Enhanced Realities

Introduction

"Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!"

The Red Queen
Lewis Carroll, "Through the Looking Glass"

In his tales of Alice's adventures, Lewis Carroll uniquely captured a world of wonder as seen through the eyes of a child. Even as adults, we can relate to Alice and the nonsensical creatures and situations of Wonderland. Perhaps we more than half believe that there are truths to be found there. But too often the rest of our "grown up" perception sees the world as all too ordinary, which may point to nothing more than a suspension of wonder. It's all too easy to lose our ability to ask Alice-like questions, to wonder: "why?"

We hope that your walk through the contributed wonderland of fresh ideas that created Enhanced Realities will rekindle your sense of childlike wonder, the essence that is SIGGRAPH. Our program is devoted to those who continue to ask why, and to those in whom inspiration and wonder has been renewed in their asking.

Of the more than 50 proposals submitted to Enhanced Realities, we chose this year to accept just the top layer, the 17 most impressive and groundbreaking innovations, for presentation at SIGGRAPH 98. This work envisions our augmented future with clever multimodal interfaces that challenge our ideas about computing in the physical world and question this dubious concept called "reality." The goal of Enhanced Realities is to make us return to that childlike wonder of discovery, to inspire us with technological innovations that immerse us in a new, enhanced reality.

I am very grateful to all the wonderful world of potential contributors – the whole of the SIGGRAPH community and beyond – whose work points the way to our most creative emerging achievements on the horizon of technology. Many valuable lessons and insights arose in our Enhanced Realities jury meeting, including several outstanding inspirations for new projects based on the work our contributors submitted!

In the following pages, we share some "insider information" on how the selection process works, what a jury looks for when reviewing proposals, and how you can best present your vision and achievements to your busy but excited peers.

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Chair, Enhanced Realities

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Enhanced Realities is dedicated with heartfelt thanks to:

All those who took the time to submit an emerging technologies proposal, our contributors who undertook the time and expense required to show us their visions of the future, and our jury participants whose careful review efforts greatly enhanced our program.

Walt Bransford and Dino Schweitzer for unfailing encouragement and guidance.

Sony Pictures Imageworks for their uncommon support, including use of facilities and resources.

The Enhanced Realities Committee for their vision, dedication, and labor.

The SIGGRAPH 98 Conference Committee whose indispensable help and feedback formed our enhanced reality.

Jury Statement **Bruce Blumberg** MIT Media Lab

What I was looking for (and sometimes found)
As a jury member, I asked four big questions about each submission:

- Is it clear?
- Is it fun?
- Is it real?
- Is it important?

Is it clear?
It would be nice if the jury members spent as much time reading your proposal as you undoubtedly spent writing it. The sad fact of the matter, however, is that your submission is likely to be one of 100 that the jury put off reviewing until several days (hours) before the jury meeting. So it is absolutely essential for you to present your proposal as clearly and as succinctly as possible. Clearly articulate what the user experience will be, and the technical significance of the piece. If it seems similar to previous installations, then be sure to put it in context (be clear about what is different). Try to do all of this in a page or two, and in your accompanying video. Have a friend who doesn't know your work read it and tell you what you are proposing to do, and see if they get it. You are only hurting yourself if you make the jury struggle to understand your proposal. Struggling juries are grumpy juries!

Always ask yourself how you can make your proposal stand out from the 100 other proposals. This is often as hard as the underlying implementation, but it is well worth the effort.

Is it fun?
I am most attracted to submissions that seem like they would be fun to experience. Fun does not in anyway imply that the underlying work is not serious and important, but rather that it is presented in a way that is accessible and clear to the guest. Indeed, "fun" is a good indicator of a great implementation and/or a novel idea. Submissions should make it clear through the video and description why an installation will be fun to experience. A great implementation based on a "little idea" can often be a more compelling installation than a "big idea" done poorly. This is not to say you should focus on little ideas, but if you have a little idea (not Turing-award material) and you know how to turn it into a fun installation, go for it. Chances are the jury will go for it too.

Statements that lapse into "art criticism speak," or videos that seem as if they were done with MTV in mind come off as pretentious and work against you. The jury isn't exactly "hard-boiled," but it is composed of people who spend more time building things than talking about things. They want to hear how an installation will feel to the guest, so they would rather read a discussion of the underlying technology than learn that the installation is a "post-modern deconstruction of (whatever)." The word "chaos" is a good word to avoid. It has been known to cause rashes among more than a few jury members.

Is it real?
You should go out of your way to encourage the jury to believe that there is some chance that you can pull off what you say you are going to pull off. For example, if your installation is predicated on natural language understanding, the jury is going to be very interested in understanding how you intend to solve that problem. Videos, published papers, and the past experience of your team can all help to bolster the jury's confidence in your abilities. Don't be afraid to add a "this is how it works" section to your proposal. This is particularly true if you are pushing the state of the art.

Speaking of videos, do yourself a favor and submit one. Without a video, it is very difficult to communicate that the installation will be fun, real, and important. The immediate assumption, right or wrong, is that if you don't have a video, there is a good reason (for example, your work is not implemented yet), and this works against you big time. The jury is composed of people who have done installations and are very forgiving of "bugs." They recognize that the video was made in January and the installation is in July, and that there is lots of time to improve things. So you are always better off showing what you have and what you need to do, than leaving it up to the jury's imagination.

While you want to go out of your way to convince the jury that your installation is real, you should be honest about the risks and remaining work. The jury may not be experts in your field, but they are generally experts in detecting unsubstantiated claims (BS).

Is it important?
One of the objectives of Enhanced Realities is to expose people to novel techniques (or novel applications of known techniques) that have the potential for becoming mainstream several years in the future. This is what I mean by importance. Is there something about the installation that is a harbinger of things to come? In your proposal and video, you should make this very clear. In general, importance should be read as "technical importance" as opposed to "sociological importance." Ideally, your installation should be based on research that is worthy of being presented in SIGGRAPH Papers or Sketches (and in the best of all possible worlds, is being presented in one of those programs), or that you are planning on submitting as a Paper next year. If you believe that the real importance of your installation lies in its sociological implications, don't be deterred, but be sure to present your rationale in a clear and down-to-earth manner.

Jury Statement **Andrew Glassner** Microsoft Research

Even before I started reading the proposals for SIGGRAPH 98's Enhanced Realities, I wanted to accept them all. I knew that every proposal represented the work of one or more people who wanted to share their coolest ideas with the rest of the SIGGRAPH community. Since I like to support imaginative and creative thinking whenever I can, I wanted to invite all the proposers to come along and show their stuff.

But that wouldn't be fair to the SIGGRAPH 98 attendees, whose time at the conference is already in short supply. Our job as a jury was to select those entries that would really reward someone's time and effort. The ideal Enhanced Realities entry would inspire a new idea or cause someone to laugh and grab a friend, insisting that they had to come and check out the piece.

There are at least two ways to think about evaluating pieces. One way is to be selfish and simply judge each entry by its impact on one's own self. Another way is to consciously act as a representative for other viewers and try to choose entries that would delight and excite them. Our chair, Janet McAndless, did a great job of selecting people who represented a cross-section of the SIGGRAPH crowd: artists, scientists, programmers, dreamers, and so on. Janet's up-front work in assembling the committee meant that we were free to be selfish. This meant that as a juror, I could operate as my mind and gut told me to.

