Documentation of Augmented reality applications

Special Project

M.Des Visual Communication

Guided by Prof. Suresh Sethi

Viswanatha kumar 02625007

Industrial Design Center

Indian Institute of Technology Bombay

Content

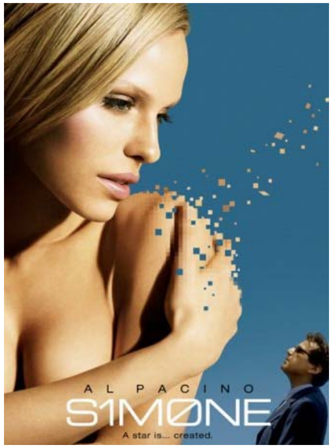
Introduction

A shot from 2001- a space odyssey,
Which Shows the protagonist passing
through a wormhole To a hyper dimension.

Dreamscapes portrayed in 'The Cell'

Physical Reality has been a subject of contemplation from time immemorial, right from the times when our ancestors pondered about the mystery behind stars to the unfolding facts about black holes today. Man has classified the physical as real and non-physical things like dreams and hyper dimensions as virtual. Virtual is something which doesn't exist. The digital technology has given rise to a new order of reality – the virtual real, which addresses all the sensory perceptions of humans and make the brain believe that something non-existent as real through the projection of a virtual world onto him.

Dali's Crucifixion portraying cross
As an unfolded hypercube.



Humans developing
Emotions towards a
Virtual character in the
Movie ‘ Simone’

A old dilapidated building reconstructed
Over real terrains.

Virtual reality (VR) is a powerful, three-dimensional method to interface with computers. By wearing a head mounted audio-visual display, position and orientation sensors, and tactile interface devices, one can actively inhabit an inclusive computer generated environment. With increasing computing power allowing for the processing of huge amounts of information in real time, VR technology has become more effective. Also with new advancements in the display technologies, virtual environments are coming closer to real environments and the VR technology has entered a period of public attention.

Virtual reality attempts to make virtual objects as real as real objects. By increase in graphic capabilities of computers, virtual is getting more and more realistic.

Augmented reality (AR) works on the same principles as virtual reality. Yet, unlike VR where the user is immersed in a completely virtual environment, augmented reality overlays virtual objects and information over the real world. This is usually achieved by the use of see-through head mounted displays and tracking devices.

A virtual clock tower overlapped
Onto a sheet of paper.

Augmented Reality is the overlaying of computer generated information onto the real world. Unlike a Virtual Reality (VR) world, where the viewer sees a completely synthetic (virtual) environment, users immersed in an AR environment can still see the real world. A classic example of an AR device is the ”Heads Up Display” found in Fighter Aircraft. In this case, information about the aeroplanes position and speed or about the enemy aircraft is displayed over the real image of the world outside. The pilot’s understanding of the world they are looking at is increased as extra information is augmenting the information which they are naturally picking up from the environment with their eyes.

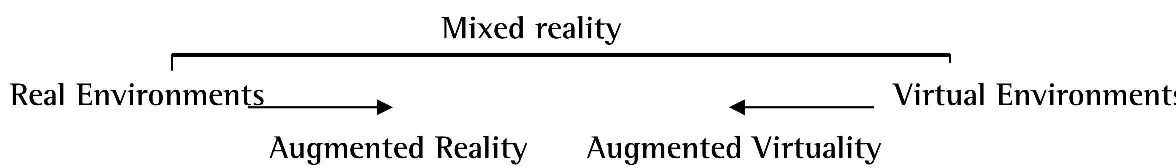
The critical problem with present augmented reality systems is the lack of real-time and accurate tracking. Since the information has to overlap with the real world, smallest errors in tracking information are detected by the human eye. Any mismatch between augmented objects and real objects can be discomforting and also result in incorrect information being given to the user.

This project attempts to document the application of AR in different fields.

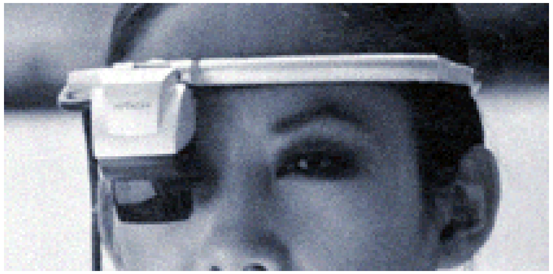
Reality- virtuality continuum

If the virtual environment tries to resemble real environments, it Can be called as augmented virtuality, in which maps and textures from Real environments give the user a sense of experiencing Reality, when virtual objects are overlapped with real environments To enhance the real environments it can be called as augmented virtuality.
This is the spectrum between real and virtual objects.

