A

Seminar report

On

Tele-Immersion

Submitted in partial fulfillment of the requirement for the award of degree of MCA

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Acknowledgement

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Preface

I have made this report file on the topic **Tele-Immersion***:* I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

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INTRODUCTION

In tele-immersion, immersive virtual reality environments are used over networks to provide shared access to simulated virtual spaces for design, collaboration, entertainment, education. Tele-immersion integrates collaborative Virtual Reality with audio and videoconferencing that may involve data mining and heavy computation. When participants are tele-immersed, not only can they virtually see and interact with each other, but when they leave, their environment continues to evolve, autonomously controlling computation and data access. The environment transmits gestures as well as audio and video, so users have a greater sense of presence in the shared space. Scientists are also trying to tackle the problem of how to provide both synchronous and asynchronous collaboration. When collaborators are on the same continent, conducting synchronous sessions in the shared space is straightforward because time differences are minimal. When collaborators are across the globe, however, the greater time differences require asynchronous collaboration —collaborators working in the same virtual space at different times so they can work during their normal work hours.

Video conferencing prices have plunged over the past few years with the advances in computer technology and the advent of high-bandwidth telephone and Internet lines in the office. However, there are **limitations.** Videoconferencing +today is like watching the remote person on television. Although you can hear the person and see the non-verbal gestures and cues, it is not really like sitting across the table from the person. People sometimes feel uncomfortable on camera and feel disconnected from the people shown on the screen. It is also impossible to make direct eye contact, because the camera and the display screen are not in the same spot.

In video-conferencing the image is close to real time but there are always delays that cause distorted video. Also if someone walked out of the view of the camera the person is no longer visible. So, to remove this problem a new technology came into existence, called **tele-immersion**. Tele-immersion is the next step of video conferencing.

Tele-immersion(National Tele-immersion Initiative - NTII) will enable users at geographically distributed sites to collaborate in real time in a shared, simulated Environment as if they were in the same physical room. In a tele-immersive environment computers recognize the presence and movements of individuals and objects, track those individuals and images, and then permit them to be projected in realistic, multiple, geographically distributed immersive environments or stereo-immersive surfaces. Tele-immersion environments will therefore facilitate not only interaction between user themselves but also between users and computer-generated models.

WHAT IS TELE-IMMERSION?

According to ***Jason Leigh***
"The term Tele-immersion was first used … as the title of a workshop … to bring together researchers in distributed computing, collaboration, virtual reality and networking".

According to ***Watsen & Zyda***
"It enables the interaction between geographically remote participants within a shared, three-dimensional space."

Tele-immersion is a new medium of human interaction that creates illusion that the user is in the same physical space like the other participants, although in reality other participants are thousands of miles away. This is a new tele-communication that combines aspects of virtual reality with 3D videoconferencing. Tele-immersion enables users at geographically distributed sites to collaborate in shared, simulated, hybrid environment as if they were in the same physical room. It is the ultimate synthesis of networking and media technologies to enhance collaborative environments. This environment persists even when all the participants have left. Tele-immersive applications must combine audio, video, virtual worlds, simulations, and many other complex technologies. They will require huge bandwidth, very fast responses, and guarantees of delivery.

The ideal tele-immersion system is not hard to imagine. Combine the best computer graphics, audio, computer simulation, and imaging, connect with networking, provide software and hardware to track gaze, gesture, facial expression, and body position, offer it as a built-in feature on all personal computers and video games. Obviously, we are far from achieving ubiquitous tele-immersion.

In the past people only dream about communicating geographically but the advancement in telecommunication along with advancement in media techniques make it possible. But still there was struggle to make them collaborate in a real time world, like efforts to have users share the same physical space, during there meetings, conferences, etc. This kind of tele-immersion differs significantly from conventional video teleconferencing in that the user's view of the remote environment changes dynamically as he moves his head.

Tele -immersion is the ultimate synthesis of
* 3D environment scanning - 3D reconstruction based on display
* Projective and display technologies
* tracking technologies
* Audio technologies
* Robotics and haptics media technologies and powerful networking.

This application is therefore considered to be an ideal driver for the research age of the Internet2 community. If the network can support network requirements for

tele-immersive (TI) sessions it is very probable that every other future network application will be also supported.

