Affective Computing
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Week - 01
Lecture - 01
Fundamentals of Affective Computing

Hello and welcome to the first lecture in the Affective Computing course, Friends I am Abhinav Dhall from the Indian Institute of Technology, Ropar and today we will be discussing about the Fundamentals of Affective Computing. So, the agenda for today is as follows.

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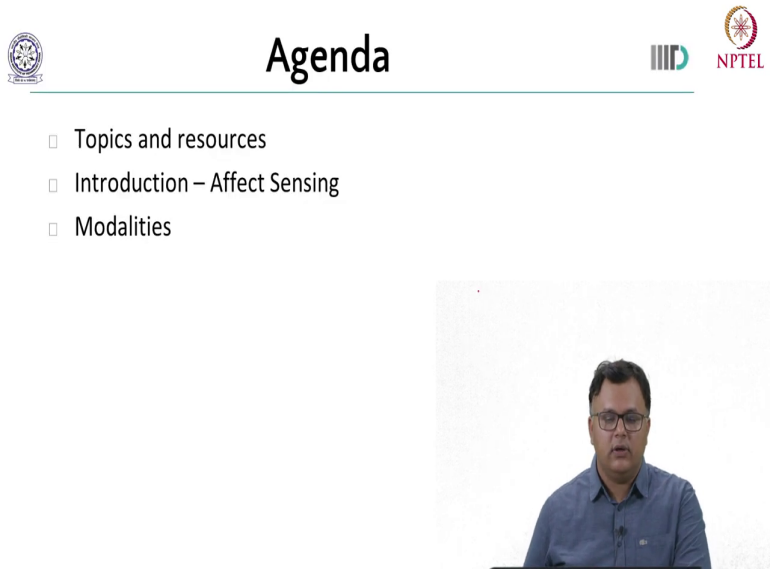

We will first discuss about the topics which are going to be covered in this course, we will talk about some resources which you can refer to and then we will introduce what is affective

computing? And dwell a bit deeper into one of the major components of affective computing which is referred to as Affect Sensing, from effect sensing then we will come on to the various components through which we can understand the effect and that is through the different modalities which is based on different sensors.

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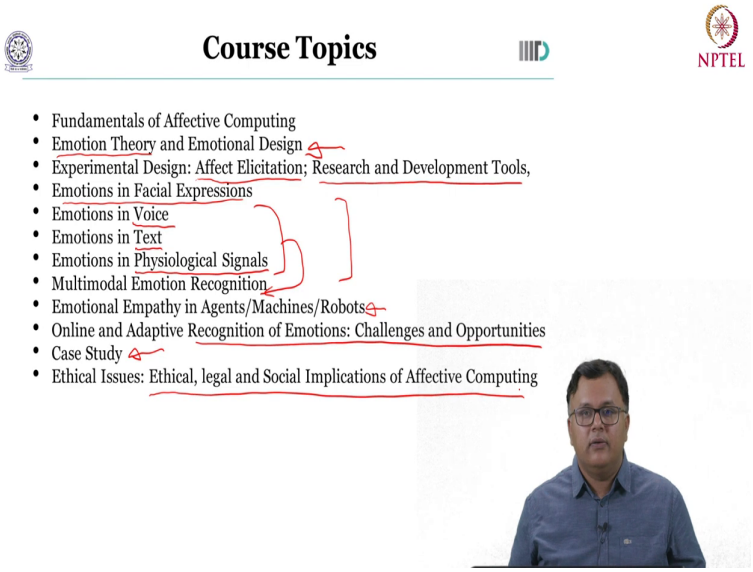

So, we will start with the fundamentals then we will move on to emotional theory and emotional design. So, some of these topics will be covered by myself and others will be covered by my colleague Doctor Janinder Shukla. So, Doctor Shukla will discuss about how the different emotion are represented computationally, what is the theory of emotions and what are the concepts of emotion enabled design.

Then the discussion will move on to how do we elicit emotions in a person. And once we have elicited emotions what are the different research and development tools which are

available in the community, which you as a practitioner of affective computing can use in your respective projects. From this we will dwell into how we can understand emotions from facial expressions.

This would be primarily focusing on the camera based image and video based analysis of affect, from this we move on to the other modality which is voice you can hear me right now you can tell what is the emotion in my speech right you can hear that in my voice. So, we will discuss the different methodologies for voiced based emotion recognition from this we move on to text and then we will move on to physiological signals your heart rate sensor the EEG and so forth.

Later on friends, we will combine this into multi model emotion recognition, that is we have data coming in from let us say voice and text or there is data coming in from camera and physiological sensor. Now once we have discussed the sensing part will also come to how emotion is reflected by a virtual agent. How can we communicated by a machine?

And if you have a Robo when you are talking about human robo interaction, how do the robo after sensing the emotional state of the user react to it. Then there would be discussions on the challenges and opportunities in this area. So, this is a very new area it was introduced only 3 decades ago.

So, if you compare it with other disciplines in computer science and signal processing this is fairly young, which means that there are lots number of opportunities and also there are a fair number of challenges which are involved. Then we will move on to a case study of a real world deployment of an affective computing system and then last, but by no means at least the very important aspect of the ethical, legal and social implications of affective computing.

Now, if we want to move these affective computing systems from let us say labs and to real world settings, what are those aspects which we need to be aware of from the perspective of ethics legal and so forth. Now this course is fairly self sustained the material which we will be

sharing with you through our lectures should be giving you a healthy amount of information about affective computing.

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And with this also I would like to mention to you some of the textbooks for those of you who would like to let us say go deeper into the concepts. Now, from Professor Rosalind Picard is the first book in this area which is aptly named Affective Computing, then a book recent book called The Oxford Handbook of Affective Computing that was also released it is a very rich set of resources for concepts in affective computing.

And then a very new book by Leimin Tian and others which is called the Applied Affective Computing that is also a very good resource. Now since affective computing is a very growing area rapidly growing area much of the newer work which is being done in

universities and in industrial labs that is first communicated to disseminated in journals and conferences.

So, the IEEE transactions on affective computing that is the standard venue, where the high quality affective computing work that is shared by researchers. The community also has a conference called affective computing and intelligent interaction and this conference is also a go to resource for the very recent works.

Now, since affective computing is fusion of concepts from computer science, signal processing, machine learning and concepts in how emotions are represented in psychology and social sciences literature. So therefore, this is an ensemble a fusion of different areas. Now, what that means is there are some other venues some other resources as well wherein in part affective computing work is presented.