Because I believed that every entry was a sincere proposal, I wanted to extract every bit of good stuff from each one, so that I'd have a chance to really evaluate how each work hit me. Unfortunately, many of the proposals didn't give themselves a fair chance. The first big problem was ambiguity. Some proposals were simply too short to explain what they were about.

Others were unclear, either because they were couched in jargon or simply poorly written. We had several proposals that were filled with "art speak." For those who are unfamiliar with this form of expression, it is the intellectual language of art that can obscure as much as it illuminates. Art speak would refer to a pencil as a "trans-physical emotional/intellectual realizer, directly projecting mental thought processes without correlated referents into concrete manifestations of private and public iconography." You get the idea. It is almost impossible to understand what this stuff refers to.

Some projects were simply without purpose, and amazingly, sometimes information was simply missing. We would see pictures or a video of a gadget or a system, and we'd be left wondering why they bothered. What good is this thing? What problem does it solve? What questions does it pose? Why is it different or better than other ways to accomplish the goal? Bottom line: why did the authors do this? When we were sufficiently bewildered, we had to let the proposal go into the reject bin.

A related problem was proposals that stressed the wrong thing. There were some projects that had very cool technology applied to toy problems, when the ultimate purpose was much more interesting and valuable. We were a little more generous to these on the whole, since so much of SIGGRAPH is about technology, and we imagined that most people would see the applications on their own if the technology was sufficiently well presented.

A few of the proposals seemed to try to enhance their credentials by referencing the many fine people and reviewers who had already said good things about the work. If a piece really had some stellar reviews, I didn't mind seeing them mentioned as supporting documentation. However, some proposals dropped names egregiously. I have to admit that I tended to think that any submission that flaunted its credentials was probably doing so to cover something up, and I usually found that something. I would have preferred that the authors let the piece stand on its own merits.

Finally, business blurbs were rejected pretty quickly. We were aware that some of the proposals represented the work of people in commercial enterprises, and that wasn't a problem. But when the submission made it pretty clear that the proposal itself was simply an advertisement for a commercial product, we were rather more careful, since we didn't want Enhanced Realities to turn into a smaller version of the SIGGRAPH 98 Exhibition.

The proposals I liked best were short, clear, well-written and illustrated, and identified the value of the piece. I appreciated proposals that identified what was already working, what could probably be done in time for the conference, and what was just blue-sky. I liked proposals that didn't strain to sell the work, but simply shared why it was done, what was cool about it, and why other people would be turned on to see it. Enthusiasm is always great to see, but the best proposals also shared the lasting value of the work. Many of the proposals that we accepted had their purpose and value stated crisply and clearly up front, and then expanded on that basic idea to show its implications.

I hope that when you tour Enhanced Realities you'll find some presentations that make you laugh, some that make you think, some that give you great new ideas, and some that give you an optimistic picture of the future we're all creating together.

Jury Statement **Kathryn Saunders** Royal Ontario Museum

Seventeen projects were selected by our jury from the 68 entries originally submitted. This year's selections continue to "raise the bar" of creative and technological excellence that is the hallmark of Enhanced Realities.

While we used the same two-step jury process (screening and finals), each of us on the jury employed our own criteria for grading the submissions. In selecting the jury, the chair astutely combined industry professionals from research, artistic, and production backgrounds, which gave rise to some lively discussions and piercing insights.

I evaluated the projects using the following criteria:

- The level of innovation
- The strength of the idea
- The quality of the content and implementation
- Audience appeal
- Significance and potential influence

Level of Innovation

Certainly the most common question asked by the jury was: "What is the innovative or groundbreaking technology demonstrated here?" Submissions such as Object-Oriented Displays managed to communicate an impressive level of innovation by using a series of diagrams to describe the technology in detail, indicating what the components were and how they were configured. Another project appeared to be based on the same level of innovative research. The jury was very interested and wanted it to be included in the ranks of the winners, but we had to give it a failing grade because it was so poorly documented. It lacked accompanying images, video, or Web site, so we couldn't reasonably take the risk of including it. Ten percent of the submissions were disqualified because of lack of documentation.

Strength of the Idea

There is a saying that computer graphics are the solution to a nonexistent problem. I, however, was completely moved when I came across submissions with strong ideas and real resonance. Stretchable Music with Laser Range Finder is one such project. Participants create music by moving their hands to stretch and distort graphics that in turn control different sounds, rhythms, and patterns. By incorporating an innovative laser hand tracker and superb programming, the effect is seamless, intuitive, and very satisfying. Other ideas were strong partly because they were so "simple." inTouch, for example, did not demonstrate breakthrough technology. Rather, its strength was its unabashed response to a basic human need for tactile communication between two people separated by distance.

Quality of Content and Implementation

I looked for content that was not only engaging and beautiful, but offered something beyond the expected. For example, Media & Mythology uses role-playing within a multi-user domain as a vehicle to learn about ancient mythology. When the jury met, much of Media & Mythology was not yet produced. However, using images of past work and conceptual sketches, the submitters were able to convince us that they had the talent and the resources to pull it off. To be accepted, contributors had to reasonably demonstrate that they would be able to control or direct a unified, consistent, holistic experience, which is not easy for most people. Entrants who worked as part of a collaborative team ranging from research scientists to artists, to shape the new technologies into meaningful experiences, were more successful. Those who actively solicited feedback from the Enhanced Realities chair enjoyed even more success.

Audience Appeal

Each of the successful submissions proposed experiences that allowed people to actively participate. Although the type of interaction varied, the jury was completely aligned on the fact that the experiences had to be fun and engaging. From the immediately accessible interactive environment of the HoloWall and Mass Hallucination to the more process-driven experience of Shall We Dance? and Virtual Head, the successful projects are to be commended overall for their interactive focus.

Significance and Potential Influence

Enhanced Realities showcases breakthrough technologies combined with innovative content. Next year, the industry will have advanced through the evolution or deviation of these and other ideas. Submissions that have the potential to act as a catalyst or influence future technologies were favored by the jury. Although technological breakthroughs received the highest marks, incremental improvements and innovations were also accepted.
One project, which resurfaced from last year, demonstrated significant advancements in its innovation. Although the purpose of the project remained constant, the technologies used in 1998 were a marked improvement over the 1997 submission.
The contributor wrote that during SIGGRAPH 97, he met someone who suggested another way of approaching the problem. I liked that. It reinforced SIGGRAPH's role in the exchange and development of ideas that are actively shaping our future.

HoloWall: Interactive Digital Surfaces

HoloWall is an interactive wall system that allows visitors to interact with digital information displayed on the wall surface without using any special pointing devices. The combination of infrared cameras and infrared lights installed behind the wall enables recognition of human bodies, hands, or any other physical objects that are close enough to the wall surface. Visitors can use both hands simultaneously. Body shape can also be an input to the system. HoloWall demonstrates several interactive environments, including a world of autonomous digital insects that respond to body movements and an interactive sound environment that reactively creates music sequences based on the user's actions.

