Knowledge-based Augmented Reality

July 1993

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Presented by Unnur & Shaheen

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July 1993

Augmented Reality

An *augmented reality* present a virtual world that enriches, rather than replaces, the real world, Instead of blocking out the real world.

Knowledge-based systems

automate the design of presentations that explain how to perform 3D tasks.

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Goal of This Paper:

"Here, we discuss KARMA—Knowledge-based Augmented Reality for Maintenance Assistance

a test-bed system for exploring the automated design of augmented realities that explain maintenance and repair tasks."

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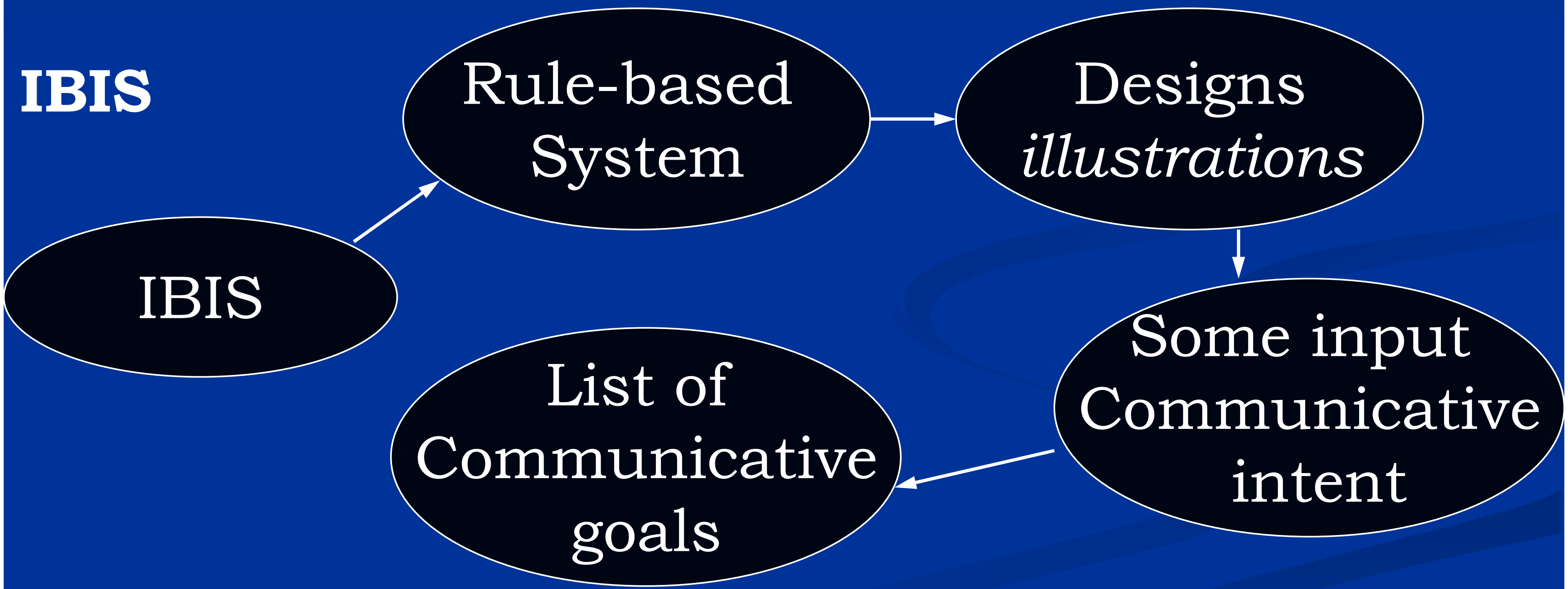
The knowledge-based graphics component we use is based on **IBIS** (Intent- Based Illustration System)

IBIS



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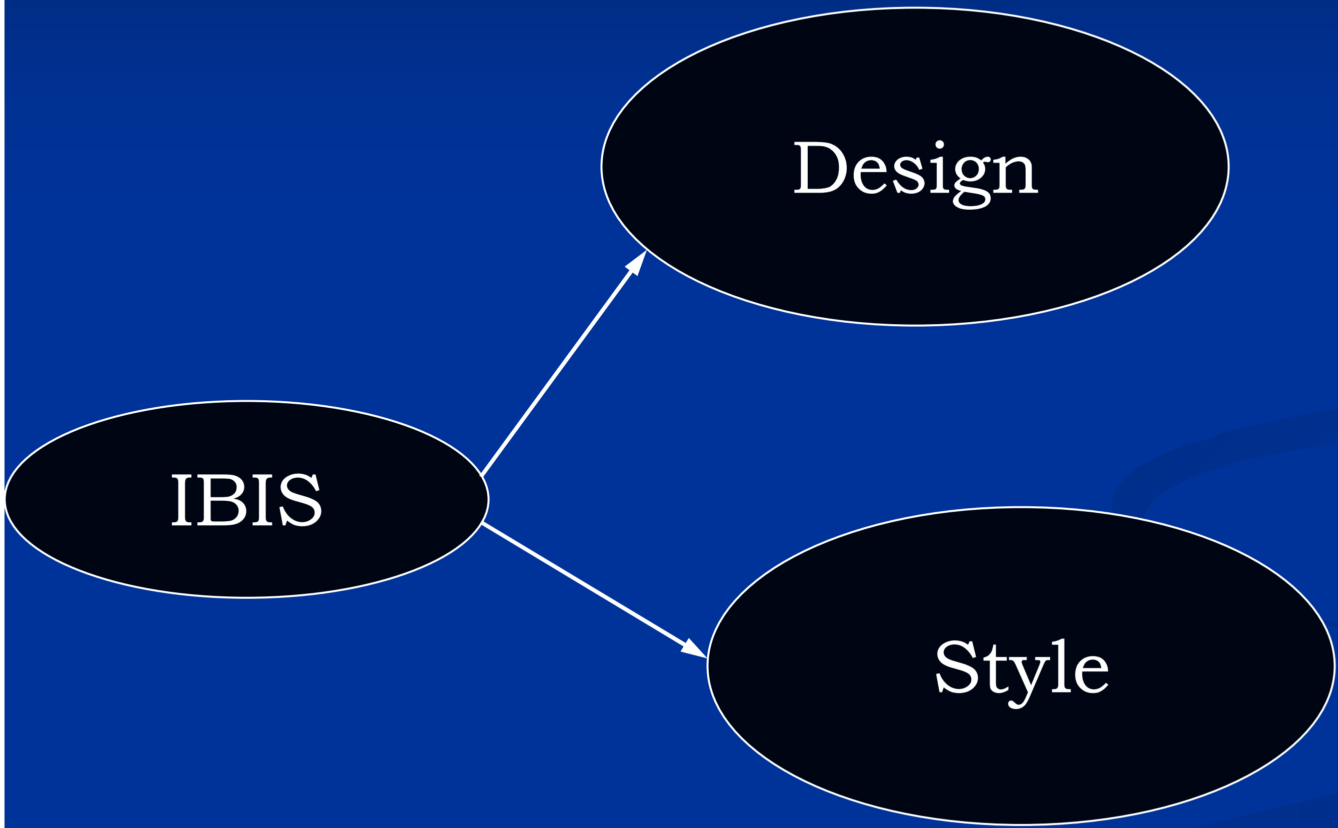
IBIS