So for example, there is a conference called ACM Multimedia, where you will find recent affective computing works published as well and then there is a conference on multimodal interaction. So, there are different sensors multi modal and then there is interaction part also we see affect related work in computer vision conferences such as the computer vision and pattern recognition and the international conference on computer vision.

Now, these resources are fairly advanced resources. So, I would suggest that if anyone is interested in exploring the recent works you know you could start that towards the later part of the course. It is not exactly within the scope of this course because our course is essentially an introduction to affective computing.

But these are extremely high quality resources for going into advanced affective computing. Now throughout the discussion in this course doctor Janendra Shukla and I would assume that you would have learned maybe credited concepts in machine learning and would have been introduced to at least 1 type of signal processing it could be through camera image processing or computer vision or it could be speech processing or NLP Natural Language Processing.

Because as I have already mentioned to you affective computing, whereas you get some data from a type of sensor you do signal processing on it you do machine learning and then there is the human computer interaction part.

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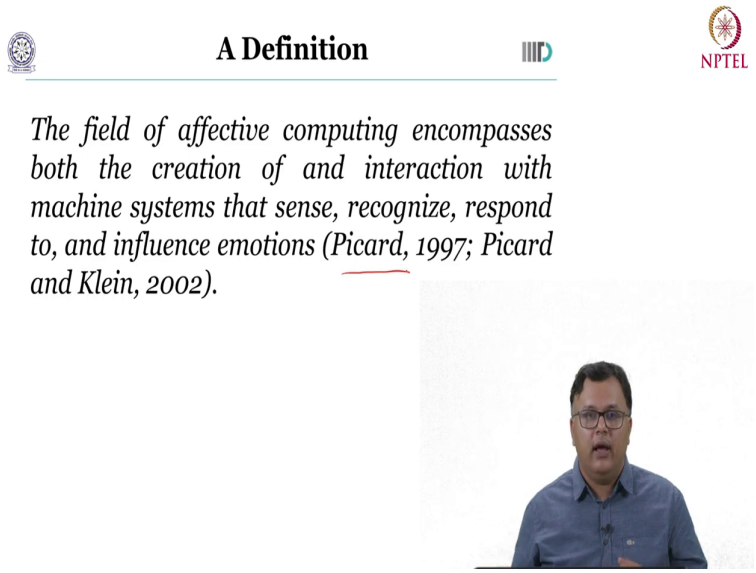

So, now friends let us formally introduce affective computing. So, the field of affective computing it encompasses both the creation of an interaction with machine systems which sense, recognize, respond to, and influence emotions. Now, this term affective computing was first term coined by Professor Rosalind Picard at the MIT media labs and it is essentially about 2 components.

First we want the machine to understand the emotional state of the user and once machine has this information how should the machine react to it? In other words how should the information be now presented through the interface or through voice or images to the user,

which is an appropriate response to the user based on the users emotional state. So, you recognize the state and you react accordingly.

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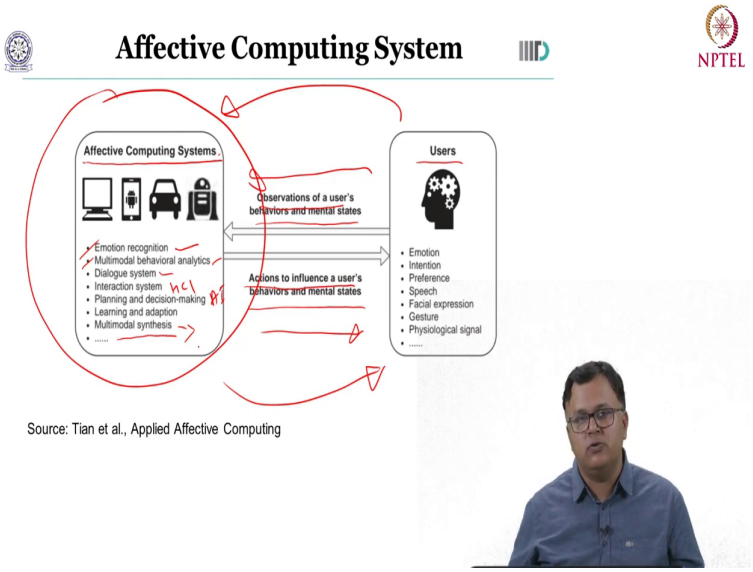

Now if you look at the affective computing systems right. So, there are a large number of components to it. So, on one side is let us say a machine could be your mobile device which has some AI capability in the camera module or in the speech modules and then on the other hand are users. So, your affective computing system can have different components it can recognize emotions it can have behavior analytics, there would be a dialogue system for interacting with the user there would be an interaction system.

Now for example, interaction system is simply let us say you are browsing through an app on your mobile phone and are using the touch sensor. So, that is the way one of the ways for the

user to give feedback. So, this affective computing system will have observation of a user's behavior and mental state.

It will understand it compute it and then it would synthesize and adapt to the user and that would be actions to influence a user's behavior and mental state. An example is let us say operator is using a complex machinery the machine senses that the user is fatigued.

So, this is this part and it would then let us say share a recommendation to the operator that you can now please have a break maybe you can relax a bit right. So, that is one of the appropriate response from the machine to the user. Now if you notice from this particular part we have signal processing machine learning again signal processing machine learning the HCI part the AI part and this is the recent works in synthesis for example, using deep learning generating images, voices, videos and so forth.

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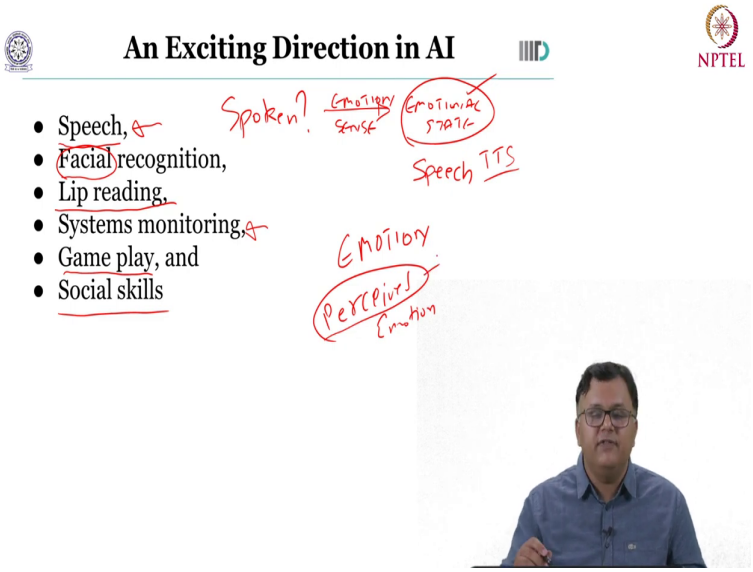

We already see that in the artificial intelligence domain there are several well established directions and in these affective computing finds high relevance. So, you start with in speech there are 2 parts to speech from a computers perspective. One is understanding the speech of the user which could mean for example, automatic speaker recognition automatic speech recognition, wherein the system tries to understand the spoken words.

