User Centric Computing for Human-Computer Interaction
Prof. Samit Bhattacharya
Department of Computer Science & Engineering
Indian Institute of Technology, Guwahati

Lecture - 03
Latest research trends

Hello and welcome to the third lecture of the course User Centric Computing for Human Computer Interaction. So, before we move into the lecture content let us first recap what we have learned so far.

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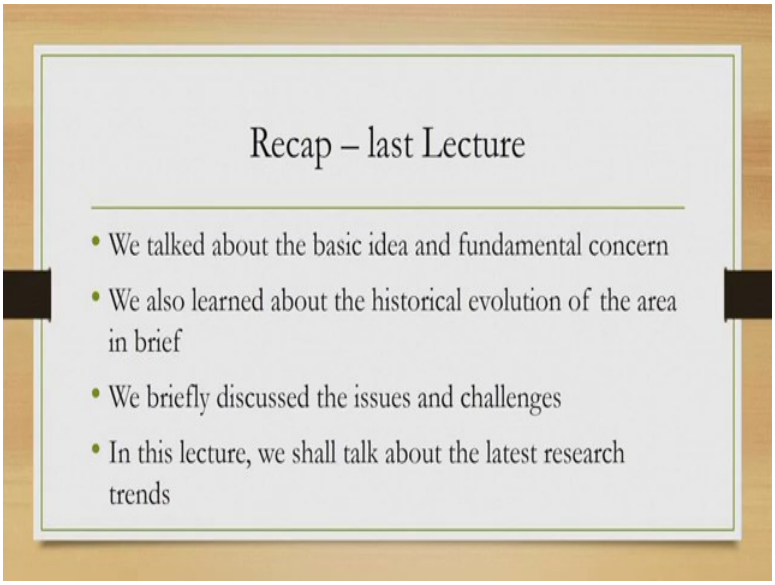

So, in the earlier lectures we have seen the basic idea about what is user centric computing, what is user centric design and so on. We also have briefly discussed about the historical evolution of the field plus we introduced the issues and challenges that typically are the main concerns for those who are working in this area or in this field.

Now, in this lecture we will discuss in some details the recent trends, the trends that define the research activities in the area. So, there are actually there can be many ways to represent the research trends, what we will do is we will try to categorize them in broad areas. So, according to our categorization we can broadly say that there are four research areas.

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Interaction with mobile devices, non-traditional interfaces and interactions, interaction in computer mediated environments and the ubiquitous environment.

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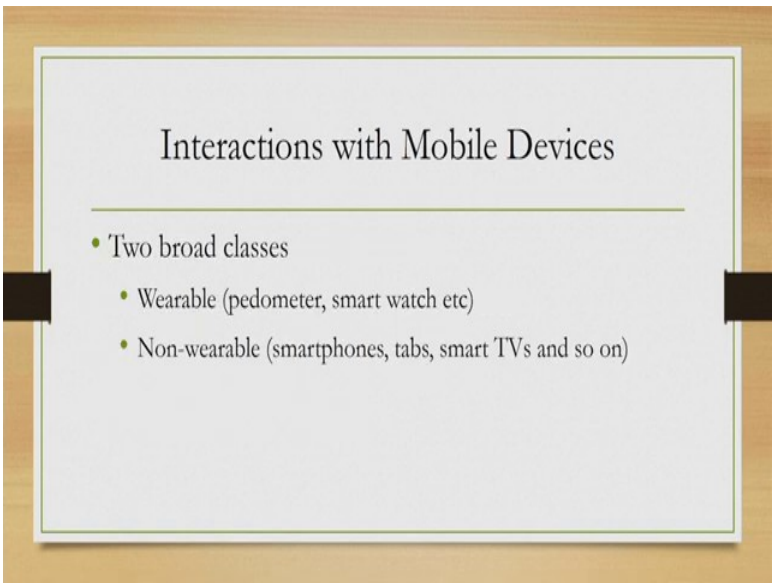

Now, let us take this up one by one. So, when we are talking of interaction with mobile devices what we mean to say is that nowadays of course, as you can see all around do all of us carry at least one mobile device. Can be a smartphone, it can be a tab, it can be a smart watch many things. Now, these mobile devices can be again divided into two broad categories; some are wearable and some are not.

Wearable devices are those that we wear on our body for example, the pedometer digital pedometer, the smart watch, the smart glass so on. Other devices that we use like the smartphone, the tab these come under non-wearable mobile device. These may include even your smart TV and so on.

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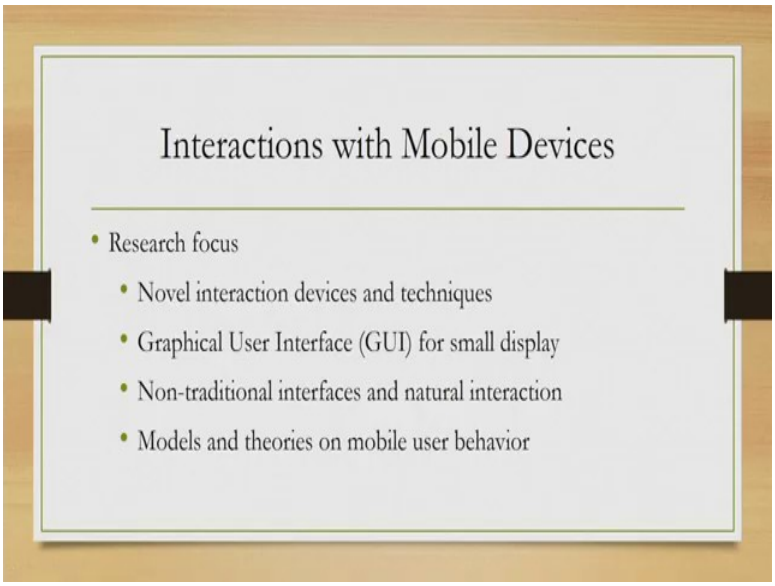

Now, what are the main research focus or the research challenges in this area? Of course, one is novel interaction. So, when we are talking of mobile devices, these devices as we have just seen these devices come in different shapes, sizes. Now so, accordingly we have to define the interaction, we have to design the interaction. So, what kind of interaction makes the user happy, what kind of interaction makes it intuitive, easy to use all these are the challenges that come under novel interaction area.

Then how to design the interface for small display devices, we have to keep in mind that these devices are typically have typically these devices have small display areas. Now, these small areas may not be suitable for displaying things that we typically want to do in a large display area such as a desktop screen. So, when we want to design an interface for say a smartphone, our design approach should differ from the way we design the interface for a desktop or a large display area device.

Now, that is another major concern, the third another important area of concern is non-traditional methods of interaction. So, typically when we say we are interacting with a computer, the first thing that comes to our mind is the interaction through mouse,

through keyboard. Of late we are getting accustomed to the fact that we now can interact through touch, gestures on a touchscreen device, but apart from that also there can be many other ways to interact with the device, one can be speech based.

So, through bias interaction we can operate the device, through eye gaze we can operate. So, there can be different ways and we need to know or we need to find out the interaction method that makes the interface intuitive and easy to use.

Finally, all the other three are related to basically the tangible aspects. Now, also many research activities are going on related to the models and theories in this area. So, how to model the user behaviour while using a smartphone and how to make use of that model in the design of interfaces for a smartphone and so on. So, these are broad research areas in the domain of mobile interaction and mobile devices.

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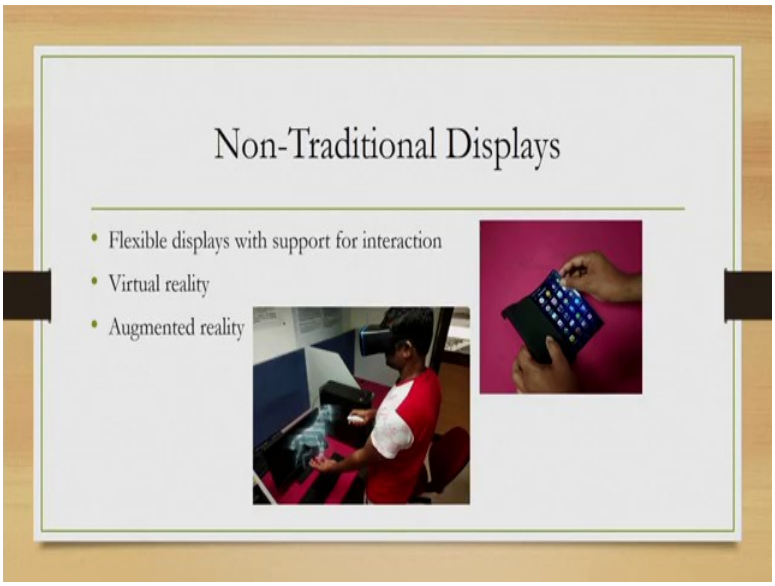

The next area is non-traditional interfaces. Now, typically when we say interface intuitively we think of some screen, some display and in the screen something is shown. Now, this sometimes may not be true. So, when we are talking of interface or interaction we are actually referring to a more generic concepts where interface may come on a screen or it may come on something else.

