Affective Computing
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Week - 01
Lecture - 02
Fundamentals of Affective Computing Applications

Hello and welcome back. I am Dr. Abhinav Dhall from the Indian Institute of Technology, Ropar and I will be discussing today the Applications of Affective Computing. Friends, this is in the series of the Affective Computing course which we are conducting on NPTEL.

So, in the last lecture, we defined affective computing and then we looked at the various modalities which enable the content to be captured can be from a camera, from a microphone, from a text respective. And then, how we can have a computational model which can predict the effect which tells us about the emotional state of a user or a group of users.

Agenda

- Applications
- Health care and wellbeing
- Education
- Human-Robot Interaction

So, the agenda for today is discussing about the applications and later on we will be talking about the different areas in which emotion, recognition, affective computing is applied.
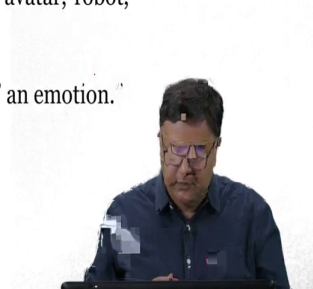
Applications (Picard, 1997)

1. **Detection:** Systems that detect the emotions of the user

1. **Expression:** Systems that express what a human would perceive as an emotion (e.g., an avatar, robot, and animated conversational agent)

1. **Perception:** Systems that actually 'feel' an emotion.

So, with respective of applications what we can do on principle is, we can have a system which can detect the emotion of the user. And then in this pursuit, the system would also express the appropriate emotion which is in response to what has been detected. So, the first step as we discussed in the last lecture is affect sensing, the machine understands the emotional state of the user. And the second is to express appropriately, which is a reply to the understanding which the machine had about the user.

Now, when we are expressing we are talking about let us say an avatar or a robot or an animated conversational agent which would try to show facial expressions or would try to have the variation in the speech which would then give a perception of an emotion which is there in the speech.

An example of that could be, let us say if I was a digital avatar, then if I was to greet a user, option 1, could be I could say hello and welcome. Now, this is very neutral the other could be, let us say I want to give a cheerful greeting, so I will say hello and welcome. So, this now has a emotion which is more towards the positive side, more towards the happy side which is indicated by my speech, right. So, this is on the generation part, the synthesis part of the emotion.

Now, we would like to actually create these systems which can perceive the emotion, right. So, this again is part of the affect sensing who step in the affective computing.

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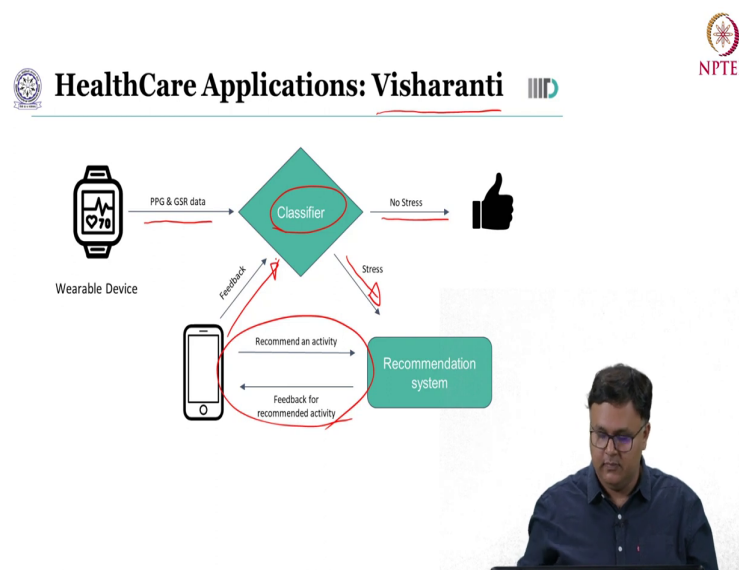
So, now, let us look at first the perception you know the detection aspect. So, if you talk about the healthcare and well-being domain, there are a large number of applications where

affective computing is highly relevant. An example is this project being done at IIIT, Delhi by Dr. Jainendra Shukla's lab which is called Visharanti.

Now, the aim of the project is using the sensors in a watch in a smart watch, we would like to predict if the user is stressed or not. So, essentially with the sensors which are there in my watch, we would be capturing the user data, then we would be using a classifier. Now, this classifier would either tell us if the user is not stressed or if the user is stressed.

Now, if the user is stressed, then there is a recommender system which would recommend an activity and then there is a loop forward and backward which runs between the user, the recommendation, which has happened and it can be added to the classifier as well.