What is being spoken? Now in this pursue of what is spoken by the user, what can be computed is that when the user spoke whatever the emotion, which you could sense while the user was speaking. So, that will give you the emotional state. Once you know the emotional state from the speech perspective you can generate speech as well right.

So, it could be let us say a text to speech system, which is generating the speech based on what was sensed from the user, let us say the user sounded sad; so how about if the text to speech system generates happy or at least a neutral toned voice right. So, that would perhaps maybe help the user.

Then we have the face analysis domain in the case of face analysis there are large number of directions an example is we are already doing things such as face detection, face re identification, verification in artificial intelligence; so the sub domain of computer vision and machine learning.

And within this we can use the same pipelines adapted to understand the facial expressions a person smiles, if you notice me right now or the person is sad right. So, we find a large number of applications in the face analysis domain now, that is again detection right, but you can synthesize as well let us say a user is interacting with a virtual agent.

The virtual agent senses that the user let us say is happy and the facial expressions of the virtual agent along with the tone are also cheerful. Then with lip reading as well you know lip reading friends is let us say we have a input video and we want to analyze the lip movement. So, that we can learn a system, which can predict what is it that the user is speaking.

Now, in this pursue lip movement also tells us about the facial structure corresponding to a particular facial expression you smile. Let us say when you are speaking or you are showing a surprise expression as you are speaking, then in monitoring as well let us say a system monitoring or even a scenario.

For example, there is a product you are showing it to bunch of users and you are analyzing the emotional state the behavior which is elicited in them in response to the product which is being shown. In the later part of this week's lecture I will give you an example of this how affective computing is useful. Then in game play as well, so along with the keyboard, mouse we can use the facial expressions the head pose information of where the user is looking.

How is the user reacting to the game play and for much serious applications perhaps let us say for training someone with facial expression issues one could have a game where you are supposed to show facial expressions and you reach only to the next round if the facial expression is as shown to the user on the screen. Then from social skill analysis in AI right.

Now, let us say you have a group of people there is a conversation happening how do we use things such as back channeling understanding of cohesion unity in a group. So, there as well we can use affective computing essentially the perceived emotion, emotion of a group and we can then add it to the social skills understanding. Now a thing to notice here is throughout this course we will be using the term emotion and perceived emotion interchangeably.

As you can see this is based on the perception. When you meet someone what do you think is their emotional state well that is based on what they are speaking, what you see on their face on their body gestures, that could be in some circumstances highly correlated, but in others it could be having a low correlation right. So, we will use perceived emotion and emotional interchangeably.

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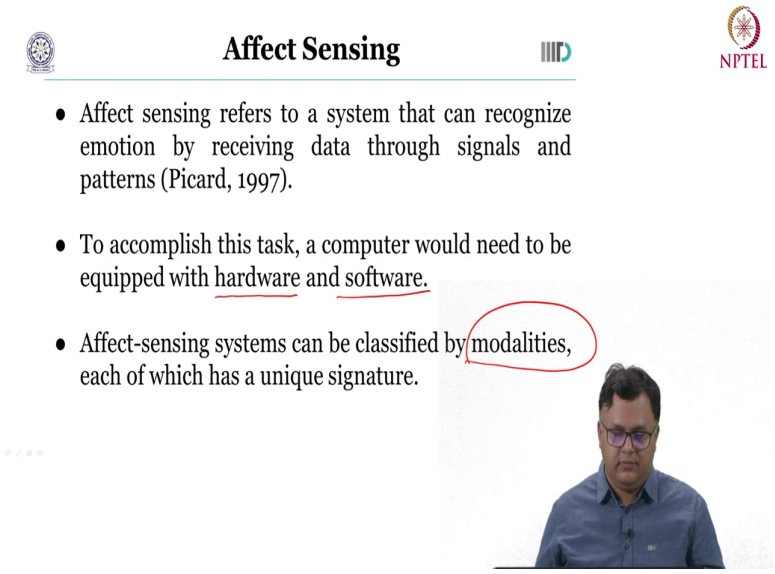

Now, coming to the aspect of the first component of Affective computing, which is recognition right, we refer to it as effect sensing you want to sense the effect of the user what is the affective state? So, formally affect sensing refers to a system that can recognize emotion by receiving some data through signals and pattern. So, this is the formal definition from Professor Rosalind Picard.

Now, for achieving this task a computer would need certain hardware and certain software, the hardware would be essentially the sensors which are going to capture the information and also as we are going to do pattern recognition in this case. We want to identify certain patterns from the data which we have captured from the sensors we would need a fast high quality compute.

Perhaps in some cases let us say a graphic processing unit, if it is a machine learning deep learning kind of system which is being built. From the software perspective platform for interfacing with the hardware sensors and software libraries, which can process the data feed coming in from the sensors and also then learn pattern recognition machine learning model.

Now if you look at the hardware we can sense from this perspective the affective computing systems on the basis of the modalities which are used to get the data ok. So, affect sensing can be identified based on what type of data are you analyzing, what is the modality of the data which will then translate into which is the sensor which you are using to fetch that data about the user.

Now a very simple thing for that would be let us say you are sitting in front of your computer and you are interacting with a software using your mouse and keyboard. So now, the modality is the data input which is coming from the mouse and keyboard right. Now let us look at the primary modalities for effect sensing in affective computing systems.

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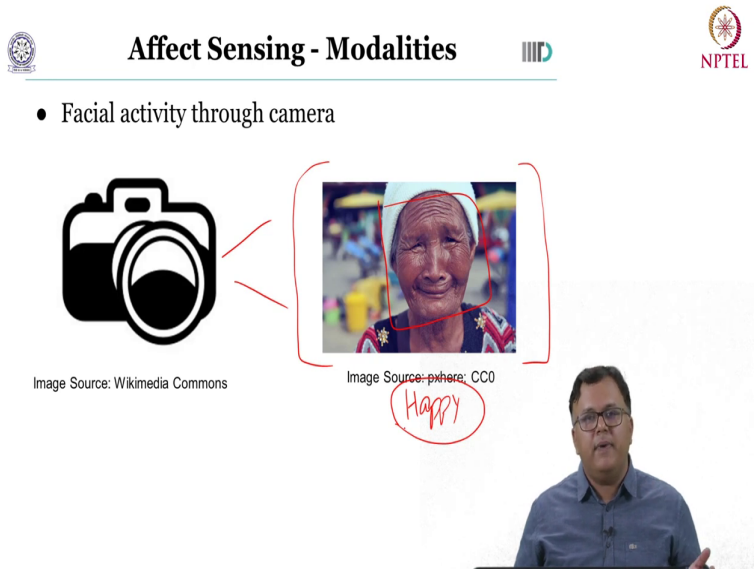

So, friends the first is using a camera sensor we analyze the facial activity. Now the facial expressions which come on your face are a window to the emotional state. So, cameras are very commonly used as one of the popular modality for affect sensing. Now what you are saying essentially here is here let us say you have a camera and on the other side you have a subject you capture the image.

