Virtual Reality Engineering
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Lecture - 66
What is Haptics?

So we will start with a very simple Introduction to What Haptics is? How many of you had heard about this word haptics earlier before? Haptics you are aware of it? Ok. So, what is haptics? Haptics.

Student: Touch sense of touch.

It is a sense of touch ok. Haptics is a sense of touch is one response what is haptics? All the sensors touches involved ok, it is the same thing in another way alright anything else.

Student: Experiencing the force.

Experiencing the force alright.

Student: Combining both the cutaneous sense and the kinesthetic sense.

Combining both the cutaneous and kinesthetic sense alright. Any other answers? By the end of this class we will come again and look at all these you know your answers whether that is correct or not, whether it is making sense or not.

Let us start with what is haptics? For vision eye is the organ right; what is a basic of our vision. Light is a basic fundamental stimulus right; for auditory ear is the organ and what is the fundamental stimulus? Pressure wave or sound is a fundamental stimulus.

Similarly for haptics skin is the organ not that is not actually correct, we are going to refine it for the time being; if you can imagine skin is the organ, the fundamental stimulus is a force, the contact force. The other organs they do not need to have a contact, where as here contact is very important ok. This is a crude introduction about what a haptics is; we are going to refine it a little better now.

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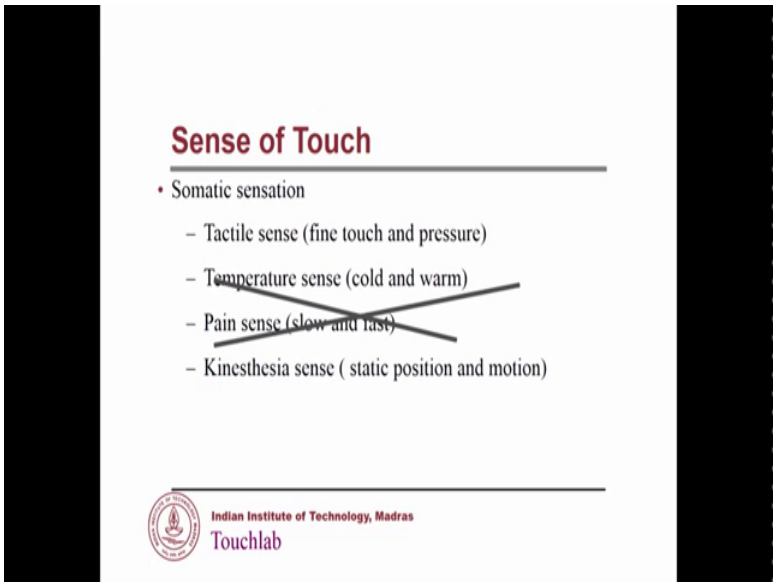

The word touch we have we have been using it very often ok; what is touch? Forget about the haptics to be how word understanding of what a touches is; when I touch something when you use touch the word touch.

Student: (Refer Time: 02:55).

When you are?

Student: (Refer Time: 02:57) texture of a surface.

Texture feeling the textures of a surface.

Student: Manipulating objects (Refer Time: 03:03) something through have a (Refer Time: 03:04).

Manipulating objects.

Student: Change of density.

Change of.

Student: Density.

Density you want to feel it.

Student: (Refer Time: 03:11) I am not feeling anything.

Ok.

Student: (Refer Time: 03:12).

Alright.

Student: Density.

Ok.

Student: Vibrations.

Vibrations you want to feel it ok.

Student: Pressure.

Pressure do you want to feel it right. So, touch is a slightly complicated word, but the end of this class; probably we will refine our understanding of what a touches is.

Only then we can understand what a haptics; ok. Touch has two aspects of it; one is the sensory point of view of touch ok. I am touching this object, and then feeling the object that is a sensory part of it ok. Another aspect of the touch is that I am manipulating this object ok; not just sensing it I am manipulating object ok; that is a second object of touches ok.

Together is what we mean by touch. So, in this slide what I have mentioned is only the sensory aspect of the touch. The sensory aspect of the touch again as some of you have mentioned, there are many dimension to it sensory dimension itself ; one of the dimension is the tactile sense; tactile senses that is a technical word for feeling of the pressure, feeling of the you know fine touch.

