



Tele-Immersion: Virtually Here!

With tele-immersion, you'll interact instantly with your friend on the other side of the globe through a simulated holographic environment. This technology, which will come along with Internet2, will change the way we work, study and get medical help. It will change the way we live.

It's 2010 and you have a very important meeting with your business associates in Chennai. However, you have visitors from Japan coming to ink a mega business deal the same day. So you go to a room you call the holodeck. There, inside a simulated environment, you contact your business associates using information technology. You are able to conduct a meeting with them almost as if you are in Chennai. You even shake hands with their holographic images, because they seem to be right there!

Tele-immersion is a technology that will be implemented with Internet2. It will enable

users in different geographic locations to come together and interact in a simulated holographic environment. Users will feel as if they are actually looking, talking and meeting with each other face-to-face in the same place, even though they may be miles apart physically. In a tele-immersive environment, computers recognise the presence and movements of individuals as well as physical and virtual objects. They can then track these people and non-living objects, and project them in a realistic way across many geographic locations.

The three steps to cons-

tructing a holographic environment are:

- The computer recognises the presence and movements of people and objects.
- The computer tracks those images.
- The computer projects those images on a stereo-immersive surface.

3D reconstruction for tele-immersion is performed using stereo, which means two or more cameras take rapid sequential shots of the same object, continuously performing distance calculations, and projecting

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them into the computer-simulated environment to replicate realtime movement. By combining cameras and Internet telephony, videoconferencing has allowed realtime exchange of more information than ever, without physically bringing each person into one central room.

The history

It was way back in 1965 that the great pioneer of computer graphics, Ivan Sutherland, proposed the concept of the

'ultimate display'. It described a graphics display that would allow the user to experience a completely computer-rendered environment.

In 1998, Abilene, a backbone-research project, was launched and now serves as a base for Internet2 research. Internet2 needed an application that would challenge and stretch its networks' capabilities. The head of Advanced Network and Services proposed tele-immersion as the application that could drive Internet2 research forward. That is how the National Tele-immersion Initiative was formed.

In May 2000, researchers at the University of North Carolina (UNC), the University of Pennsylvania and Advanced Networks and Services reached a milestone in developing this technology. A user sitting in an office at UNC in Chapel Hill, NC, was able to see lifelike, three-dimensional images of colleagues hundreds of miles away, one in Philadelphia and the other in New York. Today scientists are still developing this new communications technology. There are several groups working together on the National Tele-Immersion Initiative (NTII) to make this wonderful technology available to the common man.

Components of a holographic environment

Tele-immersive displays of earlier days required users to wear special goggles and a head device that tracked the viewpoints of users looking at the screen. At the other end, the people, who appeared as 3-D images, were tracked with an array of eight ordinary video cameras while three



Tele-immersion will allow us to manipulate holographic projections as if they were real objects.

other video cameras captured real light patterns projected in each room to calculate distances. This enabled the proper depth to be recreated on the screen. So if an observer moved her head to the left, she could see the corresponding images that would be seen if she were actually in the room with the person on the screen.

Scientists are developing new technologies to support this type of communication. A part of these new technologies is:

Telecubicle: Users will communicate by using this technology. It consists of a stereo-immersive desk surface and two stereo-immersive wall surfaces. These three display surfaces join to form a corner desk unit. The walls appear as windows to the other users' environment while the desks join together to form a virtual conference table in the centre. This will allow the realistic inclusion of tele-immersion into the work environment, as it will take up the usual amount of desk space.

Internet2: This will replace the current Internet infrastructure. It is a consortium made

up of the US government, industry and academia (180 universities) that has been formed for creating tomorrow's Internet. This new network will have a higher bandwidth and speeds that are 1000 times faster than today's Internet. This high-bandwidth, high-speed network is necessary to transfer the large amounts of data that tele-immersion will produce.

Display technologies: Stereo-immersive displays would have to present a clear view of the scenes being transmitted.

Haptic sensors: would allow people to touch projections as if they were real.

Desktop supercomputers: would perform the trillions of calculations needed to create a holographic environment. A network of computers that share power could also possibly support these environments.

Bandwidth issues

Network bandwidth required to make tele-immersion work is one of the main concerns of this new technology. It is esti-

mated that as much as 1.2 gigabits per sec will be needed for future high-quality effects. This is much higher than the average home connection bandwidth. The exact amount of bandwidth needed for each scene depends on the complexity of the background. With time, the number of megabits used will fall as advanced compression techniques are established. Currently, the 'last mile' of network connections for top computer science departments in US use an OC3 line. This can carry 155 megabits per second and supports, at a basic level, a three-way conversation. Although OC3 lines are 100 times faster than normal broadband, they are also more expensive.