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HoloWall demonstration at NTT ICC.
Courtesy of NTT InterCommunication Center [ICC]

Swamped! Using Plush Toys to Direct Autonomous Animated Characters

Synthetic Characters Group
& Vision and Modeling Group
MIT Media Lab

Swamped! is a multi-user interactive environment in which instrumented plush toys are used as an iconic and tangible interface to influence autonomous animated characters. Each character has a distinct personality and decides in real time what it should do based on its perception of its environment, its motivational and emotional state, and input from its "conscience," the guest. A guest can influence how a given character acts and feels by manipulating a stuffed animal corresponding to the character. For example, the guest could direct her character's attention by moving the stuffed animal's head, comfort it by stroking its belly, or have it wave at another character by waving its arm. Automatic camera control is used to help reveal the emotional content of each scene. By combining research in autonomous character design, automatic camera control, tangible interfaces and action interpretation, Swamped! seeks to create a rich, evocative and novel experience.

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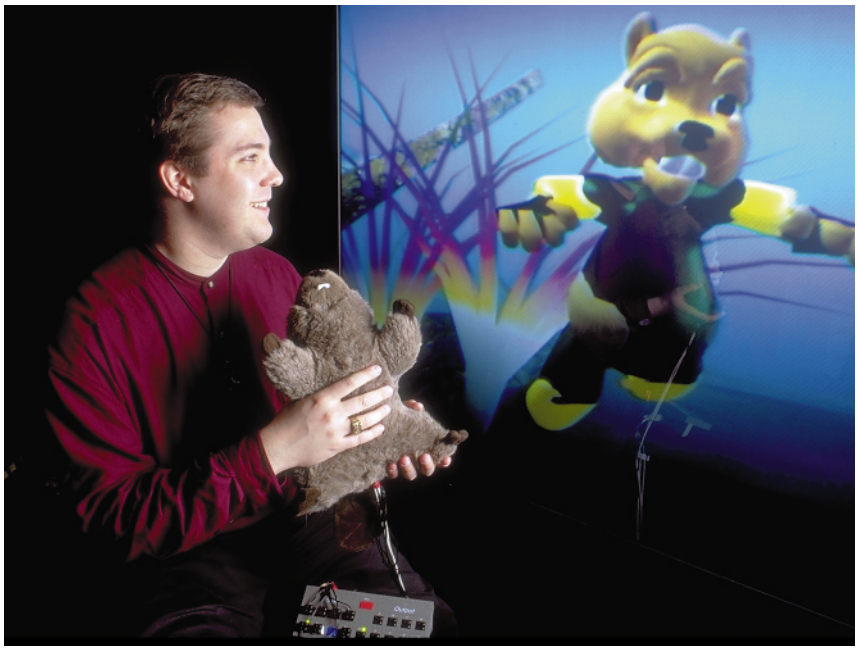

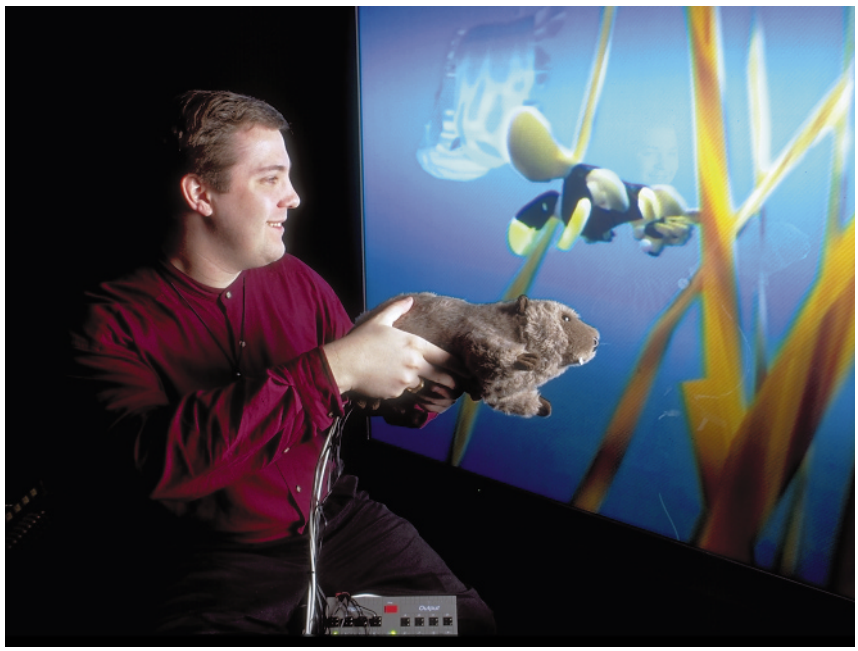

And the following undergraduates:
Jed Wahl
Jeremy Lueck
Todd Nightingale
Javorka Saracevic
Damian Isla
Zoe Chelsea Teegarden

AR² Hockey

Toshikazu Ohshima, Kiyohide Satoh, Hiroyuke Yamamoto, and Hideyuki Tamura
Mixed Reality Systems Laboratory, Inc.

In AR² Hockey (Augmented Reality AiR Hockey), players share a physical game field, mallets, and a virtual puck to play air hockey in simultaneously shared physical and virtual space. They can also communicate with each other through the mixed space. Since real-time, accurate registration between both spaces and players is crucial to playing the game, a video-rate registration algorithm is implemented with commercial head-trackers and video cameras attached to optical see-through head-mounted displays. Our collaborative AR system achieves higher interactivity than a totally immersive VR system.

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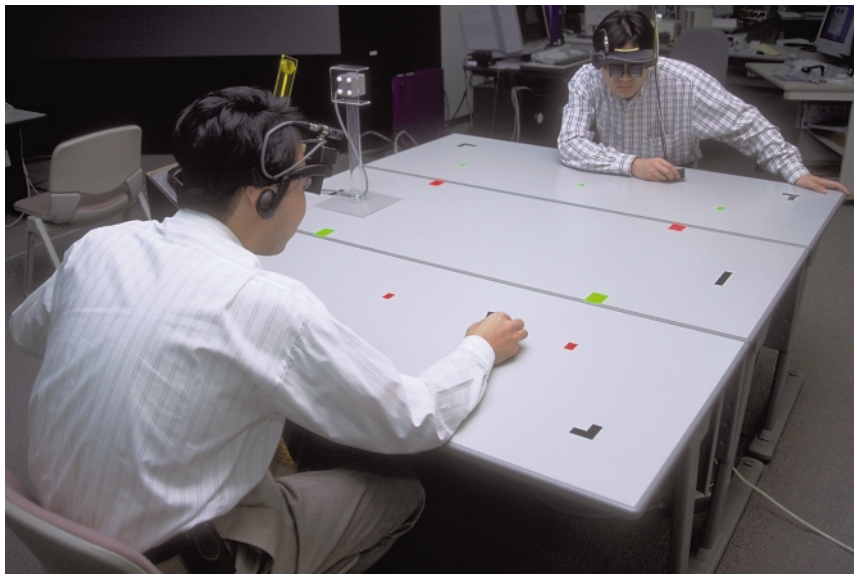