And you would like to understand that for example, for the subject in this image you know the person is happy right. So, capturing is done and after pattern recognition this is the affect which has been sensed that this person in the image looks happy.

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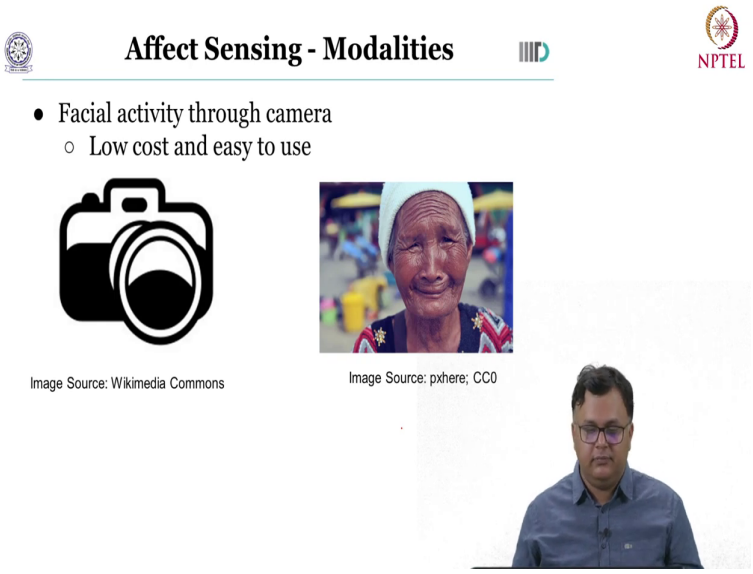

Now in the past few decades we have observed that the cameras are getting better in terms of the image capture quality resolution and so forth and in parallel due to the progress in hardware the cost of cameras is also going down. So, typically now you will see that your webcams in your laptops and the cameras which you have in your mobile phone are capable of capturing high quality clear images right.

So, it means you know if you are creating an affective computing system you can easily find a camera and if you can find a camera given that they are very well already fixed and have an easy to use interface with the machine. For example in your mobile phone or on your laptop you can fetch data from the camera.

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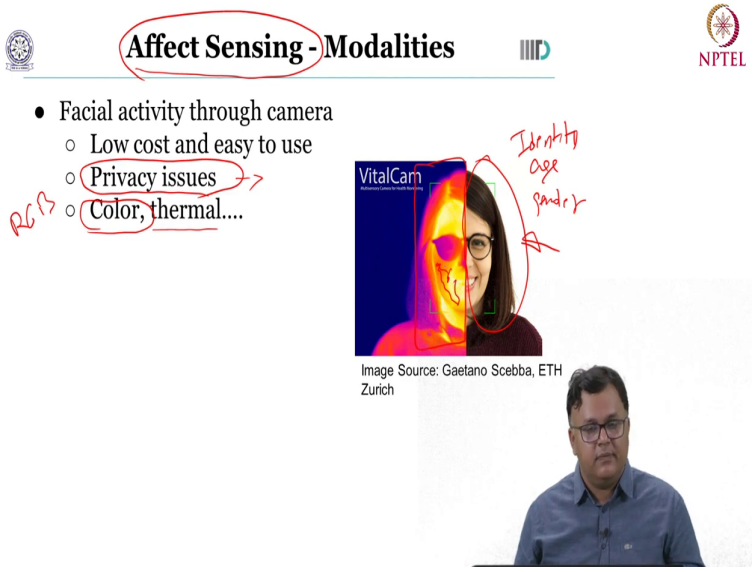

The issue which comes friends is that yes you can capture an image of a person from the camera on your laptop or mobile phone. But why were we doing this? Well the aim was affect sensing we wanted to understand the emotional state of the user. But in this pursue we are capturing the face of the person and this face of so gives us things such as identity age, gender which may or may not be required by your affect sensing system. But it can tell very important information private information about the user.

So, that is where some privacy issues come into when we are using a camera one solution is well most of the cameras which we see around us in our day-to-day lives they are RGB color based cameras right; you get a color image as you can see on this side of the right side of the visualization on the slide.

But then there are other cameras as well for example thermal cameras. So, here you see on the left side friends the feed of the same persons face from a thermal camera and what is happening is this is telling you the temperature distribution. Now, how does it tells us about the affect, an example is let us say a person is feeling fear.

So, that is the emotion and as they are feeling fear they are maybe rapidly breathing. So, when someone rapidly breathes through the nostril due to the movement and action of the muscles the region around the nostril it starts warming up. You can actually sense the temperature difference in that part of the face.

So, one can then use this difference which you observe in the feed coming from a thermal camera and predict the emotion. The advantage of course, is that it is easier to preserve the identity as compared to in the case of color camera, the disadvantages that thermal cameras are expensive and relatively have lower resolution as compared to color cameras. Now, this was for when we are looking at a face right.

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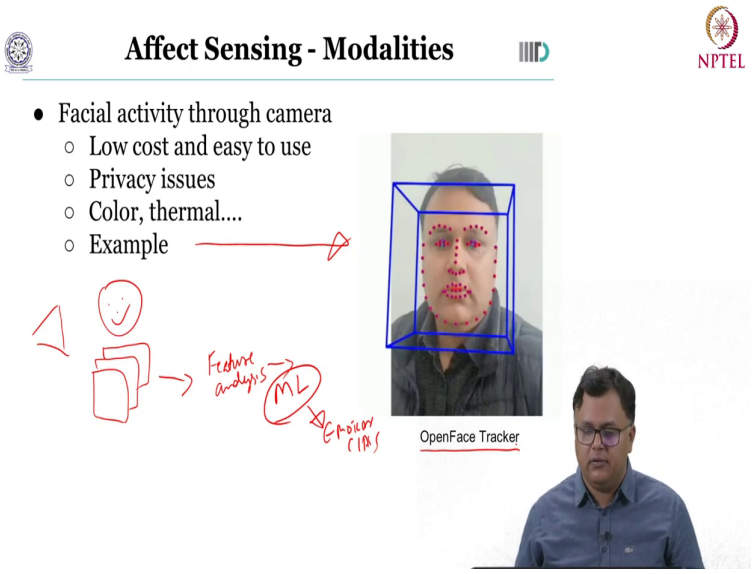

Let me show you an example friends, so let us say there is a camera. So, this is a camera which I have created here is a person you know and you got the image or the videos this is just showing you some frames, you do feature analysis some statistics well we will be studying this in far in detail in the forthcoming lectures. And then you do some machine learning ok, to predict if the emotional class.