So, what it means is we are learning online the user behavior. And then, we are trying to personalize the model, so that it can predict not just the stressed or non-stress state of the user, but also give appropriate recommendations when the classifier predicts that the user is stressed.
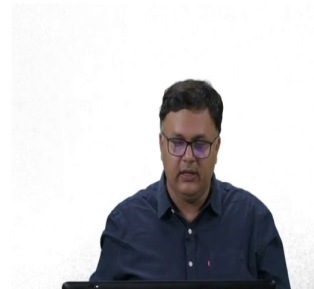
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Now, in the same direction, there is another very important application. So, typically patients who are suffering from Asperger syndrome or are high functioning autism. So, you know they are on the ASD spectrum. So, there would be record keeping which is done let us say by a parent for their child who is on ASD, could be prescribed by the doctor.

Now, in that there are several questions for example, how was the child behaving at a particular instance in time or was the child agitated, was the child relaxed. Now, the answer to all these questions is based on the subjective interpretation of the child state from the perspective of the parent. So, the parent would input into the app if let us say the child seems to be relaxed or not.

Now, this subjectivity and the continuous record keeping which is required is actually time consuming, can be noisy because you know there is possibility of confirmation bias coming

into the picture. To this end, we can use effective computing and behavior analysis to automatically detect the state of the patient for example, if the patient is looking relaxed or stressed. Now, this can be based on the visual cues, the expressions and all or it can be on the basis of speech.

And we can then use these apps which can automatically do the record keeping for us. And over the time this longitudinal data would be a very rich analytics which can be then presented to an expert a doctor and that can help in you know let us say better diagnosis or treatment.

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Now, another important aspect of role of affective computing in healthcare is in the case of PTSD which is the post-traumatic stress disorder. So, a typical example of this is soldiers who have been to war or similar you know difficult circumstances. So, when they come back

the effect of the happenings in that war or similar circumstances that may lead in a few cases to PTSD, right.

So, using affective computing, we can detect the changes which have happened in a person which is reflected in the way in which they are communicating based on the body gestures, speech and facial expressions. And this information can then be used by an expert to give suggestions treatment to a particular patient. For example, here what we see is an app called StartleMart.

It is a platform which has these virtual environments, right. So, these kind of treatments can be used wherein both the stimuli can be used for generating illicit an effect in the person and also remedies can be given. Another example from the tester HCI group is these interviewers who are interviewing this refugee. If you notice there is an EEG headset, a physiological sensor.

So, as the interviewers ask question to the interviewee, the response which is given by the interviewee and their perception of the questions, the discussion which is going on it does affect how they are feeling, and then that is recorded as part of the EEG data which is captured by the EEG sensor.

So, later post analysis can be done and we can find out different attributes about the affective state which tells us about how that person is feeling and is extremely helpful in looking into how their mental and physical health is. Which of course, for example, in this case of a refugee would be an important information and let us say their rehabilitation and how they are actually getting absorbed into the new society.

Now, changing the gears friends, there are other of course, you know health and well being applications of affective computing. Now, let us move to the education applications. So, in 2014, Darnell and others proposed EngageMe. Now, what EngageMe is this is a system which is using a physiological sensor which is measuring the skin conductance.

And along with the video feed it is capturing how the student are in a classroom such that we can collate the overall engagement and affect for the teacher to later reflect on. Now, if you see when you are looking at the skin conductance data, of course, there is a sensor which is you know on the let us say the arm of the student, and then there is a camera in the classroom as well. So, together the data from this can be combined to do rich analytics.

Of course, you know when you talking about video feeds, you have to be super careful about the implications of the identity of the person and also you know if the data which we are
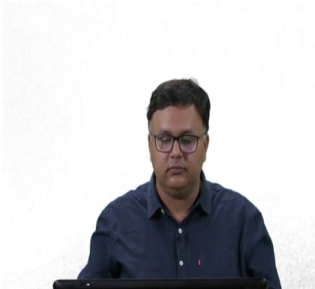
capturing about the user it is not in any way releasing or leaking the identity information about the user. Now, on the same lines as EngageMe, there is another work called subtle stone. So, it was proposed before EngageMe by Balaam and others in 2009. Now, this is fairly interesting.

Now, what Balaam and others proposed was a wireless hand held squeezable ball which allows students to communicate their affective and motivational experiences to the teacher in real time. So, now this is you can say a variable object and you know based on the how the feedback to this squeezable ball is, you know that can be uses an indicator a way of communication and we can use that as rich analytics based on the affective state.

