Biomedical Signal Processing
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Lecture – 06
Biomedical Signal Origin and Dynamics (Contd.)

Now, we will go for the electromyography or EMG signal.

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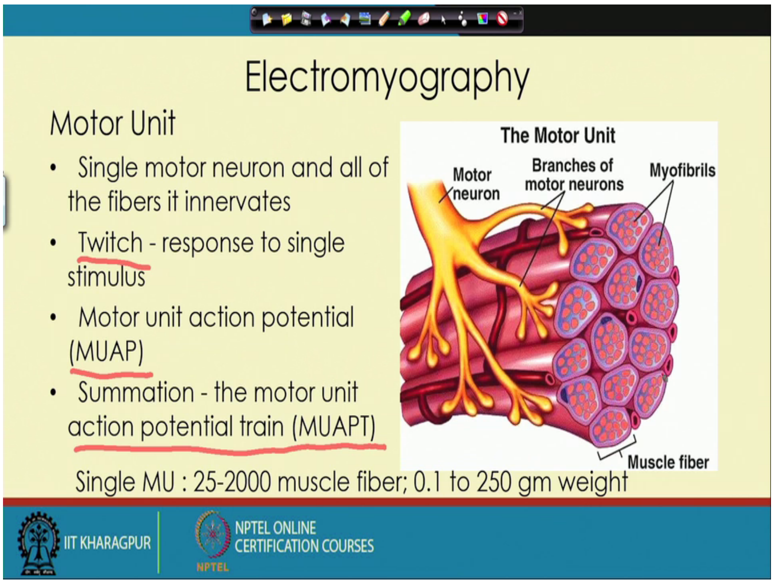

We told about the motor neurons. Those motor neurons their action, they terminate on the muscle fibres. And whenever a signal comes, that it actually stimulates that muscle. And the muscle in response it contracts, and that is what we called as twitch. And for a single motor neuron, it is not connected to one muscle fiber, but in number of them. So, we call that collection all those fibers together as a motor unit. And the action potential generated by that we called as motor unit action potential.

So that means, the signal given by a motor neuron, it is stimulating some actually fibers connected to it, and the potential generated by the action potential of all those muscles or muscle fibers; that is, motor unit action potential. And for a task they are actually engaged again and again; that means, to lift an objects say lift a heavy bag we need to ask our muscle of the arm or excite the muscle of the arm again and again to exert that force. So, that is done by train of stimulus that is coming through the motor neuron. So, the summation of them, that the motor unit action potential train in short, we call as a

MUAPT, and a single motor unit it can be connected to a very small like 25 muscle fiber up to 2,000 muscle fiber. And if we look into the weight of it could be point 1 gram to 250 gram of it.

So, depending on the span of that connection that a valid number of actually muscle fibers can be excited by one motor neuron. And the signal generated by the that contraction or depolarization and repolarization of the muscles, we can get the signal what is called as EMG. So now, let us move forward.

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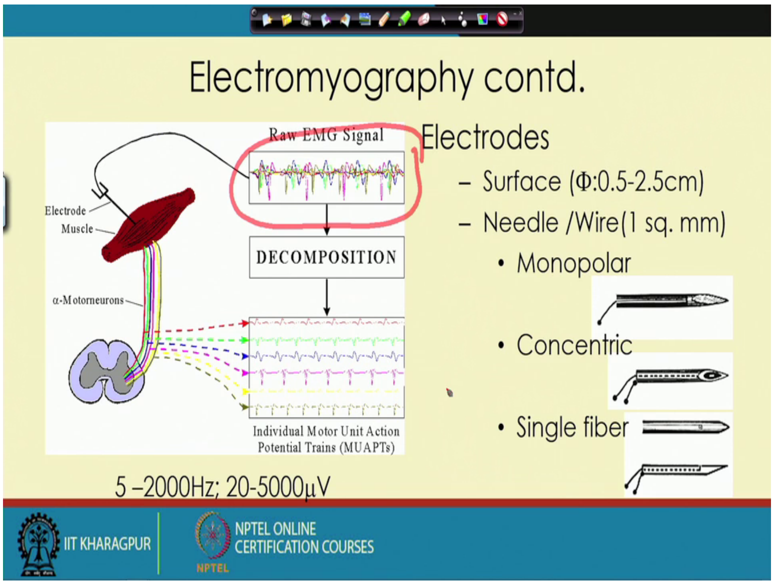

