

paper



imagine space fused with data

a model for mixed reality architecture

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Abstract

The paper presents a conceptual model of a Mixed Reality architecture by the fusion of physical and digital space exemplified with the Murmuring Fields scenario. The concept of spatial perception is supported by perceptive interfaces superimposing different levels of reality. This situation shapes the performers experience of being present in Mixed Reality space by acting. The structure of this Mixed Reality architecture is a notation system describing layers of physical and digital space for a hypermedia storybook. The interconnected space creates a new framework for communication and interaction. To this end, the result is eMUSE, electronic Multi-user stage environment for rapid prototyping of Mixed Reality architectures.

1. Envisioning Mixed Reality

Imagine space fused with data. Imagine data representing a tangible situation. The underlying paradigm of Mixed Reality (MR) is that of an information space merging components of physical and digital information. The metaphor we use for MR space is that of a room furnished with data. The basic idea is the linking of physical and digital space by perceptive interfaces.

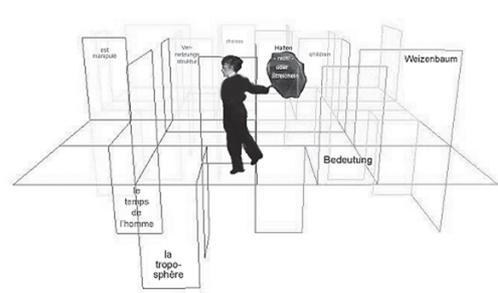


Fig 1 Interacting in a room furnished with data.

The room stands for a physical interaction space but the furniture of data is virtual and stands for an information space. It is a spatially organised information architecture in which data is revealed through users' movement and action in the combined real-virtual space, and through interaction with other users. This theatrical model is used to structure and act within day-to-day spaces. MR architecture opens up windows to data-space; conversely data-space becomes present in real space. Movement is information and reveals data from virtual space as if it were in physical space.

1.1 Sketching Mixed Reality architecture

Our approach to MR space is as an interconnection of the real and the virtual that produces a new framework for communication and interaction. The physical space is fused with the digital space. The user's exploration of the virtual space is connected to both real space and other users' experiences.

The goal is to build an architecture by rearranging spatial elements from static into dynamic environments, from canvas to pixelated mosaics, from materiality to transparency. The moving image arises as interactive data skin and is combined with cameras and microphones, sensors and actuators as the glue for MR space. In the following we describe how to interface the body wirelessly with digital space.

2. Interfaces sensing body and space

Mixed Reality requires a completely new kind of interface – one that allows humans to communicate the way they naturally communicate with each other by speaking, gesturing, touching, moving around, looking with the body and thinking with the hand. Fig 2 identifies a basic bundle of six artificial senses seemingly covering the classic senses.

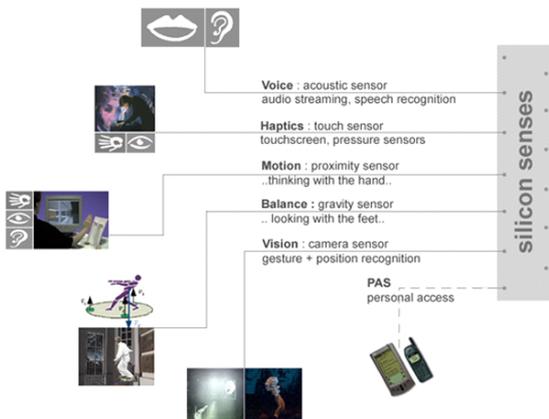


Fig 2 Perceptive Interfaces for the silicon senses

The human body with its communication channels and membranes (skin, eyes, ears, voice, and balance) are reflected and replied to by a variety of sensors embedded in real space and objects. The sensors literally hear and feel the presence and condition of the human body. The body in space is measured and detected by silicon senses e.g. a computer vision system. Thereby the interface becomes immaterial.

3 Connecting body and space

Several existing vision systems and applications provide concepts of media-related interactive stages based on video gesture control.

In the context of the MR stage we recognized several disadvantages to these systems: they are stand alone solutions which are not web-based and without access to the source code.

The computer vision system with the video camera oversees the position of people in physical space and transfers the data of movement and orientation as traces of presence in virtual space. The application scenario Murmuring Fields demonstrates this MR environment.