So, this is an example which I am going to play for you guys. So, this is well, me and what we have here is the phase being detected using a computer vision library, these dots are telling about the facial points and the corresponding location of the facial parts. So, using the facial point information you can tell the structure of the face which can tell let us say if the subject is feeling happy or not, right we are taking a very trivial example here.

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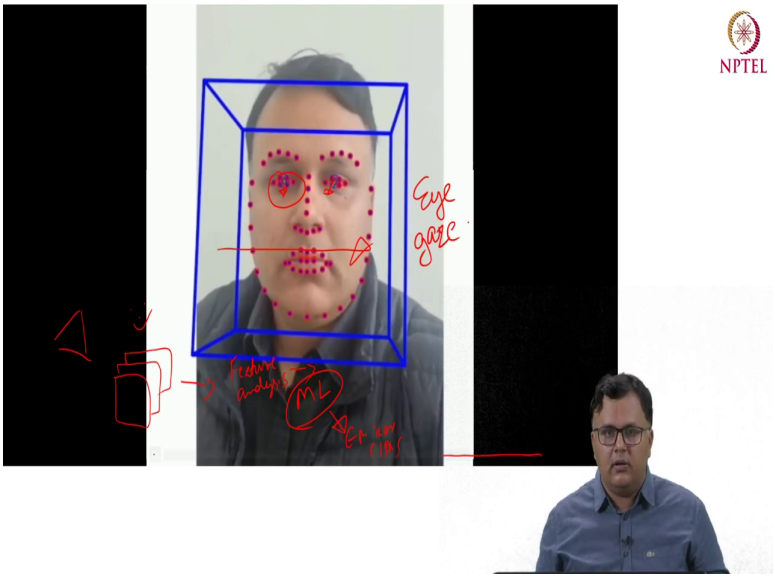

So, this is how it should look like. So, you can see in this case that let me play the video let us go back play the video. So, you see this is happy expression and also that there is a particular direction. So, this is friends this is called I guess. Now gaze also gives extremely important information about the effect. So, it tells you where is a person looking now imagine a scenario someone is watching a horror movie and they are anticipating horror scene coming up.

Maybe in that anticipation the person may not directly look at the screen and may look on their side that is a very important cue. So, you knew that the task was that the person is watching a movie, but the person is not watching the at the movie and you know their gaze is moving left or right; could be that the person is not really immersed in it in not engaged.

Or it is simply an indication that the user since is watching a horror movie is anticipating a very you know high horror quotient scene right. So, you can use the gaze now again your eye gaze is captured through the camera and we have seen in various amount of works that this camera modality based eye gaze that gives us extremely important cues about.

Let us say if a person is making eye contact or not during a conversation. Making of eye contact can be used to assess large number of attributes you know confidence are you let us say speaking entirely truth or not. So, the camera enables gaze along with face analysis.

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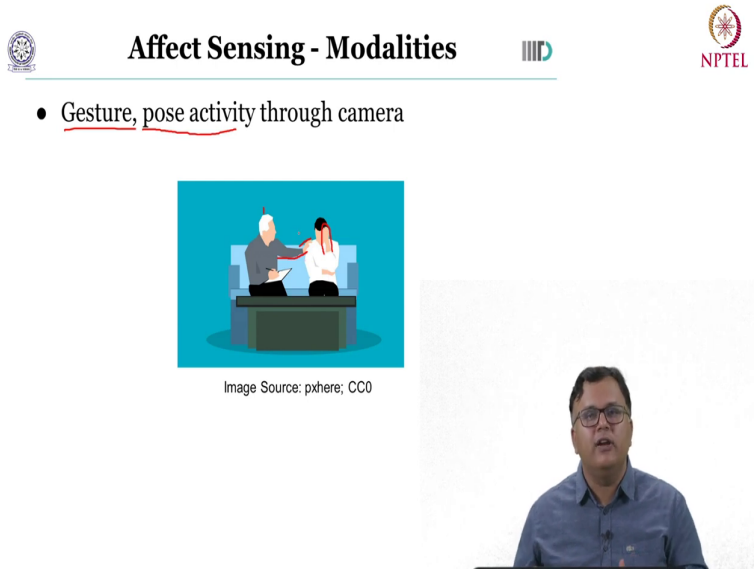

Now, through the camera modality we can also have the pose of the person ok now what does that mean; that means, if you notice my video right now and let me try to act ok. What did

you see a lion at the zoo, now what has happened here guys in this small act I had an a facial expression surprise and even the hand gestures right, they moved up what did you see wow.

Typically you will observe this when let us say people are watching a game right a football or a cricket game you can tell them from the gestures that what is the effect. So, through the camera we can easily tell the pose and the gesture and this pose and gesture can give us important information about the emotional state, you can tell very easily from the image illustration here.

So, here you have 2 people you can see that person one is keeping his hand on the shoulder of person 2 person 2s left hand is on his head and it seems as if they are you know in a situation where person 1 is consoling person 2 and person 2 visibly looks upset right, you can tell that from the gesture. So, this gives us very important information about the affect right the affective set of the user.