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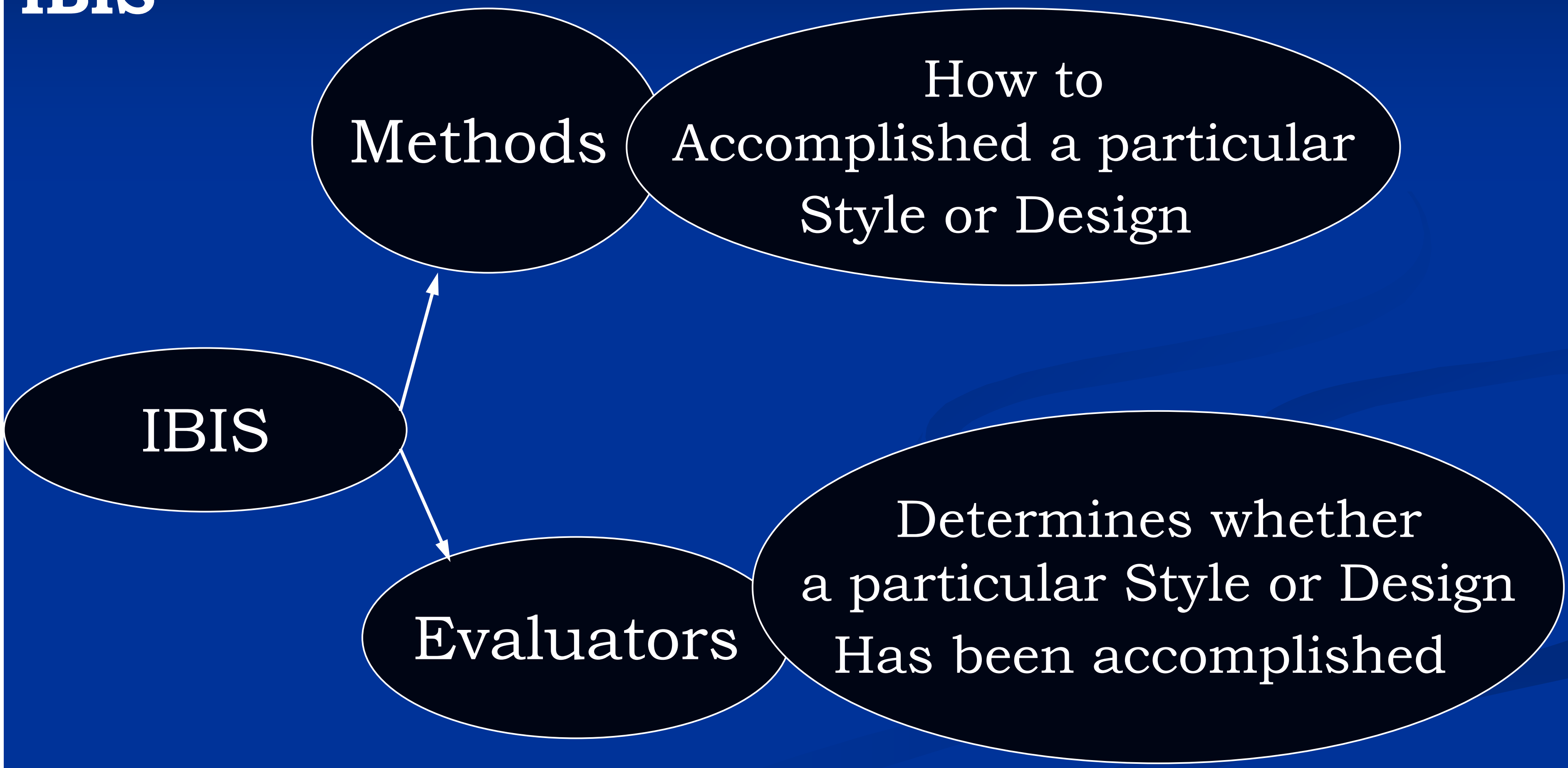
IBIS



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Extending IBIS for Augmented Reality

Generates everything seen by user	Enrich with additional information
Initial viewing specification	All control of viewing specification
Real world frozen throughout the illustration’s life	Consider changes in the real world
All communicative goals achieved by itself	The user becomes an active participant in achieving the communicative goals

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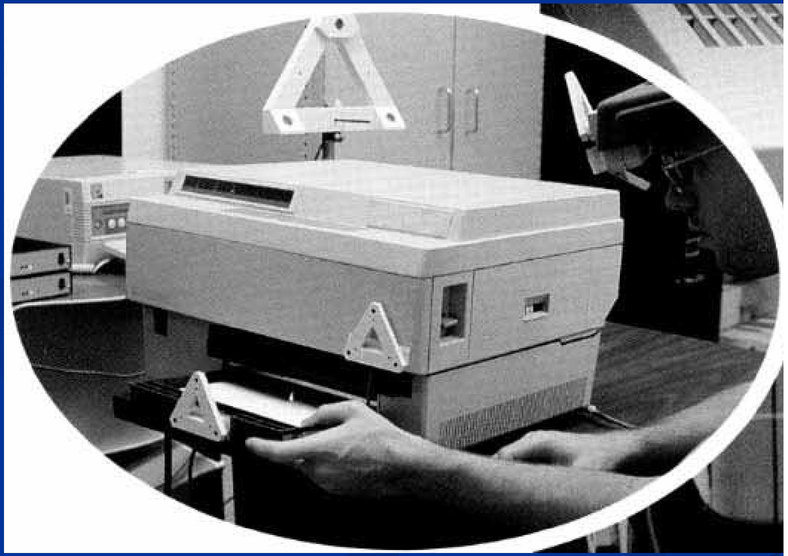
The Experiment

Test-bed Application:
End-User Laser Printer Maintenance



KARMA is a prototype augmented reality system that explains simple end-user laser printer maintenance using a see-through head-mounted display

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The Experiment

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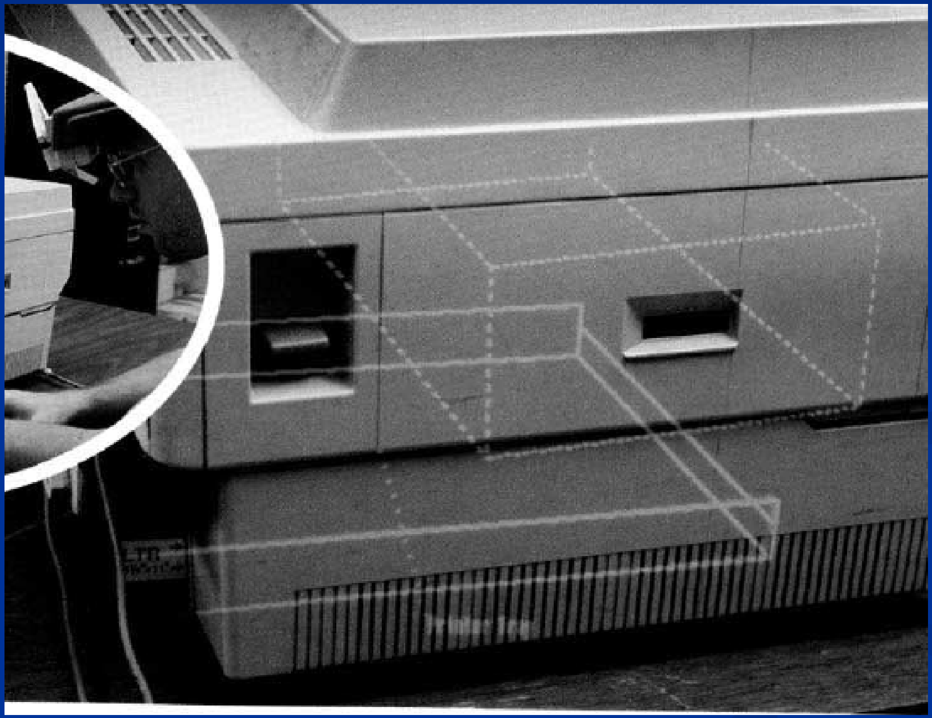

Augmented reality intended to show toner cartridge and show location of and identify paper tray. (Designed by KAMARA

Knowledge-based Augmented Reality

The Experiment

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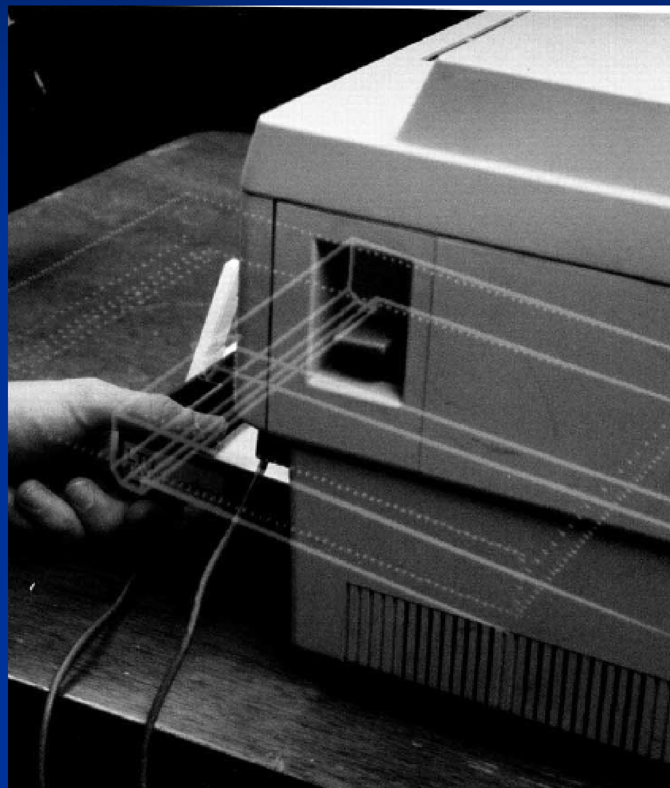

Augmented reality intend4d to show action of pulling out paper tray and resulting change in try's state. (Designed by KAMARA

