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AUGMENTED REALITY: A REVIEW

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***Abstract*— Augmented Reality (AR) is a new technology that involves the overlay of computer graphics on the real world. It is a live view of a physical, real world whose elements are augmented by computer generated sensory input i.e. sound, video, graphics or GPS data. AR is within a more general context termed Mixed Reality (MR) that refers to a multi-axis range of areas that covers Virtual Reality (VR), AR, telepresence, and other related technologies.**

This paper presents an overview of basic concepts of AR and its aspects. It briefs about the main fields in which AR is applied these days and important AR devices. Characteristics and future directions will also be discussed on this paper

Index Terms— **AUGMENTED REALITY, computer graphics .**

I. INTRODUCTION

A. What Is Augmented Reality?

Augmented Reality is a new technology that involves the overlay of computer graphics on the real world. One of the best overviews of the technology is, that briefs about the field, its many problems and the developments made up to this point. The term Augmented Reality (AR) is used to describe a combination of technologies that enable real-time mixing of computer-generated content with live video display. It is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data.

B. How Does It Work?

Video games have been entertaining us for nearly 30 years, ever since Pong was introduced to arcades in the early 1970s. Since then, there has been more advancement in the field of Computer graphics and they have become much more advanced, game graphics have crossed the barriers of photorealism. Work is being going on to pull graphics out of your TV screens and other displays and merging them into the real world. This technology called augmented reality, blurs the line between what is real and what is computer generated by enhancing are senses and what we see, hear, smell etc. Augmented reality adds graphics, sounds, tactual feedback and smell to the natural world as it exists. Video games and cell phones are enhancing the development of augmented reality. Everyone from tourists, to soldiers, to someone looking for the closest subway stop can now benefit from the ability to place computer-generated graphics in their field of vision.

Figure 1: A tablet showing augmented reality

C. Mixed Reality

AR is within a more general context termed Mixed Reality (MR) [20], is a multi-axis spectrum of areas that cover Virtual Reality (VR), AR, telepresence, and some other related technologies. Mixed reality (MR), also referred to as hybrid reality, is the integration of real and virtual worlds to form new environments and graphics where real and virtual objects coincide and interact in real time. Mixed reality takes place not only in the physical world or the virtual world, but is an amalgam of reality and virtual reality, that incorporates Augmented Reality.

D. Virtual Reality

Virtual Reality can be defined, naturally, from the definitions for both ‘virtual’ and ‘reality’. The definition of ‘virtual’ is near and reality is something which see or perceive as human beings. So the term ‘virtual reality’ basically means ‘near-reality’.

Technically, Virtual reality refers to computer technologies that with the help of software generates the realistic images, sounds and other sensations that recreate or clone a real environment (or create a virtual image), and simulate a user's physical presence in this environment. VR is a realistic and immersive simulation of a 3D environment, produced by some interactive software and hardware, which are perceived and controlled by movements of the body. It allows the user to enter and interact with simulated environments. The users “immerse” themselves to certain extents in the synthetic computers world which may either be a simulation of some form of reality or the simulation of some phenomenon.

E. Telepresence

Telepresence is describe by a set of technologies that allow an individual to feel as if they are present when they are apparently not, to give the appearance of being present, or to have a virtually produced effect, with the help of telerobotics,

somewhere other than the actual location. So, basically telepresence can be defined as a system in which an individual receives sufficient information about the teleoperator and the environment where the task is to be done, displayed so naturally, that the individual feels physically present at the original site. In virtual reality, we aim to produce the illusion of presence within a computer simulation, telepresence aims to produce the illusion of presence at the true location.

AR can be described as a technology between VR and telepresence. While in VR the environment is completely simulated and in telepresence it is entirely real, in AR a person sees the real world augmented with virtual objects.