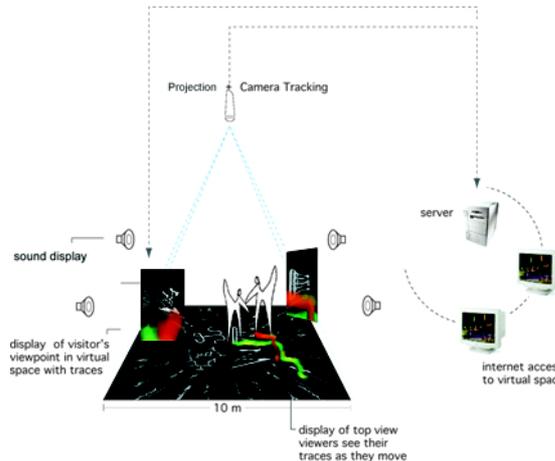


Fig 3 scene of the Mixed Reality Stage

The initial sketch for the presentation of Murmuring Fields depicts a floor projection (Fig. 3) while two side projections display individual user viewpoints. The Vision System surveys the entire inter-action in MR space. Performers are represented in digital space as colored trace of movement corresponding to their movement in physical space. The objective is to create a situation which brings the participants into mutual play by amplifying their bodily awareness of space and of each other. Thus the MR stage becomes an interface environment, not merely the connection of man and machine. It is a situation in which the performers become involved by interacting with the MR stage.

3.1 Body mapping

The electronic Multi-User Stage Environment (eMUSE) was built to link physical and digital space for group interaction around common data. It is realised as a VRML 2.0 (Virtual Reality Modelling Language) based networked environment combined with perceptive interfaces. It is a platform for multi-user interaction, communication, rendering and display organization in shared physical and digital space. The MR stage is intra-connected by the vision system, a camera-based tracking system capable of locating several humans moving in a room.

The eMUSE system consists of three main parts: the external user interface driver (EUi), the multi-user driver (mu) and a VRML browser. The external user interface driver allows arbitrary input devices for controlling navigation in the VRML scene to be attached. It reads data from input device drivers, transforms it into appropriate VRML co-ordinates for control of viewpoint and movement of avatars, and passes this data to the multi-user driver over a socket connection. The multi-user driver takes care of updating the user's local VRML scene. It runs a JAVA applet inside the Web browser and uses the external authoring interface (EAI) to communicate with the VRML browser. Changes are propagated directly between the multi-user drivers supporting individual users, through TCP/IP and UDP peer-to-peer connections. The modular structure of eMUSE enables the use of any VRML compliant browser that supports the external authoring interface. eMUSE was realised using Cosmo Player 2.0 as rendering engine. The eMUSE system can be understood as an interface for a building nonlinear communication structure.

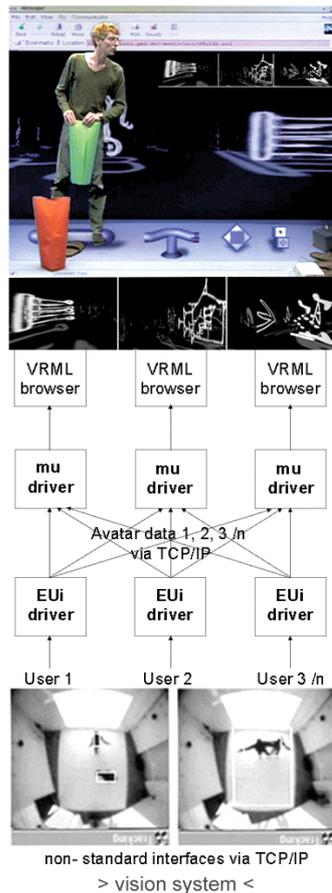


Fig 4 eMUSE interfaced by the vision system for control of several viewpoints

3.2 The Mixed Reality situation as interface

In order to realise the MR Stage concept, different perception levels need to be layered and related in a coherent structure. The interface environment functions through the interplay of the following components:

- The Vision system
- Visual representation of content
- Audio representation of content
- User representation as trace of presence
- Physical interaction space

The Vision system

A fundamental point of the MR Stage concept is connecting participant's bodily sense of being in physical space with that of being in virtual space at the same time. To achieve this we use an optical tracking system to connect participants' movement in real space with navigation in virtual space. The data provided by the tracking system controls the position and movement of the user in the virtual space, parts of which are displayed accordingly in appropriate locations of physical space. This supports the perception of virtual space reacting to users' actions as an integrated part of the physical space in which they are situated.

Visual representation of content

The visual elements of the virtual environment serve as placeholders for sounds and an orientation aid for the participants.

Audio representation of content

A participant's movement in physical space controls the creation of the corresponding trace-avatar in the virtual space. Traces of all participants trigger sounds and words in the virtual space that are emitted in the real space. The emergent soundscape inspire further movement and lead to a mutual play of the participants in producing sound patterns and dialogues together.

User representation as trace of presence

The trace of one's own movement is the orientation line. Participants communicate through their virtual traces and thereby determine the action space as well. The trace of presence becomes a visible interface and a medium for communication. It indicates the current position of the participants and triggers sounds by virtually touching sound objects. Thereby an audiovisual composition created by the participants is initiated.