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The Experiment

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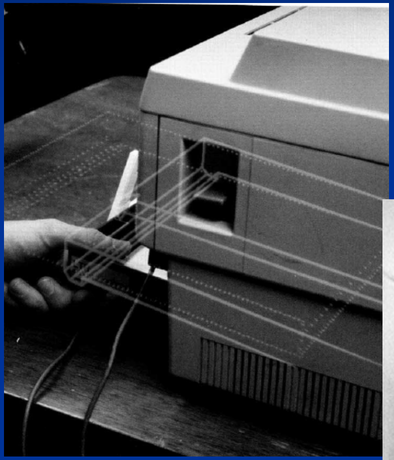

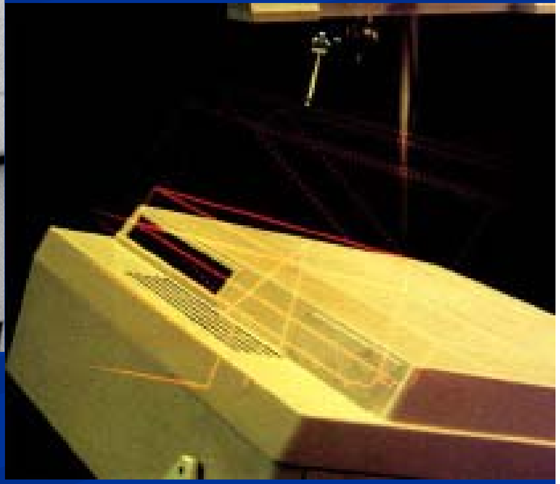

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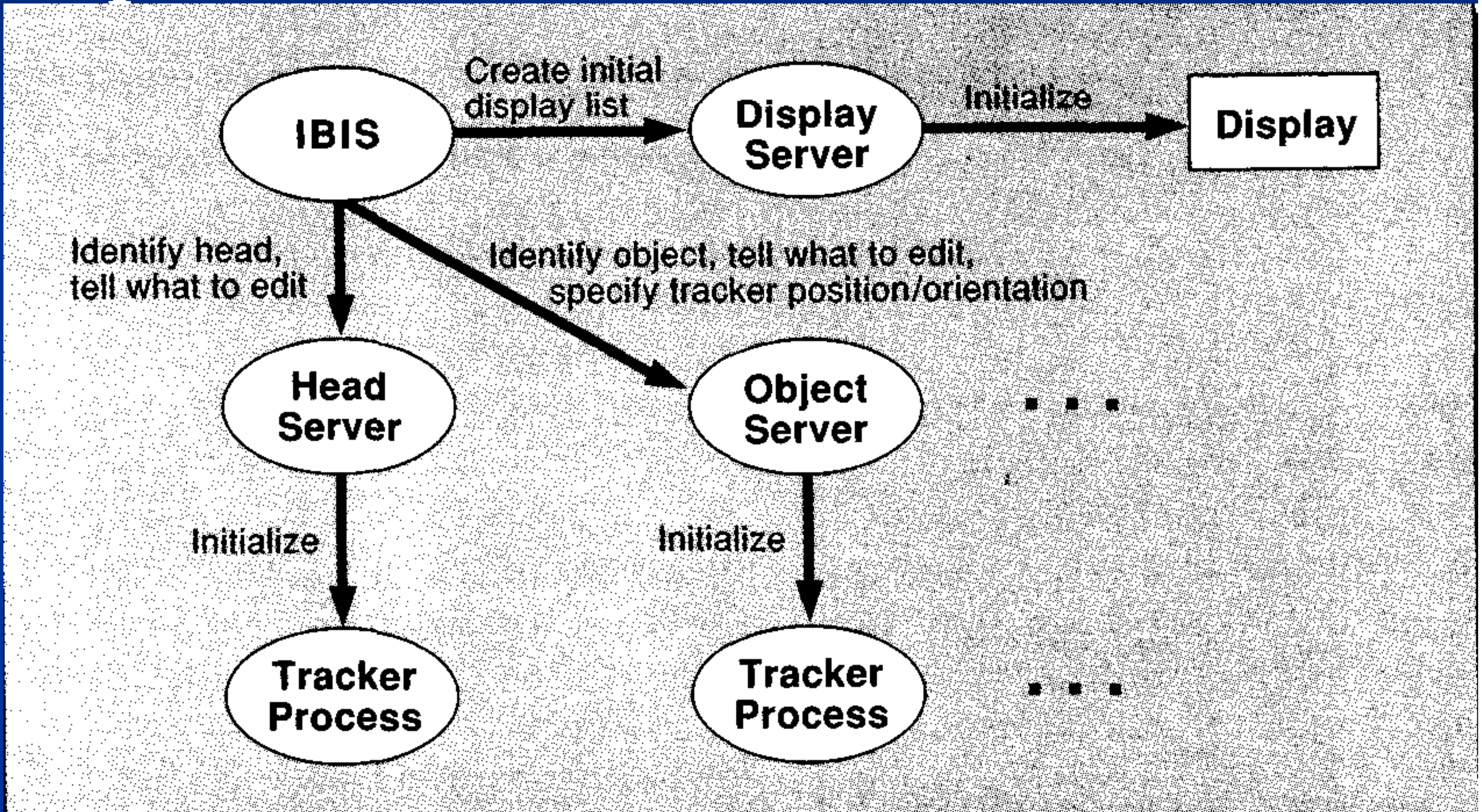
Knowledge-based Augmented Reality

The Experiment

July 1993

System Architecture



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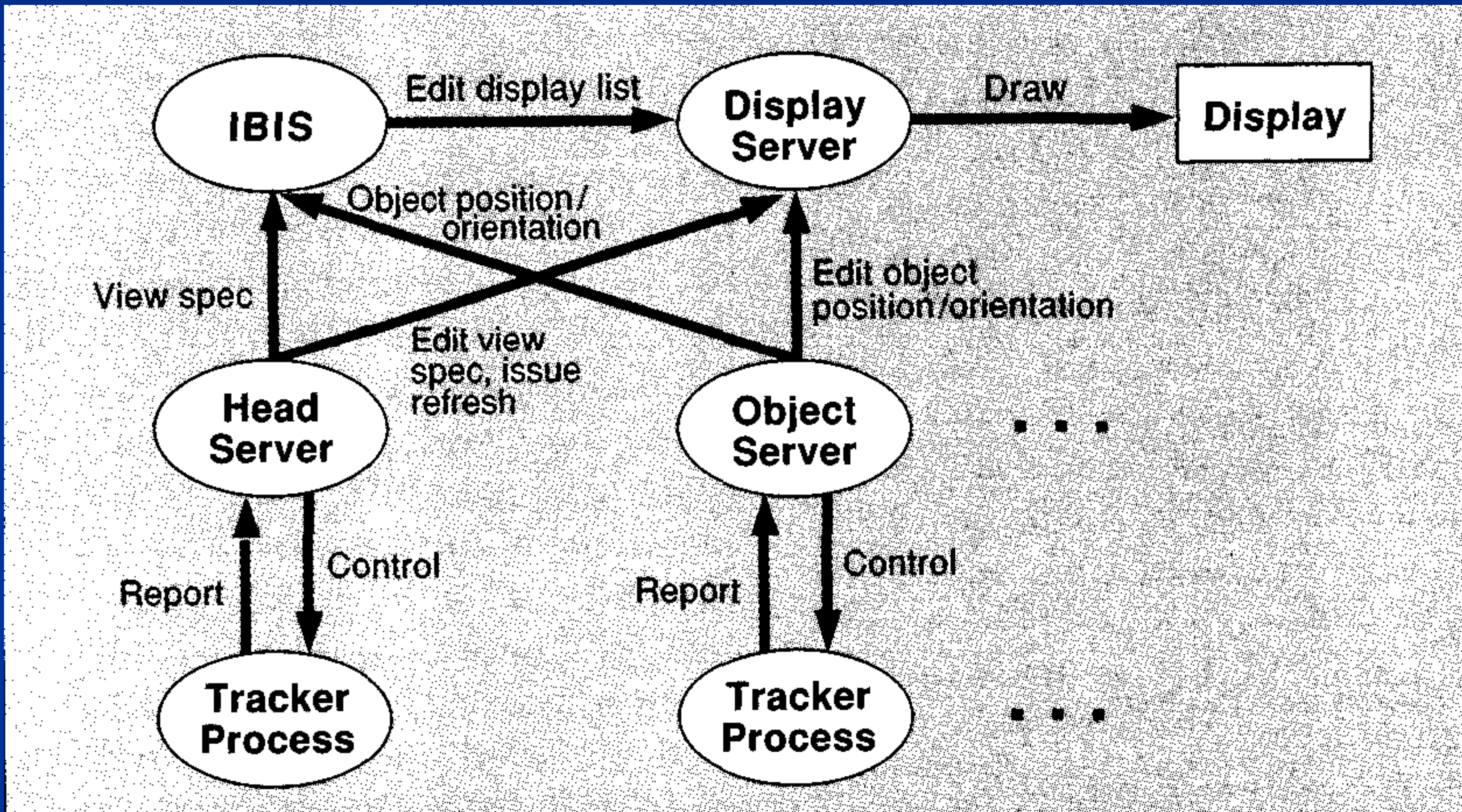
The Experiment

July 1993

System Architecture



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Implementation:

July 1993

- **IBIS** is implemented in C++ and the CLIPS production system language.