A sustainable virtual environment
Which recreates a whole day activity of a Temple, so that the user can login any time And get to know the activities of the Temple at that particular time of the day.



Technology



The Head Mounted Display (HMD)

Humans use the visual sense more than any other sense to process information. Hence the capabilities of the display device becomes more critical. The display device has to be able to provide necessary quality at an acceptable cost while minimizing the impact on the user. The main factors to be considered in choosing a display device for an augmented reality application are:

<u>See through capability</u> – A large number of HMD's are available in the market today. However, the specific requirement for this project was a "see through" capable display. See through displays use special optics to allow for the viewer to be able to use the projected images as well as the surrounds. The transparency should be sufficient enough to allow the person to make out things easily and clearly under normal lighting conditions.

<u>Display resolution</u> – Resolution is the number of pixels in the horizontal and the vertical directions making up an image. The display resolution directly affects the quality of the graphics output. Smaller resolutions will result in pixelated images and would make it difficult for the user to distinguish between two separate entities.

Field of View – Field of View is defined as the angle that the horizontal and vertical edges of the display subtend with the eye. Ideally the field of view of a display device should be equal to the field of view f the human eye (around 180 degrees). However field of view for most current systems varies from 30 degrees to 60 degrees.

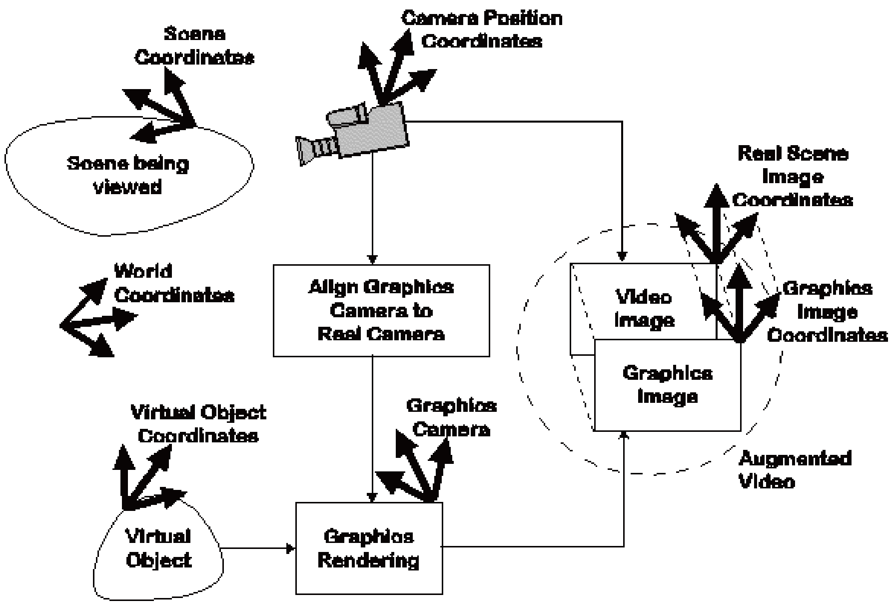
Colors – The display device for this application should ideally be color capable to allow greater flexibility and readability in the interface design.

Ergonomics - Since the device has to be worn by the user on the head for a long duration, it must be ergonomically designed so that it does not inconvenience the user, especially while carrying out any maintenance related work. It shouldn't be too heavy to exhaust the user.

Durability – Since the implementation of the project is to be for maintenance applications, the display device should be rugged and be able to take jerks and perform well under dirty conditions.

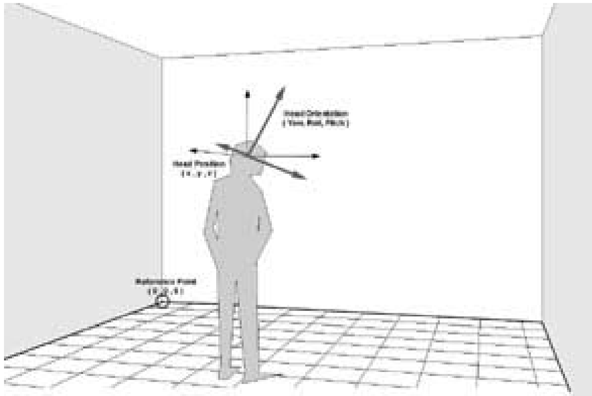
Power Consumption – Since the system is mobile it has to operate on batteries, which makes the power consumption a very crucial factor.

