

On the future of haptic computing

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Interview with Jutta Treviranus, Director of the Adaptive technology resource center. By Ana Viseu. 2000, September 18

Jutta Treviranus is a researcher and director of the Adaptive Technology Resource Center (ATRC) at the University of Toronto. Most of Jutta's research is concerned with 'universal access' that is, with access for persons with disabilities. In order to achieve this she looks for alternative modes of human-computer interaction (HCI), both in terms of data input, output and display. At the moment most of Jutta's efforts are concentrated in the development of device independent rendering and modality translation, haptics being one of those modalities. Haptics refers to the sense of touch, and it is an extremely interactive mode of (HCI) for it involves both a continuous input action and a continuous manipulation of the output.

[Note: Presently there are a few haptical devices being sold in the market, for example, the feel-it mouse. However, although the publicity has it that you can feel the web while using this mouse the truth is that if the images are not programmed with haptic rendering you will not feel a thing. Obviously, most of what is online is not rendered haptically]

Ana Viseu: Most of your research is done in the area of alternative interfaces, and haptics and tactile web, all of which falls in the category of alternative human computer interaction systems. I would like to know a bit more about what are haptics, how do they work and why you think it is useful?

Jutta Treviranus: Haptics, unlike any other modality, is both input and output. So, it is a continuous feedback loop. [While with] a visual display, you are simply getting the display component of it, and with a keyboard you are only getting the input component of it, with haptics you have a continuous feedback and interaction loop. So, as somebody manipulates something you sense the change. In that sense it

connects people much more to their material than other modalities on the computer.

Haptics is a modality of learning that is very natural to human beings and that is basically socialized out of them. You have the "don't touch, just look". And slowly kids stop manipulating, touching, but we still have the sense that "let me see that" actually means "let me touch it, let me feel it, let me interact with it haptically". You are able to see it, but you are insisting "let me see that". So, similarly to that experience, the haptic devices and the haptic work that we are doing, is trying to bring that type of experience to the computer. Haptics implies the tactile feedback that you are getting in a manual manipulation of objects.

A.V: And this manipulation is done mostly through some sort of peripheral that you attach to the computer?

J.T: Yes. There are a number of different peripherals and there are differences in them. The common devices on the market include a penceat, a virtual reality mouse, the *Feel-it mouse*, the *Phantom*, the *Wingman mouse*, etc. these are all devices that are available. Then also the tactile gloves and other more immersive VR instruments.

The difference between the low-cost ones and the high-cost ones is the dimensions of movement and within how many dimensions the servomotors will work. Things like the penceat and the virtual reality mouse and the wingman mouse really only give you feedback in two dimensions, but they say its 2+ dimensions, because the third dimension is simulated through a number of other properties that are manipulated when you feel it. What this means is that you will feel friction, you will feel forces, and you will feel things like vibrations in two dimensions, and then the third dimension is simulated by changing the forces in the first two dimensions.

Basically what you have is a servomotor that can change the force that you are feeling through the pen, or through the mouse, or whatever in two dimensions. Things like the *Phantom*, and there are several other examples of that, work in many more dimensions but only in research.

A.V: What is the *Phantom*?

J.T: The *Phantom* is haptic device which gives feedback and allows manipulation is

6+ dimensions. That means that you have the X, Y, Z but you also have the roll, pitch, etc... There are sufficient servomotors that you can actually interact with the three dimensional environment in a fairly realistic manner. And those are the devices that are used in telesurgery and telehealth applications.

A.V: And all the time are you interacting with the computer?

J.T: All of these are attached to the computer, so they act as a mouse/keyboard replacement and a display replacement or augmentation. The intention is that you use these instead of a mouse. And they give you feedback that augments or replaces the visual feedback that you are also getting.

A.V: Which do you think is the most successful implementation of haptics?

