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Tele-Immersion – A Perspective through Virtual Eye

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ABSTRACT: Tele-immersion is an advanced form of virtual reality that will allow users in different places to interact in real time in a shared simulated environment. This technology causes users to feel as if they were in the same room. The Tele-immersion technology uses a "Tele-cubicle" which is equipped with large screens, scanners, sensors, and cameras. The Tele-cubicles are linked together in real-time so that they form one larger cubicle. Through the virtual environment, participants are able to interact with other group members. Also, virtual objects and data can be passed through the walls between participants, and placed on the shared table in the middle for viewing. Tele-immersion has the potential to significantly impact educational, scientific, manufacturing, and many other fields.

KEYWORDS: Tele- immersion, virtual reality, human interaction, Tele conference systems.

I. INTRODUCTION

Human interaction has both verbal and nonverbal elements, and videoconferencing seems precisely configured to confound the nonverbal ones. The result is that all the participants, however distant, can share and explore a life-size space. Tele-immersion, a new medium for human interaction enabled by digital technologies, approximates the illusion that a user is in the same physical space as other people, even though the other participants might in fact be hundreds or thousands of miles away. It combines the display and interaction techniques of virtual reality with new vision technologies that transcend the traditional limitations of a camera. Rather than merely observing people and their immediate environment from one vantage point, Tele-immersion stations convey them as "moving sculptures," without favoring a single point of view. The result is that all the participants, however distant, can share and explore a life-size space.

II. REQUIREMENTS FOR IMMERSIVE TELE-CONFERENCE SYSTEMS

To meet the requirements the Tele-immersion technology utilizes arrays of cameras and microphones to capture 3D scenes in real time. By having this setup at multiple remote sites and streaming the 3D data between the various locations one can provide users with a level of interaction currently not attainable by conventional 2D systems. It is absolutely necessary to use a large display that covers almost the whole viewing angle of the visual system. In addition, the large display has to be integrated into the usual workspace of an office or a meeting room. Thus, themostpracticable solution is a desktop-like arrangement with large flat screens like plasmadisplays with a diagonal of 50 inch and more. Starting from such a desktop-like system and taking into account results from intensive human factors research, further requirements on thepresentation of the scene can be formulated as follows:

- •Conferees are seamlessly integrated in the scene and displayed with at least head, shoulders, torso and arms in natural life-size
- •All visual parameters of the scene and the different sources have to be harmonized

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Figure 1: Cameras used in Tele Immersion

Figure 2: Large Screen Displays

A. *Tele-cubicles:*

A "Tele-cubicle" is an oversized video display system – that presents a stereo image when viewed with polarizing glasses. The head movements of the tele-cubicle user are tracked so that the projected screen images present a highly immersive 3D viewing experience. Like the familiar virtual reality goggles, the tele-cubicle display can give the viewer the sensation of being in a computer-generated world. "A Tele-cubicle is an office that can appear to become one quadrant in a larger shared virtual office space." Initial sites were UIC, UNC, and USC, as well as one in the New York Area. 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 the needs of the same were.

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B. *How Tele cubical works:*

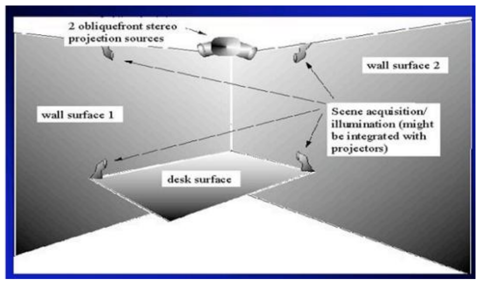

Figure 3: A Tele Cubicle

The apparatus consists of:

1. Desk surface (stereo immersive desk)
2. Two wall surfaces
3. Two oblique front stereo projection sources (might be integrated with projectors)

As illustrated (in Figure1) the three display surfaces meet each other in the corner to make a desk. At the moment four Tele-cubicles 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.

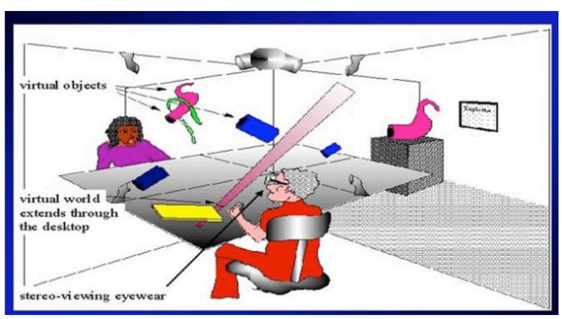

Figure 4: Working in a Tele Cubicle.

Figure 4 describes how the participants 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.