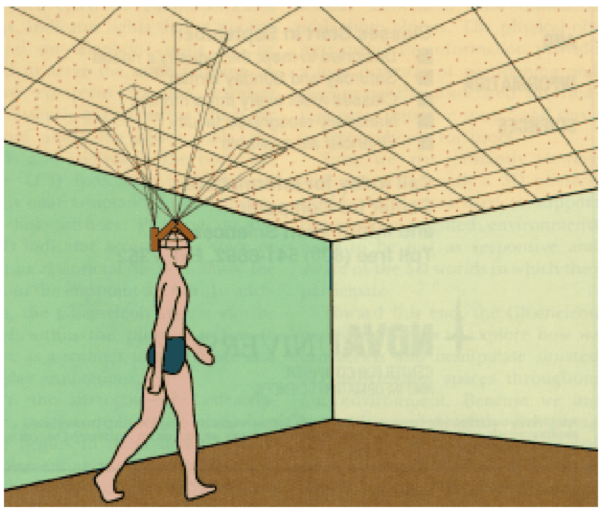
Components of augmented reality system



A standard virtual reality system seeks to completely immerse the user in a computer generated environment. This environment is maintained by the system in a frame of reference registered with the computer graphic system that creates the rendering of the virtual world. For this immersion to be effective, the egocentered frame of reference maintained by the user's body and brain must be registered with the virtual world reference. This requires that motions or changes made by the user will result in the appropriate changes in the perceived virtual world. Because the user is looking at a virtual world there is no natural connection between these two reference frames and a connection must be created. An augmented reality system could be considered the ultimate immersive system. The user can not become more immersed in the real world. The task is to now register the virtual frame of reference with what the user is seeing. As mentioned in, this registration is more critical in an augmented reality system because we are more sensitive to visual misalignments than to the type of vision-kinesthetic errors that might result in a standard virtual reality system..

Tracking Device





Tracking, also called Position and Orientation Tracking, is used where the orientation and the position of a real physical object is required. For augmented reality applications both position and orientation tracking of the viewer are critical. The First step in tracking is to locate the user in the space using position tracking. This requires the user's Cartesian coordinates (x, y, and z) with respect to a reference point. Once the viewer has been located in the space the next step is to determine which direction the viewer is looking in. This requires the orientation to be specified by three angles known as pitch (elevation), roll, and yaw (azimuth). The complete position of the viewer is hence described. For the system to be successful it should be able to determine these values continuously as the user may alter his position/orientation. This is called as six degrees of freedom (DOF).

Challenges

One of the biggest challenges for augmented reality is the registration problem in correctly aligning real and virtual objects. The human eye easily catches even the slightest error in registration. Also, there is a lag in the time interval between measuring the head location and superimposing the corresponding graphic images on the real world because of which virtual objects may appear to swim around real objects.

The critical characteristics for a tracking device are -

Resolution : Measures the exactness with which a system can locate a reported position. It is measured in terms of inch per inch of transmitter and receiver separation for position, and degrees for orientation.

Accuracy . The range within which a reported position is correct. This is a function of the error involved in making measurements and often it is expressed in statistical error terminology as degrees root mean square (RMS) for orientation and inches RMS for position.

System responsiveness . Comprises:

Sample rate - The rate at which sensors are checked for data, usually expressed as frequency.

Data rate - The number of computed positions per second, usually expressed as frequency.

Update rate - The rate at which the system reports new position coordinates to the host computer, also usually given as frequency.

Latency - Also known as lag is the delay between the movement of the remotely sensed object and the report of the new position. This is measured in milliseconds. According to a research by Durlach delays greater than 60ms between head motion and visual feedback impair adaptation and the illusion of presence. Latencies of greater than 10 ms may contribute to simulator sickness

Study

Specific applications of AR in the following fields were studied and documented.