J.T: It depends on what your criteria for success are. The most effective in allowing you to really simulate real-life experiences, really feel what it would feel to, say, perform a certain type of surgery, or manipulate an actual object, is like the Phantom where you have more than the 2+ dimensions. But, these are far too costly to implement in, say, a distance education program, or in anything but a very specialized area field. Telehealth and telemedicine is able to afford those but they are not going to be seen in every home in the next while.

However, the other devices like the *Wingman*, the *Pencat*, the *Mouse cat*, the *Feel-it*, and the VRM are in a price range where everybody can afford them. They are not much more costly than certain specialized keyboards or anything of that nature. So, they are more successful in terms of penetrating the market. The primary one has been the Microsoft *Wingman*, which is a device that Immersion puts out. Its primary penetration is through gaming, giving additional tactile feedback when you are doing "shoot-them-up" games, combat games.

A.V: In terms of software development what kind of changes does it imply for interface design?

J.T: In terms of designing the actual curriculum and the software? Basically in order to use the haptics, you have to have haptic rendering. So, just like you need to draw the visual, you need to render the haptic. This is made much easier when you can piggy back on, say, the visual. That is, if there is a direct translation from visual to haptic. That works very well.

In some instances, say, geographic topographical maps, it is also fairly easy because the way some of the maps are rendered topographically allows you to do an almost direct translation from the topographical information to the haptic information, so that you can feel the valleys and the mountains, etc...it is a direct translation.

In some instances, for example, if it is simply a bitmap, then it is impossible. There is no information that you can take from that to cause the haptic rendering.

If you do vector graphics, or if you are doing it through something like VRML or Java 3D-where you have actual objects with the description of the object-then it is much easier to derive the haptic rendering.

One of the things that all of these additional alternative modalities-the audio modality, the haptic modality-bring about is a move towards modality independent provision of information. Towards the creation of interfaces or software where you give the information and the structure of the information without hardwiring in it whether it is going to be visually rendered, or haptically rendered, or rendered in an audio form. That is a very good thing.

A.V: You mean that the information is there and can be accessed in different modes?

J.T: Right. So, the information is provided separately from the way it will be presented. And so, I have the information and I can render it in such a way that I see it, or in such a way that I hear it, or I feel it, or a combination of all of the above.

A.V: You mention in one of your online papers that the drive to this type of multi-modal access will allow users to personalize their interfaces, which means that the design has to be more focused on the user than on the final display shape. Do you think there is any danger in moving towards this type of very personalized interface, in terms of people starting to access information only in the way they like, and only the information that they like, leaving aside everything that is not of interest?

J.T: I think that that choice is already there-in terms of the information you don't like-we do already do the personal filters. The difficulty we have now is that many people cannot access the information at all because they cannot render it or access it in the way that they need to. We do have different learning styles and we do have preferences regarding how we take in information. I think the filtering the

information, or choosing which information we see is a completely separate issue.

The issue that we are dealing with at the moment is "how can I get the information and process it". We have many people who cannot process the information and don't have access to the information. Personally, I am not that interested in these issues in terms of the media perspective, but I am interested in it in terms of educational perspective. And, if the information is presented in a way that I really can't learn from it, then that is a large problem. So, this gives further freedom to personalize the information. There is no way that we are ever going to force everybody to hear or see or listen to information that they don't want to. But the issue is that if you have access then you still have the choice, but if you don't have access then you are restricted from the choice, but you have a much worse situation.

A.V: I know you usually deal with these issues from a universal access perspective, that is, access for persons with disabilities. But, do you think that this type of alternative human-computer interaction modes will ever become a standard?

J.T: Well that is what we are hoping, that is the goal, that they become a standard... and there are so many reasons why it should be part of everybody's experiences, and certainly learning experiences. The addition of haptics to any curriculum that is presented has to be an alternative. Since we are going online so much more it also has to be part of the online experience, because it is part of the general experience. I mean, try to tell any grade one, or kindergarten, or grade three teacher that she is not going to be allowed to use experiential learning, the sense of touch, and they laugh at you. There is no way, you can't teach without that.