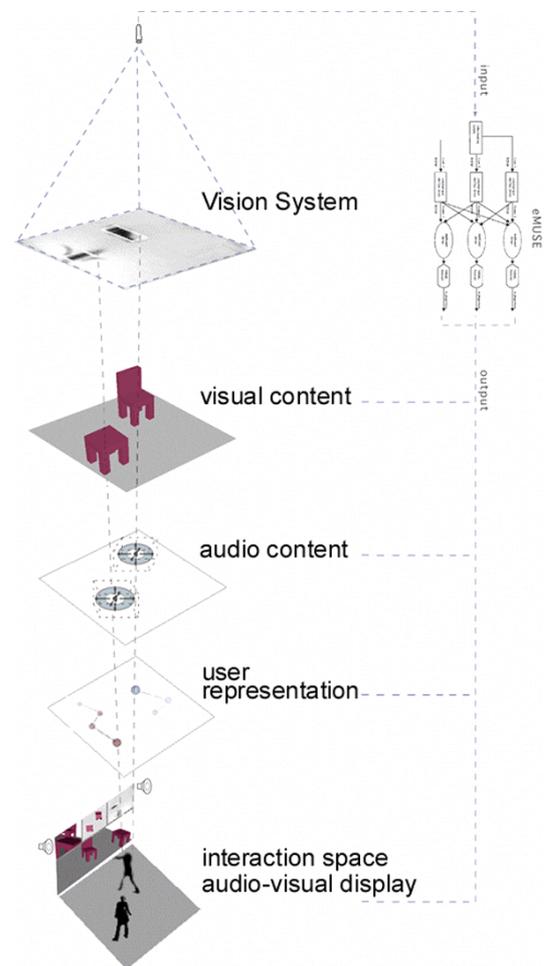


Fig 5 Layers of the Mixed Reality Stage

Physical interaction space

Unlike in systems where navigation in virtual space is achieved by directly manipulating some physical device, the MR Stage cannot be navigated without the existence of an appropriate physical space. The physical space becomes an essential part of the interface. As a participant becomes immersed in the play of movement and sound, his awareness of being in space, and of the interaction with others, becomes increasingly a bodily one.

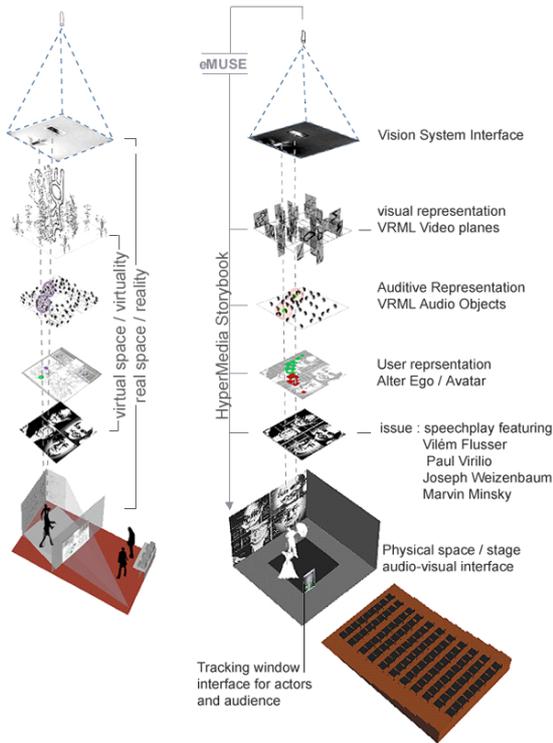


Fig 6 Murmuring Fields layers of Mixed Reality for installation and stage, Berlin/Bochum.99

4.2 The invisible map and the basic structure of the Mixed Reality soundscape

In linking, the physical and digital space must be scaled and calibrated to each other. The Murmuring Fields experiment superimposes both spaces in scale 1:1. The interactive area is 4 by 4 meters scaled to the digital scenario. In fact, the empty space is furnished with a three-dimensional audiovisual environment. In reality the performers are inside an invisible environment, minimalistically visualized on a floating screen of gauze. Sound is emitted to real space depending on the performers' position. Thereby the body is the instrument to perform in and with the MR space.

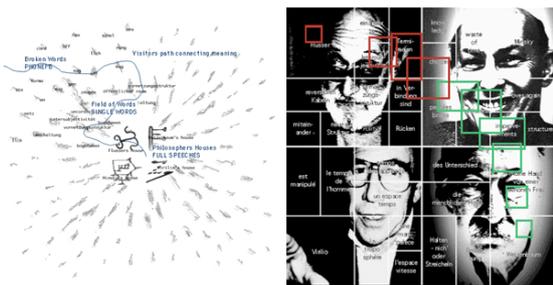


Fig.7 Two maps of Murmuring Fields audiovisual environment

The design of the audiovisual environment as shown in the map (Fig 6) builds up a field of diverse densities of spoken words and sounds. The speed of movement mixes the according sound and image. Careful and slow movement breaks a single word into phonemes, e.g. the word politik appears in an empowered dance version as poli tik, tik, tik.