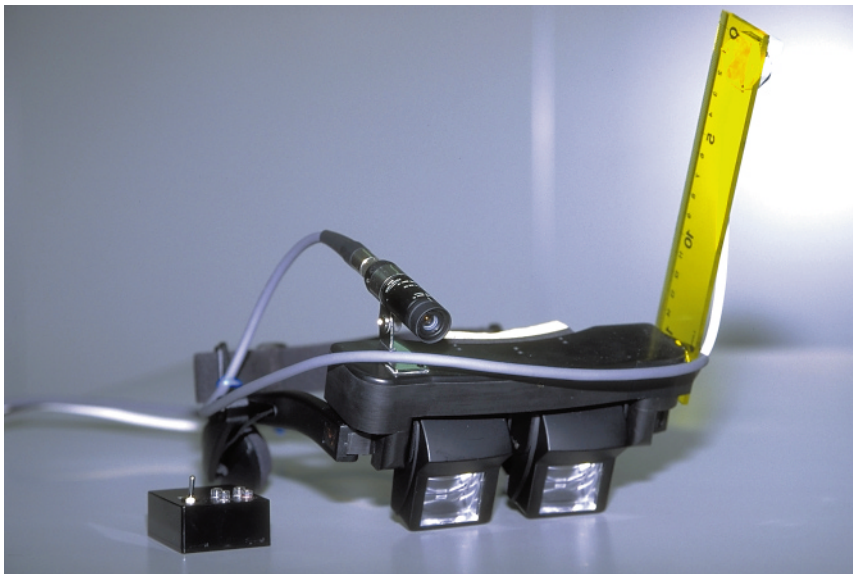

PingPongPlus

Tangible Media Group
MIT Media Lab

PingPongPlus is a digitally enhanced version of the classic ping-pong game. Various audio and visual augmentations have been added to a conventional ping-pong table with a non-invasive, sound-based ball tracking system. The "reactive table" displays patterns of light and shadow as a game is played, and the rhythm and style of play drives accompanying sound. At times, the game is subtly enhanced, and sometimes it is powerfully changed. In one mode, the table appears to be covered with water, so that playing on it creates patterns of subtle ripples. In another mode, images that race around the table change the entire scoring system and method of play. The goal of the project is to explore systems for collaborative play that push the physical world back into the forefront of design, without relying on simple GUI controllers, such as a mouse, keyboard, and joystick.

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Object-Oriented Displays

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In Object-Oriented Displays, users perceive and operate a virtual object as if it were real. Design and implementation of three types of object-oriented displays are demonstrated: MEDIA-Ace, a liquid crystal display (LCD) and position sensor; MEDIA-Cube, a position sensor and four LCDs arranged in the shape of a cubic body; and MEDIA-Crystal, which uses optical projection.

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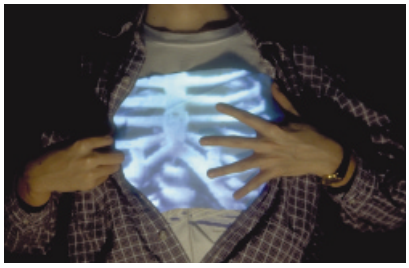

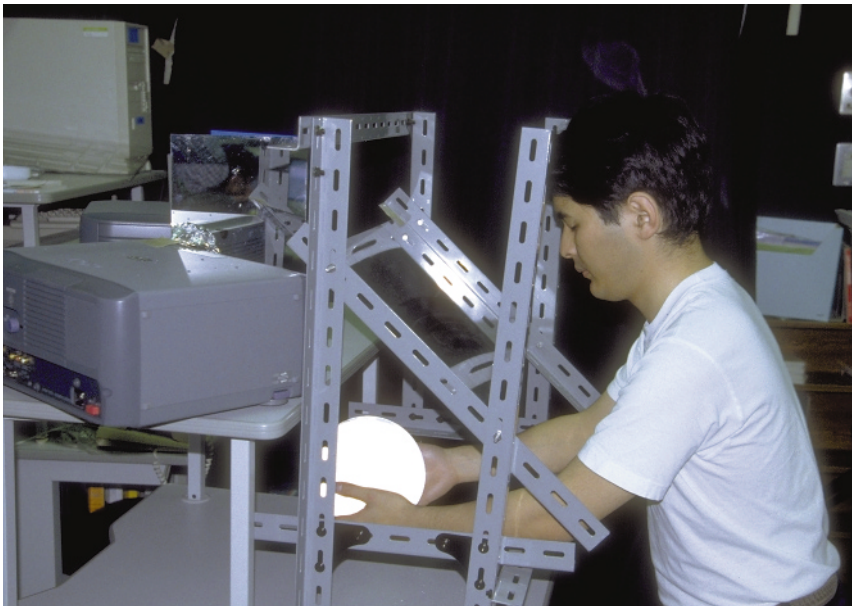

Mass Hallucination

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This imaging display changes according to the number of people watching it, their behaviors, and whether they've watched the device before. It is reflexive: the displayed image is a function of the people watching the display. It encourages crowds of people to collectively manipulate the display with their bodies or faces. Yet it is also personal, in that it can recognize the appearance of a user for short-to-medium periods of time and tailor the display accordingly. As in Magic Morphin' Mirror, a SIGGRAPH 97 Electric Garden project by the same group, this display captures video along the same optical axis as video is displayed, so images of observers can be directly manipulated, composited, or distorted on the display. In contrast to the previous work, which only considered a single user at a time and had no persistence after they left, this display is designed to visually track a crowd of people and provide a shared graphical experience. It also tracks users over time through multiple sessions. We show that continuity/consistency of experience across multiple simultaneous users, or a single user at a time, is possible.

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Foot Interface: Fantastic Phantom Slipper

Akihiko Shirai, Masaru Sato, Yuichiro Kume, and Machiko Kusahara

People should be able to use their feet just as freely in a virtual environment as they do in the real world. Wearable interfaces should not cause psychological and/or physical discomforts. This slipper-like multi-modal interface is based on those two assumptions. It features a slipper interface with cyber-worlds. Each foot's movement is measured in real time with an optical motion capture system, and feedback signals are transmitted to the soles. Phantom sensations elicited by multiple tactile stimuli allow transmission of complicated feedback information such as objects moving around the feet. Optical markers for motion capture and vibrators for tactile stimulation are installed in the slippers. Players interact with virtual objects projected onto a floor screen, sense them, and use them to play games. The system runs on a single PC.