Way finding and information finding

medical

Maintenance and Repair

Gaming and entertainment

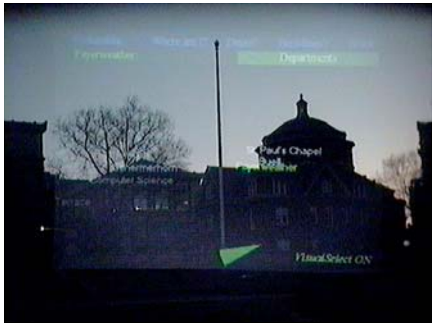
learning

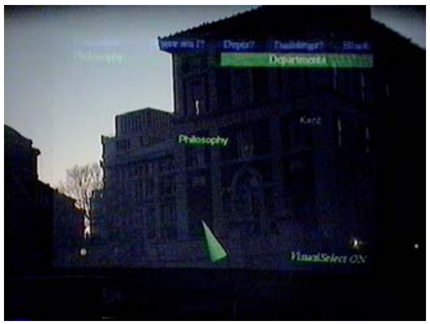
Design process

A user moving around virtual objects in the real space.

Way finding and navigation

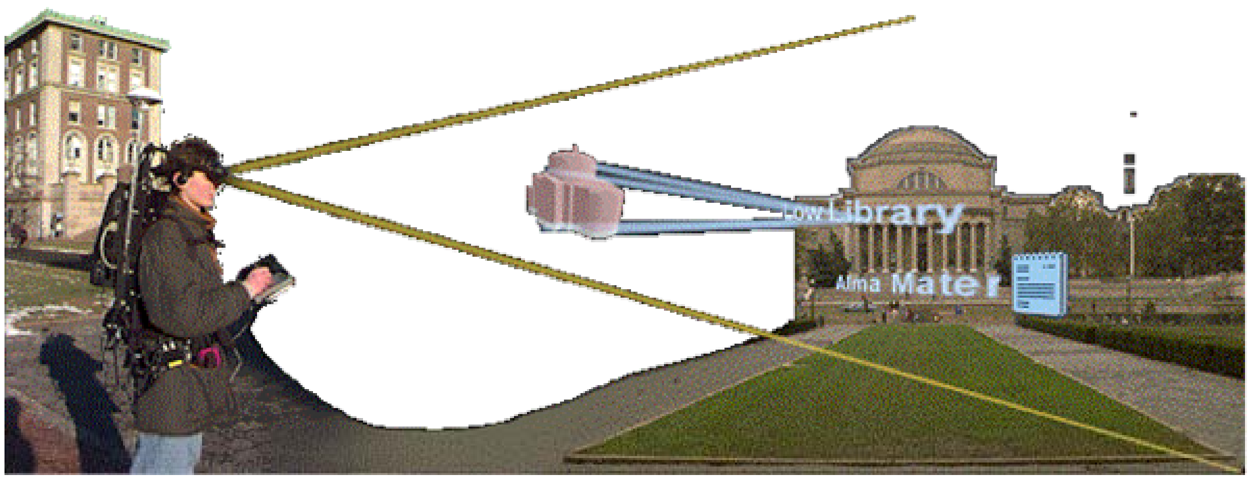
Information overlayed over the real spaces in streets.