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Now, here is an example of a student engagement and learning effectiveness measurement using facial expression cues. Now, this demo is from the machine perception laboratory at the

University of California at San Diego. And what is happening here is that this is the tutor, here is the student and they are interacting asking about some maths questions.
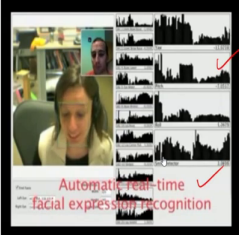
And the student is telling about the complexity of some of the questions and while they solve their facial cues are being analyzed for different expression categories and that is used to map to the self reported complexity of a question which the student felt. Now, let us look at the video.

To face the math this is the research project at the machine perception laboratory of UC, San Diego on using automatic facial expression recognition to improve interactions between students and teachers. In one particular project, we are measuring the facial muscle movements of the student in real time using a face detector and an expression recognition.

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Now, here is the rich analytics which is essentially you know given from a smile detector and then the movement of the head which of course, you know then shows you engagement and so forth.
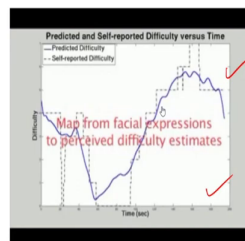
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Now, when this information is collated, you see the difficulty versus time, and you know how the self reported difficulty and predicted difficulty, they are actually having a correlation. Now, what it means is you can use the facial expressions head pose cues and then apply it to better learning environments to assess if we have effective learning in a classroom environment and in today's context in online environment as well.

Engagement Prediction

Source : LASII, IIT Ropar
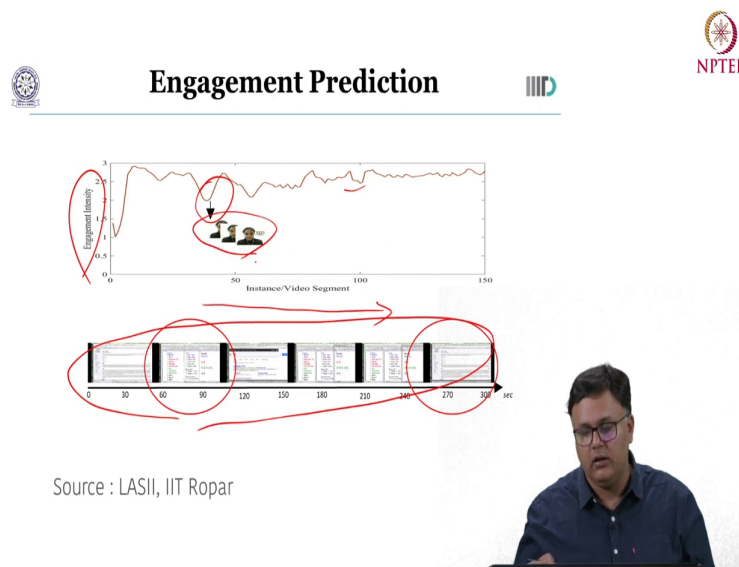
Now, let us say if it was an online learning scenario then one could predict the engagement in the form of the facial expressions eye gaze. Now, friends, eye gaze is the location on to which your pupil are fixating, right, so where are you looking at this point, ok. And using head pose gaze you can actually learn a classifier which can predict the engagement intensity, ok.

Now, as you can see in this example here, you know here is the timeline of this educational video which is being studied by the students. This is an online material. And what we see is for example, and at this points the engagement is fairly high. Here you see that there is a dip.

And you know in this case the person actually is looking downwards and not at the screen, right. So, we can do this fine grained analytics and then see what is the engagement level of a person when they are consuming, when they are viewing this material.

Now, one can go a step ahead, right. So, you can quantify engagement and you can say for example, you know you could have low level where the person is not paying attention you can tell them from their head pose and their gaze and you know let us say the facial expression as well.

And the other is high where the person is really fixating on the task. You can imagine this also from the perspective of the car driving monitoring as well if the driver is paying attention. Now, here is an example I am going to show you from human-robo interaction perspective. There are two paths, the first of course, is the sensing part. Now, what is going to happen in the video is that there is a robo and that robo is speaking about a life experience.

Now, this life experience is borrowed from a popular ted talk. In the field of view of the robo there are users, let us say these are the users. Now, based on the head pose that is the location

and the angle of the frontal part of the face with respect to the view of the robo. The robo judges the engagement of the group.

Now, if the engagement goes up the robo maintains its pitch and volume. If it goes down, then the robo adds variation. Now, this is the sensing part and the response of modulating that is the reflection on the basis of what we sensed. Now, what was also going to happen is that the gesture of the robo are based on the text which it converts to speech. So, what the robo is speaking the gestures are also generated accordingly. So, let us play the video here.