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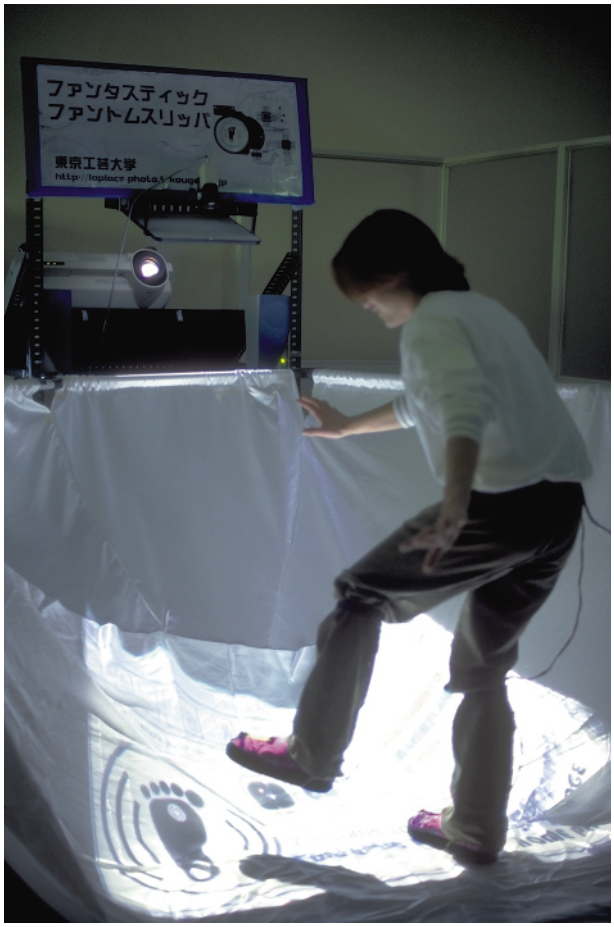
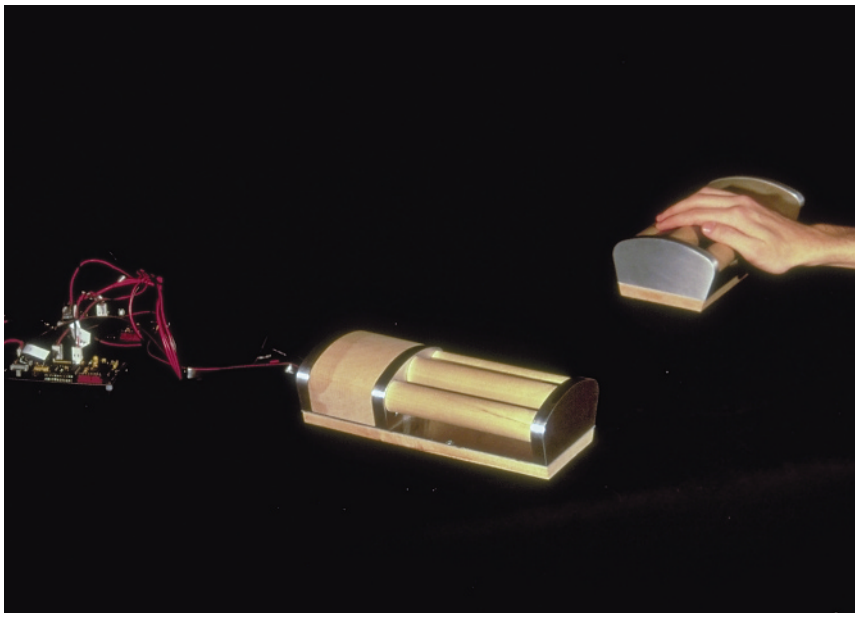
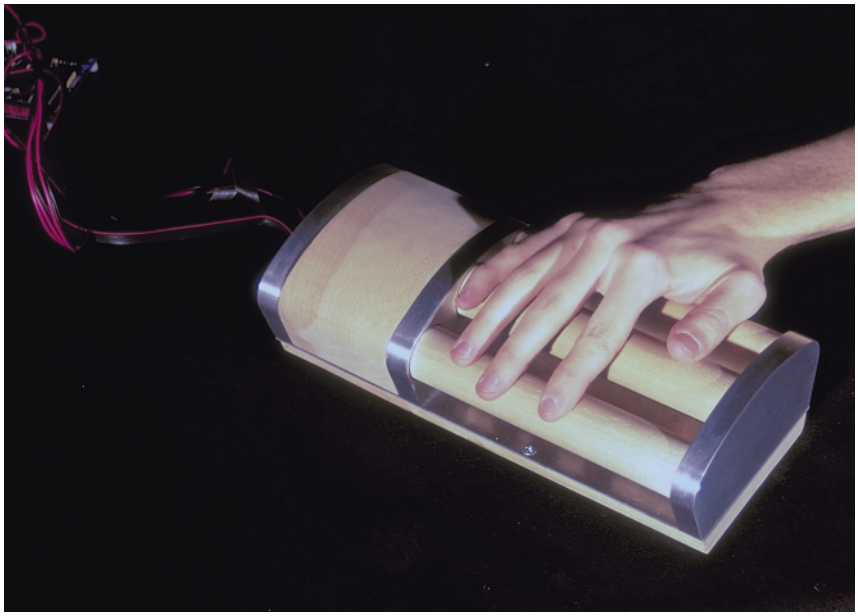


inTouch

Tangible Media Group
MIT Media Lab

Touch is a fundamental aspect of interpersonal communication. Yet while many traditional technologies allow communication through sound or image, none is designed for expression through touch. The goal of inTouch is to bridge this gap by creating a physical link between users separated by distance. InTouch consists of two separate identical objects, each consisting of three cylindrical rollers mounted on a base. The two objects behave as if corresponding rollers are physically connected, but in reality, the objects are only virtually linked. Sensors are used to monitor the states of the rollers, and computer-controlled motors synchronize those states, creating the illusion that distant users are interacting through a single, shared physical object.





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Virtual FishTank

Nearlife, Inc.

The Virtual FishTank is a simulated aquatic environment featuring a 400-square-foot tank populated by whimsical and dynamic fish.

Participants can:

- Create their own fish.
- Design behaviors for their fish.
- Observe their fish interacting with other fish.
- Manipulate behavioral rules for a group of fish.
- Discover how these behaviors can emulate schooling.
- Analyze emerging patterns.

Through real-time 3D graphics, visitors are introduced to ideas from the sciences of complexity – ideas that explain not only ecosystems, but also economic markets, immune systems, and traffic jams. In particular, visitors learn how complex patterns arise from simple rules. The first version of Virtual FishTank opens at The Computer Museum in Boston in June 1998. A second version will travel nationally to other science museums and aquariums.

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Mitchel Resnick and the MIT Media Lab
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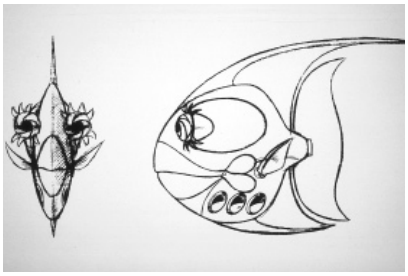

Haptic Screen

Hiroo Iwata
University of Tsukuba

Haptic Screen is a new force-feedback device that deforms itself to present shapes of virtual objects. Typical force-feedback devices use a grip or thimble, but users of Haptic Screen can touch the virtual object without wearing anything. Haptic Screen employs an elastic surface made of rubber. A 6 X 6 array of 36 actuators deforms the surface and controls its hardness according to the force applied by the user. An image of the virtual object is projected onto the elastic surface so that the user can directly touch the image and feel its rigidity.