DEVELOPMENT OF TELE-IMMERSION

It was back in 1965 that the great pioneer of computer graphics Ivan Sutherland proposed the concept of the "ultimate display". It was National Tele-Immersion Initiative - NTII team that leads the way to make Tele-immersion possible. They are working on projects to have users share the same physical space in a real time world, as if they are sitting in front of each other in the same room. This team is lead by Jaron Lanier, who was one of the pioneers in development of Virtual Reality in 1980's. National Tele-Immersion team started there work in middle of 1997 and the collaborating schools were Brown University , Providence Naval Post guard School , Monterey University of North Carolina, Chapel Hill and University of Pennsylvania. In May 2000, researchers at the university of North Carolina, The University of Pennsylvania and advance network and services reached a milestone in developing this technology.

In the time period from 1999 to 2001, entire work on realization of tele-immersive idea has been organized in **two main research areas:**

1. ***The Tele-immersion Media Technology:*** Vision-based 3D reconstruction, display and projective technologies, tracking technologies.

2. ***The SOFT (Software Framework for Tele-immersion) area:*** Software systems to support tele -immersion applications The TI concept was for the first time demonstrated in May 2000. TI participants communicated using the next generation immersive interface - **telecubicle**. So for the first time in a history it was demonstrated **"Office of Tomorrow"**.

NTII Demo

In the year 2001, National Science Foundation announced Information Technology Research award of 265 mil$ for three years to support tele-immersion project. The goal of the project was to achieve real-time, high-quality 3D tele-immersion on greater distances. This goal was achieved by the first public demonstration of TI system at the l S h Supercomputing conference in Baltimore in November 16-22, 2002, Tele-immersion system gathered and displayed remote 3D stereo-scopical scene in side-by-side booths at Baltimore Convention Center while the actual data processing occurred 250 miles away at the Supercomputing Center. Demonstrations of tele–immersion upon local computing power of the Pittsburgh Previous have relied participating TI sites

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 3-D environment that you can see but not interact with. Interaction is possible by combining the two technologies.

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Virtual reality allows people to move around in a pre-programmed representation of an environment, whereas tele-immersion is more like photography. It's measuring the real world and conveying the results to the sensory systems.

TELEPORTEC

Teleportec has cleverly figured out a way to project a human image behind a desk, or even on a stage to give the appearance that the person is sitting or standing there in real life! Using ISDN or T1 lines and, ultimately, Internet2 technology *(the next generation of the Internet is mush faster and is optimized for the transmission of moving images in real time)*, this has the potential to revolutionize one-to-one videoconferences and has enormous potential for presenters and educators as well.

The picture shows Texas Governor Rick Perry's (right) life-size image being beamed on stage to an auditorium at the University of Texas at Dallas while he was in Austin. The presentation was fully interactive. An audience member asked the governor what it was like for him. He replied that he could not reach out and touch the questioner but he could see them and it was like being in the room with the audience. Although the current technology provides only two-dimensional images, it is reportedly, very convincing as it is full-color, life size image and there is depth between the image and the background. Sitting in the back, it is very difficult to tell the image from a live presenter. This has the potential for a huge impact for meetings. High-level keynote speakers can be "beamed" to audiences at a fraction of the cost and time of flying them there directly. Teleportec has proven high quality distance communication solutions designed to provide your organization with a realistic alternative to travel. This unique technology enables people to appear live, life-sized within an apparent 3-D environment in a remote location and achieve eye-to-eye contact with all participants. Group-to-group and multi-site communication is also possible.

How Holographic Environment Will Work?

Scientists today are developing a new communications technology that will allow you and your friends to interact inside a simulated environment even if you are thousands of miles apart. It will allow everyone to come together in one virtual room, and no one will have to leave their physical location to do so. Tele-immersion will allow us to manipulate holographic projections as if they were real objects. Most of the basic components for this network are already in place to allow the development of tele-immersion. Tele-immersion is the scientific community's answer to the holodeck. By combining cameras and Internet telephony, videoconferencing has allowed the real-time exchange of more information than ever without physically bringing each person into one central room. Tele-immersion takes videoconferencing to the next level.

Beyond Videoconferencing

Videoconferencing via the Internet is not a perfect form of communication. The image is close to real time, but there are delays that cause a jerking video. Also, if someone walks out of view of that one camera, you can no longer see them. With tele-immersion, people can't walk out of the view of the camera. In fact, you can peer around their office just by looking at the display screen from different angles. It's like having a window to look through. Holographic environments will be generated by computers with computing speeds thousands of times faster than your PC.

