Immersion in Virtual Reality summary

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Artificial Intelligence & Information Analysis Lab

Introduction to Virtual Environments

- **Basic Concepts and Definitions**
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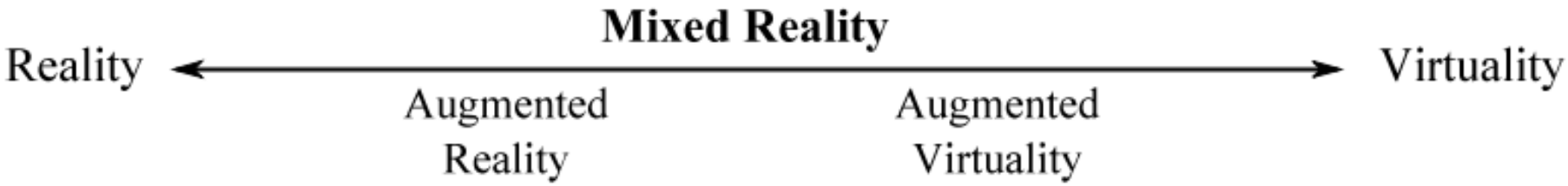
Basic Concepts and Definitions

Reality – Virtuality (RV) Continuum



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Basic Concepts and Definitions

Reality

The summation of what is existent within a system. The totality of what constitutes “real” in the system under investigation.

There are plenty of philosophical discussions about what the boundaries of reality are and the things that should be included in this category.

Basic Concepts and Definitions

Augmented Reality (AR)

Used to enhance the properties of reality.

Creation of virtual objects that are merged with the ones existing in the reality level.

Laws of the reality level (e.g. laws of physics) can be broken in order to enrich the user's experience.

Basic Concepts and Definitions

Mixed Reality (MR)

Does not have strict boundaries but is a hybrid of both reality and virtuality, as the name would suggest.

It refers to the area between the two extreme sides of the continuum.

Basic Concepts and Definitions

Augmented Virtuality (AV)

The term implies that a Virtual Reality has already been created and real objects are allowed to exist inside the virtual world.

Basic Concepts and Definitions

Virtual Reality (VR)

Composed by computer-generated environments comprising of virtual objects and characters, referred to as avatars.

Able to provide a realistic experience to the end user by deploying different type of sensory stimuli.

Users of VR systems are completely cut off reality.

Basic Concepts and Definitions

Presence

The term is used to describe a user's illusion that a mediated experience is not mediated.

A shortening of the word "telepresence", it is a phenomenon created via technology.

Basic Concepts and Definitions

Immersion

The feeling of being present in a virtual world and acting as if it was real.

A plethora of stimuli is deployed in order to make the user experience as truthful as possibly achievable.

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Presence Prerequisites

The entering sensory data must agree with human perception of reality.

For example, optical information should feel natural and have a real-like motion flow.

High enough refresh rates and low latency can help in this direction.

Presence Prerequisites

Images have to be as real-like as possible.

There are some requirements for that to be achieved:

- Adequate resolution (1080p or better)
- Low pixel persistence (3 milliseconds or lower)
- Global display where pixels are illuminated simultaneously.

Presence Prerequisites

But most importantly, the action-reaction phenomenon is mandatory in the virtual world for the user to feel a decent level of presence.

Reality-like interactions with the environment are of much more importance that the reality-like objects in a VR system.

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Presence Types

Two distinct categories of presence can be observed.

“Place illusion” or PI, refers to the feeling a user can experience that is described as “being there”. This illusion can occur in static environments where nothing happens.

“Plausibility” or Psi, refers to the illusion a system can offer to a user when there are events happening that respond to his/her actions inside the virtual environment.

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Presence Measurements

Two types of measurements are usually found in the literature in order to identify the level of presence provided by a virtual environment.

Most of the measures listed in the next slides are regarded as immature. Only a few have been extensively used and tested.

Presence Measurements

Subjective measures rely on participant reports:

- Questionnaires
- Measures based on environment comparison from users
- Measures based on psychological factor assessment

Presence Measurements

Objective measures rely on observations and automated calculations:

- User's reaction observation (e.g. reflexes)
- Post-interaction effects on the brain
- Measures based on physiological changes

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Immersion Requirements

What makes a virtual environment immersive?

When can we characterize a virtual environment as immersive?

An environment created by a virtual system is called immersive when stimulating the sensory system of a user in a plethora of different ways (vision, sound, touch, taste, smell).

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Immersion Types

Immersion can be divided into two main categories:

- Mental, and
- Physical

Physical immersion is used as a way to enhance mental immersion.

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Immersion Measurement

Immersion of a system can be measured just as presence.

The typical method for measuring the immersion provided by a virtual system is the following:

Consider two separate systems, A and B, capable of producing virtual environments.

Immersion Measurement

We can conclude that system A is producing a bigger level of immersion in comparison to system B, if and only if, system A is capable of completely reproducing the immersion provided by system B and add to it.