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She refused to sign the final adoption paper; relented a few months later when my parents promised that I would go to college. This was the start in my life. Now, there are some interesting points which come into the picture. One is let us say there is a communication

happening between an agent or a robo to a user, right. So, it could be either an agent or robo talking to a user.

Now, how does the agent or the robo realize that the conversation is ending? The other question is what is the appropriate behavior of the robo or the agent once they have predicted the affective state of the user. A simple example can be, let us say there is a robo, a social robo in a house, the user walks into the living room and is visibly distressed.

The robo using the camera locates the face of the user, analyzes the facial expression, and if the robo is able to sense that the person is distressed, then they can for example, maybe crack a joke or can ask questions or give relevant information which can help the user to feel better. Now, on similar lines one could also use affective computing and the analysis of the face and speech in training, ok.

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Preparing You for Interview

- MACH (My Automated Conversation coacH)

Source : Eshan Hoque, MIT Media Labs

So, here is an example of the My Automated Conversation Coach, the MACH system which was developed by Eshan Hoque and his team at the MIT Media Lab. Now, in this case there is a virtual agent and there is this is the user. So, they are they have a conversation. And in this lieu, during this there is a camera and the camera captures the face of the user, and in this it will look at things such as presence of smile, the head pose, gaze and so forth.

And then the user at the end of the conversation can get very rich analytics about how they were perceived based on their expression or head pose. And they can use this to train themselves let us say to speak better. An example could be during an interview process, so you can prepare yourself to speak better in an interview process. So, let us see the video. Now, this is a video of which is available on YouTube.
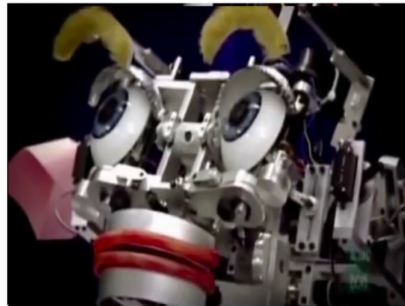
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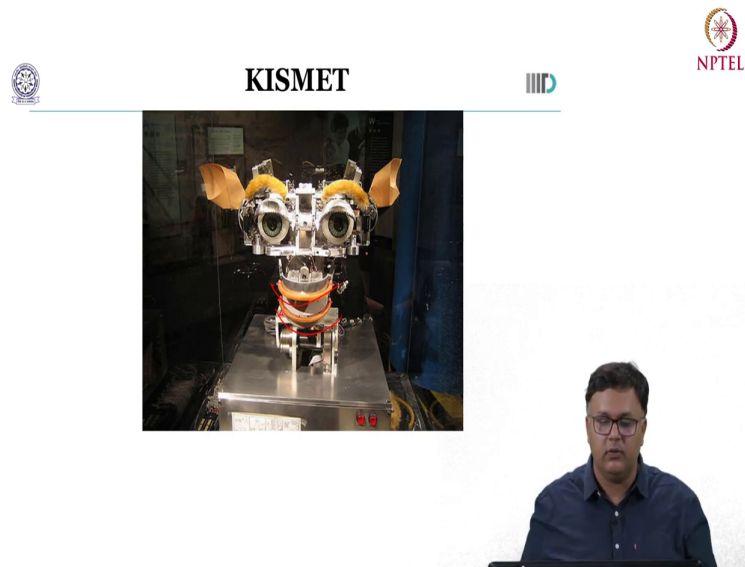
Now, here is another example. Now, this is the robo named KISMET which was developed in the late 1990s at the MIT Media Lab. Now, what the robo does is you know it senses the persons facial expression and then it will try to mimic it you know and it will as a try to give a big smile, if you showed a big smile in front of the robo. So, the aim is quite simple, you will sense the affect and then you react accordingly.
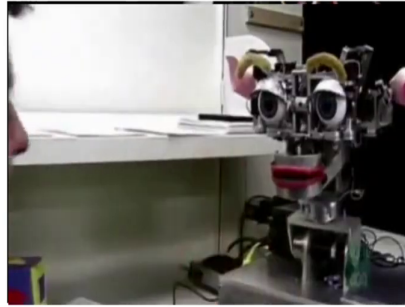
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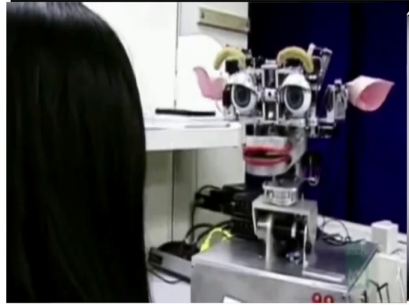

Now, here is a video of the robo.

