IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Augmented Reality-An Emerging Technology

Trupti Lotlikar[*1], Divya Mahajan[2], Javid Khan[3], Ritvik Ranadive[4], Soumya Sharma[5]
[*1,2,3,4,5] Computer Engineering Department Fr.CRIT, Vashi (Navi Mumbai) , India
truptiverlekar@yahoo.com

Abstract

Augmented reality (AR) is the view of a physical, real-world environment that is live, direct or indirect and whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. In this paper we discuss the concept of Augmented Reality as well as the various implementation techniques available in the field of Augmented Reality. Augmentation is conventionally in real-time and in semantic context with environmental elements, such as sports scores on TV during a match. With the help of advanced AR technology (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally manipulable. The general principle of the augmented reality (AR) is embedding digital information into the real world scene. Thus it is a step between virtual reality and the real world.

Keyword: Rreal-time, real-world environment, augmentation, virtual reality.

Introduction

An AR system supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world. While many researchers broaden the definition of AR beyond this vision, 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.

Three aspects of this definition are important to mention. Firstly, it is not restricted to particular display technologies such as a head-mounted display (HMD). Nor is the definition limited to the sense of sight, as AR can and potentially will apply to all senses, including hearing, touch, and smell. Finally, removing real objects by overlaying virtual ones, approaches known as mediated or diminished reality, is also considered AR.

AR provides local virtuality. The goal of augmented reality is to add information and meaning to a real object or place. Unlike virtual reality, augmented reality does not create a simulation of reality. Instead, it takes a real object or space as the foundation and incorporates technologies that add contextual data to deepen a person's understanding of the subject. For example, by superimposing imaging data from an MRI onto a patient's body, augmented reality can help a surgeon pinpoint a tumor that is to be removed. In this case, the technology used might include headgear worn by the surgeon combined with a computer interface that maps data to the person lying on the operating table. In other cases, augmented reality might add audio commentary, location data, historical context, or other forms of content that can make a user's experience of a thing or a place more meaningful.

AR has been around for about 50 years but the term was coined in 1992. Although AR has been around a long time, it hasn't been used widely. It was just too cumbersome to carry the equipment around. That's where smart phones with built-in cameras come in. Now, with them, you can have an unbelievable amount of computing power in the palm of your hand. Simply point your camera at something in real life and virtual information is overlaid onto the image.

Technologies

A range of technologies can be used for Augmented Reality. Some of them are described below:

1. Visual Displays

There are basically three ways to visually present an augmented reality. They are : -

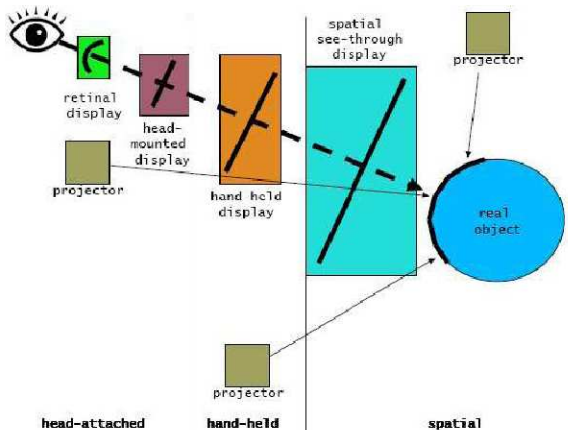


Fig 1. Visual Displaying

1.1. Head – mounted

Users mount the device on their heads, providing imagery in front of their eyes. Two types of HWDs exist:

- Optical see through
- Video see through

Fig 2. Head – mounted Display

1.1.1. Optical see through

Optical see through are cheaper and safer as compared to the other devices. However, other input devices such as cameras are required for interaction and registration.

Optical see-through HMDs work by placing optical combiners in front of the user's eyes. These combiners are partially transmissive, so that the user can look directly through them to see the real world. The combiners are also partially reflective, so that the user sees virtual images bounced off the combiners from head mounted monitors. This approach is similar in nature to Head-Up Displays (HUDs) commonly used in military aircraft, except that the combiners are attached to the head. The optical combiners usually reduce the amount of light that the user sees from the real world. Since the combiners act like half-silvered mirrors, they only let in some of the light from the real world, so that they can reflect some of the light from the monitors into the user's eyes. Choosing the level of blending is a design problem. More sophisticated combiners might vary the level of contributions based upon the wavelength of light. For example, such a combiner might be set to reflect all light of a certain wavelength and none at any other wavelengths. This would be ideal with a monochrome monitor. Virtually all the light from the monitor would be reflected into the user's eyes, while almost all the light from the real world (except at the particular wavelength) would reach the user's eyes. However, most existing optical see-through HMDs do reduce the amount of light from the real world, so they act like a pair of sunglasses when the power is cut off