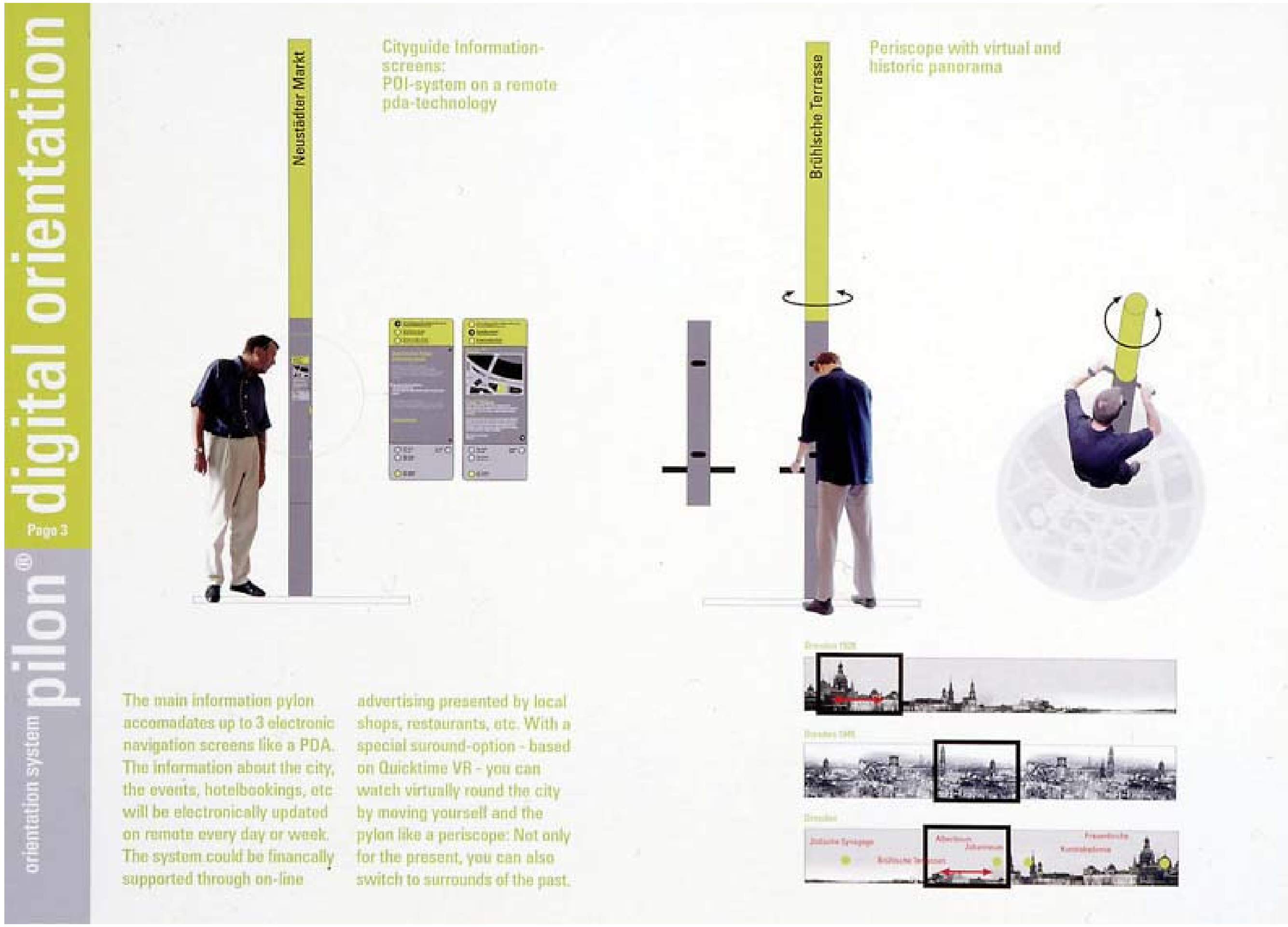




1. MARS :A Mobile Augmented Reality Systems for Exploring the Urban Environment

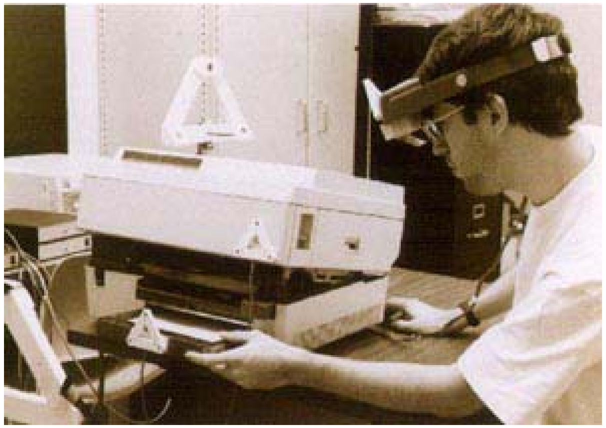
This prototype system developed by the Computer Graphics and User Interfaces Lab, Columbia University acts as a campus information system, assisting a user in finding places and allowing to query information about items of interest, like buildings, statues, etc. The user carries a backpack computer with a wireless network and wears a head-mounted display. The position of the user is tracked by differential GPS while orientation data is provided by the head-mounted display itself. As the user looks around the campus, the see-through headworn display overlays textual labels on campus buildings. The user can interact with the system to bring up related information about any building.