There are several steps to constructing a holographic environment -

- The computer recognizes the presence and movements of people.
- Those images are tracked by the computer.
- Those images are then projected on a stereo-immersive surface.

Building a Holographic Environment

The early prototypes of tele-immersive displays require users to wear special goggles, and a head device that tracks the viewpoints of users looking at the screen. On the other end, the people that appear as 3-D images are being tracked with an array of seven ordinary video cameras, and two other video cameras that capture real light patterns projected in each room to calculate distances. This enables the proper depth to be re-created on the screen. So, if viewers move their heads to the right, they can see the corresponding images that would be seen if the viewers were actually in the room with the person on the screen. Images on the screen are split and polarized to create a different image for each eye. The goggles then combine these images so that the brain recognizes only one 3-D image. This process is similar to how those old 3-D movie glasses work.

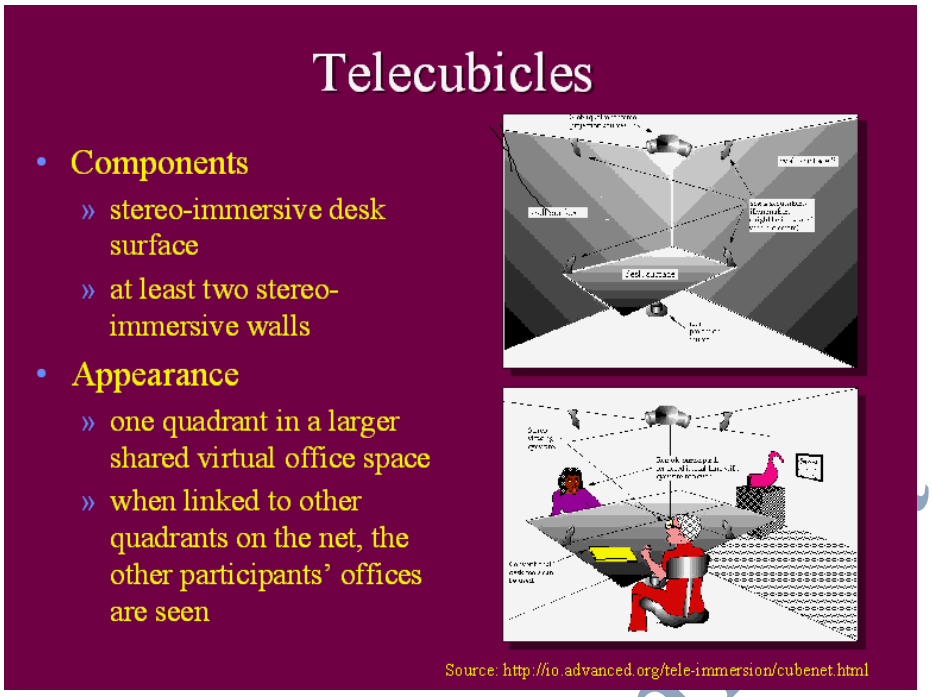
Need of Internet2

To cop up with the problems like communicating speed and better transmission of data over the network, Tele-Immersion team collaborated with Internet2 and Internet Protocol Performance Metrics. Main problem as obvious was that today's internet is not fast enough to transmit data, especially when you need to transmit a huge bulk of data across the internet about people and their environment.
Internet2, which will replace the current Internet infrastructure. This new network will have a higher-bandwidth and speeds 1,000 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, such stereo-immersive displays that can present a clear view of the scenes being transmitted. A future addition to tele-immersion will be haptic sensors that will allow people to touch projections as if they were real. Desktop supercomputers 2will be needed to perform the trillions of calculations needed to create a holographic environment. Another possibility to support these environments would be a network of computers that share power.

TELECUBICLES

"A telecubicle is an office that can appear to become one quadrant in a larger shared virtual office space." The main idea behind this work came directly from the Tele-Immersion meeting on July 21, 1997 at the Advanced Network Office. At the meeting each participant university (UIC, NPS, UNC, Columbia, and USC) brought its individual designs of cubicles and together immersed the user and the desk. One of the striking results of the meeting was the discovery of how future immersive interfaces look like, and what were the needs and requirements at that time to make this impossible looking task in the past, into reality.

How TeleCubicles Works?