II. HOW TO "AUGMENTREALITY"

One of the first presentations of augmented reality appears in a special issue of Communications of the ACM, in July, 1993. It was a presentation of a collection of articles that briefed about merging electronic systems into the physical world instead of replacing them. This unique issue helped to initiate augmented reality research, illustrating a variety of approaches that use one or more of three basic strategies:

1. Augment the user: In his the user wears or carries a device, on the head or hands, to get information about real objects. In !968 Sutherland made the earliest head-mounted display, a display device which was wore on the forehead as a helmet. Its purpose was to place images of physical and virtual world on the user's field of view. HMDs often use sensors for six degrees of freedom monitoring which allow the system to adds virtual information to the physical world and tune accordingly with the user's head movements. Researchers have developed various devices for users to wear, see through them, hear and touch synthetically-created objects and get immersed in virtual environments.

2.Augment the real object: The physical object is changed by implanting input, output or computational devices on or inside it. Physical objects are implanted with electronic devices such as sensors or logic devices etc. that respond to some type of input from the physical environment. LEGO/Logo was a version of the logo computer programming language which could control robotic Lego bricks fixed to a computer. It allowed children to use Logo to control and build anything with LEGO bricks, motors and gears. Another approach is "ubiquitous computing", in which specially-created objects are detected by various sensors implanted in a building.

3. Augment the environment surrounding the user and the object: The user and the object is not affected directly. Rather, some devices provide and collect information from the environment, which displays information onto objects and captures information about the user's interactions with them. In Krueger's Video Place, a computer-controlled animated character moved around a wall-sized screen in response to a person's movements in front of the screen. Another early example was Bolt's "Put That There" [3], in which a person sits in a chair, points at objects that appear on a wall-sized screen and speaks commands that move computer-generated objects to specified locations. Elrod and his colleagues [5] use embedded sensors to monitor light, heat and power in the building, both to make the environment more comfortable for the occupants when they are there and to save energy when they are not.

III. AR COMPONENTS

To be familiar with the technology used in AR it is important to know about the basic components used in Augmented Reality. There are four basic components used in AR:

I. Scene Generator
II. Tracking and Orientation
III. Display

These three components combine together to produce an efficient AR device. Some devices like high speed multi-processors, cameras, accelerometers can also be used to enhance the reliability of the AR equipped device.

A. Scene Generator

The scene generator is the device or software used for rendering the scene. Rendering is not much of a problem in AR, because to draw a few virtual objects, they do not necessarily need to be realistically rendered in order to serve the purposes of the application.

B. Tracking and Orientation

Tracking and orientation is used to know the user's exact location with respect to his surroundings. It is also used for tracking the eye and head movements of the user, accurately. This is the most complex part of AR technology as it has three major aspects such as user's location tracking, movement of the user's head and eye and adjusting the graphics to be displayed are done with maximum precaution. There has never been a system that has produced AR without a small delay between the real world and the virtual world till now. It is is one of the most important problems of AR systems which happens because of the registration problem. To produce augment reality it is necessary for the objects in the real and virtual worlds to be properly aligned with respect to each other, otherwise the illusion that the two worlds coincide will be compromised. For the industry, many applications demand accurate registration, especially on medical systems

C. Display

For AR there are these partially transparent displays that mix digital images with the real world. Light rays need to hit on something to be reflected to our eyes. In the real world, we are already getting redirected rays whereas in the digital world, we need to create artificial light (e.g. from LEDs, OLEDs) and then redirect them. The optical device that conflates this generated computer image with the real world is called a

"combiner." A combiner works like a partial mirror that redirects the display light and selectively let's light in through from the real world. Three types of displays are used in AR technology.

a) Head Mounted Displays [HMD]

This device depicts both the images of the physical world and the virtual world over the user's view. HMDs can be an optically transparent or video transparent device. In an optically transparent display device, partial silver mirrors are used to deliver the views of the real world through a lens and the virtual images are reflected into the user's eyes. Some products that use such displays are Sony Glasstron, Microvision NOMAD etc.

Figure 2: A head mounted display

b) Handheld Displays

These displays are small in size and will need just a hand to fit in. These devices make use of video transparent techniques which relate the virtual world to the real world. 6-degrees of freedom sensors are used along with devices like GPS trackers, and digital compasses. They are portable and due to the number of users who use camera phones, they are used widely.