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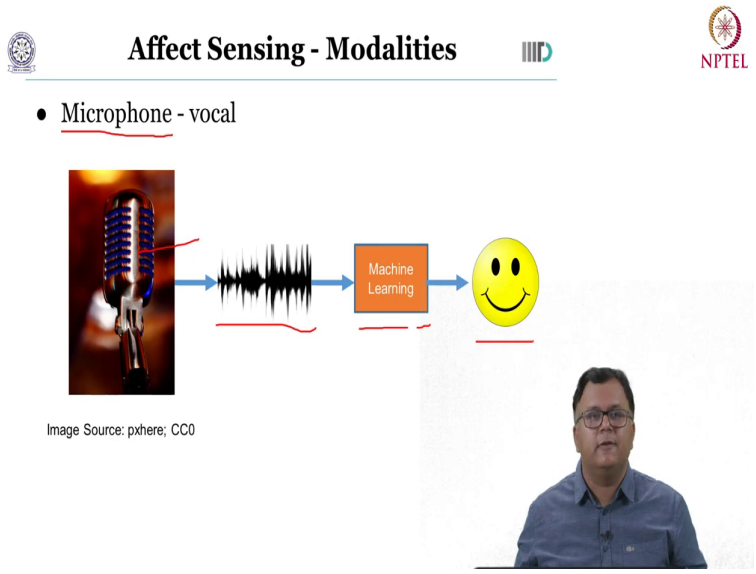

Now let us change gears and move from the camera modality. What we have here is the microphone voice based affect sensing. So, in this case you will have a microphone you will be capturing what the user is speaking and then analyzing this information to predict the effect.

Now in certain scenarios along with prediction of the emotional state of the user through his or her speech one can also make sense of the overall scene. So, through the microphone you will be capturing let us say the background noise, maybe there is some music playing in the background which can tell your affect sensing system that the user let us say is in a place where music is playing.

So, maybe no, the user is not in his or her office. Now if the user is not in her office then could maybe the chances are high that the user is in a casual setting. Now based on the

perceived emotion of this music which is playing in the background I can have auxiliary information extra information about where the user is and that can tell me a more accurate understanding of the emotional state of the user.

So, in this case you would capture the data about the user from the microphone let us say this is the waveform which is captured, we will extract some information from this waveform some features some statistics and then there would be a machine learning model ok. Similar to how we do for faces?

You have a camera you capture the face you analyze some statistics around the face and then you have a machine learning model which is going to predict the emotional state. So, friends now we have seen camera based modality and microphone based modality. So, these are the 2 types of data feeds which let us say if you were interacting with someone you would be analyzing them in real time, you know 2 people are talking one is able to understand the emotional state based on the facial expressions pose that is what the person sees and what the person hears right from the voice tone and so forth.

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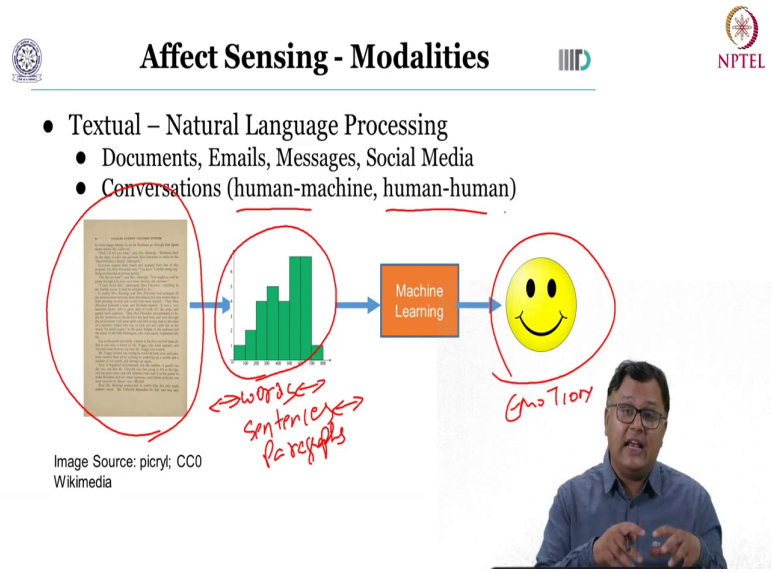

Now another modality in affect sensing which is very prevalent is coming from Textual. Now we have documents, Email conversations, Messages which we send over platforms and then social media post. So, all of this gives us huge amount of data about a user about a scene, but in the form of text.

Now, this text could let us say be a article which someone is writing or it could be a chat which is happening between a user and an agent, because this could be a virtual agent. So, this is like a conversational AI based use case. So, in this case the human is communicating with the machine through text chatting and the response to the human is also in the form of chat text. So, the user now would be sending a message and we can try to understand the affect the tone from that text right.

So, that is coming to the natural language processing right we would like to understand the affective state based on what is written by the user. Now of course, this would span across different languages and what it means is in different languages users will convey the same

emotion, but in different forms different ways of phrasing, different words. Therefore, for this human machine interaction using text we will have different models through which we can analyze words sentences and documents.

And we can also analyze human-human interaction. So, let us say there is a job interview scenario there is an interviewer there is an interviewee, later on we take the speech data transcribe the speech data into text and now what we will have is the conversation let us say between the interviewer and the interviewee in the form of text.

Now, we can analyze this conversation between the interviewer interviewee and extract statistics around that text, which can help us in predicting things such as how was the affect state of the interviewer interviewee varying as the conversation proceeded. So, that would mean an example like this here you have document, you could analyze the words the sentences paragraphs, the links between sentences how the neighborhood words are or let us say a particular word extract these statistics about the document.

Have your PRML the pattern recognition machine learning model and that can tell you let us say the emotion. Now, there are so many applications of text based sensing, you see I told you about this human-machine, human-human interaction chat email and so forth. But it is also about let us say someone was writing a poem someone had you know a document which is coming from a book 100 of years old we are digitizing it.

Now, we want to understand what was the emotion which is conveyed in the document or the poem by the writer? So, we can actually have that objectively measured right and that is the affective sensing part coming through text. Now in the case of affect sensing through text you would have noticed by now friends that the identity information you can hide that in this case. So, you know you can actually do parsing of the text, you can hide private data and then try to make the affect related sense of the data.

Now if you compare that with the camera color based camera or a speech based pattern, because in the case of speech as well one can analyze the speech and extract things such as the probable age, range, gender and even identity of the person. So, one could better preserve

privacy in the case of text as compared to speech and camera based facial analysis or body pose.