And, this second area which we are going to talk about related to non-traditional devices where the interface there is no screen to show the interface or there may be screen which

are not a screen in a traditional sense. So, for example, a virtual reality environment there we usually do not have a fixed screen. If we are talking of immersive experience, we are try to experience it through a head mounted display.

Similarly, when we are talking of augmented reality we may be wearing a smart glass which in a sense is not a traditional screen, but it can display the interface. Then we have flexible displays which is another emerging area of research where the screen we can fold as per our wish.

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So, these are some of the non-traditional displays. And what are the research focus? Research focus is how to present interface on such non-traditional displays. For example: suppose you were asked to type something on a flexible display. Now, the way a virtual keyboard you can design for a mobile smartphone display; we cannot design the virtual keyboard in the same way for a flexible display.

Because, in flexible display when we are typing depending on the pressure point the typing may be successful or not. This is unlike smartphone display where things are rigid and no matter where we type it will, in most of the cases will be registered and considered as a success. So, how to design a virtual keyboard for a flexible display for typing that can be one research. So, similarly there are many research areas which again have drawn that instead of the researchers.

Another interesting research area pertaining to these non-traditional displays is the particularly for virtual reality is the use of natural interactions, like natural gestures or speech based interaction for navigation, for manipulation of objects in virtual environment and so on. So, these are only few of many potential research areas which people are working on with respect to non-traditional displays.

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The third important research trend can be seen in the area of computer mediated communication. So, this is slightly different from whatever we are discussing, we were discussing so far. Earlier what we are discussing is related to the interaction of a human with a computer. Now, in the domain of computer mediated communication we are talking of human to human communication, but this communication is facilitated by a computer in between.

So, there are two levels of interactions: one is between a human and the computer and second is between a computer and the other human. And, through this computer we get to realize the human to human interaction. So, in this domain there are lots of activities going on, popularly this area is sometimes referred to as computer supported cooperative work.

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Now, they are the kind of systems of the kind of activities that goes on can be divided into three broad classes related to three broad types of devices or three broad types of communication between human. One communication is known as shared workspace where multiple human are present at the same geographical location at the same time.

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And, they are using one shared interface; an example is interactive table top as you can see in this figure where you can see that multiple users are present. And, they are actually collaborating to perform some activity on the same interface.

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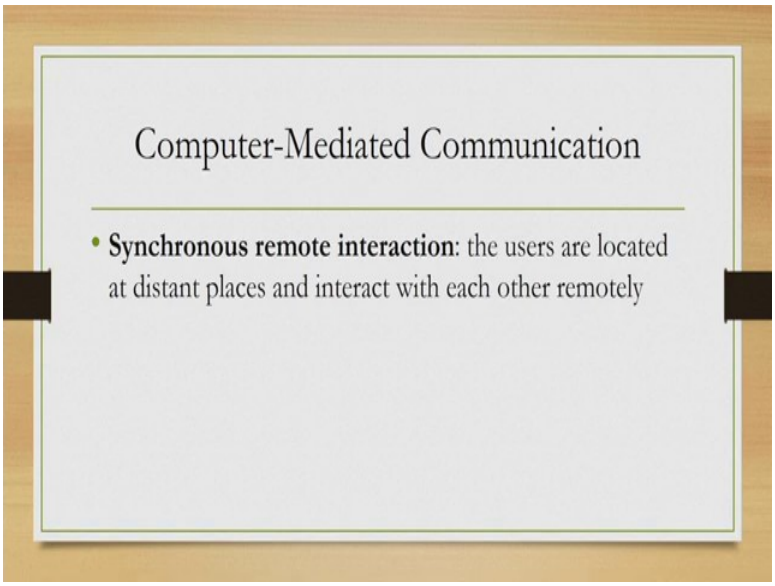

Next comes synchronous remote interaction. So, here also again human to human communication is taking place through some computer, but here the humans are not present in the same geographical location instead they are situated in different geographical locations, but they are communicating synchronously at the same time. An example is a video conference where meeting is taking place where multiple users are sitting at multiple locations and through video conference conferencing the meeting is taking place.

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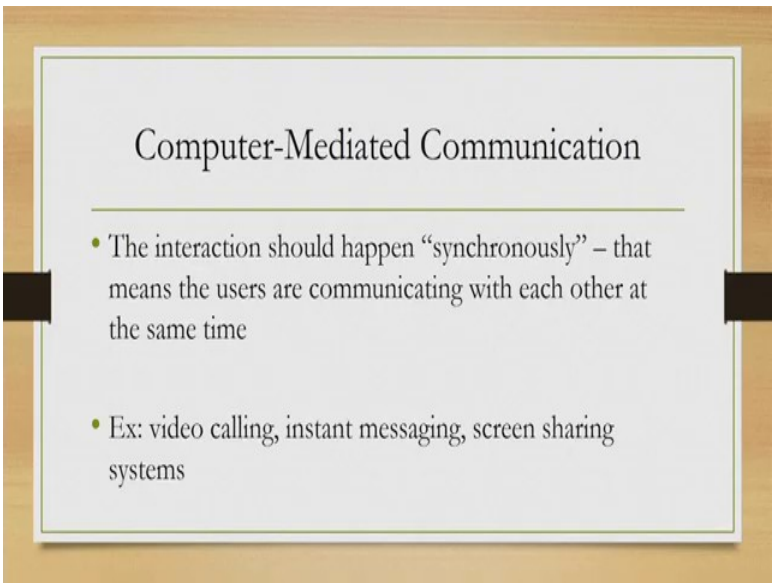

Or instant messaging or screen sharing, video calling all these are examples of synchronous remote interaction.

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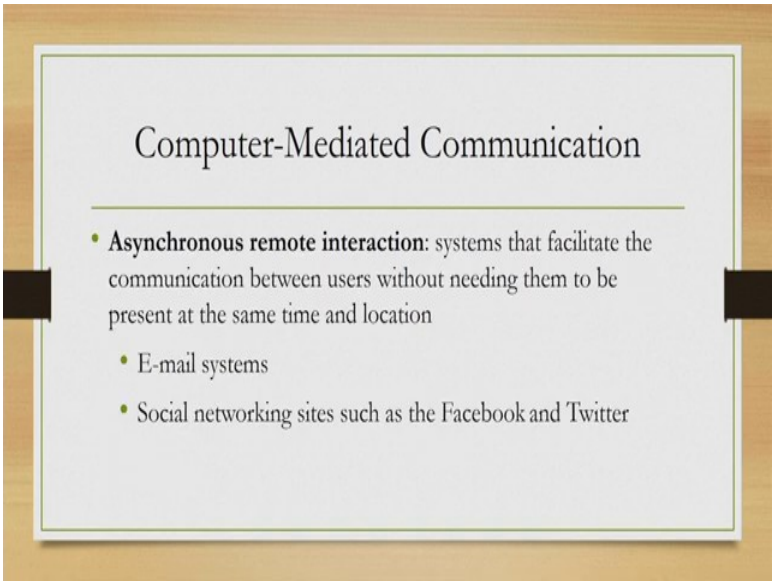

And finally, we have asynchronous remote interaction. Now, in this case people may not be interacting at the same time. So, they are situated at different locations and they are interacting at different points of time depending on their interest, an example is the social media sites. So, when we are say using Facebook or Twitter it is not necessary that all your friends or whoever are there in your friend list be active on the Facebook at the same time.

But, you are actually communicating with your friends through Facebook where they are using it at their own convenient times. Similarly, email systems another very common example of asynchronous remote interaction which predates the social networking sites. Now, in this domain what are the research focus? Again interfaces, how to design the interfaces, how to design the interactions and what are the theories and models particularly related to group behavior which can help us design better interfaces or interactions.