Or, why are we accepting that you teach things without that [haptic sense] online? I mean, we can't, we are multi-modal learners and we have learning preferences. And the same way that there are situations in which we have mentor learning, there are situations in which we need to manipulate and feel, and if we restrict the use of certain modalities simply because we are doing our learning over the computer then we are not optimizing the learning experience.

A.V: Do you think that there is any danger that as these things become the standard and start being developed as a commercial product the aspect of universal access will be lost? Or do you think it is something that you can use for your own profit?

J.T: Our goals will be met when the universal access aspect gets lost. As soon as it

becomes transparent and is assumed and is taken for granted, then we have met our goals.

A.V: What type of other alternative interfaces or modalities of human-computer interaction do you envision for the future? I am thinking specifically of Steve Mann's type of research, that is, of this type of embedded, wearable, wireless, networked, micro computing.

J.T: Well, in my field the alternative modalities and the assisted technology have two aspects to them. The first is ensuring that the standard technology is accessible. This implies making sure that the presentation is separated from the actual information and structure, and that the control method is separated from what is being controlled, or the functionality.

The second is using technology to act almost as a prosthesis, or as an augmentative system or replacement for lost skills or lost functionality. And, it is here where I see work that Steve Mann is doing coming in. I mean, I don't think it is new work, we have hearing aids, we have cochlea implants, we have retinal implants, that is already happening and it has been happening for quite a while in our field. Steve is attempting to bring it to the general world, and asking us to consider this for other things. That is great, I think any additional consciousness about the possibilities of that are good.

However, there also all sorts of ethical issues that that brings up and also questions about the delineation between man and machine and how we allow the machine to invade our body. These boundaries have already been crossed, we have a lot of technology implanted in a lot of people. But the general population has been able to separate those out and say, "oh, well that is only in these instances and I am never going to be met with that situation". Again, from my perspective the more that comes into the general mainstream and is seen as something that is not special or something that someone else does, but rather a possibility that affects me as well, the better. Because [this will make] the technology advance, the price go down, and thus there will be greater social acceptance of this type of technology and the use of that technology.

Steve Mann is dealing a lot with visual medium and this is good , because while we have hearing aids which do all sorts of re-processing of information and filtering of information and re-presentation of information, we haven't really explored the same

type of technology for people with visual problems. Well, we have but only in a limited sense. So, its good that Steve brings attention to that possibility: that if we can take information coming into the hear and augment it, add it, filter it, shift it, change it, and then bring it back to the ear and listen to it, why can't we do the same with thing with our visual sense? Why can't we take it and enhance it, change the contrasts, do the colour, make a bit more visible?

A.V: My next question has to do with these ethical issues that come up with using this type of new technologies. These issues come up in all sorts of ways: privacy issues, computer mediated reality issues... Do you think that the use of so much technology-especially in education, with children-enhances these problems?

J.T: I am not thinking of using the type of technology that Steve Mann is working with as an educational tool per se. I am thinking of it as a personal prosthesis and, in that sense, I don't see that there would be many issues... Well, in the sense that we have a technology that is potentially connected, yes, that is a potential danger... But, along with developing the technology we need to set up privacy, and all of those other rights.

Technology is a double-edge sword. In any introduction of technology we have had to take the necessary precautions because with any freedom there are also dangers. So, when we get the freedom we need to ensure that we take into account the dangers. I can see that there are a lot of benefits to be derived from having the ability to share an experience, the ability to share knowledge, the ability to connect to other people that we wouldn't necessarily connect with. So, if I can look in the webcam at what someone is doing in India, or Kosovo, or wherever, and get a sense of what their life is like, then I will have the my empathy will, hopefully, somewhat increase, and certainly the knowledge of other person's experiences will increase. But, there are dangers to that and privacy obviously is a large one, and information overload, et cetera.