- HPUX on an HP 9000 380 TurboSRX graphics workstation.

- 50MHz intel 486DX-based PC.

Recent Advances in Augmented Reality

November/December **2001**

Ronald Azuma

HRL Laboratories

Yohan Baillot

NRL Virtual Reality Lab/ITT Advanced Engineering

Reinhold Behringer

Rockwell Scientific

Steven Feiner

Columbia University

Simon Julier

NRL Virtual Reality Lab/ITT Advanced Engineering

Blair MacIntyre

Georgia Institute of Technology

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Augmented Reality (AR)

”We define an AR system to have the following properties:

- combines real and virtual objects in a real environment;
- runs interactively, and in real time; and
- registers (aligns) real and virtual objects with each other”

Augmented Reality (AR)

Milgram's reality–virtuality continuum. (Adapted from Milgram and Kishino)

AR History

- Sutherland’s work in the 1960s, which used a seethrough HMD to present 3D graphics.
- In the late 1990s, several conferences on AR began, including the International Workshop and Symposium on Augmented Reality, the International Symposium on Mixed Reality, and the Designing Augmented Reality Environments workshop
- A software toolkit (the ARToolkit) for rapidly building AR applications is now freely available at
  http://www.hitl.washington.edu/research/shared_space/

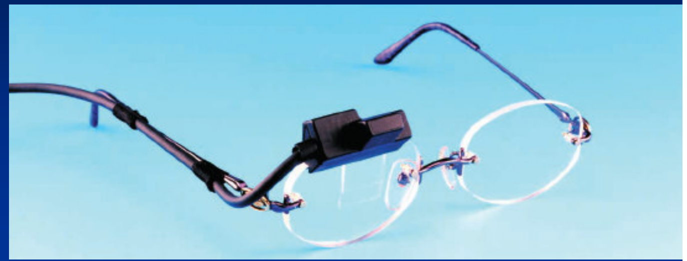
AR Enabling technologies

❖ ***Displays***

We can classify displays for viewing the merged virtual and real environments into the following categories:

- head worn,
- handheld, and
- projective.

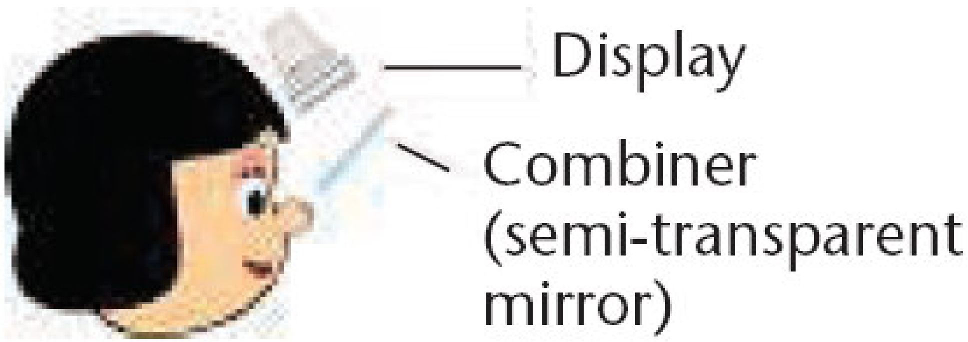
AR Enabling technologies

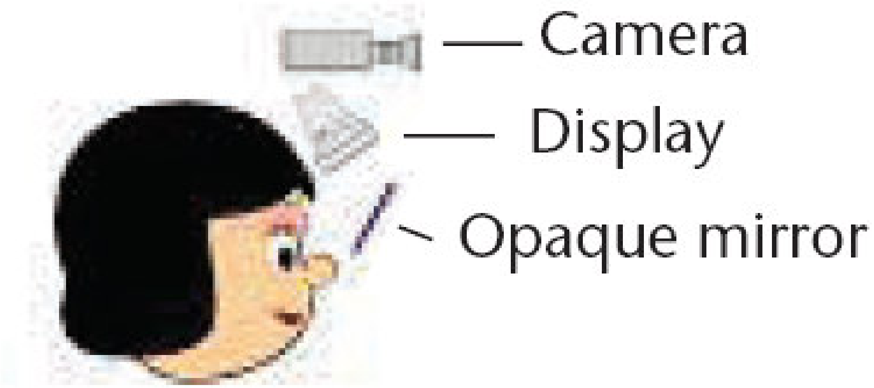


- ***Displays***

Head-worn displays (HWD).

(nothing but a sunglass, weigh less than 6 grams, 800 X 600 resulation)





optical seethrough

video see-through

AR Enabling technologies

- *Displays*

Handheld displays

handheld, flat-panel LCD displays that use an attached camera to provide video see-through-based augmentations

AR Enabling technologies

- ***Displays***

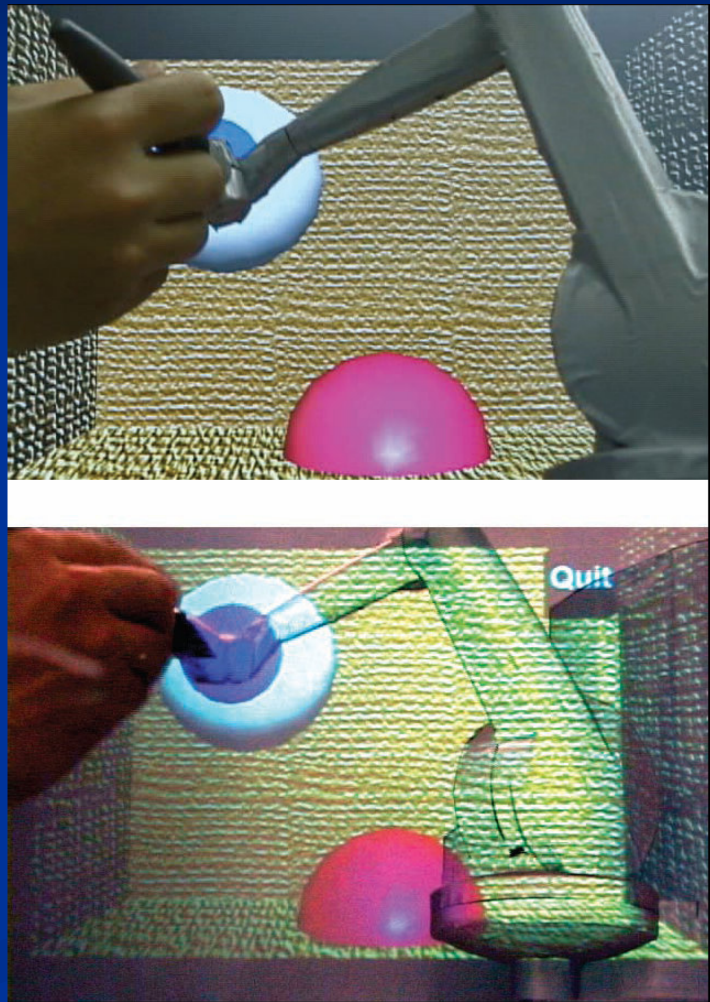
  Projection displays.

Experimental head-worn projective display using lightweight optics. (Courtesy of Jannick Rolland, University of Central Florida, and Frank Biocca, Michigan State University.)

AR Enabling technologies

- ***Displays***

Projection displays.