Let us see that how the signal looks like, here we are showing some of the signal. Here what is shown that, usually we collect the signal from the skin, and there we would not be able to get the signal from a particular motor unit. The multiple motor units the signals they would be combined together and we get the combine signal.

So, the combine signal we will look like a little (Refer Time: 04:21), but if we could decompose them, we could get them separately having their own characteristics. Now how the signals are connected? First is, through the surface electron, and usually that the diameter of that electrode is 0.5 to 2.5 centimeter. So, it could be very small up to about a inch dia. So, these are patch electrodes. Now if we want to pin point and want to collect that more specific information, then we need to go for needle or wire kind of connections. The typicals are actually cross section of it is about one square millimeter. And there could be different kind of needles, it could be mono polar where the needle is connected to one wire, or it could be concentric; that means, 2 connections are there one from the sheet another going through inside.

So, we can get very localized activity within this region, then it could be a single fibre also. And it could be going through a actually pipe shaped needle, it could be just place inside just to protect it, and to help it to reach that space from where we want to collect the signal. So, there are different types of electrode, and depending on their activities that the we will get different kind of signals. And here in case of EMG another things we should look at that the signal strength again is again small in microvolt range as you show it here. But the frequency is much higher. For both ECG and EEG, the frequency range was below 100 hertz, in this case it is starting from 5 hertz to 2 kilo hertz.

So, frequency band is much bigger, and the signals looks more like a noise signal or we can say just like the EEG signal here also we cannot get any shape, rather we have to look at that signal which is looks like a random signal and try to analyze that or quantify that signal.

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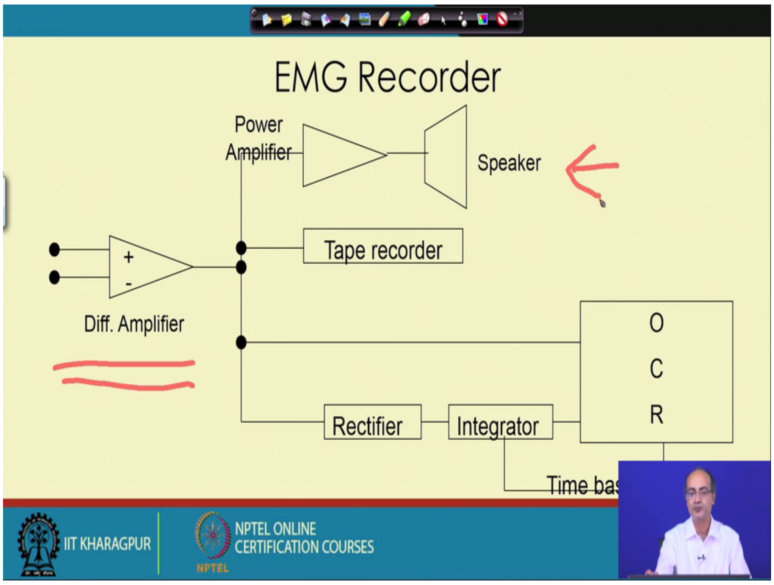

Next, we look at that how we can pass if this kind of signal or quantify this kind of signal. That signal here is said to a differential amplifier to enhance the level of the signal. So, that it can drive some other electrical equipment, and a few after using the power amplifier the signal can be boosted, and can drive a speaker.