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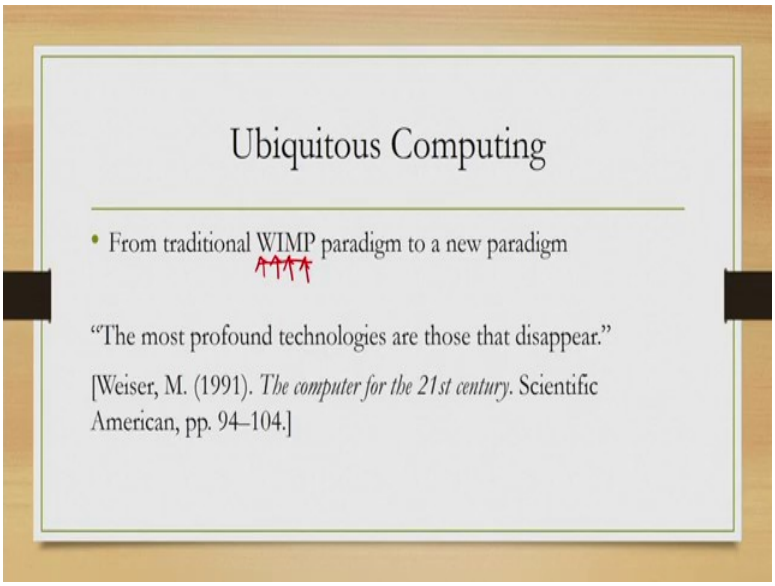

Or final research area that we are going to discuss we will spend some time on it as it is a very important thing and we should have some idea on what is going on in this area and what are the major issues and challenges. If you may recall in our historical evolution discussion we said that we are in the modern age where most of the devices are connected to each other and that we termed as a ubiquitous environment.

Now, this is different than our traditional interaction with computers through wimp interfaces. You may be knowing the meaning of the term WIMP which stands for Windows then icon I stands for Icon, M stands for Menu and P stands for Pointers. So, this WIMP paradigm that used to be the dominant paradigm in interaction till sometimes ago has been replaced with the ubiquitous environment where we no longer talk off WIMP only.

What is the hallmark of WIMP? That in the interface there will be icons which are metaphors, there will be menus through which you can perform activities and there will be a pointer which will help you select something point and select some on screen element. Nowadays of course, if you have noticed we do not get to see such interfaces everywhere.

Typically we see those in our desktop or laptop, but not on other computers that we are using and that is one of the difference between the earlier times and modern times. Now, in 1991 in one seminal article Mark Weiser stated that the most profound technologies

are those that disappear. So, if you are interested you may go through the original article which was published in Scientific American, The computer of the for the 21st century.

Now, what this statement means? The statement means that when we are talking of computers or technologies, if the user of those technologies do not feel that they are using those technologies then that is actually the most profound technology where the users are not aware of their existence, but they are using that. And, that is the idea behind a true ubiquitous computing environment. But are we there yet? We are not and lots of research activities are going on to take us to that stage where actually we can realize the dream of Weiser.

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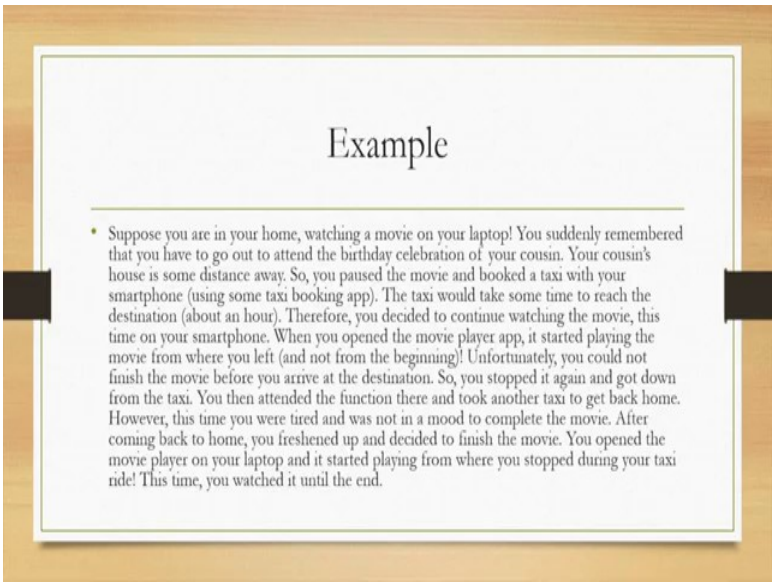

Where we are now we can illustrate with an example, let us go through the story. Suppose you were in your home and watching a movie on your laptop, you suddenly remembered that you have to go out to attend the birthday celebration of your cousin brother. Your brother's house is some distance away so, you pause the movie and booked a taxi with your smartphone using some taxi booking app.

The taxi would takes some time to reach the destination maybe about an hour and therefore, you decided to continue watching the movie during your right, but this time you are watching it on your smartphone. Now, when you open the movie player app it started playing the movie from where you left and not from the beginning.

So, when you left the home you pause the movie at certain instant and when you opened it in your smartphone the movie started playing from there only. Now, unfortunately we again could not finish the movie because your destination has arrived. So, you stopped it again and got down, attended the party, function and took another taxi to get back home. But, this time you decided not to watch it during your taxi ride back home because you were too tired and you took some rest.

Once you were there at the home you again decided to finish the movie; so, you opened your laptop and started playing the movie. Now, the movie started playing from where you stopped it while watching it on your smartphone and this time you watched it till the end. So, this is the story.

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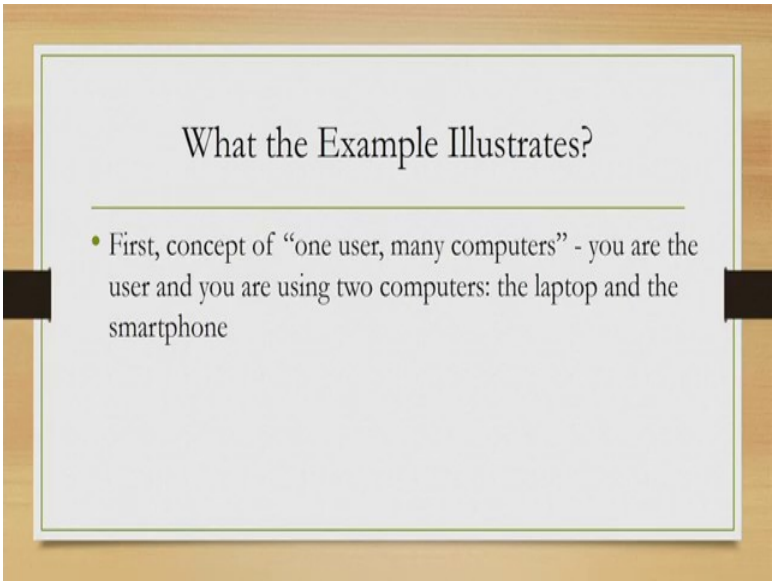

Now, what the story tells you and what should we note in this story? First of all you note that now we are talking of one user multiple computers, earlier 20 years ago we are talking of one user one computer that is specifically desktop computers. And, all the interface related researchers were focused towards designing better interfaces for desktop computers. Now, here we are talking of one user and multiple computers; in this case you have access to smartphone and laptop.

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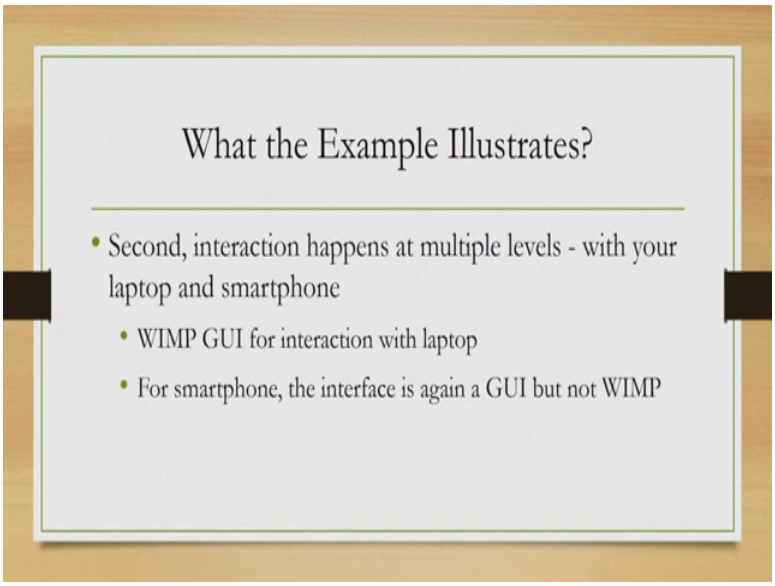

Then if you have noted in the story the interaction happens at multiple levels, you are interacting with your laptop and you are interacting with your smartphone. So, when you are interacting with your laptop you are interacting through a typical GUI or Graphical User Interface which supports WIMP Windows Icon Menu and Pointer paradigm.