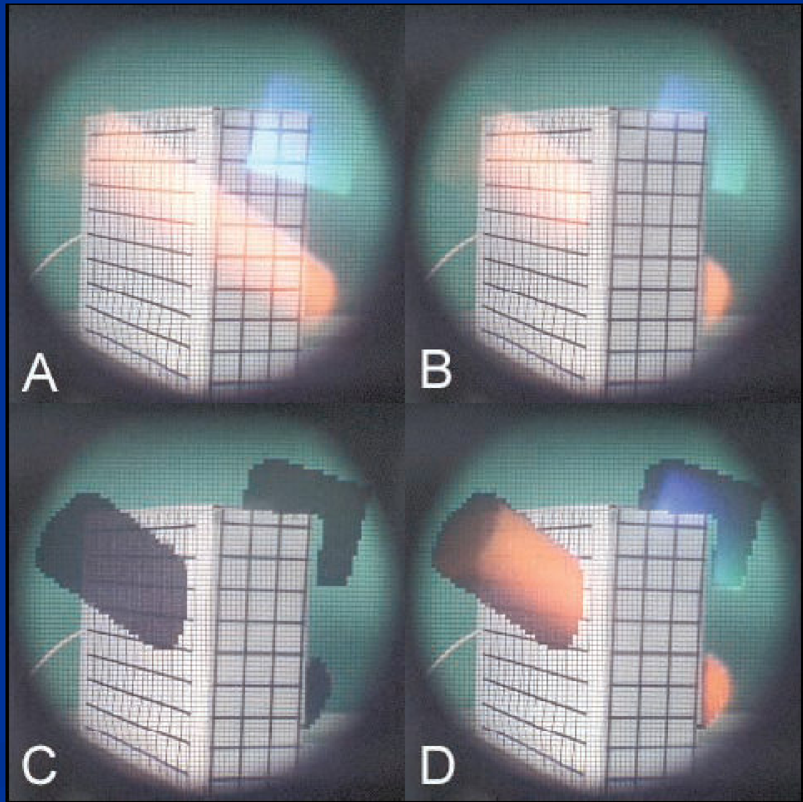
Projection display used to camouflage a haptic input device. The haptic input device normally doesn't reflect projected graphics (top). The haptic input device coated with retroreflective material Appears transparent (bottom).

AR Enabling technologies

❖ *Displays*

Problem areas in AR displays

Images photographed through optical see-through display supporting occlusion. (a) Transparent overlay. (b) Transparent overlay rendered taking into account realworld depth map. (c) LCD panel opacifies areas to be occluded. (d) Opaque overlay created by opacified pixels. (Courtesy of Kiyoshi Kiyokawa, Communications Research Lab.)



AR Enabling technologies

❖ *Displays*

Environment Sensing :

- Effective AR requires knowledge of the user's location and the position of all other objects of interest in the environment.
- Kanade's 3D dome drives this concept to its extreme with 49 cameras that capture a scene for later virtual replay.

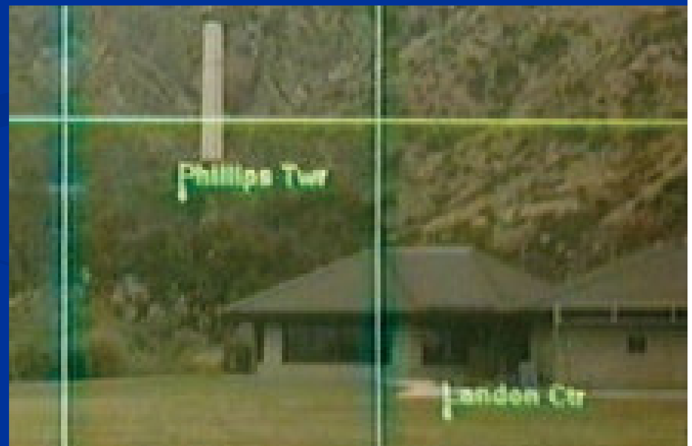
AR Enabling technologies

- **Outdoor, unprepared environments:**

•fiber-optic gyroscopes

•the Global Positioning System (GPS) or

•dead reckoning techniques



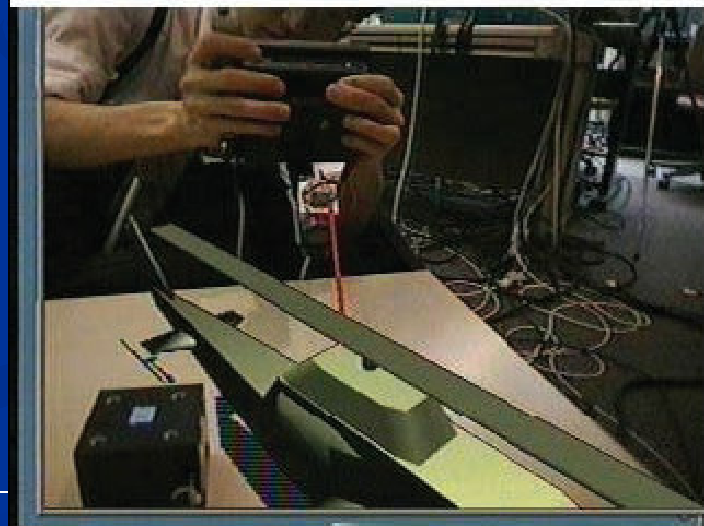
Motionstabilized labels annotate the Phillips Tower, as seen from two different viewpoints.