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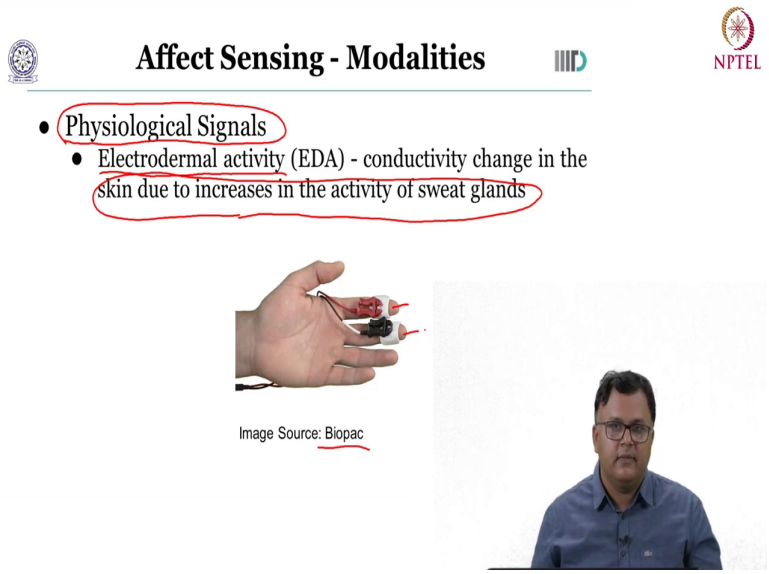

Now, moving in this direction forward the other type of modality which is commonly used in many affective computing applications for sensing the affect is through physiological signals. You could think of it this way when you hear someone and you see someone expressing topic, hearing and watching viewing is based on the facial expression and voice which are outside of the person right.

You see what how their facial expression is you hear what they are saying. Now how are the different parameters attributes of the person inside implicit information. Now what could that implicit information can be a very simple example is heart rate. So, if a person's heart rate is

relaxed with reference to their normal then that is a very strong information for a classifier to judge if a person is let us say neutral relaxed or is aggravated right.

Now, a commonly used physiological signal sensor along with heart rate sensor is your electro thermal activity or Electrodermal activity sensor called EDA. What it does? So, it will sense the change in conductivity in the skin due to the increase or decrease of the activity in the sweat glands which we have on our skin, you know to mind the very small micro scope observable sweat glands. Now what that means? It has been established that as your affective state changes.

You know you could feel more stressed or not stressed angry fear or happy we see changes happening on the skin as well ok. Now you could measure that for example, here you see one of the sensors from biopac where, you are actually measuring this ok. So, there are 2 electrodes here and you are measuring the change in EDA activity ok Electrodermal activity.

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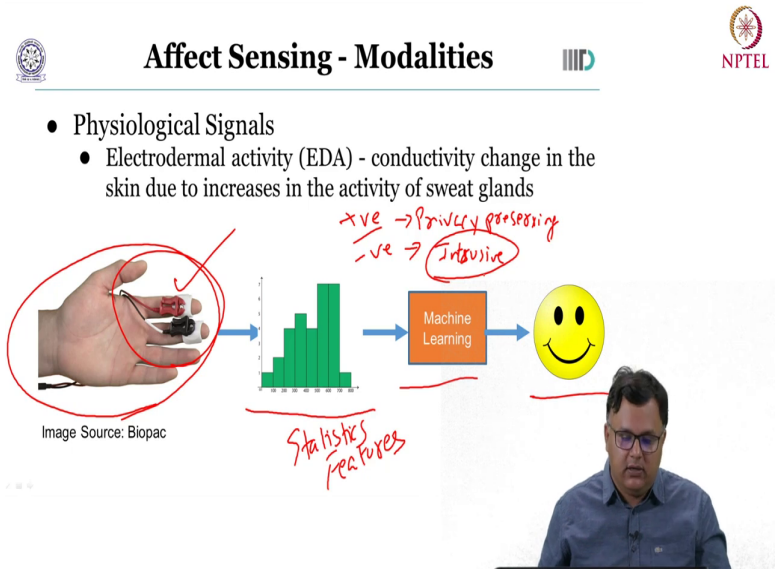

Now, similar to how we did for text you have this modality physiological sensor EDA continuous, let us say data is coming in and we are extracting statistics again about the EDA data there is a ML model and then you predict. Now in the case of your EDA data what is the positive side, you know it is privacy preserving we are not recording any information about the entity of the subject. What is the disadvantage the user has to wear it so it is intrusive right, this is not natural setting we do not wear these sensors.

Of course, now if you see friends the smart watches which are getting quite ubiquitous very common they will have these sensors. So, as the form factor the user experience is such that these sensors are gelling well on the human body in their human uses natural environment they will not notice. However, for these kind of sensors you know high quality high fidelity sensors the user notices that there is something on the finger or you know on the skin.

So, they are intrusive ok, so in a few cases this may actually add to it is own bias to the data that the user is aware of something; but then that is also possible in the case of a camera, right. Now I am looking into a camera and if I was asked to smile or you know show fear expression, I may become camera cautious right. So, that may not be the very natural expression which I otherwise would show in the world around me.

If I was not aware that there is a camera which is noticing me, same goes for this physiological sensor if it is on my fingers I may be aware that, you know if I move too much my hand I am actually you know maybe break away or you know I will add some damage or noise to the data. However, strong you know advantage is that you are preserving the privacy.

Typically we will use these kind of sensors as an ensemble you know they will have multiple sensors in your physiological signal based affect sensing. So, another very commonly used sensor along with the EDA is your EEG ok

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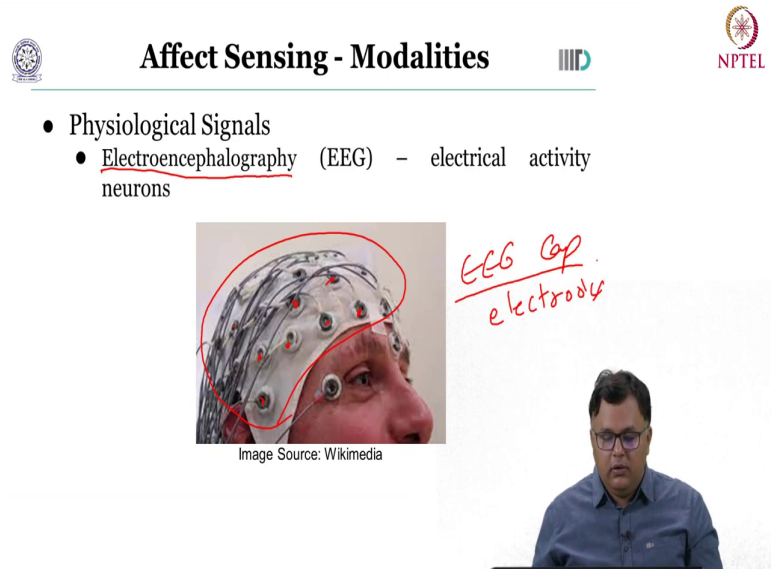

So, that is your Electroencephalography EEG sensor. What is your EEG sensor? Friends you can see here this is a EEG cap ok. What you have here is these electrodes these electrodes and what these electrodes are doing is they are recording the electrical activity in the brain in the neurons.