But, when you are working with your smartphone you are again accessing the things through GUI only, but this time it is not WIMP; you do not have any explicit pointer as such you can directly select. So, different interaction modes.

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There is a third crucial component, recollect in the story that from laptop the movie content got transferred to smartphone. Now, your phone knew where you stopped and when it started playing the movie it started from that position only not from the beginning.

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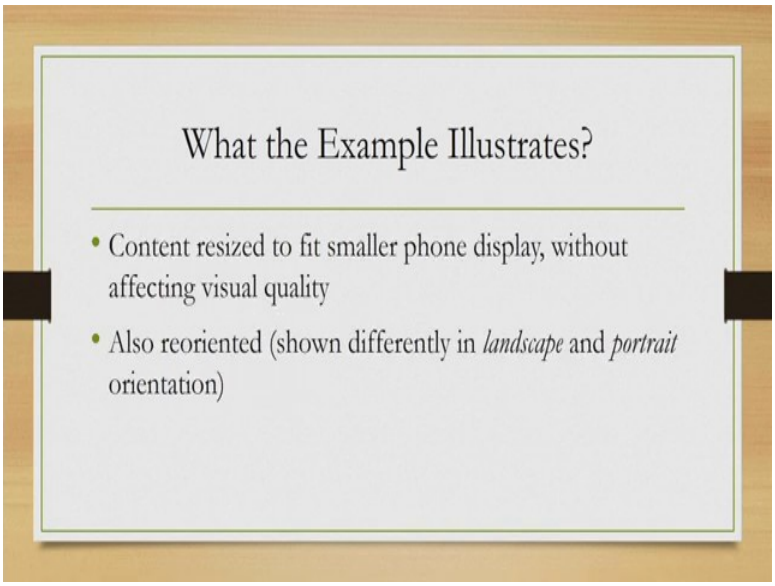

Now, while it played the movie, it resized it to fit into the smartphone screen. So, the content got resized to fit into the screen size and the content got reoriented as well; that means, if you are holding it in the landscape mode then it was shown in that particular mode only. If you held it in the portrait mode then the content would have been shown in that way. So, the system knew how you are holding and accordingly it tried to reorient the content; so, that you get a better experience.

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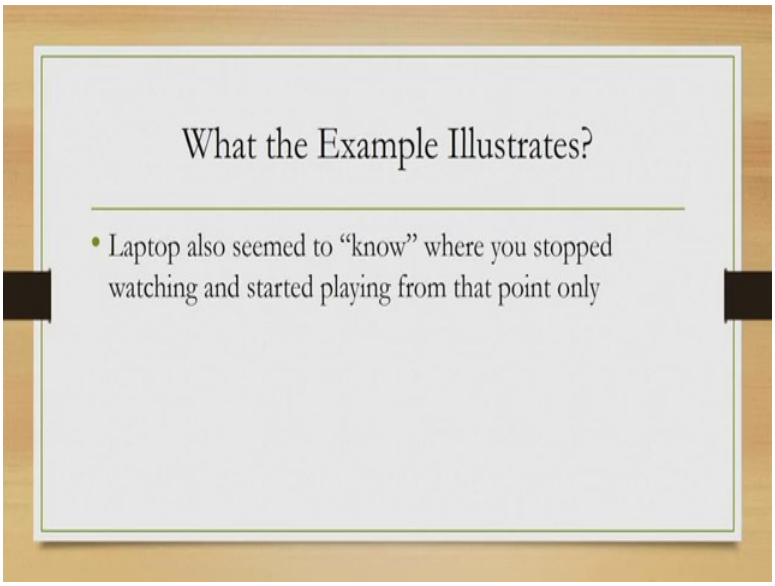

And finally, your laptop also seemed to know where you stopped watching while you were watching it in your smartphone and it started playing from that point only.

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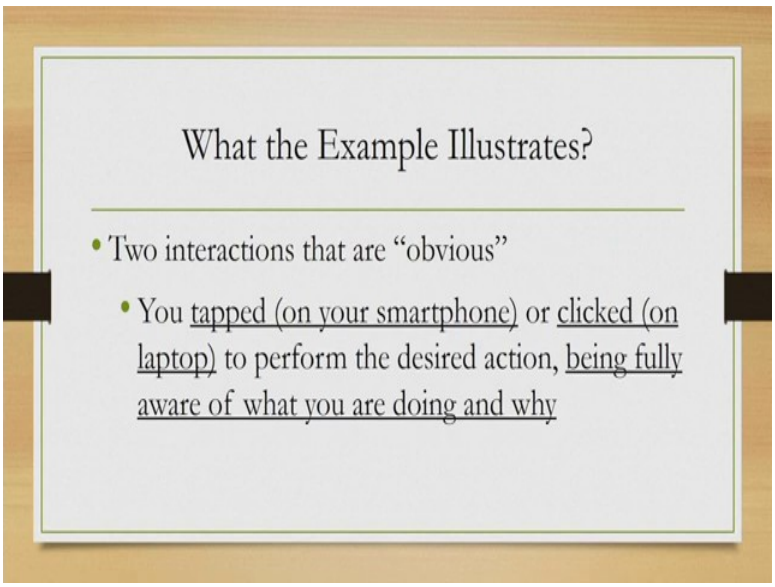

So, all these things tells us that there are many things that seem to be done in a smart way. Now, in all these what was your role? So, you perform two specific or obvious interactions with your smartphone and with your laptop either you tapped on your smartphone or clicked on your laptop to play or pause the movie.

So, in those interactions you were aware of what you are doing, you knew that you wanted to start the movie or you knew that you wanted to stop the or pause the movie. So, you knew that you were dealing with a computer where certain interactions are required.

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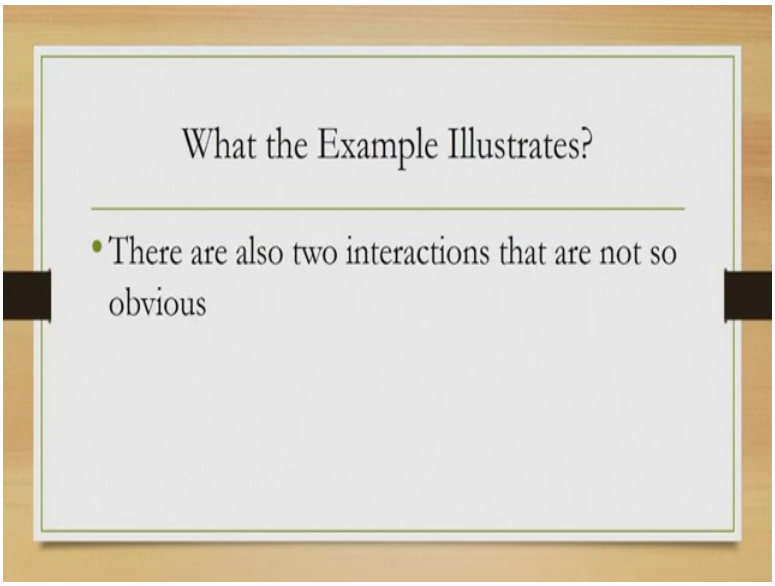

But there were instances where the interactions were not so obvious. So, you did not know what you were doing.

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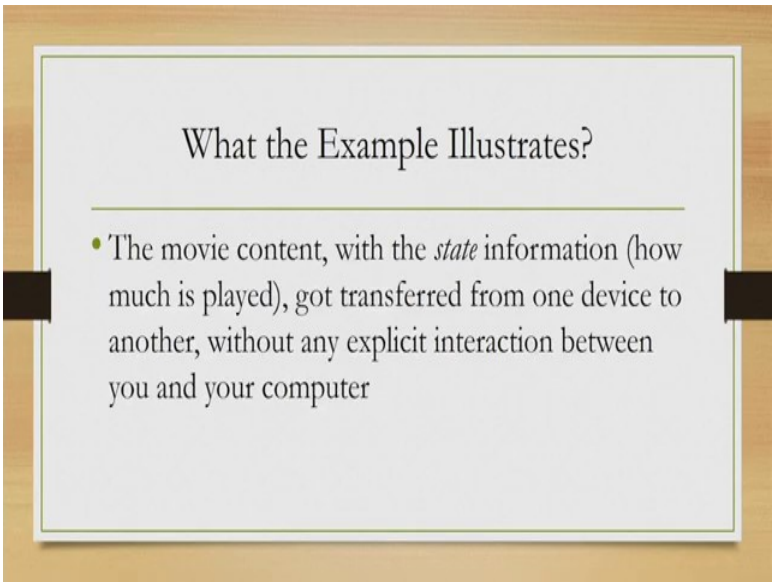

What were those interactions? So, the movie content got transferred from your laptop to the smartphone without any explicit instruction or interaction from your site.