Recent Advances in Augmented Reality

November/December **2001**

User interface and interaction

User interface and interaction



Recent Advances in Augmented Reality

November/December **2001**

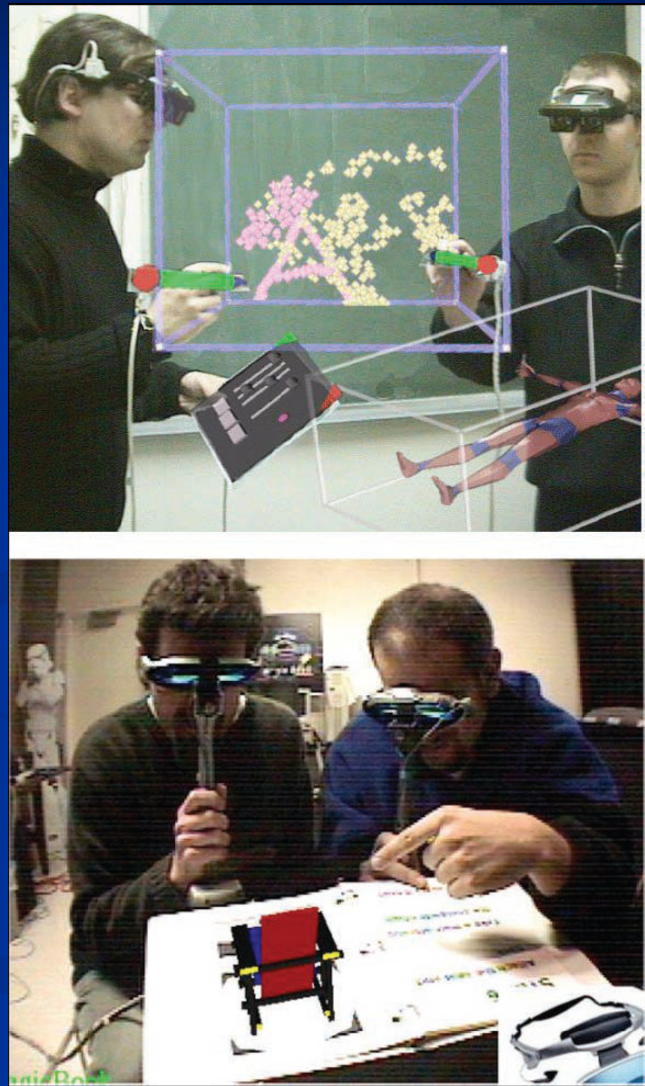
User interface and interaction

Presented by ***Unnur & Shaheen***

Recent Advances in Augmented Reality

November/December **2001**

User interface and interaction

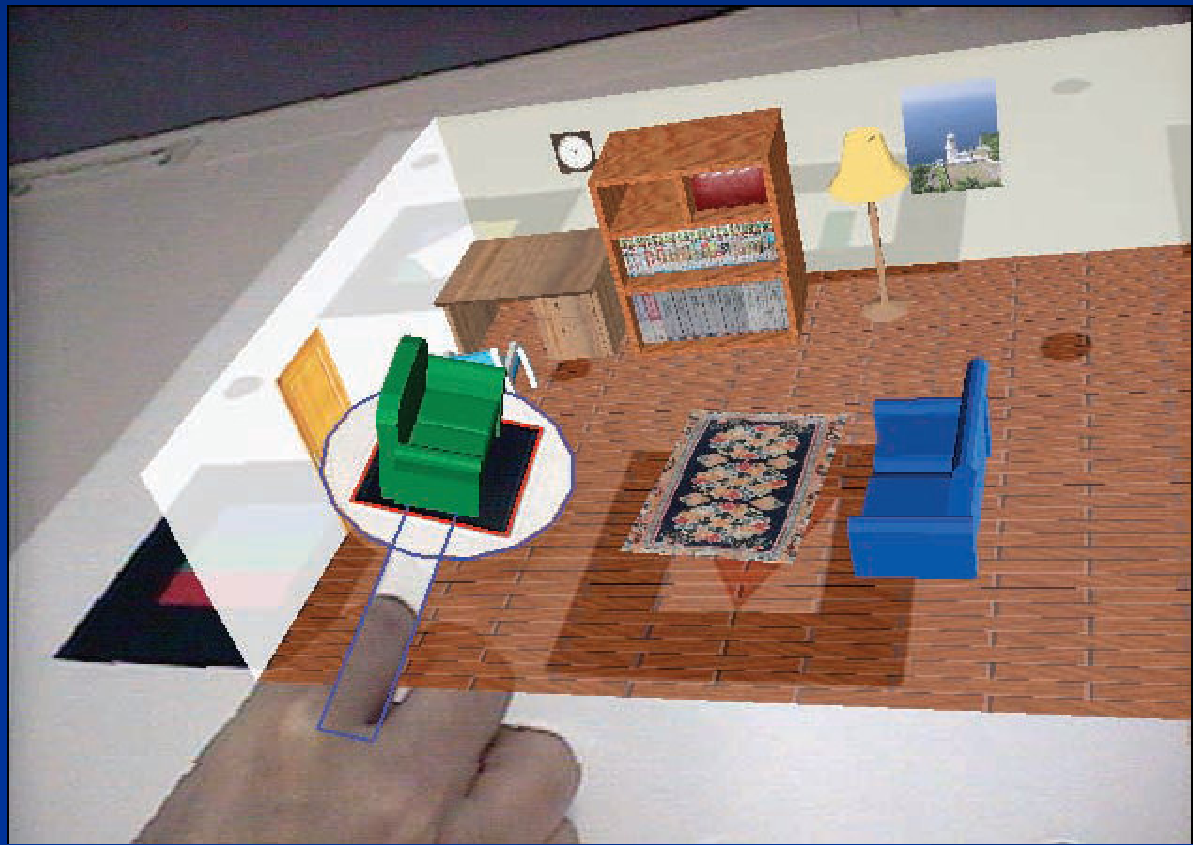


Presented by ***Unnur & Shaheen***

Recent Advances in Augmented Reality

November/December **2001**

User interface and interaction



Presented by ***Unnur & Shaheen***

Visualization problems

Data density.

Data filtering to reduce density problems. Unfiltered view (top) and filtered view (bottom),

Visualization problems

Mediated reality

Virtual and real occlusions. The brown cow and tree are virtual; the rest is real.

Human factors studies and perceptual problems

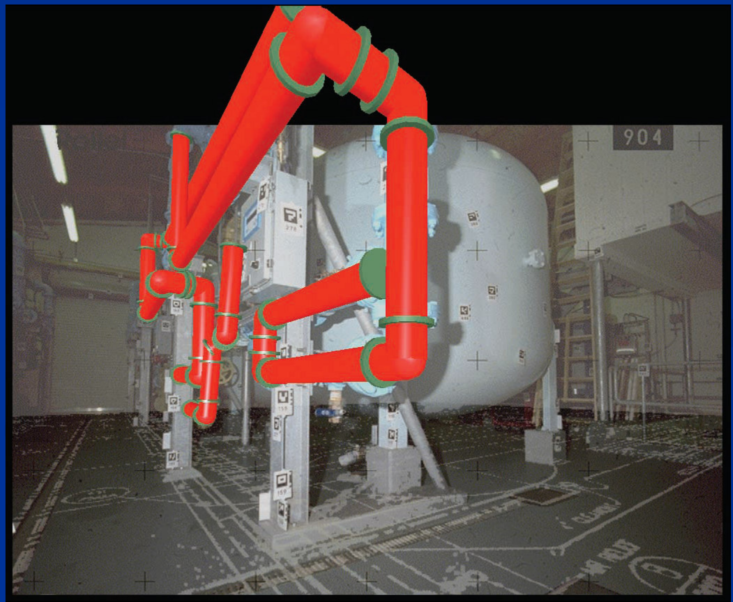
- Latency
- Depth perception
- Adaptation
- Ftigue and eye strain.

November/December 2001

New Applications.

"We've grouped the new applications into three areas:

1. ***Mobile***
2. ***Collaborative***
3. ***Commercial applications"***



Two-dimensional shop floor plans and a 3D pipe model superimposed on an industrial pipeline.

Recent Advances in Augmented Reality

November/December **2001**

New Applications.

Mobile applications

November/December **2001**

New Applications.

Collaborative applications

Many AR applications can benefit from having multiple people simultaneously view, discuss, and interact with the virtual 3D models. AR addresses two major issues with collaboration:

seamless integration with existing tools and practices

&

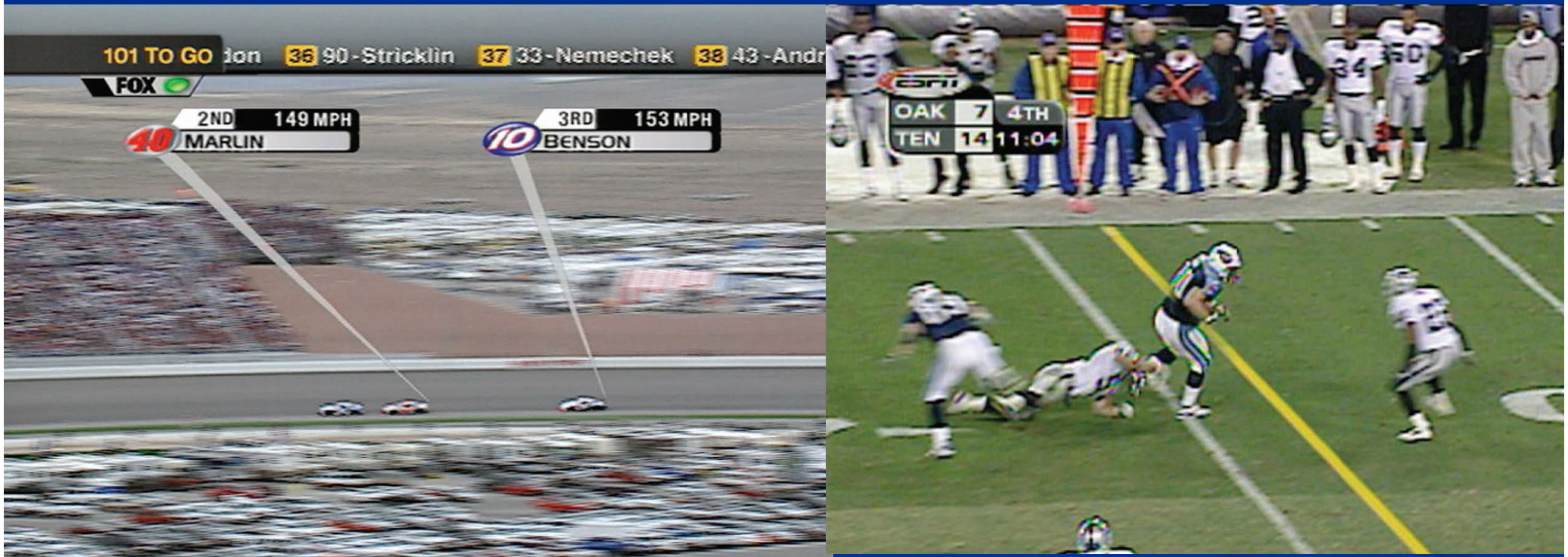
enhancing practice by supporting remote and collocated activities that would otherwise be impossible.

Recent Advances in Augmented Reality

November/December **2001**

New Applications.

Commercial applications



AR in sports broadcasting. The annotations on the race cars and the yellow first down line are inserted into the broadcast in real time.

New Applications.

Commercial applications

Virtual advertising. The Pacific Bell and Pennsylvania Lottery ads are AR augmentations.