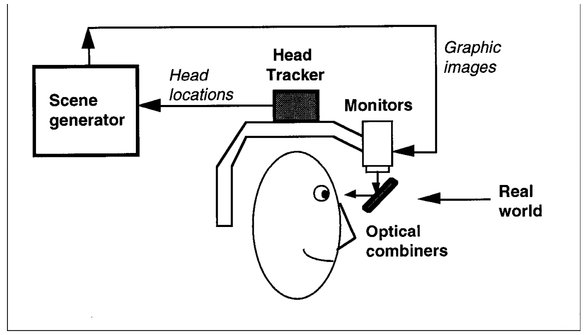


Fig 3. Optical see through HMD

1.1.2. Video see through

Besides being the cheapest and easiest to implement, this display technique offers the following advantages. Since reality is digitized, it is easier to mediate or remove objects from reality. Also, brightness and contrast of virtual objects are matched easily with the real environment. The digitized images allow tracking of head movement for better registration.

Video see-through HMDs work by combining a closed-view HMD with one or two head-mounted video cameras. The video cameras provide the user's view of the real world.

Video from these cameras is combined with the graphic images created by the scene generator, blending the real and virtual. The result is sent to the monitors in front of the user's eyes in the closed-view HMD. The background of the computer graphic images is set to a specific colour, say green, which none of the virtual objects use. Then the combining step replaces all green areas with the corresponding parts from the video of the real world. This has the effect of superimposing the virtual objects over the real world.

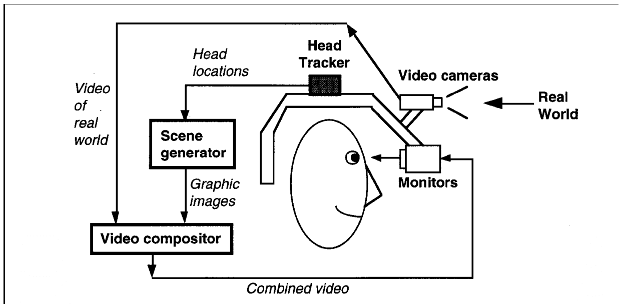


Fig 4. Video see through HMD

I.2. Projected

In this approach, the desired virtual information is projected directly on the physical objects to be augmented, with no need of special eyewear. They can also cover large surfaces for a wide field-of-view.

I.3 Monitor – based

In this approach, one or two video cameras view the environment. Video of the real world and the graphic images generated by a scene generator are combined, just as in the video see-through HMD case and displayed in a monitor in front of the user. User does not wear the display device. Optionally, images may be displayed in stereo on the monitor,
requiring the use of stereo glasses.

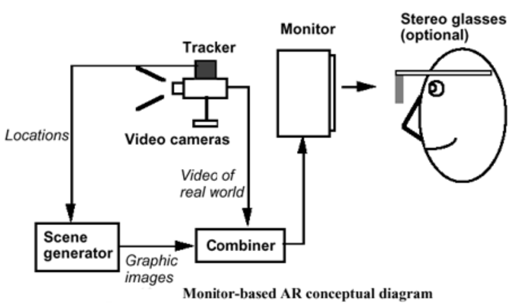


Fig 5. Monitor based display

2. Tracking Sensors

Before an AR system can display virtual objects into a real environment, the system must be able to sense the environment and track the viewer's (relative) movement preferably with six degrees of freedom (6DOF): three variables (x, y, and z) for position and three angles (yaw, pitch, and roll) for orientation. There must be some model of the environment to allow tracking for correct AR registration. Furthermore, most environments have to be prepared before an AR system is able to track 6DOF movement, but not all tracking techniques work in all environments. To this day, determining the orientation of a user is still a complex problem with no single best solution.

2.1. Modeling Environment

Both tracking and registration techniques rely on environmental models, often-3D geometrical models. To annotate for instance windows, entrances, or rooms, an AR system needs to know where they are located with regard to the user's current position and field of view. Sometimes the annotations themselves may be occluded based on environmental model. For instance when other objects occlude an annotated building, the annotation should point to the non-occluded parts only. Fortunately, most environmental models do not need to be very detailed about textures or materials. Usually a "cloud" of unconnected 3D sample points suffices for example to present occluded buildings and essentially let users see through walls. To create a traveler guidance service (TGS), Kim et al. used models from a geographical information system (GIS), but for many cases modeling is not necessary.