The secondary dimension is the sense of temperature ok, cold or warm or heat it; that is a second dimension. The third dimension is the pain it may be your surprise for many of you; pain is also a part of the touch. Usually we do not consider; pain as a part of the touch right, but it is a third dimension of the touch. The fourth dimension is called the kinesthetic sense. Kinesthetic sense maybe very neat to many of you. Let me briefly introduce what a kinesthetic sense and why do we need a kinesthetic sense yes Rahul.

Student: Sir what about the internal bens?

What about the?

Student: Internal bens like the muscle bens?

Yes we will come to it ok. Kinesthetic sense that is the sense of position; suppose if I close my eyes and; then I try to touch my nose with my fingertip I try to touch my nose with a fingertip; at every instance I have this sense of position where my tip is there. How do we feel that sense, where is the position since coming from? Without that sense of position I would not reach the target right.

If I reach an object at even though I am not looking at my hands, I have the sense of position where my hand is that is the reason I could reach it without much error in it that sense of position is called a kinesthetic position. We are going to go very deep into what kinesthetic senses; how what are the sensors in our body which gives us these kinesthetic sense very detailed in the later classes; but you should know that there is also yeah dimension of the touch.

So, we have seen that touch has two dimension: sensory dimension and the and the manipulation dimension. Sensory dimension itself there are four other dimensions one is called the tactile sense, second is called the temperature sense, pain sense and the kinesthetic sense

In all this four dimensions, in this course we are not going to talk about the temperature sense and the pain sense. We are going to talk about in very much detail of tactile sense and the kinesthetic sense, why? Because we have technology to give you the simulated tactile sense and the kinesthetic sense, but we do not have technology to simulate temperature sense and pain sense; maybe it will take another 5 years or 10 years or who knows ok.

So, as a part of this course we will talk about only the tactile sense and kinesthetic sense. So, sensory aspect of touch is called the passive touch in the literature. Sensory and the manipulation aspect of touch is called the active touch right. So, again usually do use your hands to move things, we use only hands right, but how about other part of the body

? Do you, use your skin to move things do you use your legs to move things? Can you move your skin by the way some of the animals can do.

Student: Snake.

You can see the deers in the campus, when the flies are sitting on it they move the skin to you know drive it off right. Mostly we use only the hands right. So, use the hands to manipulate things all other part of the organ is actually passively sensing the touch.

For example, you may be sensing the pressure applied by your dress by the skin ok. There is a passive touch it is not just touch is not just the skin level every tissue let us take a for example, you know muscle.

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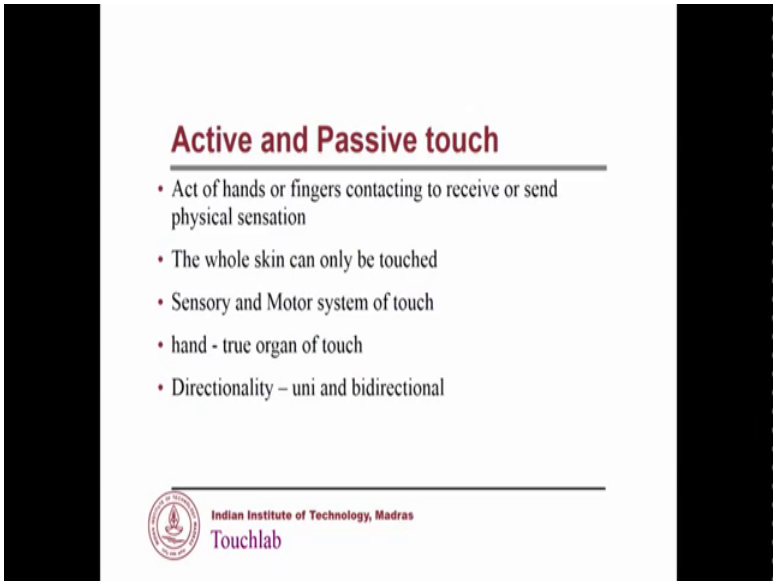

Muscle also has a sensor in it the muscle has to elongate when it is elongating how much it is elongating; it needs to know I am extending my hands how much each muscle has to move in order to extended my hands, whether I have extended my hands or not there are sensors in each of these muscles which gives feedback to the brain.