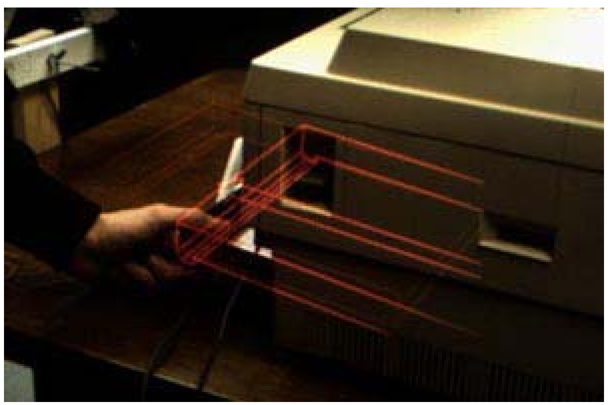




Pilon is an augmented way finding pole in heritage sites which overlays panoramic view of city scapes on the city itself through a see through pole, which contains necessary information for a newcomer.

A dilapidated building virtually reconstructed and Overlayed to the remains of the actual building, when viewed Through augmented reality goggles.





KARMA (Knowledge-based Augmented Reality for Maintenance Assistance)

KARMA is a prototype system that a see-through head-mounted display to explain simple end-user maintenance for a laser printer. Several Logitech 3D trackers were attached to key components of the printer, allowing the system to monitor their position and orientation.

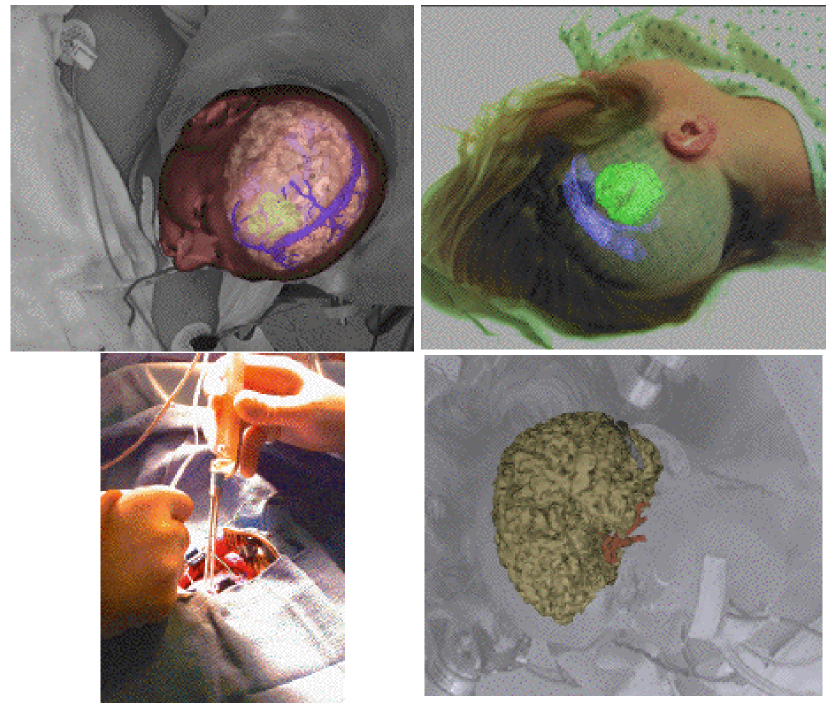
This virtual world is intended to complement the real world on which it is overlaid. For example, one rule states that if a goal is to show the user where an object is located, the system must determine if the object is blocked by other objects. If it is blocked, it will be displayed so that it appears to be seen through the blocking objects; if it is already visible in the real world, it need not be drawn at all.

AR guided assembly in construction sites

AR books

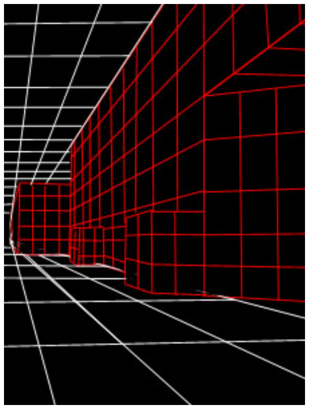
Young children often fantasize about being swallowed up into the pages of a fairy tale and becoming part of the story. The Magic Book makes this fantasy a reality by using a normal book as the main interface object. People can turn the pages of the book, look at the pictures, and read the text without any additional technology. However, if they look at the pages through a handheld Augmented Reality display, they see three-dimensional virtual models appearing out of the pages. The models appear attached to the real page, so users can see the AR scene from any perspective simply by moving themselves or the book. The models can be any size and are also animated, so the AR view is an enhanced version of a traditional three-dimensional ”pop-up” book. Users can change the virtual models simply by turning the book pages. When they see a scene they particularly like, they can fly into the page and experience the story as an immersive virtual environment. In the VR view, they are free to move about the scene at will and interact with the characters in the story. Thus, users can experience the full Reality-Virtuality continuum.