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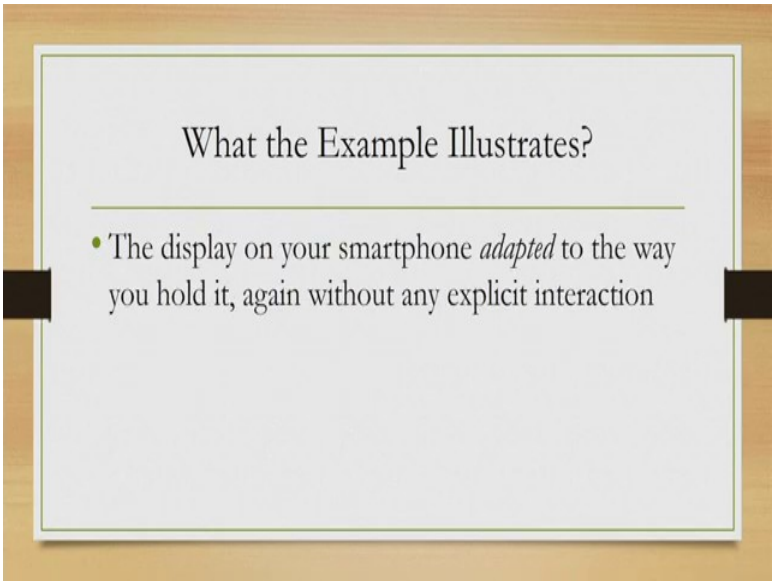

The display of your smartphone got adapted to the size as well as to the way you are holding it, without again any specific or obvious instruction or in interaction from your site.

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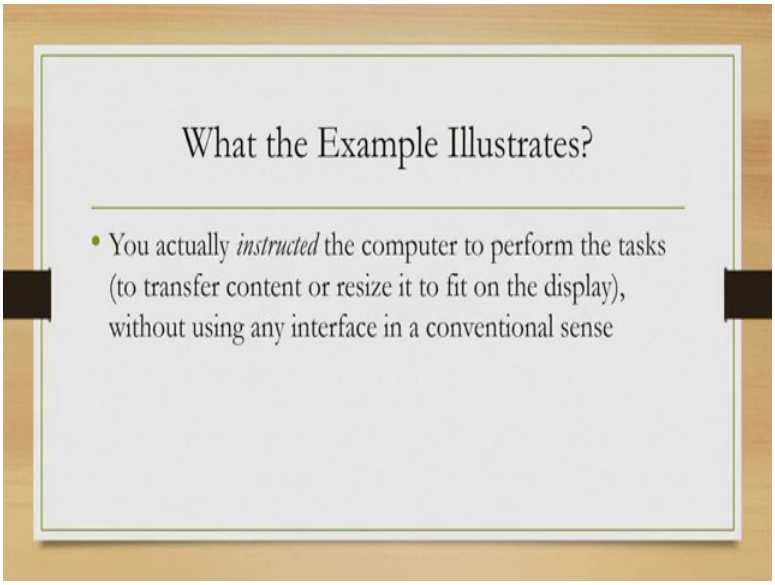

Although if we go deeper we will get to see that you actually instructed in certain way to do the things, but you are not aware of those instructions. So, it appeared that the computers did it automatically without your explicit intervention.

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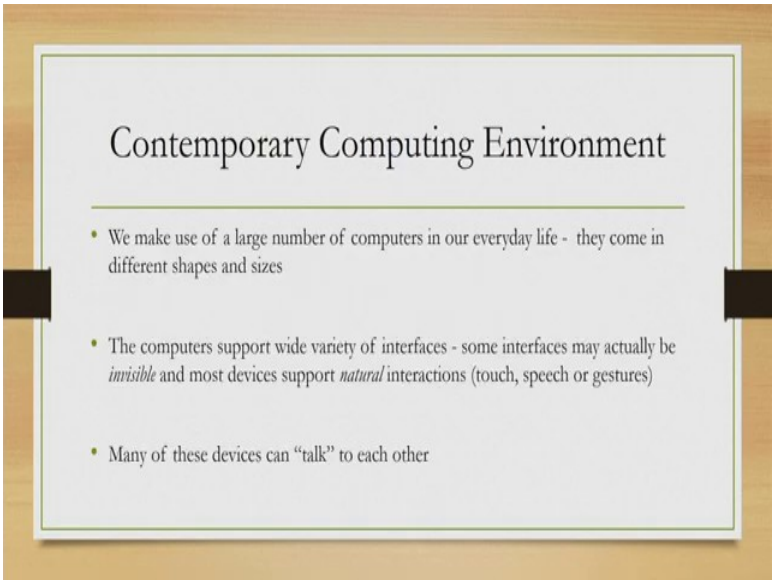

So, that is the thing which defines the modern day computing environment where we are surrounded by many computers. Now, these computers support different types of interfaces; some interfaces may be visible some may not be visible.

And, many of these devices support natural interaction either through gesture or through speech or through touch and more importantly they can talk to each other. So, many of these devices are connected to each other, they can share information between them and they can take decision based on feedback from each other.

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And, this figure shows an example in ubiquitous computing environment as we encounter in our day to day life. So, here as you can see we as users have typically access to many computers, some are obvious like this desktop, laptop or tab. Some are not so, obvious like the smart TV, microwave oven, refrigerator or washing machine, digital pedometer.

So, in the first lecture we already have seen how these not so obvious devices are actually computers. So, we will not go into the details of how their computers again, but this figure gives you some idea of how we are surrounded by computers and we are actually interacting with them in our day to day life.

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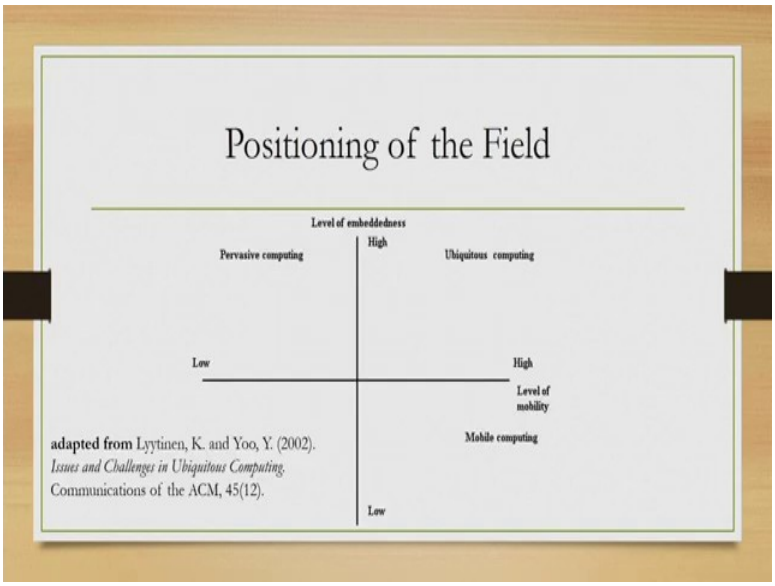

Now, when we are talking of ubiquitous computing, you will get to here many related terms; one is pervasive computing. So, let us have a look at this figure. So, in this figure as you can see we have positioned ubiquitous computing in a particular quadrant and the axis, the x axis indicate the level of mobility. The y axis indicate the level of embeddedness. Now, when we are talking of mobility we mean to say that whether the devices, the interfaces that we are interacting with a mobile.

When we are talking of embeddedness how embedded those are in the environment. So, you can see that pervasive computing is one term which we you will encounter or probably you have already encountered at many places. This has high level of embeddedness and low mobility; that means, if suppose you are surrounded by many desktop computers then and those computers you are using to perform certain activities. Then it can technically qualify as a pervasive computing environment.

So, when you have high level of mobility and low level of embeddedness then we are in the mobile computing environment and who when we have high level of mobility as well as high level of embeddedness then we are in the ubiquitous computing environment. So, here we are surrounded by computers and all the computers or mobile; so, that is the ubiquitous compute. When we are not surrounded by computers only few computers are there, but they are all highly mobile then we are in the mobile computing environment.