In the above figure, the three display surfaces meet each other in the corner to make a desk. At the moment four telecubicles can be joined to form a large virtually shared space. The walls appear to be transparent passage for other cubicles during this linkage, and the desk surfaces join to form a large table in the middle. Objects at each place can be shared for viewing across the common desk and through walls can be seen the colleagues at other end and their environment. Figure below describes how the participa22nts so far away share the same physical space, through common immersed stereo desk and can see each other environment, virtual objects place in the others environment, across the walls which looks like transparent glasses when cubicles connected together. So the virtual world extends through the desktop. The short term solution at that time was to have remote environment pre-scanned which lead towards the goal which was obviously to have environment automatically scanned.

2222222222How Tele-Immersion Works?

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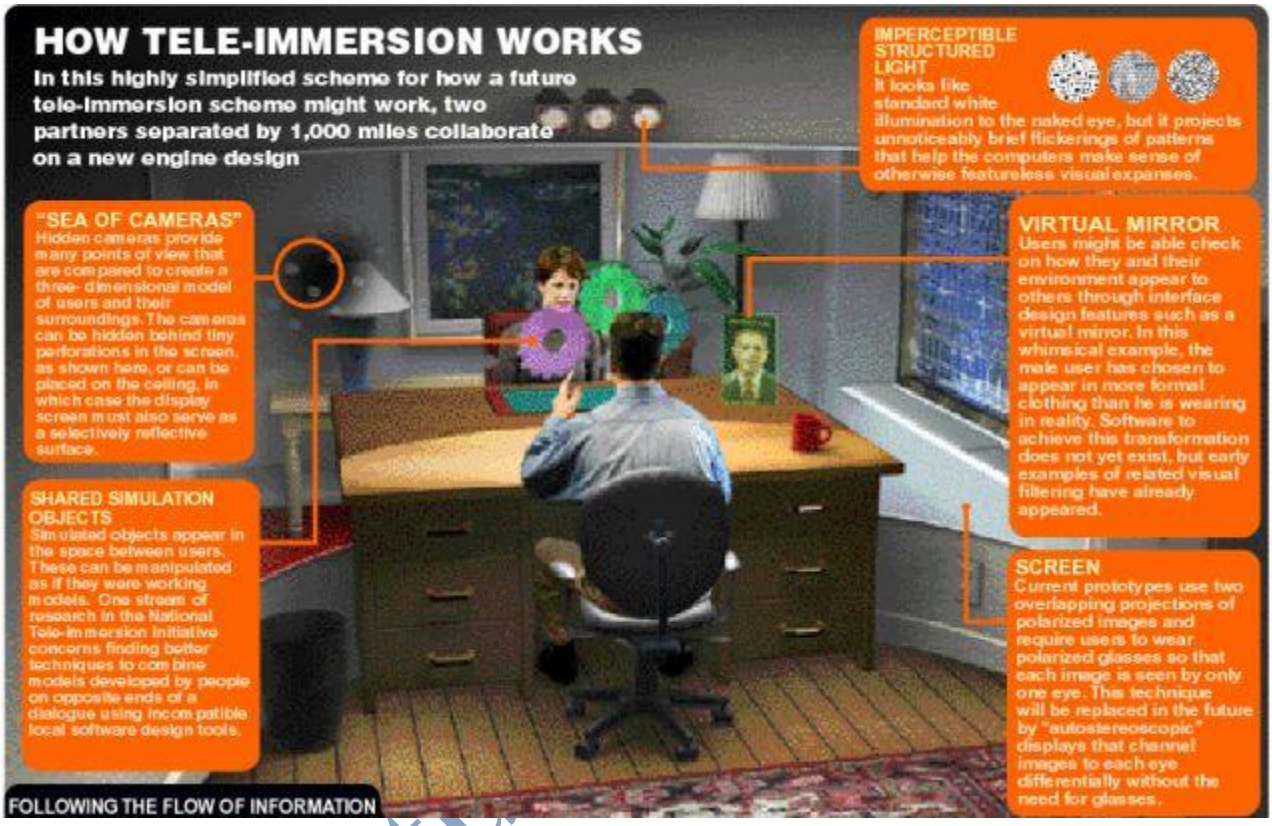

Above figure is a nice description of the Tele-Immersion implementation. Two partners separated by 1000 miles collaborate with each other. There is a sea of cameras which provide view of users and their surroundings. Mounted Virtual Mirrors provide each user a view how his surrounding seems to other. At each instant camera generated an image which is sorted into subsets of overlapping trio. The depth map generated from each trio then combined into a single view point at a given moment.