2.2. User Movement Tracking

Compared to virtual environments, AR tracking devices must have higher accuracy, a wider input variety and bandwidth, and longer ranges. Registration accuracy depends not only on the geometrical model but also on the distance of the objects to be annotated. The further away an object the less impact errors in position tracking have and the more impact errors in orientation tracking have on the overall miss registration .Tracking is usually easier in indoor settings than in outdoor settings as the tracking devices do not have to be completely mobile and wearable or deal with shock, abuse, weather, etc. Instead the indoor environment is easily modeled and prepared, and conditions such as lighting and temperature may be controlled. Currently, unprepared outdoor environments still pose tracking problems with no single best solution.

User movement tracking can be achieved using –

- Global Positioning System
- Radio

3. User Interface and Interaction

3.1. Visual UI and Gesture Recognition

Instead of using hand-worn trackers, hand movement may also be tracked visually, leaving the hands unencumbered. A head-worn or collar-mounted camera pointed at the user's hands can be used for gesture recognition. Through gesture recognition, an AR could automatically draw up reports of activities. For 3D interaction, Ubi Hand uses wrist-mounted cameras enable gesture recognition, while the Mobile Augmented Reality Interface Sign Interpretation Language recognizes hand gestures on a virtual keyboard displayed on the user's hand. A simple hand gesture using the Handy AR system can also be used for the initialization of marker less tracking, which estimates a camera pose from a user's outstretched hand. Cameras are also useful to record and document the user's view, e.g. for providing a live video feed for teleconferencing, for informing a remote expert about the findings of AR fieldworkers, or simply for documenting and storing everything that is taking place in front of the mobile AR system user.

3.2. Tangible UI and 3D pointing

Devices like the mouse are tangible and unidirectional, they communicate from the user to the AR system only. Common 3D equivalents are tangible user interfaces (TUIs) like paddles and wands. Ishii and Ullmer discuss a number of tangible interfaces developed at MITs Tangible Media Group14 including phicons (physical icons) and sliding instruments.

Some TUIs have placeholders or markers on them so the AR system can replace them visually with virtual objects. Poupyrev et al use tiles with fiducial markers, while in

StudierStube, Schmalstieg et al allow users to interact through a Personal Interaction Panel with 2D and 3D widgets that also recognizes pen-based gestures in 6DOF .

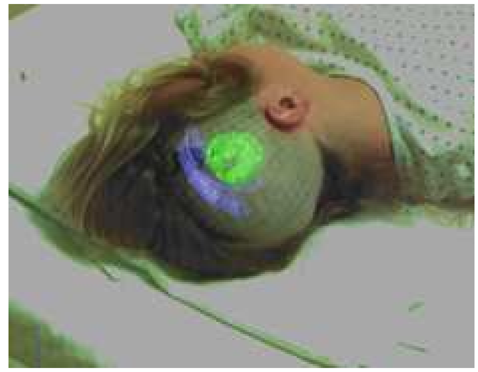
Applications

There is a huge variety of applications that can be created using Augmented Reality. In this paper, we would be mentioning only a few categories of these applications. The actual applications are so vast that they can only be limited by the limit of our imagination.

1. Medical Applications:

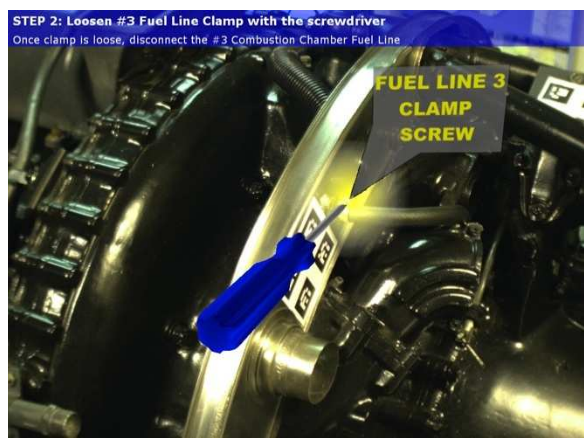
Medical Applications of Augmented Reality are all such that they would be most helpful in the case of non invasive or minimally invasive surgeries. Using Magnetic Resonance Imaging (MRI) or Computer Tomography scans (CT) or ultrasound imaging, the internal structure can be viewed and this can be projected on the top of the human body. This would make it exceedingly simpler to perform minimally invasive surgeries as the basic problem with such surgeries i.e. visibility would get solved.