In 1997, professor Brooks and his team built KISMET, a small robot with eyes, ears and a mouth, so it could see, hear and experience the world around it.
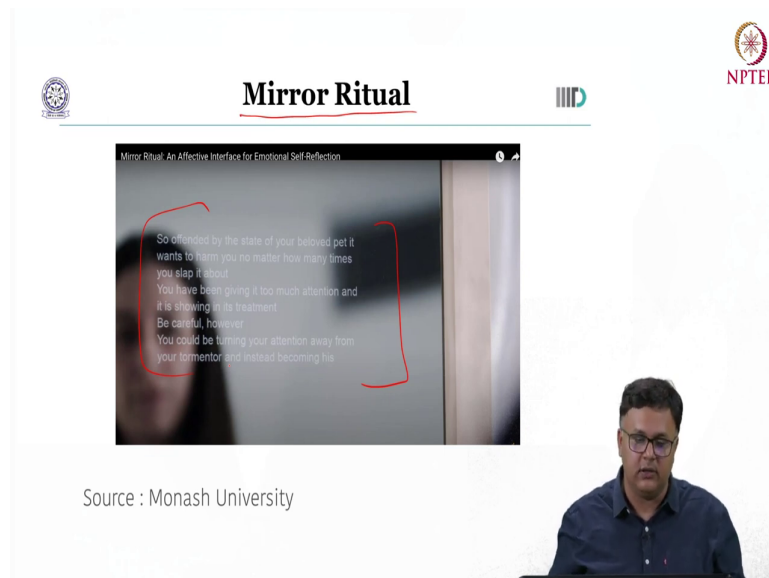
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Mirror Ritual

Source : MIT

Look at my smile. (Refer Time: 22:33) that was cute.

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Source : Monash University

Now, moving to an a smart interface. So, this is an example from Monash University wherein they proposed a mirror ritual system. What it does is it looks at the emotional state of the user through a camera and then it would generate this text could be a poem which is better mapped to the emotional state of the person, right.

So, they propose this as emotional self reflection tool. So, there is a mirror, there is a camera you come in front of it, it senses your emotion and then it will generate this poem which is based on the emotional content which is you know a reflection of how the user is feeling based on their facial expressions and so forth.
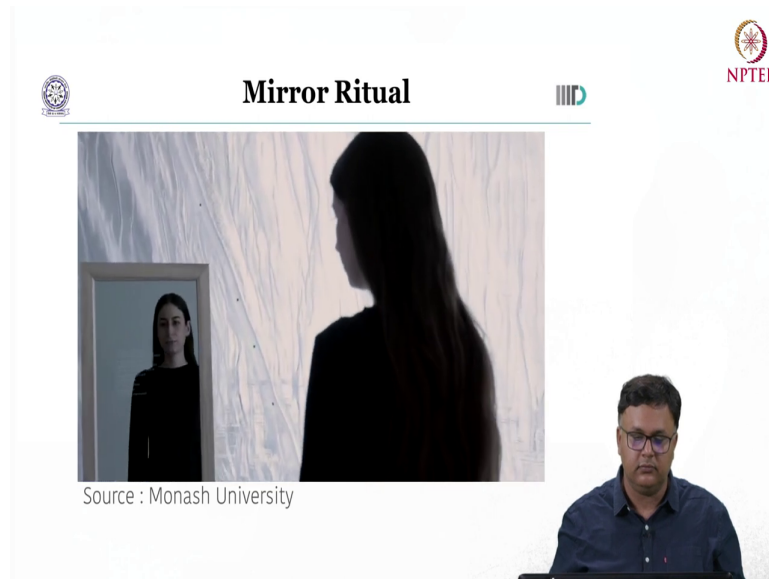
So, again in this we see the sensing part and the response part. I mean the response here is the text which is generated by the mirror. So, here is the video.

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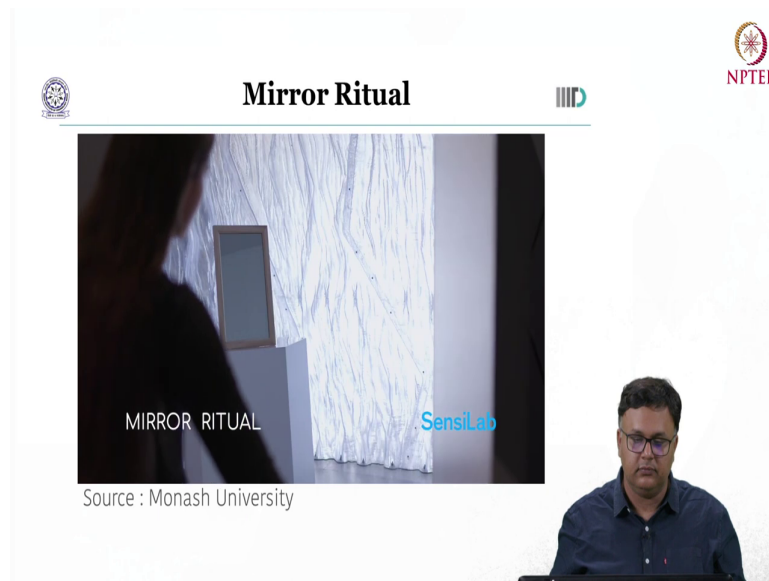
Mirror ritual is an interactive artwork that challenges the existing paradigms in our understanding of human emotion and machine perception.