And, this figure is taken from the article by Lyytinen and Yoo and if you are more interested you can have a look at the original article. So, once we are able to position our concept of the ubiquitous computing in the context of mobility and embeddedness, then it is easier to discuss the issues and challenges in this area.

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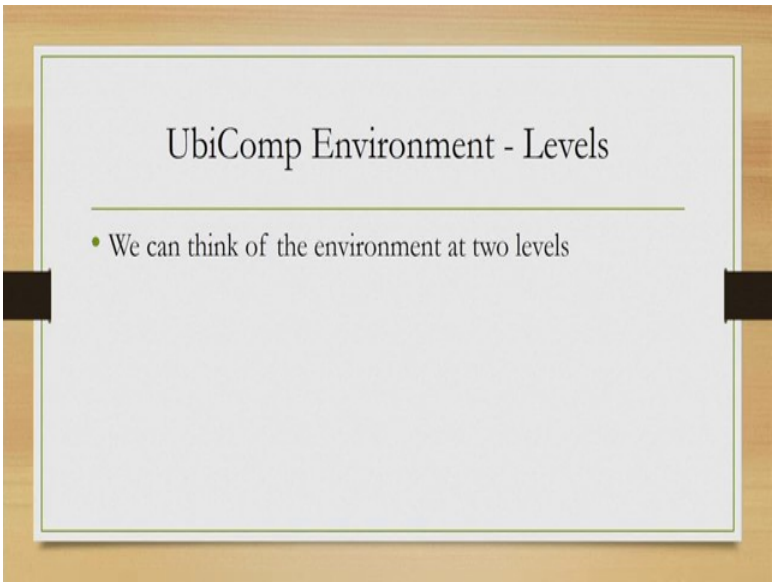

Now, when we are talking of the ubiquitous environment, we are actually referring to two levels of environment.

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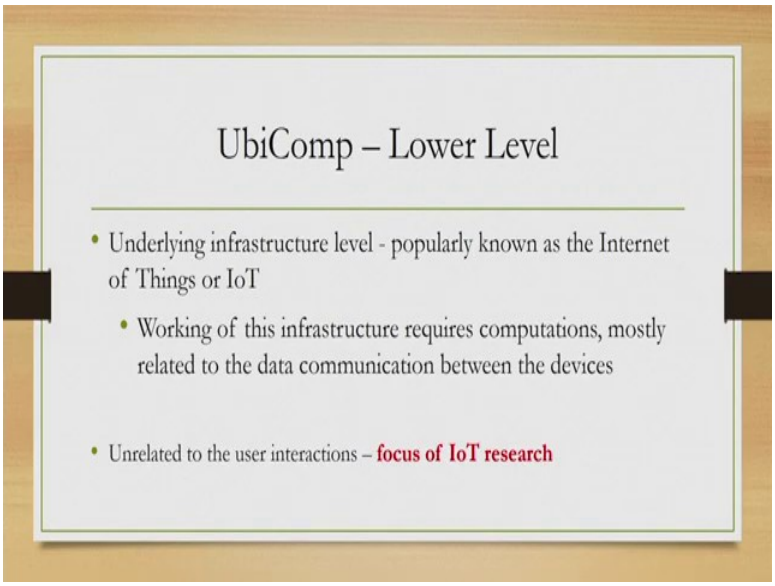

So, in the lower level we can call it a lower level, we are actually talking of the underlying infrastructure. Now, these infrastructure level we can term it as IoT or Internet of Things. Now, if we want to work at this level then the focus would be on computations that are mostly related to data communication between the devices. And, this is the focus of IoT research and it has nothing to do with user interaction with the environment. So, lower level we can roughly equate it to the IoT or internet of things.

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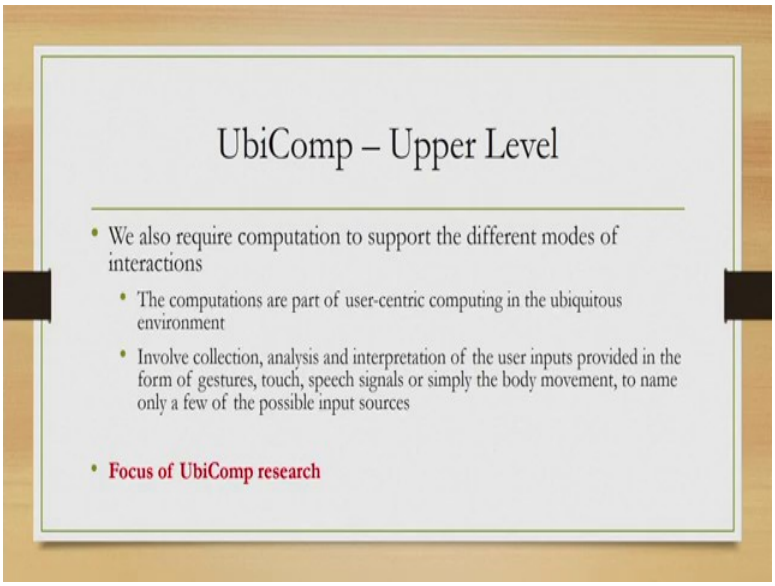

The upper level of ubiquitous computing environment is that level where interaction is more important. So, at this level the whatever computations are done, they are done to basically support different modes of interaction with different types of devices. These computations involve collection, analysis and interpretation of the user inputs that are received from user gestures, speech, touch or simply body movement or from any other sensor.

And, then using that to provide natural interaction environment which sometimes makes it appear that the computer is not there. So, the user feels that there is no computer, the interface becomes invisible and he or she does things without being explicitly aware of the presence of the computer or the interface. Now, this area is or this level the upper level is the focus of UbiComp research.

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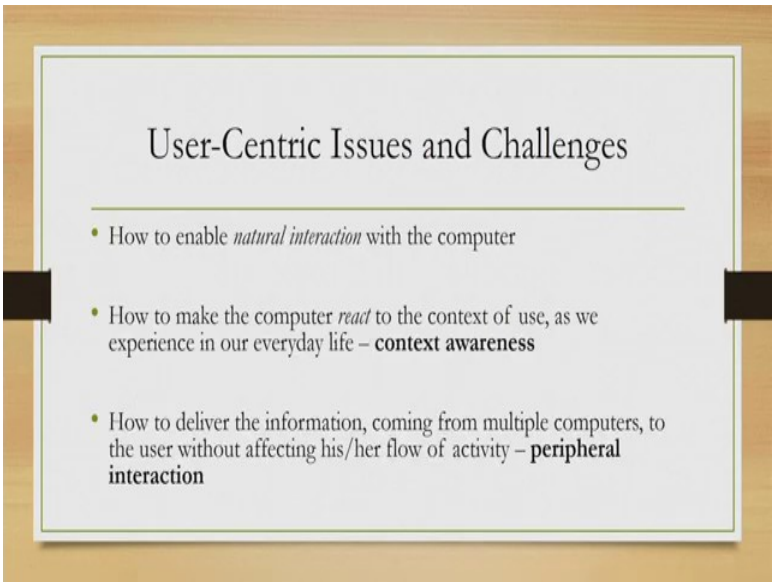

So, then the next natural question comes; what are the issues and challenges in the ubiquitous computing environment? Those issues and challenges are from the user centric perspective. So, broadly three challenges are there: one is how to enable natural interaction with the objective that the interface becomes invisible; if not fully then to the extent possible. Then how to enable the computer with which we are interacting, react to the context of use as we experience in our everyday life.

So, that is context awareness and finally, how to deliver the information coming from different sources or multiple computers to the user without affecting his or her flow of activity. So, this comes under research area known as peripheral interaction. So, natural interaction, context awareness and peripheral interaction are the three broad areas in which most of the research activities are focused.