III. SCIENCE OF TELE-IMMERSION

Tele-Immersion has an environment called TIDE. TIDE stands for Tele-Immersive Data exploration Environment. The goal of TIDE is to employ Tele-Immersion techniques to create a persistent environment in which collaborators around the world can engage in long-term exploration and analysis of massive scientific data-sets. When participants are Tele-immersed, they are able to see and interact with each other and object in a shared virtual environment. Their presence will be depicted by life-like representations of themselves (avatars) that are generated by real-time, image capture, and

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modelling techniques. The environment will persist even when all the participants have left it. The environment may autonomously control supercomputing computations, query databases and gather the results for visualization when the participants return. Participants may even leave messages for their colleagues who can then replay them as a full audio, video and gestural stream.

All users are separated by hundreds of miles but appear collocated able to see each other as either a video image or as a simplified virtual representation (commonly known as an avatar). Each avatar has arms and hands so that they may convey natural gesture such as pointing at areas of interest in the visualization. Digital audio is streamed between the sites to allow them to speak to each other.

TIDE will engage users in CAVEs, Immerse Desks and desktop workstations around the world connected by the Science and Technology Transit Access Point (STARTAP) - a system of high speed national and international networks. TIDE has three main parts:

1. Tele-immersion server (tis)
2. Tele-immersion client (tic)
3. Remote data and computational services

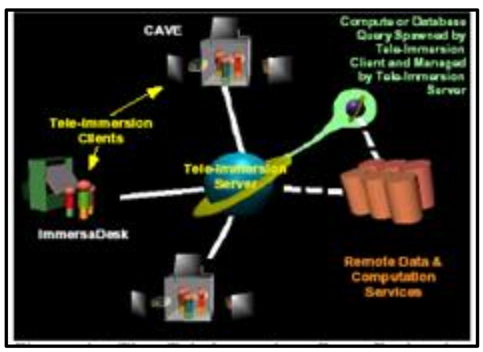

Figure 5: The Tele Immersion Architecture.

IV. TELE-IMMERSION SERVER

The Tele-Immersion Server's primary responsibility is to create a persistent entry point for the TICs. That is, when a client is connected to the TIS, a user can work synchronously or asynchronously with other users. The environment will persist even when all participants have left it. The server also maintains the consistent state that is shared across all participating TICs. Finally the TIS stores the data subsets that are extracted from the external data sources. The data subsets may consist of raw and derived data sets, three dimensional models or images.

V. TELE-IMMERSION CLIENT

The Tele-Immersion Client (TIC) consists of the VR display device (either CAVE, ImmersaDesk, etc.) and the software tools necessary to allow "human-in-the loop computational steering, retrieval, visualization, and annotation of the data. The TIC also provides the basic capabilities for streaming audio and video, and for rendering avatars to allow participants to communicate effectively with one another while they are immersed in the environment. These capabilities come as part of EVL's Tele-Immersion software framework called CAVERNsoft.

VI. HARDWARE REQUIREMENT FOR TELE IMMERSION

The Tele-immersion test bed is a continuously evolving system. Before delving into the individual algorithms describe the first hardware la y-out realized in spring 1999. Each side consists of

1. A stereo rig of two CCD-cameras.
2. A PC with a frame grabber.
3. A PC with an accelerated graphics card capable of driving stereo-glasses synchronization.

The spring-99 version has an Intel Pentium-II 450 MHz and a Matrox-Genesis Frame Grabber at the local site. The latter includes the TI C80 processor as a component. The CD-cameras are the Sony XC-77. For visualization we use the Diamond FireGL-4000 board with Crystal Eyes stereo-glasses. Both sites are connected to the network and send their data using the TCP/IP protocol. Implementation of networking is for the local area network and will be extended to include compression and to compensate for lossy transmission protocols in a wide area Internet2 connection.

VII. LIMITATIONS

The Tele Immersion technology gives the world a whole new way of interacting with each other even if people are miles apart or in two corners of the world. But this technology also has some of the problems which can be caused that are to be dealt with.

- Cameras produce a lot of noise.
- Poor reconstructions.
- Small range of capturing.
- Some cameras do not work properly.
- Delay in data transfer.

VIII. CONCLUSION

The wide use of 3D-data from reconstruction raises demand for a higher quality of shape representation. We are working on the critical problems of occluding contours and specularities arising in stereo reconstruction. The dynamics of the scene necessitate shape representations that will be easily updatable using some simple assumptions on temporal coherence. Even if we use multiple cameras to obtain a surround capture we need surface parameterizations that can be also spatially registered in a simple and robust way, the 3D-data have to be transmitted over the network. The challenge for progressive 3D wavelet-like representations which simultaneously address the critical issues above remains open.

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