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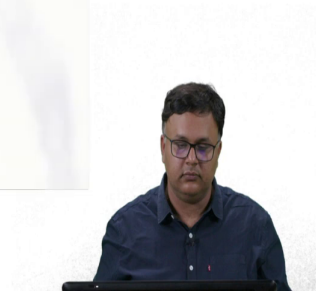Through AI generated poetry, the mirror speaks to the viewer.
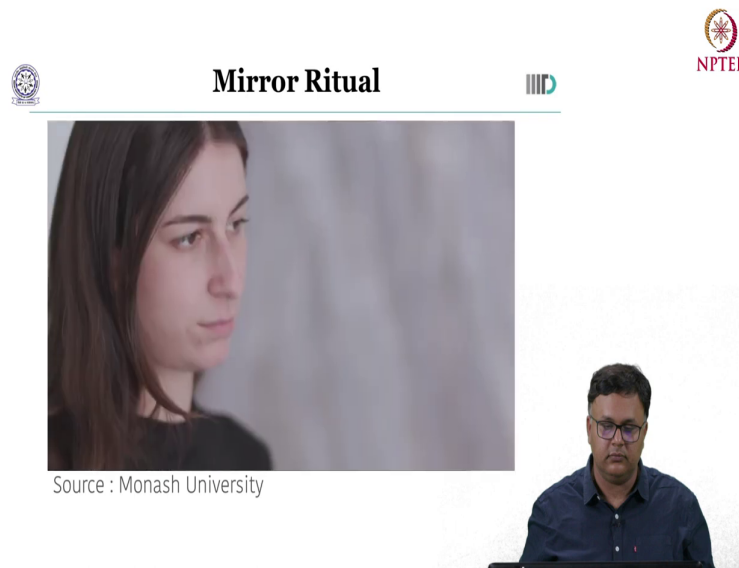
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Mirror Ritual

Source : Monash University

Each poem unique and tailored to the machine perceived emotional state.

Mirror ritual augments the human experience of emotion, expanding it beyond the internal un reflected experience into the realm of the tangible and expressible. Now, friends, we see all these applications, right in healthcare it is there, it in education domain it is there, we have it in driving as well. In fact, now there are games coming up. Now, in these games you know one of the expectation from the user is to show let us say a particular facial expression.

So, let us say we have this game which is designed, created to help a patient learn to express better, to show facial expressions better. So, in that case the task would be to generate to show facial expressions on the users face. And then there is system which is trying to predict that if let us say the smile was you know a high intensity smile, right only then the person moves to the next level. So, you know there is a gamification as well. So, in this as well the facial expressions and the affective cues are being used.

Now, for such interfaces you know where you go to the next level in a game when you show a certain facial expression, now these are now emotionally aware or you know emotion aware interfaces. So, the pursuit of again is now on the lines of creating these smart interfaces which are aware of the emotional state of the user. So, that the content which is shared to the user is in-sync with how the user is feeling. And let us say not to overwhelm the user with information which can have any adverse effect.

Now, in the pursuit of creating these interfaces you know there is the whole domain of UX you know. This the user experience how the user will be experiencing when they are interacting with the you know interface and there is a whole line of study in this user experience, how we can get the requirements, how we can then test the requirements, right.

I will briefly touch upon this and then I will discuss on you know how we can use for example, you know an affective computing based technique to expedite and to know the user requirements and the user response better, when you are talking about the user experience, ok.

So, let us formally introduce user experience. So, UX now it is a very broad area it encompasses many aspects of a user's interaction with let us say a product. You could be designing a website and the organization, ok. So, it is typically saying you create a website and now you would like to understand before releasing it to the masses how do the users in a control group feel about that website.

Now, in this context usability is more the practical side of the things. So, the question is you know how much easy it is let us say for a user to achieve a certain goal through this website or this product which you are creating and in that pursue of achieving that goal how easy or how easy interpretable the information which was presented to the user was.

Now, the combination of these two would lead to a better understanding of the emotional experience and interaction with a brand and you know hopefully add to a memorable positive experience. An example of that is let us say we are creating a website for old age users, ok.

