HCI Research at the Electronic Visualization Laboratory

Tom Moher, Andy Johnson, Tom DeFanti, Maxine Brown,
Dan Sandin, Jason Leigh, Bob Kenyon
Electronic Visualization Laboratory
University of Illinois at Chicago
Chicago, IL 60607 USA
+1 312 996 3002
moher@uic.edu

ABSTRACT
This overview describes research in four areas of human-computer interaction at the UIC Electronic Visualization Laboratory: tele-immersive learning environments, collaborative tele-operation, teleconferencing, and video avatars.

Keywords
Virtual reality, tele-immersion, interactive learning environments, video avatars, remote collaboration, presence

INTRODUCTION
The Electronic Visualization Laboratory was founded in 1973 by Tom DeFanti and Dan Sandin to support research in computer graphics and electronic arts. Over the past 25 years, the laboratory has expanded its scope to include such areas as virtual reality, human-computer interaction, communication, and networking. EVL is probably best known as the birthplace of the CAVE™. In recent years, the focus of work at EVL has centered on remote immersive collaboration technologies and applications.

TELE-IMMERSIVE LEARNING ENVIRONMENTS
Our work in this area has focused on immersive environments supporting children's conceptual learning in science and mathematics. We are investigating the potential value of advanced visualization technologies to support learning programs in regular elementary school settings. Toward this end, EVL has established a partnership with Lincoln elementary school in Oak Park, Illinois, and has installed an ImmersaDesk™ there to support instruction and research; to our knowledge, it is the first elementary school in the world with permanently installed virtual reality facility.

We have previously reported on two of our research projects. The NICE project focused on exploratory, tele-immersive learning in a virtual garden [1,2]. NICE offers a persistent simulation in which children may plant and harvest vegetables, remove weeds, observe the effects of rainfall and sunlight, and interact with one another (often in unanticipated ways.) NICE was demonstrated at Supercomputing '97, with users from ten sites on three continents playing together in the garden.

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In the Round Earth project, tightly structured distributed collaboration was used to test a pedagogical strategy supporting conceptual change in children's conceptions of the Earth's shape [3,4,5]. By placing second grade students on a simulated small-diameter asteroid, we were able to help teach children understand concepts such as the relativity of "up" and "down," the continuity of a spherical surface, and the self-occluding nature of a globe, without invoking their prior confidence in the flatness of the Earth's surface.

Current work centers on the design of VR-based environments which support the early stages of scientific inquiry: exploration, observation, and data collection. In the Correlations project, children collaboratively plan, execute, and report on an investigation of conditional co-occurrence of vegetation in a simulated world. In the Temple World, children develop and justify reconstructions of an ancient temple from component ruins and clues contained in simulated contemporaneous manuscripts. Children's facility in developing non-egocentric perspectives are investigated in the Piaget project. We are also investigating the use of tele-immersion as a vehicle for the design of tightly coupled collaborative learning interventions.

COLLABORATIVE TELE-OPERATION

We have assessed the effects of network latency and jitter on a tele-immersive task in a collaborative virtual environment. Two remote partners worked together to manipulate shared virtual objects over a network. The task was to minimize the time to transfer a ring through one of four paths of varying difficulties with the least number of collisions. Four different network conditions were used: 10 and 200 msec delays with and without jitter. Jitter had the greatest affect on performance when using long delay networks and high difficulty tasks [6].

The results of this study provide some empirical data, which can be used to define QoS for CVE networks in the near future. The impact of jitter and latency on QoS really depend on the task and the level of difficulty of the task. We are working to develop a metric that will take into account these and other aspects of the application along with the network characteristics in providing a usable value for an interactive quotient.

TELECONFERENCING

EVL is developing new technologies to support equitable access by persons with disabilities in teleconferences. The AccessBot system pairs a 50-inch diagonal HDTV-format plasma display, mounted vertically with a remote controlled camera, under the control of custom software developed at EVL. The goal of AccessBot is to ensure that users have not only virtual presence, but *equal* presence, via life-sized displays.

Presently, a pair of AccessBots have been at EVL and at NCSA's ACCESS Center in Arlington, VA, connected via a vBNS network.

VIDEO AVATARS

EVL is exploring 2D (flat), 2.5D (flat images mapped onto 3D wireframe face models) and 3D video representations. While we can point video cameras at users and open windows on VR displays so colleagues can see one another, the user appears flat (like a TV screen) and decoupled from the data; our goal is to immerse the avatars in the simulation itself. Current research uses blue screen technology to separate users from their physical environment and literally "cut them out" and insert them into the simulated environment. However, blue screens only work with ImmersaDesks. In order to extend this technology to CAVE environments, are now experimenting with a depth isolation camera, which provides grey-scale information on foregound and background, so that we can isolate users from their physical backgrounds.

ACKNOWLEDGMENTS

The research, collaborations, and outreach programs at the Electronic Visualization Laboratory (EVL) at the University of Illinois at Chicago are made possible by major funding from the National Science Foundation (NSF), awards EIA 9720351, EIA-9802090, EIA-9871058, ANI-9712283, ANI-9730202, and ACI-9418068, as well as NSF Partnerships for Advanced Computational Infrastructure (PACI) cooperative agreement ACI-9619019 to the National Computational Science Alliance. EVL also receives major funding from the US Department of Energy (DOE), awards 99ER25388 and 99ER25405, as well as support from the DOE's Accelerated Strategic Computing Initiative (ASCI) Data and Visualization Corridor program. In addition, EVL receives funding from Pacific Interface on behalf of NTT Optical Network Systems Laboratory in Japan.

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