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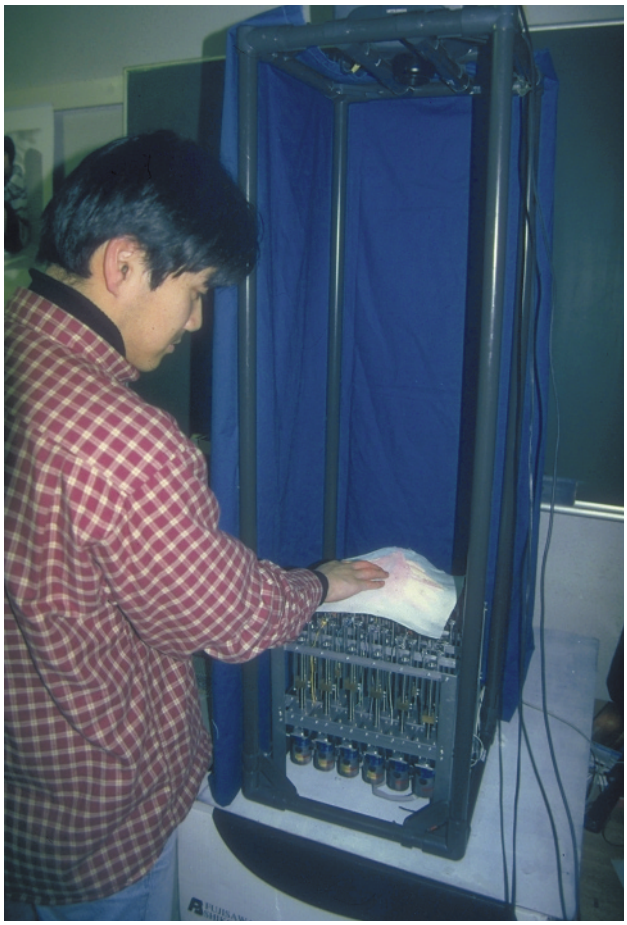

Natural 3D Display System Using Holographic Optical Element

Laboratories of Image Information Science and Technology

In this natural 3D display system, a holographic optical element (HOE) overcomes conflicts between convergence and accommodation. Users experience clear stereoscopic vision, without glasses, of a broad field of view. With its multiple-focus HOE, the system offers two pairs of viewing points in back-and-forth or horizontal locations.

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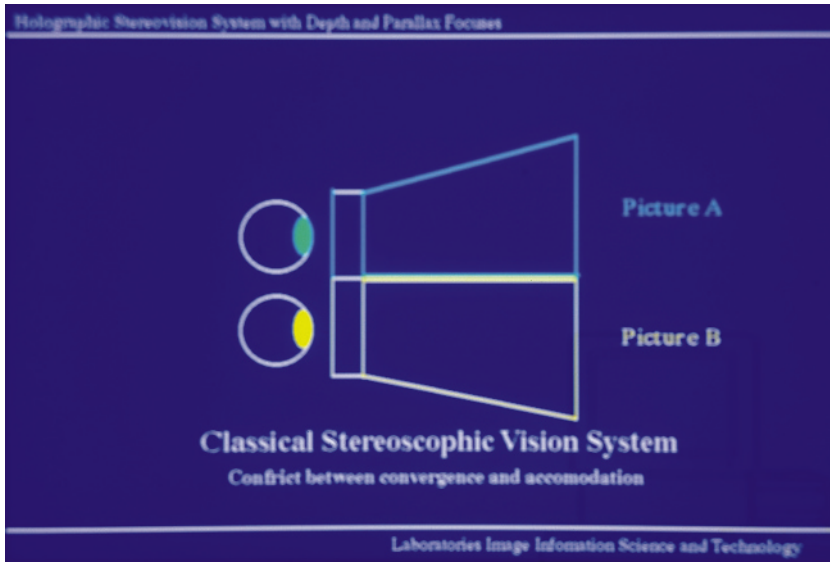

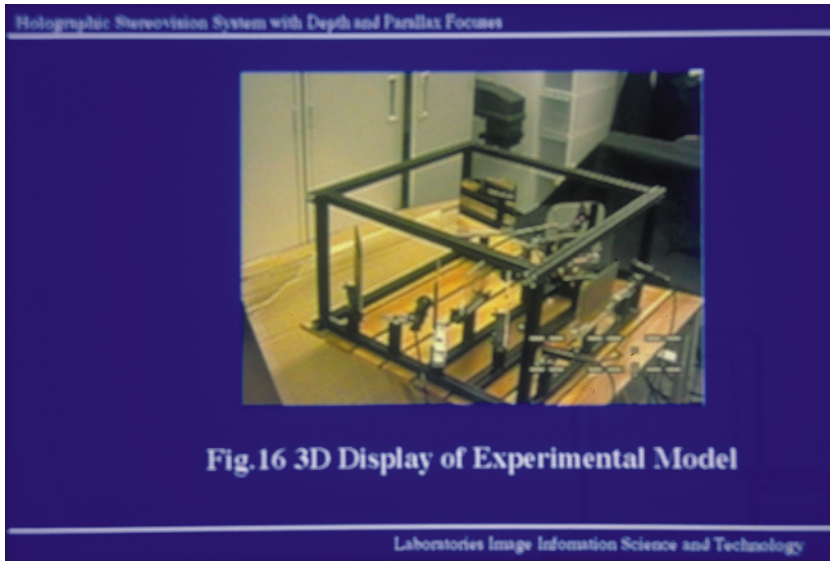

Direct Watch & Touch

Laboratories of Image Information Science and Technology

This 3D display offers access to a virtual stereoscopic world without special glasses. When users "touch" the world with real tools (for example, a hammer, a surgical knife, a wrench, tweezers, etc.), directly and interactively, they hear and feel contact and transform virtual objects. This binocular parallax display combines virtual and real environments in full, high-resolution (XGA) color. It is a new approach to virtual reality that handles virtual objects with "real" tactile feedback.

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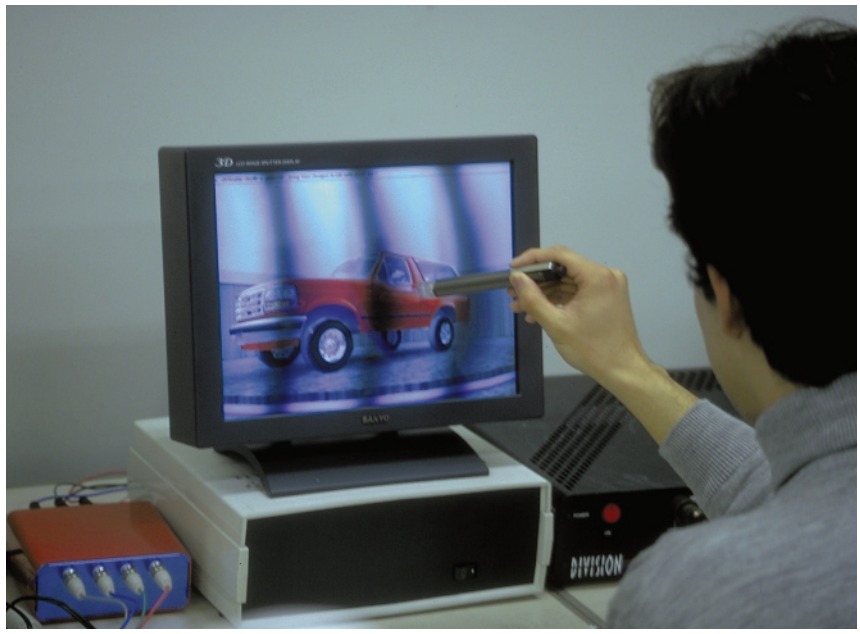

Media & Mythology

Institute for Simulation & Training

In ancient times, mythology was the high-tech method for storing data on a society's history, rituals, and ethical systems. The paradigm in use for these early information systems was storytelling. Media & Mythology explores the link between traditional mythologies from several cultures and new technology/new media. Man and Minotaur allows visitors a chance to portray the two ancient combatants and the gods that taunt them within a fully immersive, synthetic version of Dedalus' Labyrinth in ancient Crete. In Video Totem, expressionistic visitors create and view their own mythologies on a large digital totem pole. Dear Oracle integrates contemporary media into traditional soothsaying. The result is a new form of oracle: digital divination.