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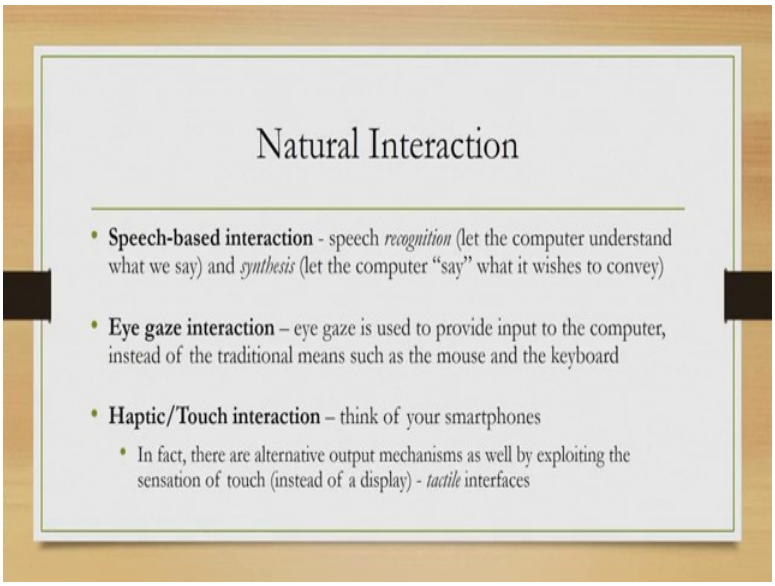

Let us briefly discuss a little bit more on these three areas so, that you get a better idea on these areas. So, first of all natural interaction, when we are talking of natural interaction what we mean? Now, natural interaction can be implemented in different ways. If we are having a system where we operate the computer through the use of our voice speech or non-speech sounds, then it comes under natural interaction. So, there the speech recognition and synthesis both are important research areas.

Then we have interaction done through our eye gaze, eye blinks or movement of eye eyeballs. Now, these eye gaze interaction is another type of natural interaction mechanism. Third important area is haptic or touch interfaces, we are already familiar with these type of interactions; particularly since the advent of the smartphone or tabs that are touch enable devices.

Now, closely related to this is the tactile interfaces where the display is not the traditional display, but something which can be experienced through touch.

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Other modes of there can be other modes of natural interactions as well for example, in your gestures. So, when we are talking of touch gestures we are assuming that the gestures are performed on the touchscreen or a fixed screen. Now, we can also perform gestures in air without touching any surface and that gesture can be used to operate the computer.

So, in air gesture is another natural mode of interaction and when we want to interact through our head or body movement that gives us again the feel of natural interaction.

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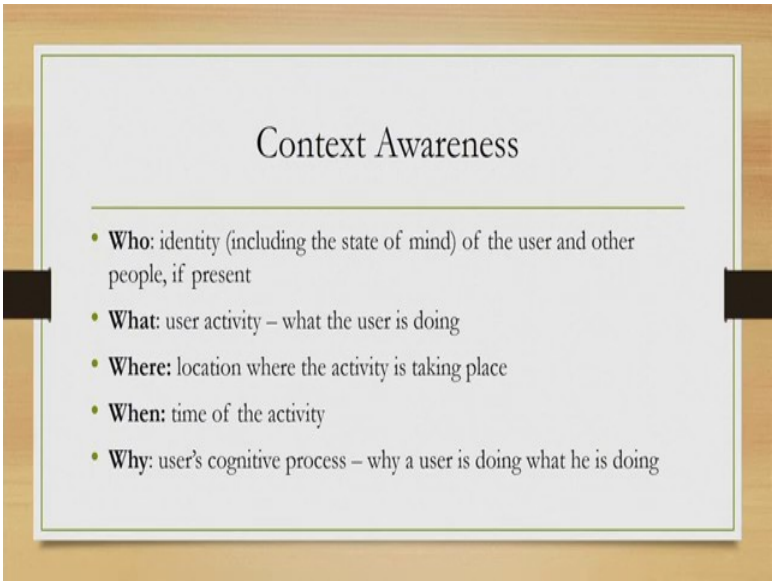

Now, these are various modes of natural interaction: speech, gesture, touch, in air gestures and head movement. And, there are research activities going on, extensive research activities going on to detect to utilize to theorize to model user activities with respect to each of these natural interaction modes. Our next challenging area is context awareness.

So, when we are talking of context aware environment, when we are talking of a computer that reacts based on the context what we mean, what is the context of use? So, one very popular definition of context is a collection of five entities, these are the five entities: who, what, where, when and why.

Now, who indicates that the identity of the user and other people if present, who are the people who are present in the present context of use. Then what indicates the user activity, what the user is doing, where is the location, where the activities taking place. When is as is obvious the time of the activity and why is the users cognitive process, why a user is doing what he is doing.

Now among these five of course, the last one why is very difficult to detect because here in this case we have to basically understand the cognitive process of the user, how user is thinking. So, when we are trying to capture context, capturing who, capturing what, where, when maybe easier compared to why, but the objective is to capture all to get a full view of the context. And, the research activities that are going on in this area related to how to capture these context and how to make sense of the data and map it to the context information.

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Typically, in a ubiquitous computing environment this contextual data comes from presents of sensors in various devices or standalone sensors. And, we try to utilize those sensory data to identify context, but as I said not all context can be captured successfully. So, sometimes we may have to work with partial context information so, that is another challenge how to make the computer react based on partial context information so, that it look like context aware.

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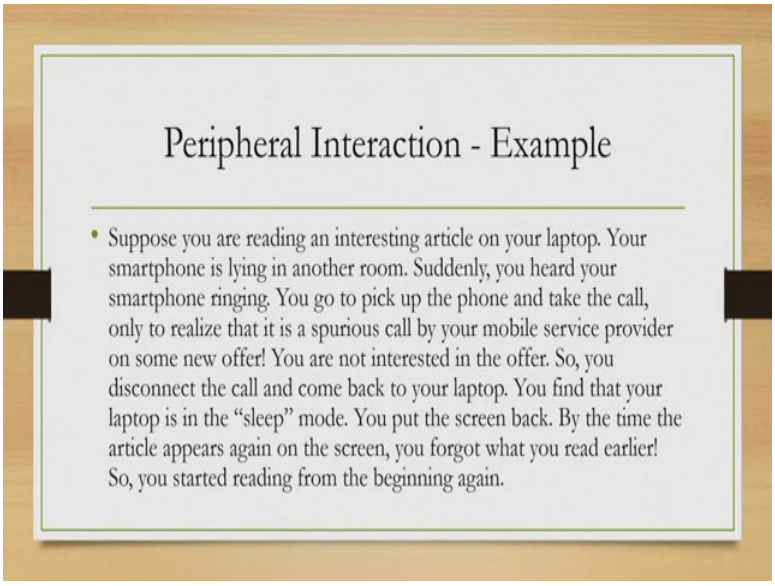

And, the third research area is somewhat difficult to understand. So, we will try to understand it in terms of one example. So, the third area as I said is peripheral interaction. Now what it means? Let us try to think of a scenario, suppose you were reading an interesting article on your laptop, your smartphone is lying in another room.

Suddenly you had your smartphone ringing, you went to pick up the phone and take the call, but there you realized that it is a spurious call and it is just waste of time if you take the call. So, you decided to cut the call and come back to what you were doing back to your laptop. Now, after coming back you have noticed that the laptop went into the sleep mode.

So, you put the screen back by the time the article appeared again you forgot actually what you were doing; so, you have to start it again from the beginning. So, what it tells? Tells us very interesting thing. First of all there are two computers: one is your laptop, one is the smartphone and both of them are trying to grab your attention. Now, it is quite natural for a human to attend only one at a time, both cannot be attended at the same time unless you are a genius.

Now, if you attend one and ignore others then definitely some activity that required that other would be disturbed or disrupted. Now, if you knew who was calling then you probably would have been able to decide that I am not going to disrupt my current activity of reading and you could have simply continued reading without bothering to pick up the phone. So, that would have helped you not disrupting your current interest.

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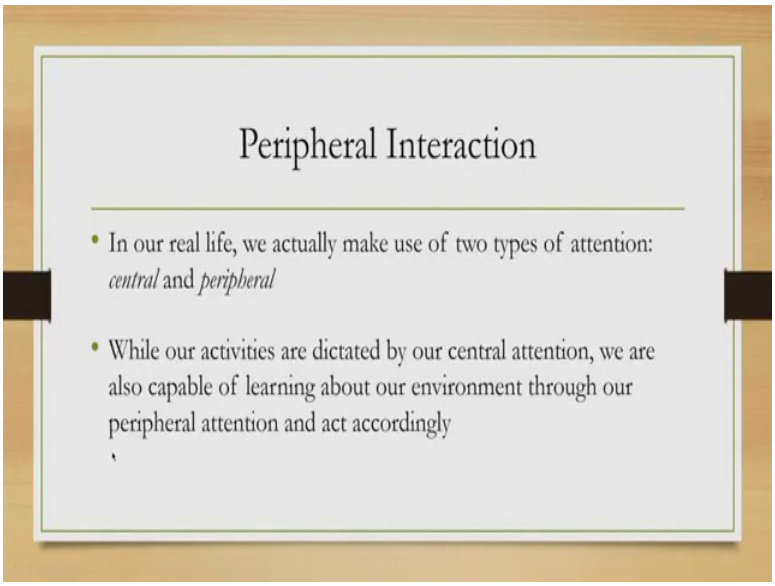

Now, in our real life we faced many situations where similar things happen. So, what we do? We make use of two types of attention: one is the central attention and the other one is called peripheral attention. For example, suppose you are walking along a road, you are looking straight and there is a side road. But, while you are looking straight through your periphery of attention you can still see if something is coming from that road and based on that you take a decision.