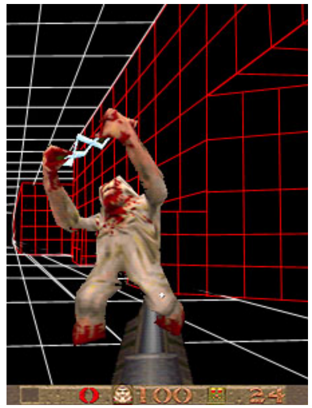
Image guided surgery

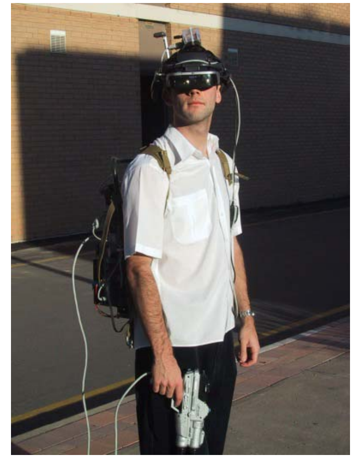


AR helps surgeons to perform a surgery which is pre programmed and guides the surgeon through out the surgery.

Gaming



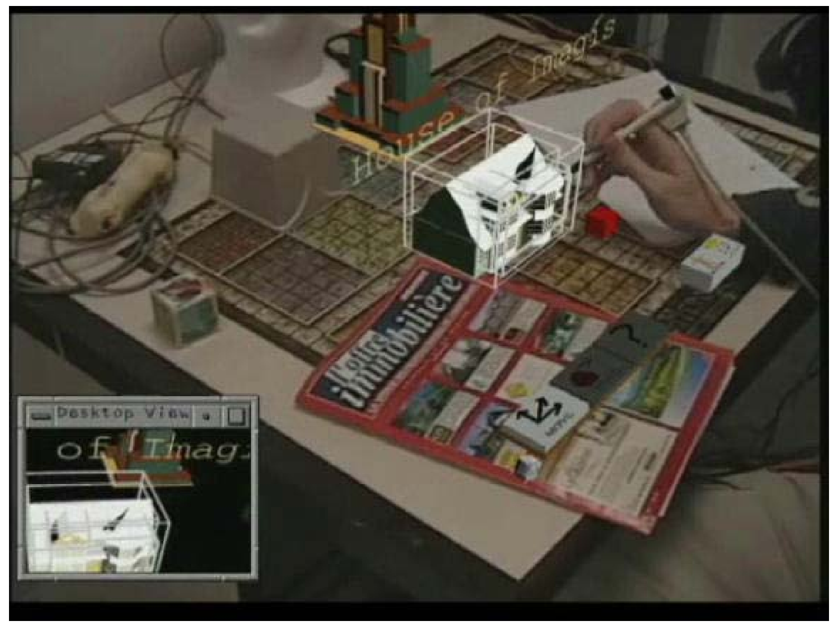




ARQuake is an Augmented Reality (AR) version of the popular Quake game. AR quake takes all the monsters and the guns etc. out of the quake game and to make them roam around a real environment. The player of the game to move around the real world and have all the monsters appear as though they were standing next to and behind real buildings.

AR in visualization

AR used in collaborative visualization in an architects
Office, In which two people move and alter the virtual objects during
A discussion.



Conclusion

Augmented reality opens a new possibilities in different fields. This kind of real time overlap of virtual objects and information over real environments can enhance the information richness of a space by have different layers of virtual information on top of it. Virtual spaces can be customized to the viewers need and can help him navigate and find objects in information rich spaces like city scapes, library etc. This becomes a new medium for the designers to explore.

Acknowledgement

I would like to thank professor Suresh Sethi for his able guidance and insights on the topic.

Thanks George for his valuable inputs.

Thanks Mom, Dad, Subha and varun.

References

http://www.howstuffworks.com/augmented-reality.htm
http://www.se.rit.edu/~jrv/research/ar/introduction.html
http://www.hitl.washington.edu/magicbook/
http://wearables.unisa.edu.au/projects/ARQuake/www/papers/index.html

http://www.usc.edu/dept/architecture/mbs/thesis/anish/thesis_report.htm