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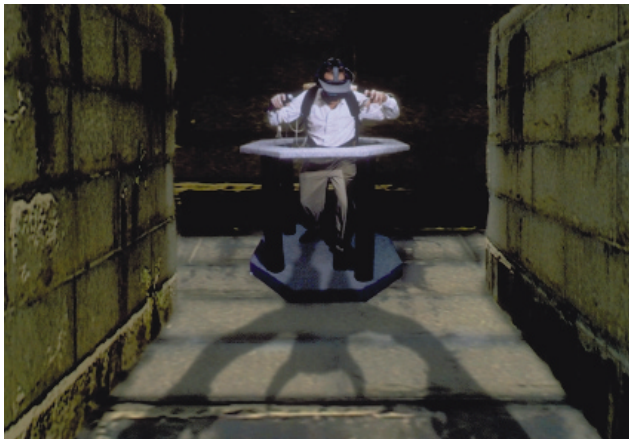

Natural Pointing Techniques Using a Finger-Mounted Direct Pointing Device

John Sibert and Mehmet Gokturk
The George Washington University

Pointing with the index finger is a natural way to select an object, and if it can be incorporated into human-computer interaction technology, a significant benefit will be obtained for certain applications. This demonstration presents a prototype solution.

Based on an infrared signal power density weighing principle, a small infrared emitter on the user's finger and multiple receivers placed around the laptop screen generate data for a low-cost microprocessor system. The microprocessor sends its output to a laptop computer, where it is used to determine coordinates for the cursor location. The prototype is not only a proof of concept. It is also a tool for further research on human performance in pointing and further development of interactive techniques.

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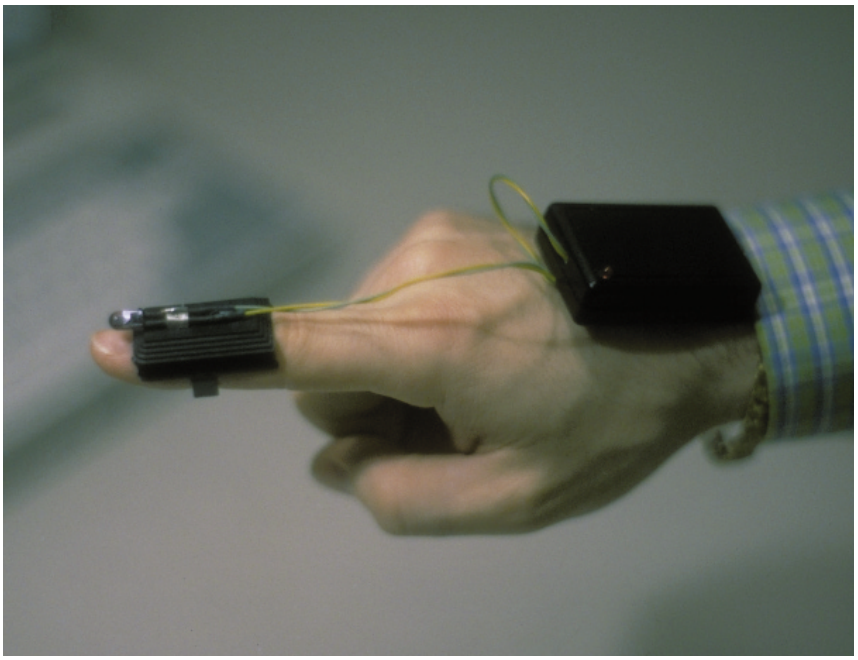
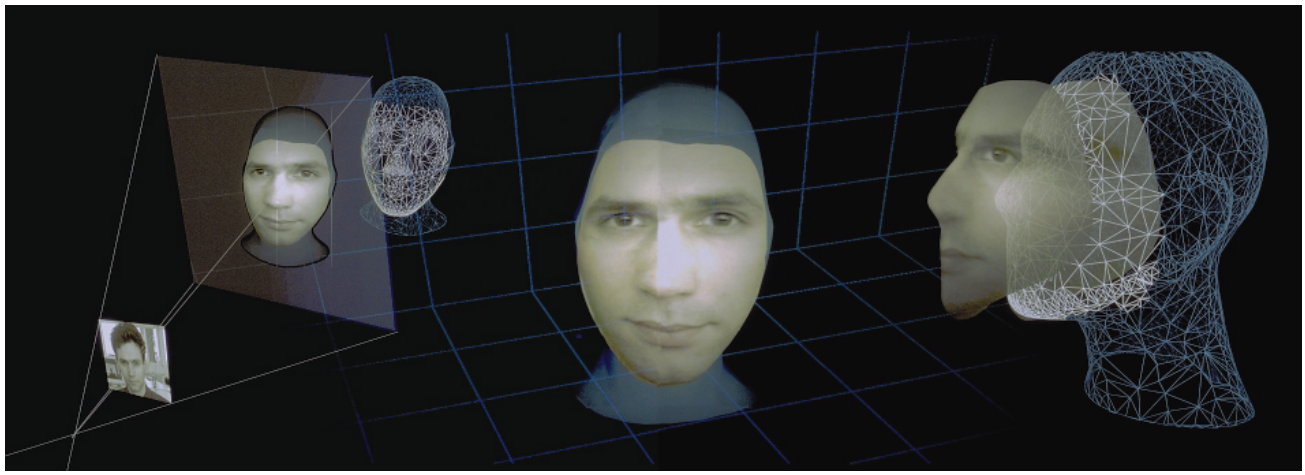


Wearing the finger-mounted emitter. (The black box on the wrist contains batteries and the modulator circuit.)

The prototype in use.

Virtual Head

Echtzeit GmbH



Virtual Head is a new approach that enhances communication in virtual environments and telepresence. It tackles one of the key problems in the field of innovative telecommunication technology: how to represent oneself in virtual environments in such a way that an emotional and natural way of communicating with others is possible?

The Virtual Head conferencing prototype renders three-dimensional images of every communication partner in real-time. It establishes eye-to-eye contact among the communication partners by projecting live-video textures onto 3D geometry of a head. The application translates the head movement so that video-images show the original movements. Compressed video and audio information is exchanged via a high-bandwidth network to establish a remote conferencing scenario. Video and audio are decompressed on both sides, and the images are projected onto a screen.

This approach uses original face images with all their facial expressions and tries to transport the main factors of human communication such as line of gaze, which indicates attention and significantly drives a conversation. According to psychologists, most of the information we remember after talking with somebody is non-verbal. Improving technologies for visual communication that includes a more “emotional” way of meeting each other in virtual environments will become possible with high-bandwidth networks in the very near future.

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Stretchable Music with Laser Range Finder

MIT Media Lab

Stretchable Music with Laser Range Finder combines an innovative, graphical, interactive music system with a state-of-the-art laser tracking device. An abstract graphical representation of a musical piece is projected onto a large vertical display surface. Users are invited to shape musical layers by pulling and stretching animated objects with natural, unencumbered hand movements. Each of the graphical objects is specifically designed to represent and control a particular bit of musical content. Objects incorporate simple behaviors and simulated physical properties to generate unique sonic personalities that contribute to their overall musical aesthetic. The project uses a scanning laser rangefinder to track multiple hands in a plane just forward of the projection surface. Using quadrature-phase detection, this inexpensive device can locate up to six independent points in a plane with cm-scale accuracy at up to 30 Hz. Bare hands can be tracked without sensitivity to background light and complexion to within a four-meter radius.