So, why are we using this for affect sensing? When you see a stimuli a video or you are talking to a person we are sensing what they are saying we are observing the world and that whole perception is happening inside our brain which triggers different neural pathways and that is measured by EEG.

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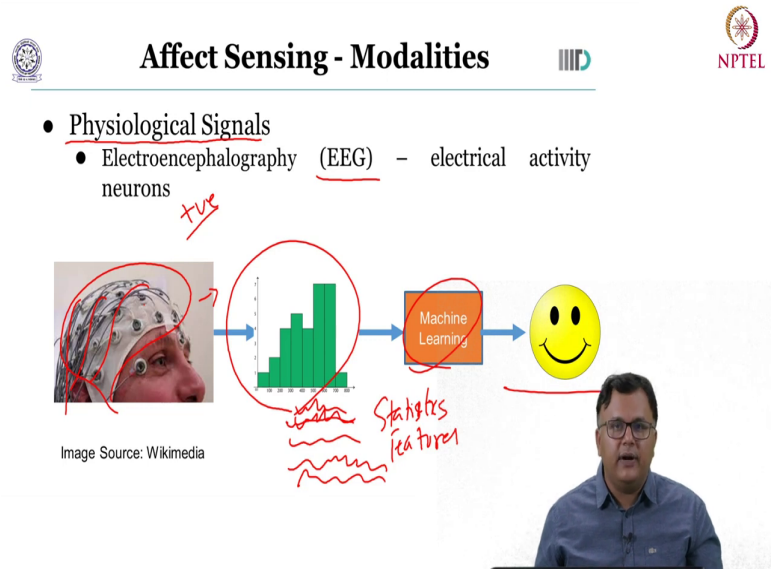

Now you can see here in the case of the EEG the person has to wear you know slowly EEG caps are also getting very user friendly easy to wear. Similar to how we had for EDA strong positive point you are actually trying to get data right from the brain, what does that mean how does it make it different from a camera.

Let us say I was a very good actor maybe I was feeling very happy prior to I came to an environment where the environment is supposed to make me show in the social settings a bit of a sad reflection right. So, what I am trying to convey here is what you are feeling and what you show on your face sometimes that may not have the direct correlation ok. So, what you are capturing from the camera or hearing from the microphone in the terms of your voice of a person that could be more towards a perceived emotion.

But not maybe the real emotion of what the person is feeling right. classic example is the actors you know they some actors will get so much well into the role that they will show different emotions, but are they truly feeling those emotions you know there could be a gap here but, when you come to these physiological sensors for example, through the EEG.

There you are measuring the different signals from the electrode. So, let us say these are different electrodes right, the user can try to control their thought, but that again you know this whole pursue would be captured. So, it may sound like now that you know the EEG is the most perfect type of sensing modality for affective computing.

But it has it is own challenges well one is it is not natural to wear these EEG caps you know the user is aware that there is a you know something on their head, then you have a bunch of electrodes which are connected to these wires. So, if the user moves you know a bit then that noise is also added to the signal which has been captured, the placements of the cap.

And also that if let us say there is a particular sensor you know one of the electrode that is not functioning correctly, you may not actually realize that till you analyze the data. So, the whole process of data capturing has been done, but one may not realize ok. The other challenge which comes with EEG is you cannot trivially easily take it outside right outside of the laboratory setting.

Now, if you compare that with the camera or microphone you can use the microphone or the camera sensor in a mobile phone, take it anywhere with the user and you are able to sense the affect. But with EEG you that is a challenge, but what we get is a ground truth data, data which is far more closer to the user.

So, what is going to happen guys in the pipeline you have the EEG sensor, you sense this data again similar to how we have been doing is extract statistics features and then you have your machine learning model and you give the affect. So, there are a large number of these sensors which are available to us to predict the affect.

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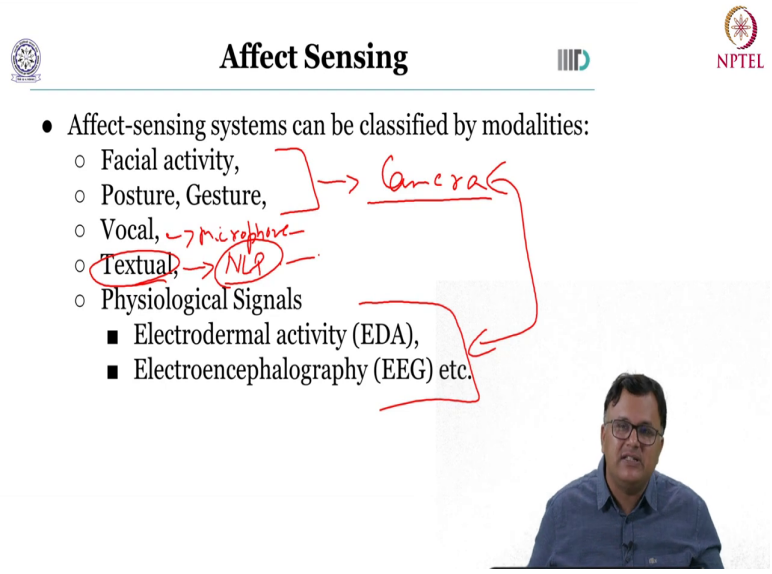

So, in nutshell we see that we can divide based on our discussion the modalities based on camera driven modalities, which give you the perception of sight, the faces, the body pose gesture simple things such as you know the hand tension. Let us say you know me right now strongly clutching my hands and then rotating this give this can give you a very vital queue if in a real world setting I was doing this you know it could tell you a lot of information about how I feel.

Then we have friends your microphone which gives you the voice the background knowledge and you can use 1 microphone when you have multiple people right 2 3 people who are let us say in a closer proximix closer to each other in space and you can have one microphone in between.

Now the challenge with camera would be you may require multiple cameras to focus on different people of a group right. So, there are the settings based challenges which are going to come. Then friends we have your language processing natural language processing through text data documents emails and so forth that is another modality.

And then we took examples of these 2 physiological signals based on EDA your skin and then based response and EEG the brain neuron based response. Typically we will have combinations you know you could have camera plus this or maybe you know a text which is being read by a user. So, you have microphone you have the text.

So, we can use these different modalities in tandem together to get complementary information. Now all of this is dependent on the type of project on which we are working right, what is the type of data which is available, what is the scenario in which the user will be using the system?

So, that will decide you know if a camera is possible is privacy super concerned and if it is a static position let us say a person can sit and then you can use a EEG kind of sensor or not. So, with these friends we reach to the end of the first part of the Fundamentals of Affective Computing, in the second part I will be introducing you to some of the applications in different domains of affective computing.

Thank you.