So, we are going to see how all the sensors are networked in the brain and how brain again processes the information and then commands the muscle back to apply certain pressure, the entire circuit we are going to see how we are actually manipulating it.

The whole skin can only be touched; sensory system is one aspect of it and then motor system is the other aspect of the touch. Hand is the true organs of the touch in fact, one of the theories which is in the haptics literature is that; it is conflicting with the theory of evolution you know the theory of evolution Darwins theory of evolution right. So, that is what we have studied in the textbook.

The haptic researchers claimed that the theory of evolution is not what Darwin proposed. As the animals learned how to use the hands better and better; as the animals have more controlled over the fine movements of their hands and fingers, the brain evolves; it is not that brain. Let us say the hand evolve, it is a hand that is evolving the brain; that is a concept they are proposing here.

It is very interesting, we will see some details of this alternative hypothesis of the evolution in the later classes. One major difference between other senses and the touch senses, this other senses had can only sense eyes can only sense, ears can only sense the sound pressure, taste or others, but only the hands only the touch sense and the hands can not only sense it, but also can manipulate things; it is a bidirectionality. The last sentence in the slide you can see it is a directionality that makes it touch very unique about all the senses and also that is what complicating it ok.

That is one of the reasons haptics has not evolved so much, because there are a lot of challenges; technological challenges because of this bidirectionality, in the internet it is going to be a huge problem and the tactile internet, which I mentioned; now we have certain solutions to address this bidirectionality. We will see details later.

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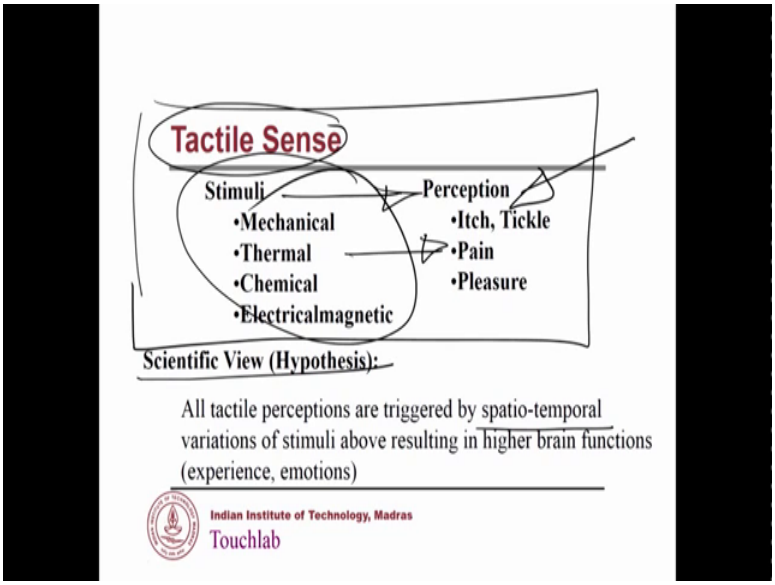

Now, the four dimensions of the touch sense we can see each one of them in detail of course, maybe [vocalized-noise one or two lectures will be on tactile sense, but in this class; I will just introduce what are tactile senses. So, the tactile sense is a sense of pressure fine touch is what we have seen it, but can we have a in a proper scientific definition of the tactile sense. We are going to see such as scientific definition of each of these senses as in the later classes this is just an example.

What are the input to the tactile sense; it is not just the fine pressure it is a mechanical input it is all called a stimuli stimulus ok. The stimulus can be mechanical, the stimulus can be thermal, chemical or electromagnetic optical also can be there ok. Some of the research students are working in a variety of stimuli now.

Once the stimulus is there that is lead to experience two different experiences like are itch or tickle or pain and pressure pleasure there is a perception level. So, there is a stimulus there is a perception ok. So, how the stimulus is related to the perception is one of the important, that is that is going to be the focus of this course; it is not just to understand and stimulus ok. Tactile sense means it is the totality of the entire system, what is the input to the system? What is the output to the system? Output is a perception ok.

So, what is perception? How do we measure the perception? What do we need to measure the perception? Only when we measure the perception we can improve things

ok. So, we are going to see yeah quite a few classes on this perception; how do we measure the perception esses; essentially coming from the haptics, how do we measure it and how do we improve on it that the whole feel called psychophysics, which I am going to introduce in one of the classes.