Future work

- *Technological limitations*
- *User interface limitations*
- *Social acceptance*

Tankwar – Tabletop war gaming in augmented reality

Trond Nilsen, Julian Looser

Presented by Unnur and Shaheen

- Evaluation paper
- The role of social interaction in table top and computer gaming.
  - Augmented reality
  - Tabletop games
  - Strategy games
  - Colaboration
- AR Tankwar

- Before computers, game playing was almost universally a social activity.
- Computers are not well suited for social interaction
  - Single player games don't need interaction
  - Strategy and role playing games need social interaction

Social interaction in games

- Stimulated communication
  - Part of the game itself
- Strategic communication
  - Discussion of game play and actions
- Meta-game communication
  - Is about the game in general
- Audience communication
  - Between those not directly involved in some part of the game
- Natural communication
  - Background interacton, e.g. chatter and gossip

- Computer games
  - Remote
    - Face the screen
    - Hard to communicate, usually text is used
  - Co-located
    - Communication is easier
- Tabletop games
  - Players face each other and therefor its easy to communicate

Previous work

- Shared Space interface
- Zsolt szalavári – Personal Interaction Panels
- False Prophets
- The Stars project
- The Battleboard 3D project
- Hybrid AR Worms

Motivations

- Simple model for considerating different ways players are engaged in games
- A player's enjoyment of and engagement with a game is comprised of four aspects:
  - Physical engagement
  - Mental engagement
  - Social engagement
  - Emotional engagement
- Goal: To create a augmented game in which players can interact socially

- Iterative design and evaluation
  - Iterative process of design, play, discuss, design, play, discuss...
  - User studies to compare similar games in different mediums
- Video See-Through AR
  - Users wear head mounted display with a camera to see real and virtual contents simultaneously.
  - Limitations
    - Delay and monoscopic view
    - Eyes and part of face is obscured – hard to see facial expressions
- Lens based interaction
  - Controllers, such as gamepad or mouse, augmented with a virtual lens

AR Tankwar

- Table top wargame
- Game state primarily represented by location of models on a game table
- A turn ususally consists of unit movement, exchanges of fire and morale
- Modelling, historical recreation, strategic gaming and social interests most common for war gamers
- Smoke, fire and such visualisations are easier in a computer game

- 2 or more players and spectators
- Virtual game map and pieces
- Transitional interface
  - Players shift between augmented reality viewpoint(exocentric) and fully virtual viewpoint(egocentric) on the game map.
- Different viewing clients
  - Desktop client, web based client and other ways that support view by spectators

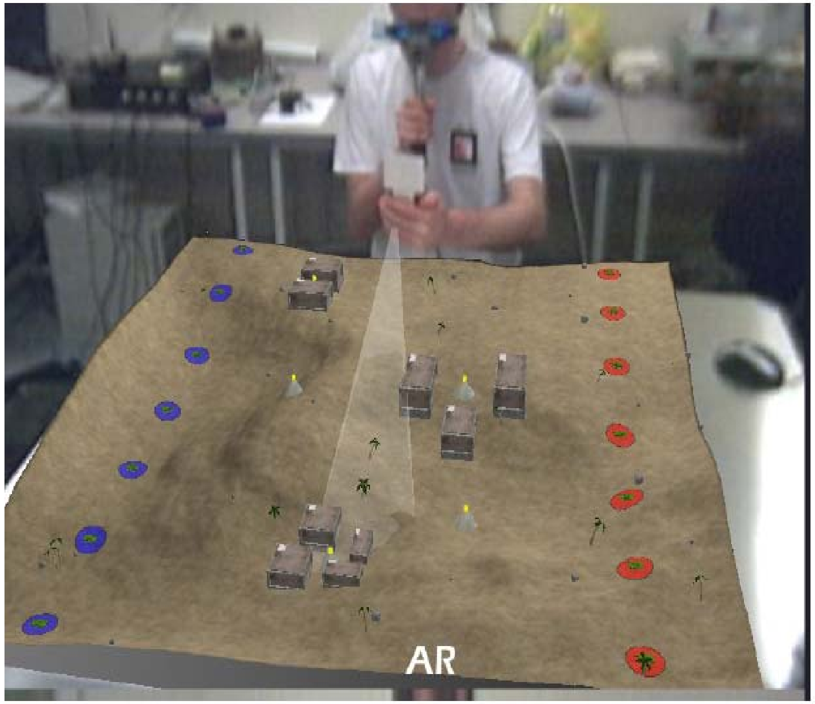


Figure 1: AR Tankwar - tabletop view. Units can be seen highlighted in blue and red

Design Process

- The predecessor "Hybrid AR Worms" helped to guide design decisions
- Distributed clients around a single server
- Takes place on a single tabletop
- Interface overhead is reduced
- Slow real time strategy game where every player is involved
- Designed to be as extensible as possible

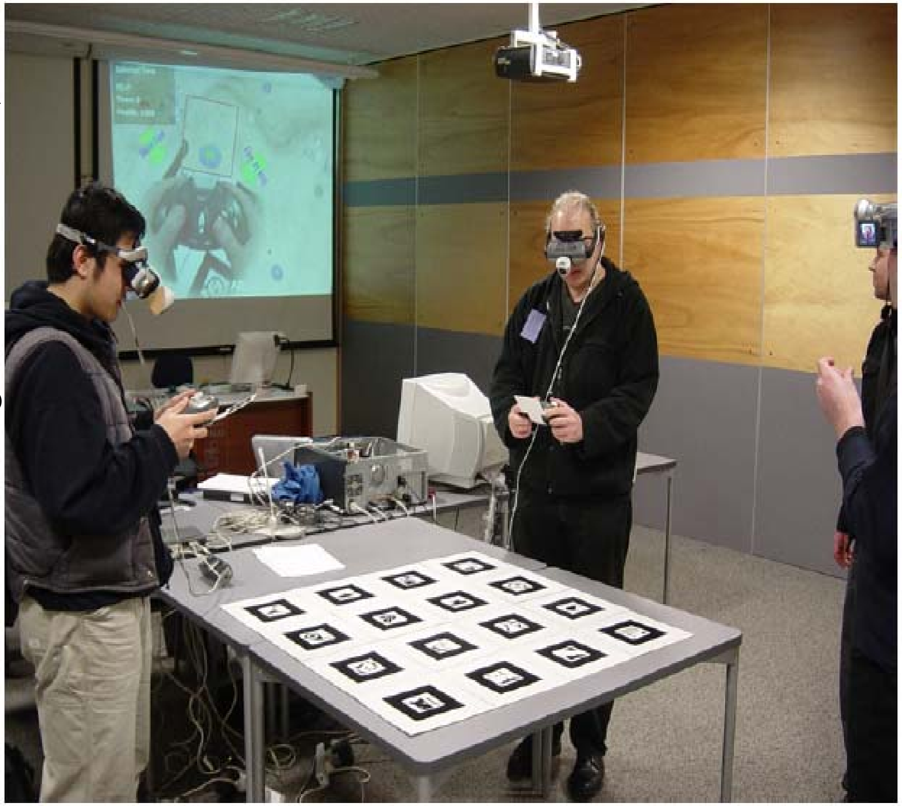


Figure 2: A game of Tankwar in play (NZGDC 2004). A spectator view can be seen in the background.

Evaluation

- Formal evaluation is being prepared
- Informal evidence that they are succesful in acheiving the goal
- Demonstrated at the New Zealand Game Developer's conference
  - Played by about 50 attendees who were observed

Future work

- Formal study of AR Tankwar
  - Compare with analogous table top and desktop PC games
  - Players recorded solving in-game problems
  - Questionnaire and interview
- Continue developing AR Tankwar

Social Presence in Two- and Three-dimensional Videoconferencing

J.Hauber, H.Regenbrecht, A.Hills,
A.Cockburn, M.Billinghurst

Presented by Unnur and Shaheen

- Social presence serves as a measure of how persons feel when they are connected through a telecommunication interface
- Study measuring the social presence in three conditions:
  - Desktop 2D videoconferencing
  - Desktop 3D videoconferencing
  - Face-to-face communication in a real environment

- Use of video conferencing is increasing
- Limitations:
  - No eye-contact
  - Lack of shared social and physical context
  - Limited possibility for informal communication
- 3-D metaphors have been applied to simulate face to face meetings
  - SmartMeeting
  - AliceStreet
  - cAR/PE!

The assessment of satisfaction with entertainment systems and with productive performance in teleconferencing and collaborative virtual environment is based largely on the quality of the social presence they afford.