Technology is just a tool and we have to be careful about how we use the tool. We cannot be blinded by the hype around it. We have to take a good rational look at the benefits and the disadvantages, without all the fear and without all the overexcitement and hype.

A.V: Changing topics, what type of projects do you develop here at the Adaptive Technology Resource Center?

J.T: In the education piece, we develop model courseware and tools to create courseware. We also do a lot of web accessibility work, we look at developing new modalities and we do pro-active work with companies that we think are developing the emergent technologies in order to make sure that they have the hooks in there for access.

The courseware work consists of creating courseware-authoring tools and creating student interfaces. But not as a production, more as a model for other courseware. We are more interested in researching what are the tools that can be used to create courseware, what are the things you can do within a courseware. We want to expand these notions so that, for example, we can make authoring tools easy to use and we can ensure that whatever courseware is created using them will be accessible to everyone. With the modalities research we want to make sure that there is the broadest spectrum of alternative input/output and display. And with the student interfaces, we are trying to ensure that people can accommodate their own learning style preferences and access.

A.V: I am personally interested in the theme of 'bodynets', in the whole area of networked, wireless, wearable, portable, micro computing devices. My question is if you see this as being the future? Do you think that the personal area network (PAN) is where we are heading?

J.T: Yes and no. I think that a lot of the human tendencies will continue to exist. I don't see that the technology is going to necessarily make us open up to additional connections and networks. Maybe initially, but even with email and with the recent flood of other ways to get connected people initially did that quite a bit, but I would challenge anyone to say that anyone has that much greater of a personal network than they did before through letters and other means of communication.

The places that we interact with, or where the people are, there I think that, to some extent, we have diminished the effective distance and time. But, I don't think we have made that many more connections individually. I think that as technology becomes smaller, as it becomes less visible, and as the ability to become more transparent and less cumbersome grows we will exploit it in various ways. But I don't see us all turning into cyberborgs.

A.V: Well, there is, for example, some research being done on memory

enhancement so that everything you see and do is recorded on this computer.

J.T: Yes, but it is still a retrieval problem. I can see a memory prosthesis for someone who is losing their memory. I think there is great potential there. But I think that even if we had a data store of everything we have ever experienced, first of all is that really so relevant, and wonderful, and interesting? And second of all, it is a retrieval problem. We need to remember what we want to remember.

A.V: Can you tell me a bit more about the projects developed here?

J.T: We have a project [VRML] where you can feel and see the city of Toronto, you can see the buildings and their geographic structures. There is also this project where you can feel how a PIP joint [located in the fingers] bends. Here you can simulate any pathology so that if I have shortening of the tendons, or I had a previous break... you can feel them all. And you will be feeling them over the web.

We are also working with the DFI, Digital Frog International, where you can do a virtual frog dissection. We also have projects in things like the digital rain forest and the digital wetlands. The wonderful thing about these projects is that you can not only see what these things look like, but also feel what it feels to hold a bunch of frog eggs in your hand. If we are trying to give kids, or anyone, the experience of actually doing those things than it involves haptics, it has to involve haptics. And if we want to do things like save our rain forest without having to many people go there and destroy them, we need to provide a similar digital experience. We are moving towards eco-conservation.

A.V: I read in your papers that one thing that drives haptics research is the imitation of real life, to create the illusion of real space. Is that really so?

J.T: I wouldn't really say that. I would say that what we are trying to do is to get the same information to people who are losing a sensory modality or who are unable to control a sense. Our goal is to allow free-communication, because that is what control is, it is communication, and if you have a disability which doesn't allow you to manipulate things or to speak or to manipulate a keyboard then or not able to communicate what you want to communicate. If you have lost a sensory modality, if you are blind or hearing impaired, then you are getting a lack of information input. So, we are not necessarily trying to simulate the real world but we are trying to ensure that everybody can get the information they want, and they communicate

the information they want.