And the focus of this course is psychophysics, this course is you can find it two very different from any other engineering courses in you had had in your a the engineering curriculum, because we are going to talk about what is happening inside the brain. So, we are go to give measurement or we are going to give numbers to the mental events what is happening; that is what the experiences is; that is what the perception is; haptics is all about perception it is not you know just sensing it is not just manipulation it is also about the perception the human experience ok.

This experience is what we are going to measure it, the experience we are going to give numbers, and then we are going to find out how to design systems in order to improve this experience. Only when we measure things one the; we can control things ok, we can design do you gadgets in order to improve this experience, that is going to be the focus of this course ok.

So, the scientific view of what is tactile senses all tactile perceptions are triggered by spatiotemporal variations of stimuli, above resulting in higher brain functions experience and emotions. So, this is a stimuli which is varying in both space as well as time and, that is what letting to the their different experiences that is a simple definition of what a tactile senses.

Similar definitions we will see for the other or senses as well ok.

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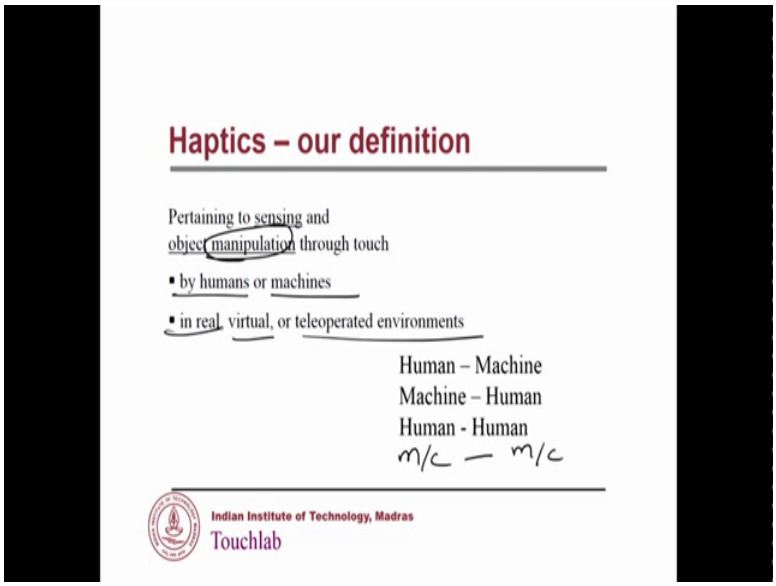

You have no idea what a tactile senses; you have some idea about what a kinesthetic senses, that is a sensory aspect of haptics or touch. This along with the manipulation is together is what a haptics is. Haptics our definition is that it is pertinent to the sensing and object manipulation, through touch by the humans not only by the humans it can be between two robos in the future two robos may be no interacting through touch it is not just the robo interacting with a human may be two machines will be interacting with a human haptics.

It can be in the real, it can be in the virtual, it can be in the teleoperated environments; that is a very general definition of haptics. In fact, if you look at the literature, what haptics is; there will be many definitions you will find that none of the definitions are quite correct with a with a holistic approach of both sensing and manipulation.

In fact, I am going to you know ask you to a do a very small homework ; if you can search Google search it or the other literatures you can search for the definition of the haptics; and then list out at least couple of you know 5 definitions, other when you write down the 5 definitions also you know provide the references from where you are getting this the definitions.

Compare that definition with this definition what we have oregano over here you can see in each of the definition what is missing; sensory aspect is focusing or manipulation is focusing or both are focusing you can check it up.

So in fact, you know we it is our plan to write a full general paper itself on the definition of haptics, because it is not there. There is so, much of confusion among the haptics researchers, what haptics is; it is not very clear. So, we are going to write a definition paper in the future ok.

So, the haptics is between the human to human, it can be human to machine or machine to human or machine to machine also machine to machine also. So, you are brain computer interfaces can be part of this definitions not only brain machine interfaces, brain to brain also it is possible.

So, brain signals can be trapped, and then processed in the computer and then again put it in the another persons brain. So, that whatever this person thinks that can be conveyed to him without any you know intermediate things. So, brain to brain communication also is possible we have done some experiments we can share it in one of the later classes.