So, in this mode, what we are interested? In from the that EMG signal we are getting generating a sound. So, if the muscle activity takes place for example, the person is lifting a that weight, and there would be some muscle contraction would be there and we have connected the electrodes or those muscles, and that is fed to the speaker using the different sets of amplifier. We can get some sound that is due to the EMG signal output. Now at the level of the sound we can get that how much actually EMG signal is generated. If the muscles they are not working properly, that level of the signal will go down. So, that can give us an indication about the amount of EMG signal generated or the health of that muscle.

The next thing that after the differential amplifier, a tape recorder may be used to record that signal for future use. For example, if some patient is under treatment. So, and he has given different kind of treatments like medicine physiotherapy and all. So, we want to see that for the same experiment, what is the improvement in the muscle strength. So, we need to record the previous signal, and the present signal and need to play them one after another 2 perceive the difference, or the improvement in the after the treatment.

The other mode of actually judging that is, whatever the signal we get we give it to the CRO after rectification and integration. This rectification and integration will provides us the envelope of the signal. Later on, we will get more details what we mean by the envelope, but at this point you can take it in this way that it will give us the level of the signal, and that we can visualize in a CRO. And when we look at the CRO, we are able to get the change of the strength of the signal over the time. So, it gives us more information about the signal. So, that is another mode of visualizing the EMG signal or EMG recordings.

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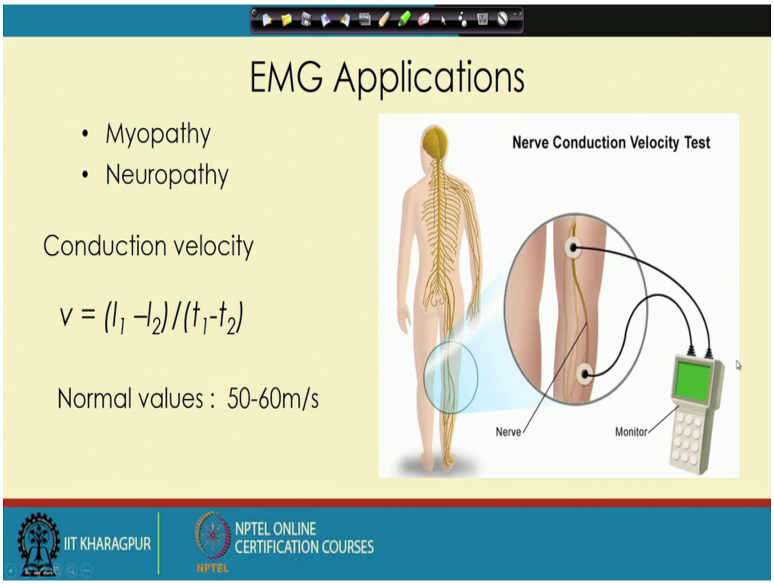

Now, let us look at some applications of this EMG. That here when we have this kind of problem, that the person find that the muscles are not working actually 2 things can happen. One thing there could be a disease of the muscle. So, that is called as myopathy, that muscles or the muscle fibres are getting degenerated. Other thing could be that muscles are healthy, but there is some problem in the that the electrical connection to the muscles, which is actually stimulating the muscle. In other words, the neurons that is activating the muscles have some problem.

So, in that case it is called as neuropathy. So, when we have some problem of the mass muscles, that would be the complaint from the patient or that can be immediately visualized the first thing is to find it out that whether it is a problem of myopathy, or it is a problem of neuropathy; that means, the muscles are diseased or the neurons are having some disease. Because unless we know that the treatment planning cannot be done. So, to change that what it is done? That we put the that sensor at different parts of the body. Now to do that we need to now that how the nerves are laid in the body. So, that knowledge is required here the problem is in the leg muscle. So, that 2 points from there that in on the that nerve, that about a half hour metre apart 2 sensors connected, and the this signals are actually tagged from or acquired from these 2 points.