Initially, bandwidth-intensive applications will have to be limited to the larger organisations that can afford high connection speeds. The amount of data sent to render this tele-presence will also require fast processing power. This will need to be available as required on the Internet. A new network called the Grid could be a solution. The Grid will use distributed computing. There are not enough supercomputers to deal with the enormous amounts of data that will rush through the Net in the future. As a solution, new networks will connect their PCs so they can share processing power and hard disk space. They will be locked in to a grid—effectively creating one supercomputer.

Tele-immersion and virtual reality

Tele-immersion may sound like virtual reality but there are major differences between the two technologies. While virtual reality allows you to move in a computer-generated 3-D

environment, tele-immersion can only create a 3-D environment that you can see but not interact with. However, interaction is possible by combining the two technologies.

Applications

Tele-immersive holographic environments have a number of applications. Imagine a video game free of joysticks, in which you become a participant in the game, fighting monsters or scoring touch-downs. Instead of travelling hundreds of miles to visit your relatives during the holidays, you can simply call them up and join them in a shared holographic room. Doctors and soldiers could use tele-immersion to train in a simulated environment. Building inspectors could tour structures without leaving their desks. Automobile designers from different continents could meet to develop the next generation of vehicles. Surgeons in different geographical spaces could experiment with virtual medical procedures before working on actual patients. Medical technologies that are physically inaccessible in some places could be used to save lives by manipulating virtual models, for instance, on offshore oil rigs and ships. In the entertainment industry, ballroom dancers could train together from separate physical spaces. Instead of commuting to work for a board meeting, businesspersons could attend it by projecting themselves into the conference room.

The list of applications is large and varied, and one thing is crystal clear—this technology will significantly affect the educational, scientific and medical sectors.

Medicine: Tele-immersion



Tele-immersion streams

can be of immense use to the field of medicine. The way medicine is taught and practised has always been very hands-on. It is impossible to treat a patient over the phone or give instructions for a tumour to be removed without physically being there. With the help of tele-immersion, 3D surgical learning for virtual operations is now in place and, in the future, the hope is to be able to carry out real surgery on real patients. A geographically distanced surgeon could be tele-immersed into an operation theatre to perform an operation. This could potentially be lifesaving if the patient is in need of special care (either a technique or a piece of equipment), which is not available at that particular location.

Tele-immersion 'will give surgeons the ability to superimpose anatomic images right on their patients while they are being operated on'. The argument against this is: how reliable is this technology? What would be the legal implications if the technology fails suddenly and the tele-immersed surgeon disappears in the middle of an operation, with the patient left without medical help? How accurate

are the movements of the transported doctor when within an environment? Will the doctor be able to sense a patient's mood and feelings? These are difficult questions to answer and there are bound to be many sceptics.

Uses in education

In education, tele-immersion can be used to bring together students at remote sites in a single environment. Relationships among educational institutions could improve tremendously in the future with the use of tele-immersion. Already, the academic world is sharing information on research and development to better the end results. Tele-immersion will only promote this collaboration. This will be a distinct advantage in surgical training. While it will not replace the hands-on training, this technology will give surgeons a chance to learn complex situations before they treat their patients. With tele-immersion in schools, students could have access to data or control a telescope from a remote location, or meet with students from other countries by projecting themselves into a foreign

space. Internet2 will provide access to digital libraries and virtual labs, opening up the lines of communication for students. Tele-immersion will bring to them places, equipment and situations earlier not available, helping them experience what they could have only watched, read or heard about earlier.

Future office

In years to come, instead of asking for a colleague on the phone you will find it easier to instruct your computer to find him or her. Once you do that, you'll probably see a flicker on one of your office walls and find that your colleague, who's physically present in another city, is sitting right across you as if he or she is right there. The person at the other end will experience the same immersive connection. With tele-immersion bringing two or more distant people together in a single, simulated office setting, business travel will become quite redundant.

Videoconferencing via the Internet is not a perfect form of communication. The image is close to realtime but there are delays that cause distorted video. Also, if someone walks out of the view of a camera, the person is no longer visible. However, with tele-immersion, people will always remain in view of the camera and you will be able to look around their office just by looking at the display screen from different angles. Tele-immersion takes videoconferencing to a higher level. It is a dynamic concept, which will transform the way humans interact with each other and the world in general.