The biggest challenge of TI system is creation of adequate way of visual sensing people and their environment. The illusion that they are sitting in the same room is achieved by 3D acquisition of the scene using the method “sea of cameras” where the angles of a bigger number of cameras are mutually compared. Every camera inside of the “sea of cameras” captures visual features from its angle. By comparison of angles and using the algorithms this captured data can be combined as three-dimensional model of the scene.

APPLICATIONS

Tele-immersive holographic environment have a number of application. Imagine a video game of joysticks in which you become a participant in the game fighting monsters or scoring touchdowns. Instead of traveling hundreds of miles to visit your relatives during the holidays you can simply call them up and join them in a shared holographic room. The list of applications is wide.

Some of them are described below:-

- **MEDICAL:** Now with tele-immersion it is possible to treat a patient over the phone or give instruction for tumor 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. Tele-immersion will give surgeons the ability to superimpose anatomic images right on their patients while they are being operated on.

  Remote-Surgery: Through advances in advanced networking applications such as haptics (touch-sensitive or tactile enabling technologies), surgical simulation training and collaborative videoconferencing technologies, Internet2 is enabling pioneering scientists in medical and technical fields to make minimally-invasive, Internet-based surgery techniques a future reality. Professor W. Le Roy Heinrichs of Stanford University demonstrates the use of haptically-enabled laparoscopic tools to demonstrate simulated surgical procedures across Internet2 advanced networks.

- **IN BUSINESS LIFE:** The project **"Office of the future"** from the University of North Carolina (Chapel Hill) is best for describing a level of business cooperation that tele-immersion is going *to* give in the future using telecubicles.

The Office of the Future project is striving to bring together geographically distant persons in a realistic, tele-collaborative environment. Using real-time computer vision techniques, dynamic 3D images of your colleague in their office surroundings are captured and transmitted to your Office of the Future where virtual reality technology is used to create a life-size, visual portal into the distant space. By transmitting these 3D streams over the advanced networks of Internet2, participants in remote locations are able to interact with each other and manipulate shared virtual objects in real-time.

- **IN EDUCATION:** In education tele-immersion can be used to bring together students at remote sites in a single environment. Relationship among educational institutions could improve tremendously in the future with use of tele-immersion. PEBBLES is the world's first fully functioning 'telepresence' application - a revolutionary solution for hospitalized, homebound and special children. PEBBLES connect children to their home classroom, allowing for total participation in classroom activities and complete social contact. PEBBLES was first used in 1997 at Toronto's Hospital for Sick Children (Sick Kids) and as launched in 2001 in the United States at Yale-New Haven Children's Hospital. The technology is now in use in Canada, US, and the Netherlands.

FUTURE SCOPE OF TELE-IMMERSION

Tele-immersion will blur the lines between real and computer-generated images. It will be the ultimate tele-commuting technology; almost entirely eliminating the rush hour drive to work Instead of commuting, people could attend those board meetings by projecting themselves into the company's conference room.

The tele-immersion system of 2009 would ideally:

- Support one or more flat panels/projectors with ultra-high color resolution.
- Be stereo capable without special glasses.
- Have tether-less, low-latency, high-accuracy tracking.
- Have exquisite directional sound capability.
- Be available in a range of compatible h/w and s/w configurations.
- Incorporate AI-based predictive models to compensate for latency and anticipate user transitions.
- Use a range of sophisticated to couple to human movement and touch.

CHALLENGES OF TELE-IMMERSION

Tele-immersion has emerged as a high-end driver for the Quality of Service (QoS), bandwidth, and reservation efforts envisioned by the Internet2 leadership.

From a networking perspective, **tele-immersion is a very challenging technology for several reasons:**

- ✓ The networks must be in place and tuned to support high-bandwidth applications.
- ✓ Low latency, needed for 2-way collaboration, is hard to specify and guarantee.
- ✓ Data transmissions (called "flows") need to be provided for and managed by the networks.
- ✓ The computers, too, are bandwidth limited with regard to handling very large data for collaboration.

CONCLUSION

Tele-immersion allows widely separated people to share a complex virtual experience. In the years to some it will be one of the major developments. You could visit each other environment, but one thing which is far behind to achieve is the physical contact of individuals at each end.

So it can be summarized as:

- Collaboration at geographically distributed sites in real-time.
- Synthesis of networking and media technologies.
- Full integration of Virtual Reality into the workflow.

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