3.3.3 Spatial Displays / Spatial Augmented Reality [SAR]

This is very different from the other two techniques mentioned above. In this, there is no need to carry the display, rather, the virtual image is related to physical objects by using a digital projector. The only problem is that the user has no contact with the display. Since a projector system is used, these displays have better and a bigger resolution than others. The resolution can be increased by using more projectors which expands the area.

IV. How Augmented Reality is controlled

Augmented reality devices are often controlled either by touching a pad or voice commands. The touch pads are often situated on the device that is easily accessible. They work by sensing the pressure changes that are caused when a user touch or swipes at any place on the pad. Voice commands work just as the way they do on our smartphones. A small microphone on the device will recognize your voice as an input and then a microprocessor will interpret the commands. On the Google Glass augmented reality device, voice commands are preprogrammed from a list of usable commands. On the Google Glass, almost all of them start with "OK, Glass," which alerts your glasses that a command is next to follow. For example, "OK, Glass, take a picture" sends a command to the microprocessor to take a photo of whatever you're looking at.

Figure 3: A view through google glasses

V. Applications

The Augmented Reality technology has many possible applications in a wide range of fields, including entertainment, education, medicine, engineering and manufacturing.

A. Medical

Imaging technology is very prevalent throughout the medical field, it is not surprising that this field is viewed as one of the more important for augmented reality systems. Most of the medical applications consider image guided surgery. Pre-operative imaging studies, such as CT (Computed Tomography) or MRI (Magnetic Resonance Imaging) scans, provide the surgeon with the view of the patients internal anatomy. The surgery is planned from these images.

Image of the path through the anatomy of the affected area is done by first creating a 3D model from various views and slices in the pre-operative study. This model is then recreated over the target surface to help the surgical procedure.

B. Entertainment

Augmented reality has been in use in the entertainment and news business for quite a while now. When you see a weather report, you see the speaker standing in front of changing weather maps. While in the studio the reporter is actually standing in front of a blue screen. This real image which you see on screen is augmented with the help of computer generated maps using a technique called chroma keying. AR is also being applied on game development. Advancement in games can be made to such an extent that the user will feel like he's the character in the game.

C. Security, Defence and Training

AR technology helps in giving the soldiers in the field important information about their surroundings and the movement of their enemies. Police officers use this technology to get a complete and inmost view of a crime scene or robbery.

The military uses displays in cockpits that give vital information to the pilot on the windshield of the cockpit or the visor of the flight helmet. This is a form of augmented reality display.

D. Engineering Design

Let's say that a group of architects are working on a model of a complex project for their client. The architects and client want to do a joint design review even though they are physically away from each other. If both parties had a conference room that had an augmented reality display this could be accomplished.

The prototype that the architects have built up is imaged and displayed in the client's conference room in 3D. The client can walk around the display looking at different aspects from different angles of it. The client can point at the prototype to highlight areas which is going to be reflected on the real model in the augmented display in front of the designers.

CONCLUSION and future work

Despite of the many recent advances in AR, there is lot more to be done in this field. Application developments can be made by using available libraries. One of the libraries is AR Toolkit, that gives computer vision techniques to calculate a camera's position relative to marked cards so that virtual 3D objects can be surfaced precisely on the markers.

Here are some fields that require further research if we want AR to become commonly deployable.

I. Ubiquitous tracking and system portability: The ultimate goal is to have a tracking system that supports accurate registration in any arbitrary unprepared environment. To Allow AR systems to go anywhere we need portable and wearable systems that are comfortable and unobtrusive.

II. Ease of setup and use: If we want AR applications to become commonplace, then the systems must be deployable and operable by non-experts. This needs robust systems that avoid or decrease calibration and setup requirements.

III.Photorealistic and advanced rendering: Our goal is to ultimately render the virtual objects to be indistinguishable from the physically real ones. This should be done in real time, without the manual intervention of programmers. New techniques in image based rendering should be considered in order to achieve this task.

AR in all senses: Researchers are focusing primarily on augmenting the visual sense. Eventually, compelling AR environments may need engaging other senses as well (touch, hearing, etc.).

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