As a user leaves traces of presence in the digital environment, the path of connected meaning and the notation of movement is rendered as part of the scene. In Murmuring Fields public installation visitors walk along landscapes of faces. They are engulfed in a soundscape of the voices of media philosophers Vilém Flusser, Marvin Minsky, Paul Virilio and Josef Weizenbaum.

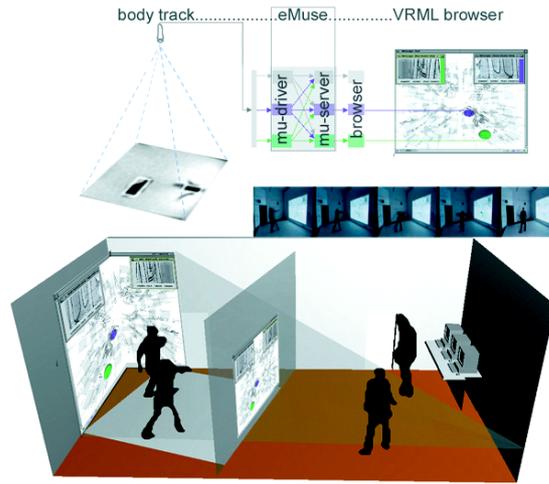


Fig 8 Configuring physical and digital space as interactive and interpassive zones

4.3 Murmuring Fields in public and performance space

The visitors of Murmuring Fields are situated in a soundscape of one hundred sound samples. The interactive protagonists control the sound stage by their position on stage. The layers of sound created by each participant intersect and weave together, thereby generating a collage of sound. This interactive body conversation of sounds is augmented by a visual map, projected on semi-transparent displays. The impression for the users is that of an invisible field of sounds existing in the physical space and revealed through their actions.



Fig 9 Emergent behaviour in Murmuring Fields Installation

To summarize: one or several participants in the physical space are simultaneously present in an information space that is made visible only through participants' actions in the real space. The overlapping and integration of these two spatial situations creates a new reality of perception.

The second public trial of Murmuring Fields took place in the context of a theatre festival. In the rehearsals, we perceived the professional performing artists having more problems in playing and exploring than the accidental visitors in the installation version. In contrast to the traditional theatrical concept of performing on stage, the MR stage requires to recognize the body as an instrument playing in an orchestra (Fig.9).

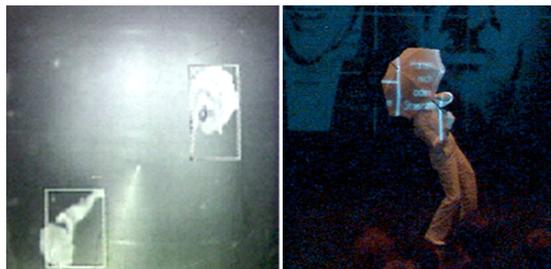


Fig. 10 Performing artist on stage and seen through the vision systems tracking window

5. Conclusion

With eMUSE we have built an architecture to design and operate Mixed Reality space and a playfield for communication in networked space. The discoveries made through the MR stage in terms of emergent patterns of behaviour and different perceptions of reality go beyond the boundaries of the theatre.

6. Outlook: streaming forward

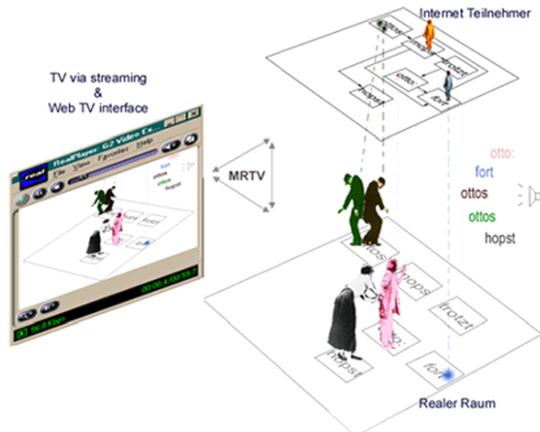


Fig. 11 Loops of streamed cycles

For the distributed poetry play "Ottos Mops" by Ernst Jandl, thematic spaces like MUDs and MOOs build up the structure for a semantic map. People meet remotely, brought together by a RealVideo window streaming and recollecting the happening. Loops of streamed cycles unfold layers of echos in space.

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