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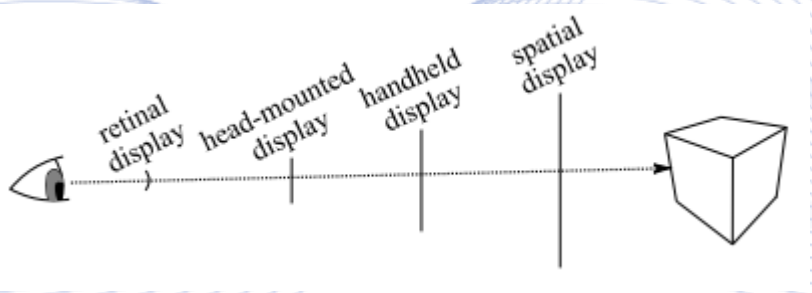
Displays

Specialized equipment is needed in order to visually integrate the virtual and the real world.

The range of the mixed reality displays used to achieve the integration is depicted in the following figure



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Head-worn

Head Mounted Displays (HMDs)

The most common devices used in mixed reality applications.

There are two types of HMDs:

- Monocular
- Binocular

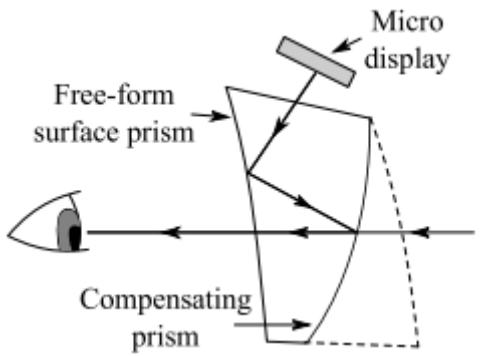
Source: Wikipedia

Head-worn

Free-form surface-prism HMDs

Makes use of a triangular area behind a semi-transparent mirror and a micro display that projects the virtual environment. Main drawbacks:

- Objects seem to be semi-transparent,
- All objects appear in the same distance,
- Quite heave, may cause inconvenience.



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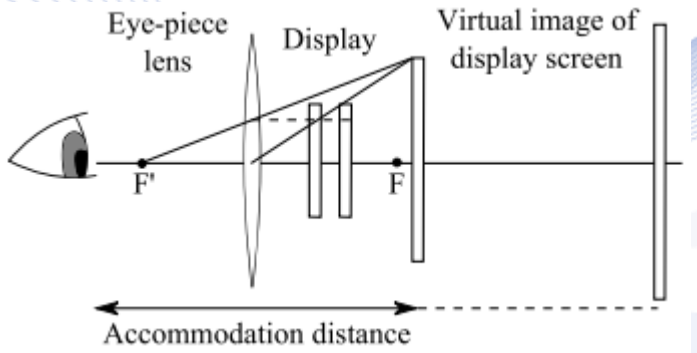
Head-worn

Variable-accommodation HMDs

Designed to eliminate the visual loss of focus.

A magnifying lens is used to appropriately modify the focus adjusting the visual accommodation response.



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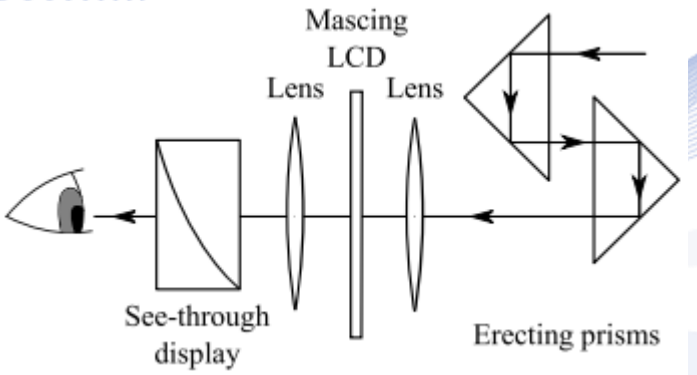
Head-worn

Occlusion handling HMDs

Try to eliminate the transparency of virtual objects superimposed on real scenes.

Based on a masking LCD panel, two curved lenses and a prism that puts the virtual object in the real world.



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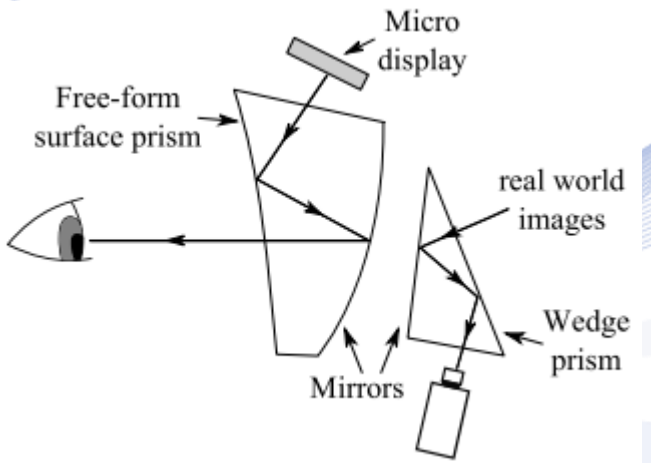
Head-worn

Video See-Through HMDs

Capture real world images by a set of cameras.