Biocca et al., 2001

Social presence measurement approaches:

- Semantic Differential measure
  - Participants rate telecommunication systems on a series of seven-point bipolar pairs such as “impersonal – personal”, “cold – warm”
- Networked minds measure

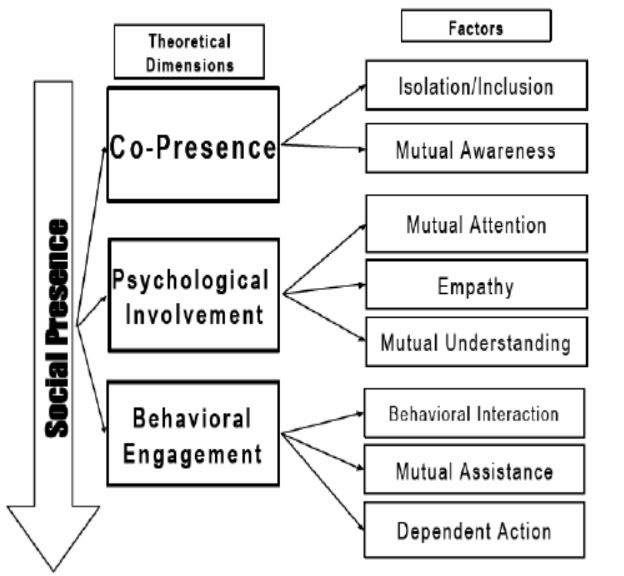


Figure 1: Factor structure of the Networked Minds measure of Social Presence [2]

Factor scale	Items	Example
Isolation/ Inclusion	2	“I often felt as if I was alone”
Mutual Awareness	4	“I hardly noticed another individual”
Mutual Attention	8	“I paid close attention to the other individual”
Empathy	6	“When I was happy, the other was happy”
Mutual Understanding	6	“The other understood what I meant”
Behavioral Interaction	6	“What I did affected what the other did”
Mutual Assistance	4	“My partner worked with me to complete the task”
Dependent Action	2	“The other could not act without me”

Table 1: Example items of the Networked Minds measure of Social Presence

Method

- Group of three work on a collaborative task in three rounds
  - Face to Face
  - With 3D interface
  - With 2D interface

Figure 2 "Face-To-Face" (FTF) Condition

Method

- Three rooms with identical PC's, monitors, head seats and web cameras
- 2D and 3D interface variants of "cAR/PE"
  - In 3D participants can move around and it supports 3D sound.

Figure 3 Screenshot Condition "3D"

Figure 4 Screenshot Condition "2D"

Method

- 42 participants
  - 14 sessions, 3 rounds per session and participant
- Collaborative task: “Desert survival”
  - Assign priorities to a given list of items based on how useful they are surviving an extreme situation
- Questionnaires applied after each round
  - Combination of both measurements

- **Hypothesis 1:**

  Every factor of Social Presence, measured with the Networked Minds measure of Social Presence, is higher in the Face-To-Face condition than in both mediated conditions and at least several factor scores of Social Presence are higher with the three-dimensional interface than with the two dimensional one.

- **Hypothesis 2:**

  Social Presence, measured with the semantic differential technique, is higher in the Face-To-Face condition than in both mediated conditions and Social Presence also is higher with the three-dimensional interface than with the two-dimensional one.

Results

- Reliability analysis of the items in all factors was performed first. Cronbach's Alpha was calculated for each variable:

Factor	Nr of Items	Alpha
Social Presence	9	0.93

Table 2: Test for internal consistency for the semantic differential measure of Social Presence

Factor	Nr of Items	Alpha
Isolation	2	0.54
Mutual Awareness	6	0.83
Mutual Attention	8	0.76
Empathy	6	0.70
Mutual Understanding	6	0.88
Behavioral Interaction	6	0.84
Mutual Assistance	4	0.74
Dependent Action	2	0.32

Table 3: Test for internal consistency for the Networked Minds measure of Social Presence

Results

- Semantic differential measure:

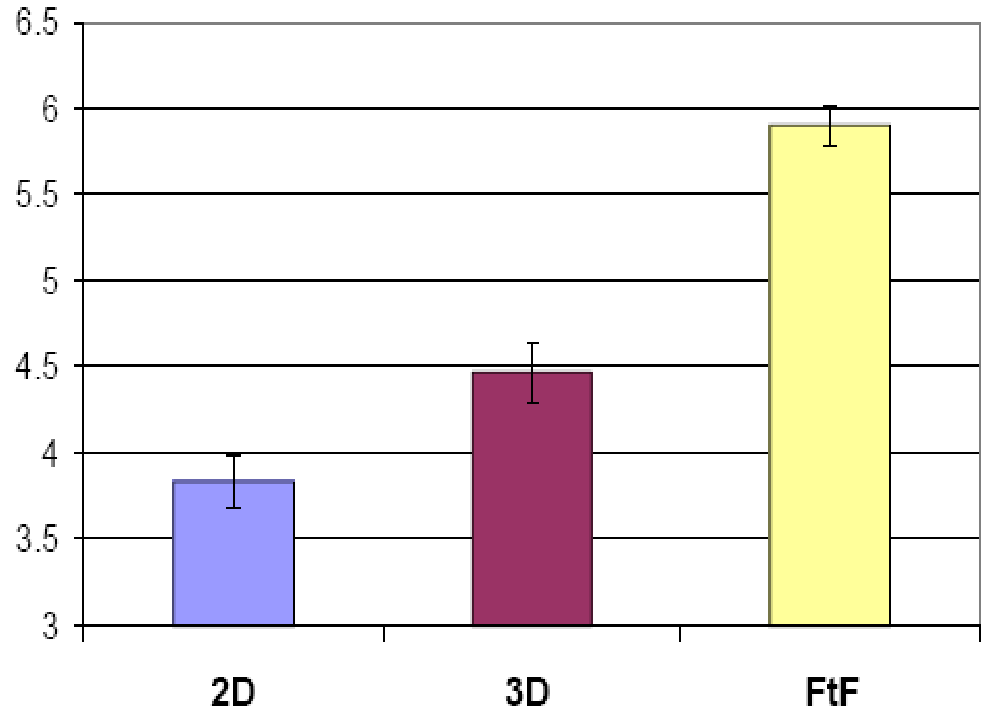


Figure 7: Mean Difference and Standard Error in Social Presence, measured with the semantic differential measure of Social Presence

Results

- Networked Minds measure

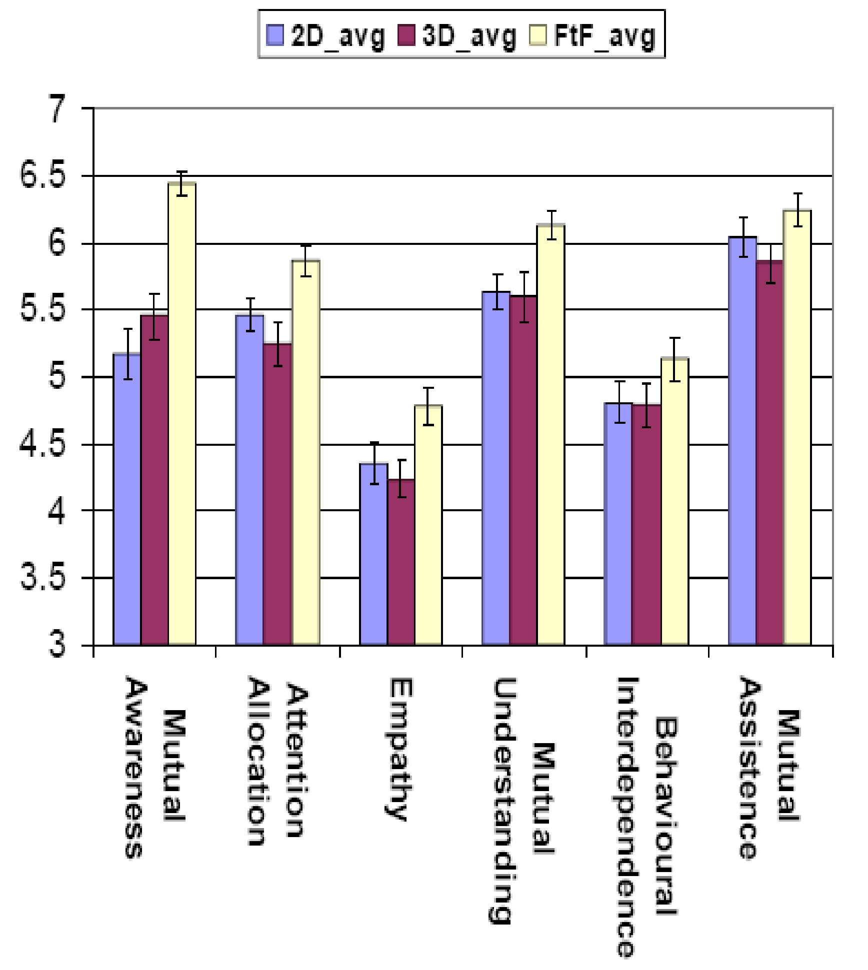


Figure 6: Mean differences and standard errors in the factors of Social Presence, as measured by the Networked Minds Measure of Social Presence

Further findings and limitations

- Experimenters wrote notes during the sessions about their observations
  - Interface in 3D is not fast enough e.g. For head movements
  - Users clearly liked the 3D sound
  - There is a need to have some virtual presentation mechanism

Conclusions

- Social Presence increase from 2D and 3D interfaces to real face to face communications
- Further researches are needed to answer questions like “Is task performance better in 2D or 3D?”