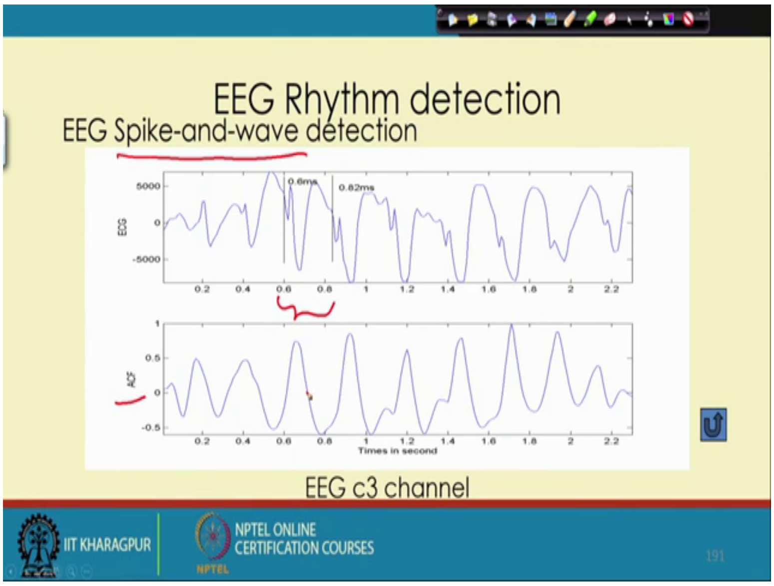

So, first we take the example of that spike of and wave, these kind of wave form which is a long duration, discrete event, we have taken this portion 0.6 milli second 2.82 mili second that that is the occurrence of a spike and wave, and by computing the auto correlation function here we could get the peaks which is higher than 0.5 and we can say that spike and wave is present throughout the signal.

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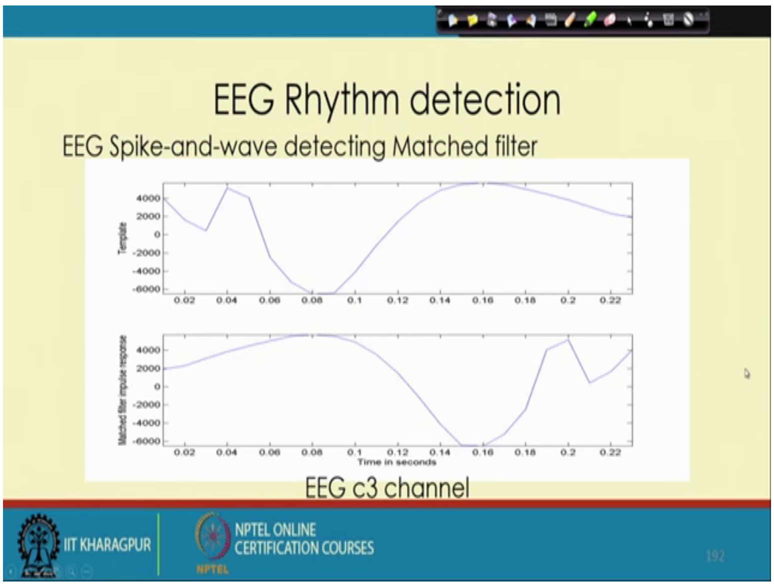

Now, let us look that how we can construct a match filter out of it. To do the match filter first we need to take that template, here we have taken the template that starting point 0.6 that is again and going up to this part that here we have given that signal. Next what we have done to create the match filter we have time reversed the signal or flip the signal. Now flipping that signal by that it should go in the negative side of the x axis, to make it casual we have moved it in the right hand side and thereby we have introduced some delay of about 0.22 seconds.

And here is the that template we could get for the match filter. So, with that now we are ready to find out that spike and wave, presence of the; that the spike and wave we can detect that using the match filter.

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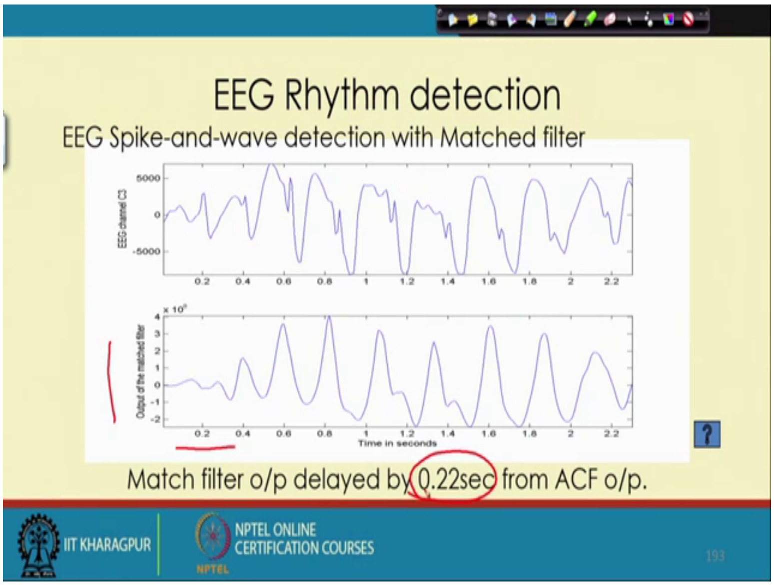

Now, we take that the test case that is signal the channel c 3 and visually we get that spike and wave is present there, in each of this place that we get spike and wave kind of nature and then slowly it is actually becoming different. So, a lot of portion that almost starting from point 2 to 2.2 second that we have in these kind of that repetition of the spike and wave. Now to get that using the that match filter we are actually computing the output of the match filter, we see that match filter also it has peaks very similar to the ACF coefficients. So, they have peaks which are very similar to the ACF coefficient, but there is a small difference. If we look at the ACF coefficient we see the peaks are starting from the beginning.