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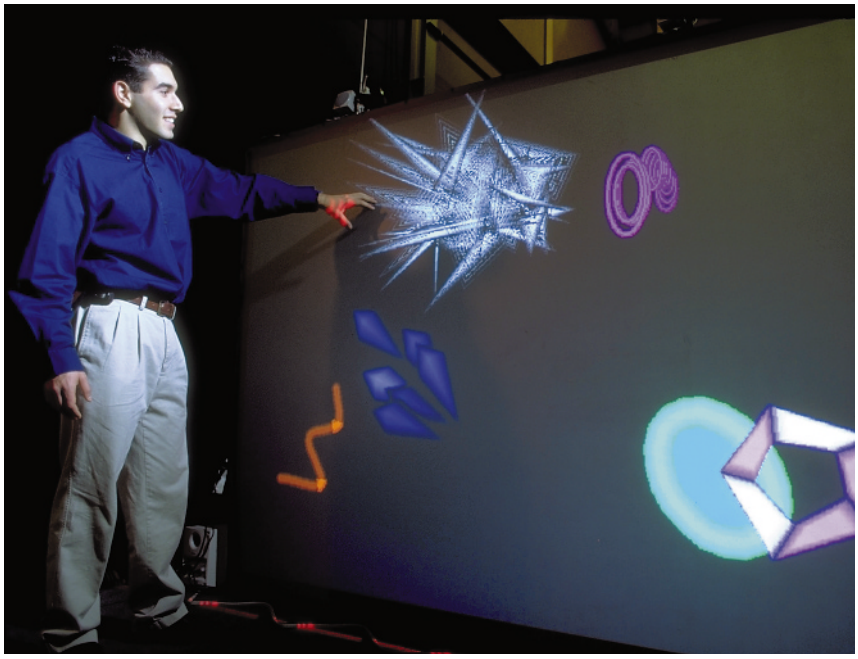
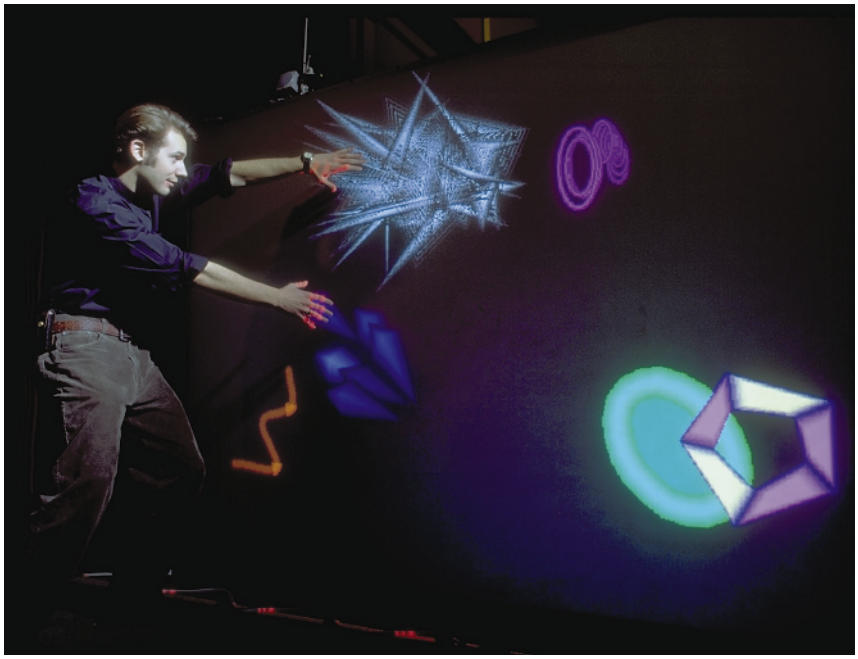
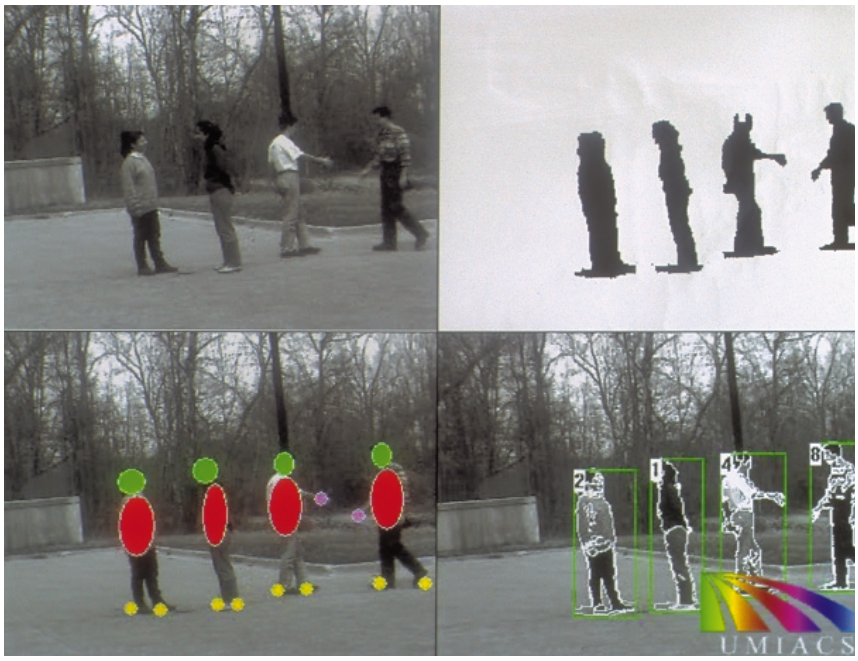


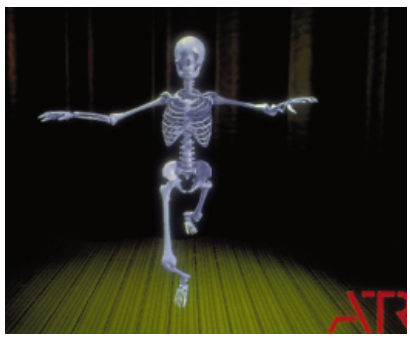


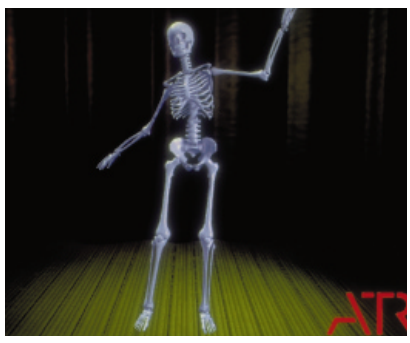
Shall We Dance?

ATR Media Integration & Communication Research Lab and University of Maryland

Real-time 3D computer vision gives users control over both the movement and facial expression of a virtual puppet and the music to which the puppet "dances." Multiple cameras observe a person, and human silhouette analysis achieves real-time 3D estimation of human postures. Facial expressions are estimated from images acquired by a viewing-direction controllable camera, so that the face can be tracked. From the facial images, deformations of each facial component are estimated. The estimated body postures and facial expressions are reproduced in the puppet model by deforming the model according to the estimated data. All the estimation and rendering processes run in real time on PC-based systems. Attendees can see themselves dancing in a virtual scene as virtual puppets.







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