Now, further signal will come here and then to the next point. So, here what we look at what is the time difference between this 2. And thereby we can get actually that what is the velocity of the signal through the that nerves. And we know the normal actually speed should be 60 to 50 to 60 meter per second. If it becomes much lower; that means, we know that nerve is not conducting properly. So, the problem is with the nerve and we need to do the treatment of the nerves. If the speed is fine then we get the nerve are working fine they are giving the stimulus as the way it should give, but the muscles are not responding to it; that means, the muscles have become weak. So, for that we need to have the treatment of the muscles. So, that the muscles fibres can get regenerated and regain their strength.

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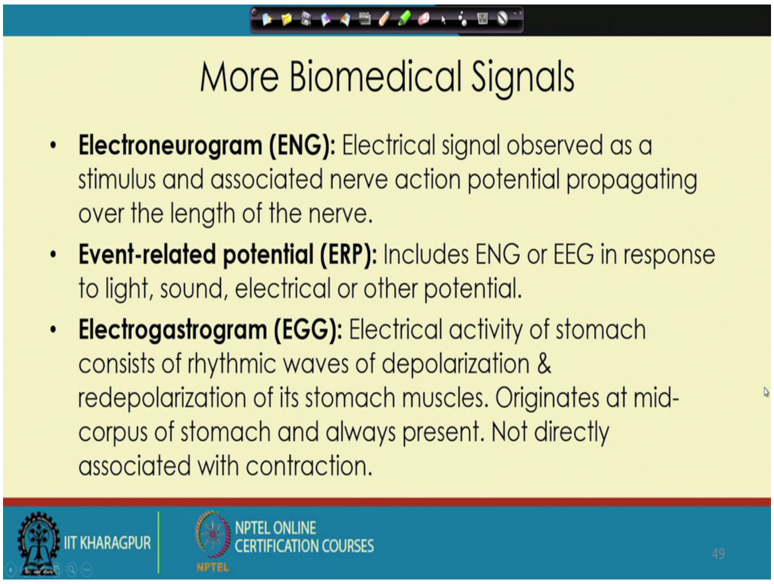

Now, we can look at actually more such signals, which can be acquired from the body. First, we look at the electroneurogram, the electrical signal which is acts as a stimulus to the muscle and the nerves carrying them, and it is passing through the nerve taking the command or taking the signal from the sense organ to the central nervous system. We can look at the velocity of that, and if we do the recording over the length of it that signal is called electroneurogram; that is called as electroneurogram or in short ENG signal. In the previous page we actually depicted one example for the neuropathy, we have to take the that neuron that at electroneurogram.

The next signal is event related potential. Event related potential means, if there is any stimulus, in response to that whatever the signal is generated we can call it as event related potential. And that is why it has another name called evoked potential. And where we can get the event related potential or ERP, we can get that in EGG. ENG for example, if some stimulus is given in the form of light or sound or some electrical signal or even the touch. That can actually give rise to some change in the that the signal we are looking at that is EGG or ENG. As it is evoked, or related to that particular event, we call it as event related potential or ERP.

Next, we can look at electro that gastrogram. Electrogastrogram is the electrical signal of the stomach and the actually that elementary canel. We know, the peristals is happening which is nothing but some rhythmic moment or rhythmic contraction. And the contraction and expansion are synchrozed in such a way, that the food will move in one direction. So, that muscle moment and the comment to them they together form a signal which can be captured from the elementary canal throughout including the stomach. And that particular kind of muscle single again, you can tell that is also a variant of EMG. They are called as electrogastrogram.

So, you can tell us that how the muscles in our alimentary canal they are working, and how they are helping us for the digestion. If they become weak then we may have the problem of digestion.