But when you go for this match filter output we see that the front portion that there that is there is no activity, and there is a delay actually from where this peaks are coming, and that delay is same as that that 0.22 second that delay, what we have actually introduced to make the template as casual. So, actually the output of the match filter is very well that correlated with the output of the auto correlation function, the only difference is that there is a delay at the beginning and the delay is also pre determined, that is the delay we introduced to make that template that as a that impulse response of ht which should be a casual filter.

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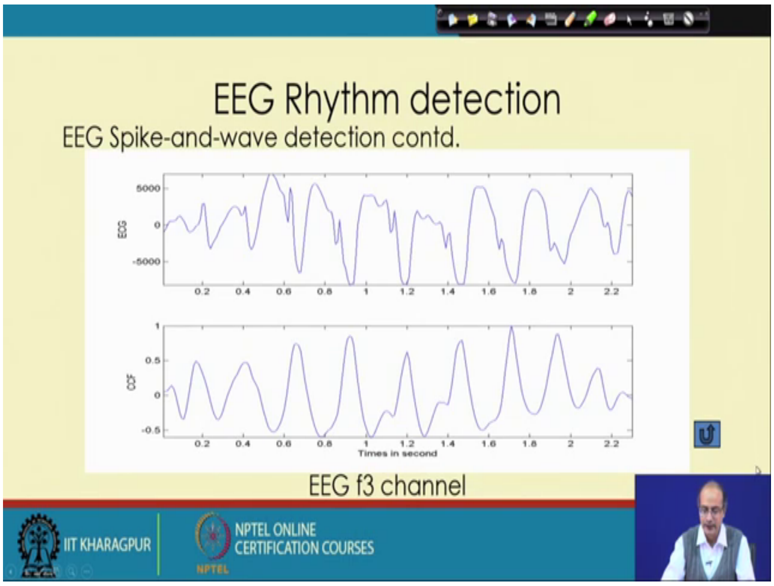

Now, let us look at another such example, again we have that spike and wave in this case that instead of the same signal we are taking a different signal is a f three channel.

So, to get actually the presence of that that spike and wave, that here we do not have any template that is taken from the previous one that we need to go for cross correlation function, that is the time domain approach that we have taken so. Now, if we want to go for the that match filter again we already have the match filter template that is given.

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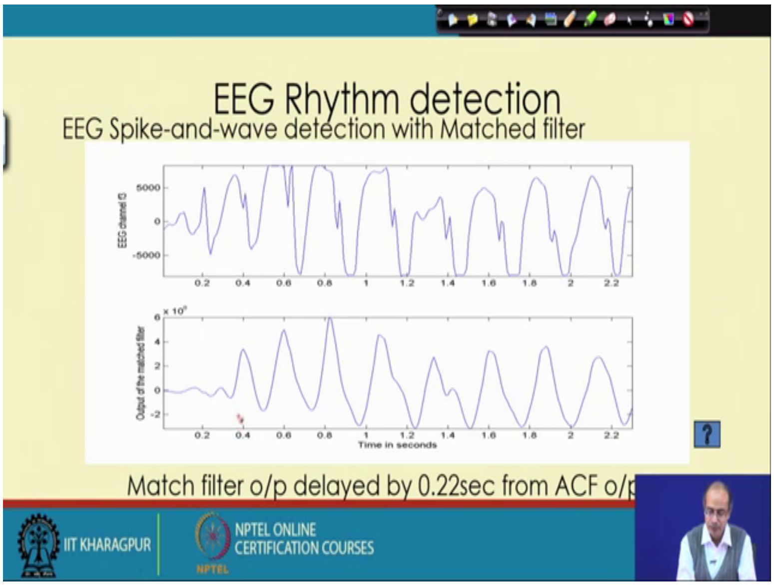

So, with the help of that that we can actually compute the output of the match filter, again we get the same kind of peaky nature this part that we get same kind of peaks.

So, we can say or conclude very well that there is spike and wave, that wave form is present in the channel F 3 and; however, in the front part of it this part we see that there is a flat actually response and again that is that about 0.22 second that delay that we told earlier its matches with that. So, if we look at the previous signal that the thing be become clear, that that here that delay is by the that delay that we have taken to actually create this the template of the match filter for that the delay has come or in other word the technique what we call as a match filter, it is nothing, but the a different implementation we can say of that that correlation filter

Thank you.