Now, when this old age user goes on online, goes to this website, and let us say they are supposed to find certain information, ok. Now, how easy is it for them to fetch that information, and how can the system recognize that if a person is now struggling to find that information.

Once it recognizes this let us say confusion state then how can the system react, right how can the information be better presented. For example, if you do not find any information may be trying to increase the font of the certain part of the page on your website.

Now, in this whole process, before let us say you make your website live how are you going to test it, right, how would you actually know that the experience is good, it is easy to use and

the purpose is also achieved, right. The purpose of let us say while you are creating a website in the first place.

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So, but additional approach would be to do you know this participation design. So, a typical approach here would be to do participated design acceptance test. You know where you have these control group stakeholders who would be involved in the design, right. So, from the website for elderly example you know you could actually have a few elderly users and you could fetch the information from them, that how they anticipate you know how they expect the website to be, right.

Now, this will give you idea about the aspects of the user centered design. This is what the user wants, right. And then once you know what the user wants you can actually have the website design accordingly. Now, there are different approaches from 91 from Muller, this

PICTIVE approach. And then once you have done this you have the acceptance testing as well, right.

Now, you would like to test the product and you want to understand the functionality, usability, reliability and compatibility. Now, from our example of the website for the elderly you know how correctly the website is functioning, how is the user reacting and what is the feedback from the user.

Now, this feedback from the user is typically done in the form of self reporting, you know you could actually let us say give a form to the user. And then have a series of questions which would be validating, you know let us say your design hypothesis and your design philosophy and are the goals of the product let us say the website example which I shared with you are those goals you know served or not.

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Problems!

- Users have to articulate exactly how they feel about the products in the form of focus groups and surveys, which can be plagued by issues like participant bias, recall bias etc.
- Advanced UX/Neuromarketing
  - Application of Affective Computing/Neuroscience to marketing.
    - How customers use their mind while responding to products?
    - How this impacts their decision making?
- *To gain new perspectives and have a more accurate measure of customers' functional mind*

Now, there are some issues when you are talking about these self labeled or you know these surveys which are performed. The first is you know it is non-trivial sometimes for the users to articulate very clearly you know how they are feeling about or what is their experience with the product. And typically, what is observed is that these are you know affected by things such as the participation bias, you know n number of people already saying this is the good product.

I am not so sure, but well you know because n people are saying, I will also say yes this is the good product, right. And then also based on our prior experiences you know history how the prior memory, you know memory is going to affect our judgment of the current product in during this testing phase.

Now, let us say you know you we take an example of this website and this is about you know marketing, ok. So, and videos, so these videos which you want to show on to this website which is for elderly users. So, what we can do is you know we can use affective computing now here. Now, you see how affective computing is going to come into the picture. We understood the user requirement, we created the website and now we want to understand how the user feedback is, ok.

Are our objectives met or not? If they are not met, then we would like to go back you know rehash and improve the site improve the product, and before releasing it to a wider audience. So, what we can do when the people in our control group the participants they are exploring the product the website in this case.

You know we can then have the them being analyzed using a system which is going to look at the different aspects such as expressions and head pose and so forth, ok if you are using a camera. And once you have this information, you can then you know make a decision about how you know the changes should be or how the product is actually turning out.

So, let us see you know what we can do in this case. So, you can you know we are taken this example of a web based interface for the you know website and some main considerations when you are going to create this kind of website or user interface usability with, usability testing with affective computing is you know how are you going to have this control group?

What are the type of sensors which you are going to use? Are you going to have you know large number of users, who are going to be evaluated? And how comfortable these users are let us say to be analyzed through a camera? Or how comfortable are these users when you put a physiological sensor on them? Right.

So, here is an example. So, this user is participating in a study. Let us say there is the website which the user is browsing. Now, here we have the EEG headset. We also have a camera. So, you can now analyze the let us say the action units, the facial expressions, and along with the EEG signals you can use it to understand how was the user behavior when they were doing a certain task on the website, ok.

So, this can give you very valuable information. And when you are going to collate it over large number of subjects you can then find out similar to that engagement example, ok. So, they when the user let us say is trying to search for a information, that is where you know they let us say lose interest because it is non-trivial to find information on the website. You know, this is an example.

Now, while we are discussing all these applications it is important to explore the ethical considerations, right. You talked about health related applications, education related applications, right. Now, particularly for health and well being we might be dealing with the patient. So, it is extremely important to be observant of the following.

When the user is prompted that ok, you may take a break because the system sense that you are a bit stressed. The system sensed that the user is stressed. Now, there are these ethical boundaries here, ok. Is the user aware that the system is analyzing the user? Is let us say recording their physiological sensors or is analyzing the speech or vision?