For example, if somebody is coming or some car is coming through that side road you do not need to look at that, you through your through the corner of your eyes you get to see it and then you probably stop; that is called periphery of attention. Now, while our activities are most of the time dictated by central attention, but our peripheral attention can also influence the way we perform the activities. And so, it is very important that we take care of this periphery attention in our design of interfaces.

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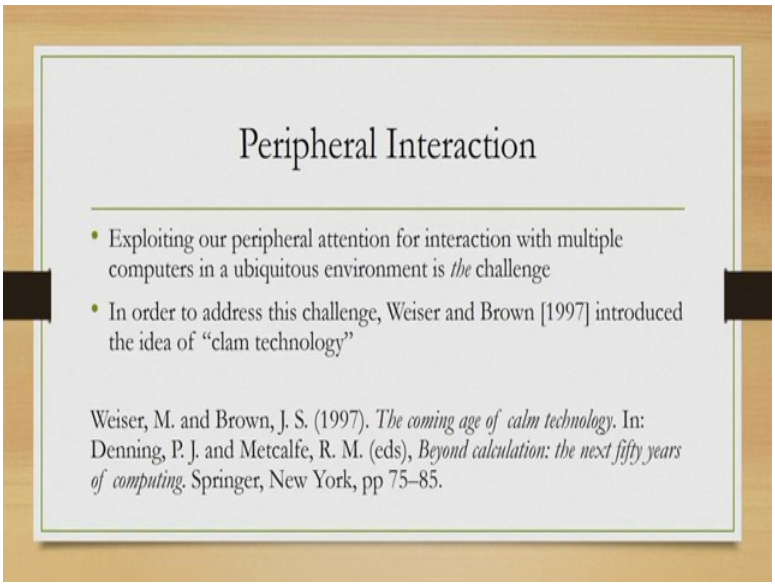

Now, this is one very interesting research area that have been taken up in the context of ubiquitous computing because, there are multiple devices; all are trying to grab your attention and you can pay attention to only one at a time. So, there has to be some way to manage this phenomena.

Now, in order to address this challenge in an article Weiser and Brown in 1997 proposed a new idea called calm technology. You can go through the original article which was published in a book by Springer in 1997; the article was titled The coming age of calm technology.

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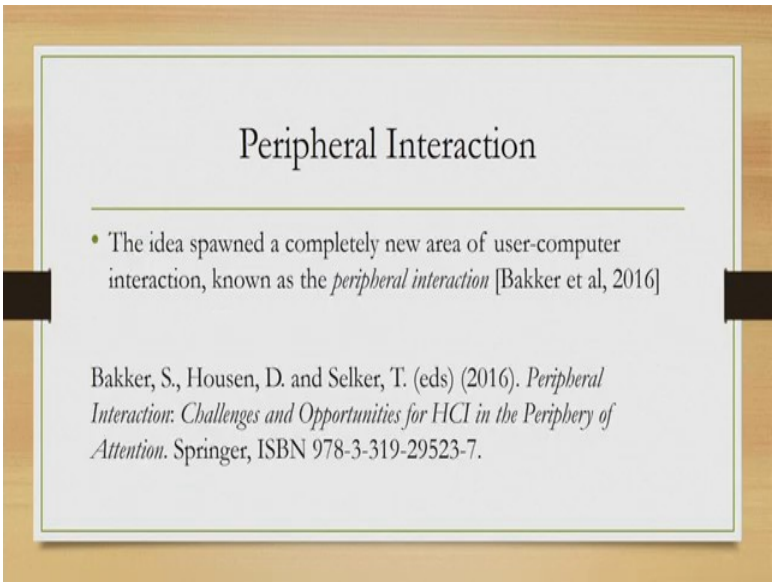

Now, based on this idea a totally new area of activity, new area of research started and this is known as peripheral interaction. And, for more details on this area you can again referred to this book by Springer which was published in 2016 by Bakker et al; Peripheral Interaction: Challenges and Opportunities for HCI in the Periphery of Attention.

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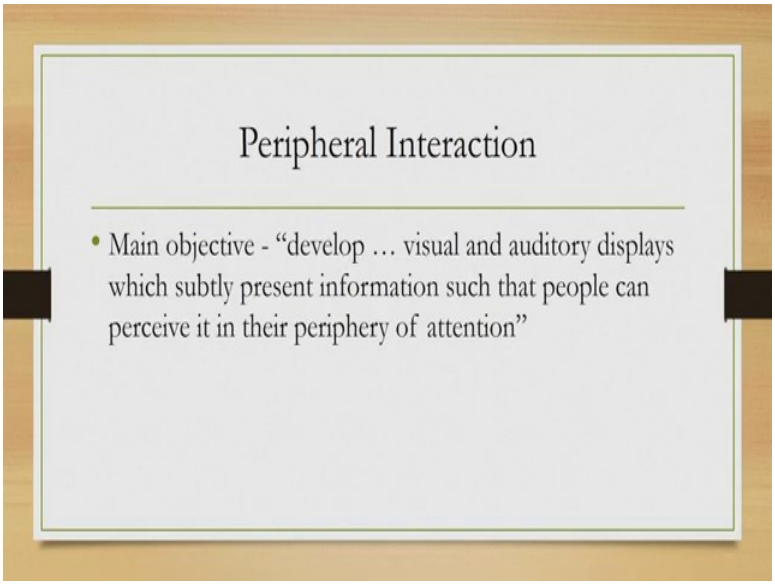

So, the main objective in this area of research is to develop visual and auditory displays which subtly present information such that people can perceive it in their periphery of

attention. So, the research focus is basically to manage the display; so, that when information from multiple displays are coming to the user, the central attention should not be affected too much.

Now, these are broadly the areas in which current research activities are focused in this area of user centric design. So, let me repeat those once again. So, broadly four areas are there: one is mobile devices; one is non-traditional interfaces, one is computer supported cooperative works or computer supported communications and the fourth is the ubiquitous environment. And, we have given some idea and some issues and challenges that are the active research focus in these areas.

So, with that we come to a conclusion of our introduction to this field. So, in those introductions we covered the basic idea, the historical evolution, the issues and challenges and the research focus with the objective that you get some idea on what is the field all about and what are all the things that we need to learn and we need to think of.

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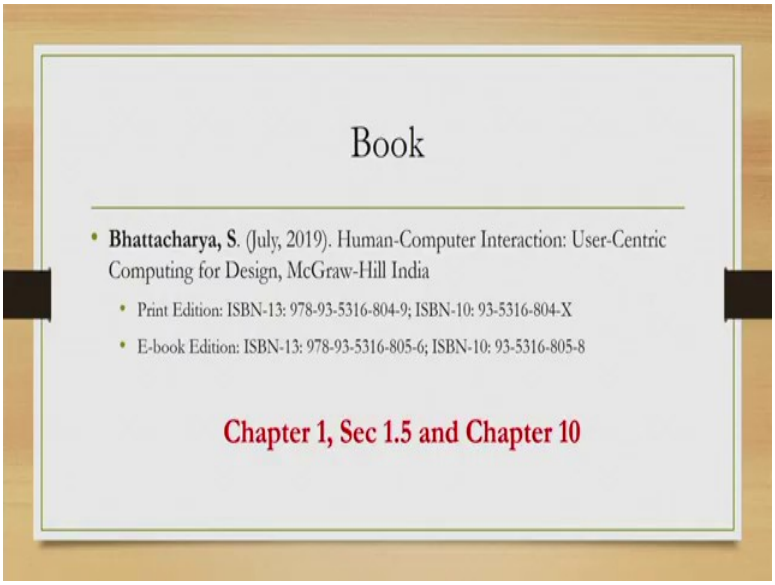

Now, all the material that I covered in today's lecture can be obtained from chapter 1 section 1.5 and chapter 10 of this book.

So, thank you and goodbye.