Apart from this, augmented reality can also be used in order to help out students and doctors by providing them stepwise instructions for performing the surgery in real time.



2. Manufacture and Repair:

Instructions of any type would be much easier to follow if they are present in the form of 3 dimensional applications rather than in the form of manuals with pictures and illustrations. This is where augmented reality comes into picture with respect to manufacturing and repair. Imagine a situation where the internal structure of entire machinery is demonstrated to you on top of the machine. It would be much easier to understand the working of the machine. There may be augmented reality applications, which may also help you to repair your vehicle. It would give you stepwise instructions in real time about what to do now, what to do next and how to do it. Several research projects have demonstrated results in this area. One of the most notable ones amongst this was BMW's Augmented Reality Glasses which help a person in car repairs.



3. Annotations and Visualizations:

Augmented Reality based annotations, notes and visualizations can be used for explanatory purposes. Suppose we are demonstrating a new technology in an online video lesson. We can make an augmented reality application which puts a label in our video for whichever part of the technology we are currently pointing to. Using augmented reality, we can also visualize the internal structures of buildings on top of them. This would be helpful for architects while making demonstrations. It can also be coupled with maps to give seamless directions to various places, using arrows and other directional pointers.

Apart from the above applications, augmented reality can also be used for robot path planning, for entertainment purpose in movies and can also be used for military applications like target locking etc. Thus the applications of augmented reality are vast and belong to various fields.

Limitations

Augmented Reality still has some challenges to overcome. One big range of applications of augmented reality are with the help of maps. However, these are limited by the efficiency and the distance limits of the maps used. In addition to this, technologies like GPS do not work very well indoors.

Many of the augmented reality applications are based on mobile phones. However, mobile phones are already platforms that are limited greatly by screen size, battery life and processing power. People may not want to overload their cellular phones with this technology. For example, imagine the small screen of your mobile phone pointing you directions to a certain place. These directions may very well become difficult to read while driving.

There are various privacy concerns involved. For example, very soon augmented reality applications may get released which allow you to take a person's picture and view information about him from various websites like Facebook, Twitter, Orkut etc.

Lastly, all the illustration and instruction based applications of augmented reality ultimately increase your interaction with a machine rather than a human being. While machines can be designed to become good teachers, they would never be able to control a classroom or provide a human touch and will not be able to give you the true experience of learning.

However, most of the limitations can be overcome by providing better platforms, better processing power and better set ups for augmented reality applications.

Future

The future of augmented reality seems to be more inclined towards haptic and tactile feedback (which uses sense of touch). With the technology, users will be able to feel bumps and ridges, and also figure out which areas are rougher than others. Image-recognition software coupled with AR will, quite soon, allow us to point our phones at people, even strangers, and instantly see information from their Facebook, Twitter, Amazon, LinkedIn or other online profiles. With most of these services people willingly put information about themselves online, but it may be an unwelcome shock to meet someone, only to have him instantly know so much about your life and background. You may learn things about the city you've lived in for years just by pointing your AR-enabled phone at a nearby park or building. If you work in construction, you can save on materials by using virtual markers to designate where a beam should go or which structural support to inspect.

Conclusion

Thus, augmented reality is a very good technology, which can be used to make human life simpler in many situations and can also be used to entirely redesign the way in which humans currently interact with computers. Certain researches related to this are already being carried out in the form of sixth sense technology.

While it may be having some limitations, most of these can be overcome through better technology. Due to its widespread applications, augmented reality may very well prove to be the next step in proving that everything is achievable through technology, most importantly, better living and robust health and an easy life.

References

[1] Tele operators and Virtual Environments, 355-385 "A Survey of Augmented Reality" Ronald T. Azuma Hughes Research Laboratories -200
[2] Ronald Azuma HRL Laboratories, Yohan Baillot NRL Virtual Reality Lab/ITT Advanced Engineering, 2010
[3] Simon Julier NRL Virtual Reality Lab/ITT Advanced Engineering, Blair MacIntyre Georgia Institute of Technology, "Recent Advances in Augmented Reality", 2011
[4] The International Journal of Virtual Reality, 2010, Delft University of Technology, Delft, The Netherlands
[5] James R Vallino "Interactive Augmented Reality", 2011