Combines the pictures taken with virtual objects to create a new virtual environment.



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Spatial

Devices permanently put in the environment allowing for free-viewing virtual or mixed reality display.

Fixed distance between the user and the environment's objects makes any attempt to grasp them a tricky task to complete.

Spatial

Cave Automatic Virtual Environment (CAVE)

Three rear-projection screens for the walls and a down-projection screen for the floor as shown in the picture.

3D sound makes system more immersive.

High cost, may not be suitable for children.

Source: Wikipedia

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Hand-held

Can be implemented in hand-held devices (e.g. cell phones), allowing the user to freely move around the room.

Flexibility makes them suitable for daily use.

Are left behind as they are still in a primitive stage of development mostly due to technological limitations.

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Technologies Used

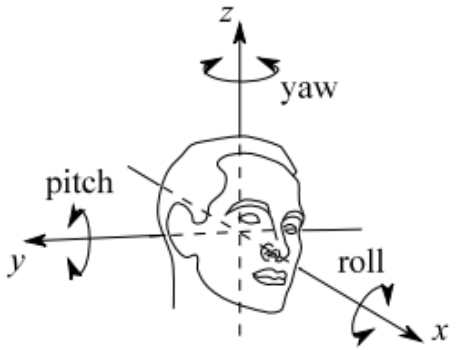
Motion Tracking

In order to evaluate the position and orientation of the human body, especially the parts that are typically used during VR usage (head and hands), motion tracking is deployed.

The rest of the human body parts are then rendered inside the virtual environment based on the initial estimation of head-hand position.

Technologies Used

Tracking devices calculate body part positions in 3D coordinate system, as well as their orientation in terms of yaw, pitch and roll.



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That is why they are also called 6-degree-of-freedom (6-DOF) devices. Gyroscope and motion sensors are also deployed.

Technologies Used

Low delay is of high importance for any motion tracking system, since latency can have a negative effect on the user's experience.

Other factors taken into consideration are:

- Sensor update rate
- Device standard resolution
- Signal quality

Technologies Used

A tracking device can be categorized as:

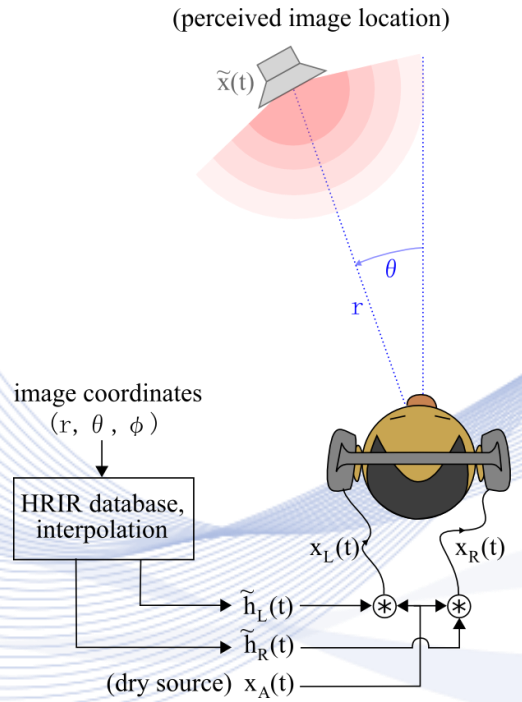
- Mechanical
- Acoustic
- Inertial
- Magnetic
- Optical
- Vision based
- Wireless

Technologies Used

By splitting the sound produced by the system as:

- Sound received by the left ear, $x_L(t)$
- Sound received by the right ear, $x_R(t)$

and using the relationship between image coordinates we can extract local information by proper convolution calculations.



Source: WikiMedia

Technologies Used

Motion Controllers

Game controllers that use various sensors in order to transform the player movement into system input.

In the picture, a typical Wii Remote with its original strap is depicted.

Source: WikiMedia

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Applications

Immersive Videoconference

Reduces transportation costs and save precious time.

Clearance as to whose turn is to talk is still hard to achieve.

Eye contact maintenance is key to the method’s success.

Applications

Immersive Learning Environments

A novel learning experience through VR technologies.

Cost is continuously dropping, more and more available.

Preservation of teaching quality is a must.

Applications

Mixed-Reality Books

Designed to make reading more immersive.

Use of 3D images, animations and sounds to enrich content.

Hand-held devices equipped with a camera are deployed.

Applications

Immersive TV

Next big thing in the field of immersive media.

The user will be able to interact with the images broadcasted.

Give the real time experience of being there when an event is taking place (e.g. concerts, disasters).

Applications

Entertainment

There is a huge market for immersive virtual reality gaming.

Improvement in accessibility of VR devices boosted the field.

3D cinemas, sporting event coverage, virtual theme parks.

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Q & A

Thank you very much for your attention!

More material in
http://icarus.csd.auth.gr/cvml-web-lecture-series/

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