So, has the user approved for this? And once the user let us say has approved the system analyzes for stress or let us say you know the facial expression which are going to link to the emotion and gives the recommendation, then is the system trying to manipulate the user. So,

the what is that fine line, what is that boundary which we can allow for the system to recommend the user about something? Ok.

So, what this means is it is not about just computer science scientists who are going to come and create the system, but it we also need experts from social sciences about what is going to be the user behavior, how the user ideally should react and how the system should present the information.

The other super important aspect is privacy. You know quoting from Professor Rosalind Picard emotions perhaps more, so then thoughts are ultimately personal and private, right ah. How you feel, it is a very private thing. And to analyze the emotion of a person or user through facial expressions or speech or a through other modalities could be invading into their privacy.

So, what it means is we have to be mindful of the user identity and personal information being hidden. An example of that is, let us say a system was being created for analyzing the effect of adding certain new feature in app which is used by children. And for analyzing the effect of adding that feature the developers use facial expressions.

Now, when you analyze the facial expression of this subject, you have to make sure that you only share or record the facial expression, but not the identity or the personal information. And that facial expression can simply be saying for example, at time stamp t 1, subject 1 was showing a neutral expression.

What could be invading into privacy is you could say at times mt 1, subject 1 name showed neutral expression, right. You do not want to diverge the identity and right. And also what are the scenarios where you are going to use this information. So, let us say if we have a system which is used to online assess an interview candidate and the candidate is shown to be visibly stressed, the system detects that the person is stressed.

Now, maybe that person is stressed due to something which is outside the scope of that interview, ok. Should that be communicated to the interviewer or anyone who is going to

analyze the video later on? So, we have to be very mindful in effective computing about the privacy aspects of the user.
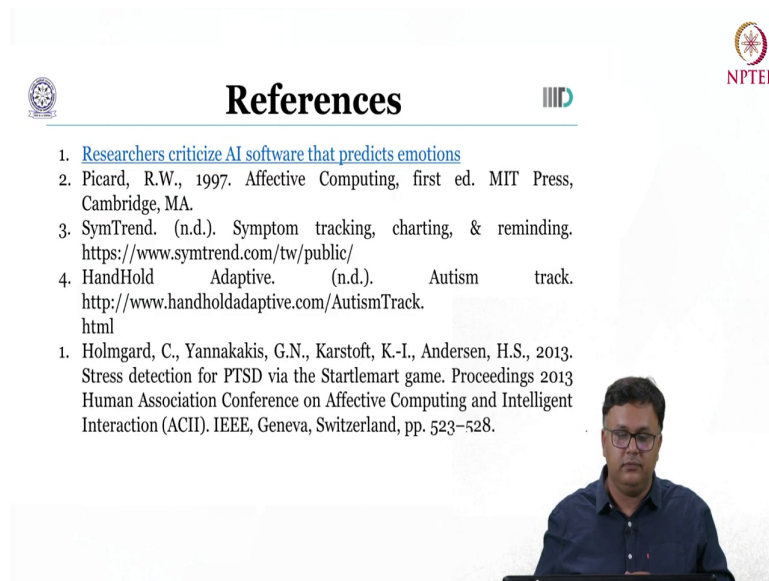
Now, the third, ethical consideration is emotional dependency. Could having users routinely use these moral agents create codependence? Checking your expression or you know getting and getting analyzed your speech pattern and then you know getting this feedback from the system, that ok please let us say take a break or you know you are doing very well. So that means, the user gets too used to this, you know is too dependent on this kind of information.

So, this means when designing such application and system which use affective computing, we need to bring into experts from interaction perspective as well, that what is that point after which the user could get too dependent, right; could like to get the feedback from the system, so as to do simpler tasks.

Now, the designer could have started you know the system could have started with a noble, you know aim that we would may a let us say the expression or the emotion and then we will recommend something or you know we will show a some analytics. But on the other side we see you know that the user gets so dependent on it. So, what is that fine line?

And of course, then; that means, this is actually based on how the system was designed, what was the intention of the system, and how well it was tested before that effective computing enabled system is released to a masser audience.

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So, friends, with this we reach towards the end of the application part of the fundamentals of affective computing lecture. We discussed about the different applications of affective computing focusing on healthcare and well-being. Moving on to the applications in the education sector, online tutoring, and then we saw examples of human-robo interaction and interfaces as well.

Later on, we moved on to how we can have objective feedback in the form of the emotions which can be used in let us say an example like neuro marketing or creation of a product, where you would like to understand the user feedback, right from the perspective of user experience and so forth.

Thank you.