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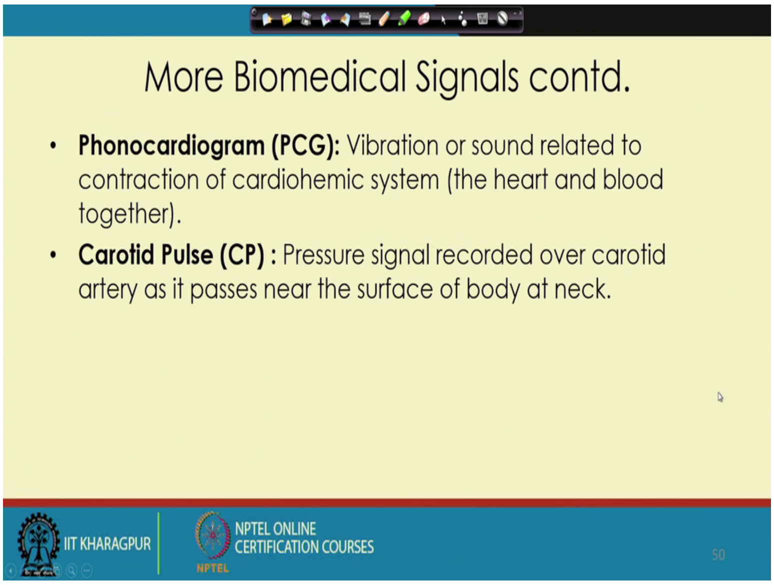

Next, we get another signal called phonocardiogram. Phonocardiogram is the signal of the heart and the connected vessels. We know heart is a pump, and when the pump is working, that there is actually transfer of fluid that is a blood from one chamber to the other and there are number of valves. If the valves are not operating properly, or that the transfer is not smooth, it can give rise to some signal.

In the same way when they are actually forced through the artery, they it give rise to some turbulent motion and it can create the some sound or vibration. And if that is captured, that that is called phonocardiogram. In fact, this PCG signal is a very good source of information about the health of the heart, and it is a you can collect that in a non-invasive way. Now, what kind of information could come or how this vibration is generated, think of the valves they are actually having some calcium deposition. So, if there is calcification of those the valves, then instead of making a smooth landing it will make a metallic sound. Whenever it is closing it will make a metallic sound. So, that would be brings that will bring some change in the PCG signal.

Again because of the calcification or some slackness of the valve, if they are not closing the valve properly when supposed it is supposed to close. What will happen? That there will be some leakage, and because of this leakage, the leakage would be is small. So, when the that chamber is actually getting contracted, say the ventricles are getting contracted and because of the leakage some blood is again flowing back to the artery. So, in a atrium. So, where it is supposed to go through that the ventricles. That can give some hissing sound. So, we would look at that signal and that would actually can give us some indication that there is some leakage of some of the valve and it is creating some problem. Again, the main that arteries they are taking the blood, carrying the blood, if they are becomes narrow. Because of deposition of the that lipid or because of calcification, then there would be a highly turbulent flow, and that will also cause sound very near the heart. So, that will also be captured as ECG signal, and that is why we called that it is a cardio hemic system. That heart and the blood together that makes this sound. And that is captured in phonocardiogram.

And now let us look at another similar signal called carotid pulse signal. We know that carotid artery, it carries the blood from the heart to our brain. It is the main supply to the blood to the brain. And brain is one of the biggest consumer of the blood. It needs a lot of blood to keep it alive and do all the activities. Now this main artery it flows very near the skin and just like we can actually get the pulse near our wrist; same way, very near to our that neck there are some points if we touch that that we can get actually feel the pulse there. And we know that what is pulse? When we have the systolic pressure, then we get a thrust and we can feel that as a pulse.

So, if that signal is connected collected from that carotid artery it is called carotid pulse, and when there is that high pressure of the systolic pressure is actually changed; that means, the ventricales they stop the contraction and start relaxing. There is a momentary dip in the pressure again as a valves are closed that the pressure maintains and we get the pressure as the that diastolic pressure. And that helps to maintain the uni directional flow of the blood. So, that change over point also we can get in the carotid pulse signal and that can act actually as an indicator of the activity of the our heart. So, this is all about an introduction of different kind of that biomedical signals.

Thank you.