Reality and Perception: Utilization of Many Facets of Augmented Reality

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ABSTRACT

What we perceive with our senses becomes the basic real time information that directs and helps with the tasks we do. Our perception may represent the real world environment or what is perceived is a view of the real world modified with simulated elements of the environment. Augmented reality (AR) represents a system where a view of a live real physical environment is supplemented by computer-generated elements such as sound, video, graphic or location data.

Development of AR systems has been facilitated by the advancement in both hardware and software technologies, making it easier to implement all functionalities in real time. Such real time enhancements have been helped by new techniques in such areas as computer vision, object recognition, and registration methodologies which enable user to interact with and manipulate the real world environment effectively.

AR advanced computer graphics is integrated to real world data and viewed by the user using see-through head mounted display (HMD). This immersion of the integrated real and simulated world provides a unique perception to users. What he sees, feels, hears, and smells is indistinguishable between what is real and what is computer-generated.

Technology has propelled AR systems from experimental laboratories to the marketplace demonstrating great promise in the fields of arts, architecture, archaeology, commerce, construction, education, entertainment, gaming, system maintenance, medical and military applications.

Keywords: Virtual reality, Augmented reality, Simulated reality, Displays.

Index Terms: Perception; Spectacles; Glass; Synthetic Environment; Immersion.

1 INTRODUCTION

In the later part of the last century, it was the system simulation that provided the system designers the feel of the proof of concept (POC) to prototyping, product design and system operation. Mathematical relation between input and output of a component, module or subsystem was translated into implementable electrical signals to evaluate the system behavior. Due to limitations on the speed of operation as well as restrictions on the available memory, many simulations utilized hybrid computation methodology. This technique used modeling of static components with digital means while the dynamic environment was provided by the analog simulation. These two simulated components were integrated and merged together to provide a working dynamic simulation of the system [1]. In this methodology, however, all system inputs were introduced via keyboard and all outputs used external means to display or record.

Visual perception [2] plays a key role in the believability of an event or a process. Any activity observed visually establishes psychological reality in human mind. Thus came the concept of virtual reality (VR), initially a term used by Jaron Manier in 1986 [3]. This type of simulation convinces the user that they are within the computer-generated environment - an environment of complete 3-D graphics which is recalculated and redisplayed regularly to maintain persistence of vision. VR technique provides high degree of immersion and interaction that makes the experience of the user believable.

The experience of believable perception is achieved by this technology using the visual channel in HMD, auditory in audio devices, haptic in data gloves and tracking devices. The virtual environment desired is flexible and programmable and the experience has the additional advantages of immersion, interactivity and information intensity.

2 TECHNOLOGY DEVELOPMENT AND CONSTRAINTS

Initial development of virtual reality systems was constrained by several issues that plagued other similar technology products. Speed of operation, need for large memory, microminiaturization, high data rates requiring large bandwidth, visual data conversion and transmission include some of these constraints. Registration for the alignment of superimposed simulated elements on the real-objects and the requirement of user motion also impaired technology development.

Development and utilization of new components that supported the enhancement of this technology include items as GPS for location, accelerometer (attitude), nanotech components (microminiaturization for user friendly adaptation), RFID technology for sensed data monitoring and new power resources (solar, motion, etc).

Augmented Reality (AR) is a variation of VR or Virtual Environment (VE), where the user views the real world with superimposed virtual objects, supplementing reality rather than replacing it. AR provides an environment where both real and virtual objects coexist in the same space.

There is also a concept of Spatial Augmented Reality (SAR) which augments information without monitors, head-mounted displays or hand held display by using digital projectors to display graphical information onto physical objects.

Many consider AR a middle ground between VR (VE) which is completely synthetic (simulated) and tele-presence, which is completely real. while some researchers associate AR with head-mounded display (HMD). In essence, the technology has three key characteristics - 1) it combines the real and virtual information, 2) it is interactive in real time, and 3) the displays are registered in 3D.

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3 Augmented Reality Components

Current smart phones and tablet architectures include processors, displays, sensors and input devices. They also consist of camera and MEMS sensors (*i.e.* GPS, accelerometer, solid state compass). Display technology specifically utilizes an optical projection system, monitors, hand held devices, and self-worn display system. A head mounted display (HMD) is an integrated part of VR/AR in various products.

HMD places both real and virtual objects in the field of view of the user. Monitoring by sensors provides DOF and allows the system to align virtual information to the physical world through the adjustment of information according to head movements. Among the input devices is the speech recognition system which translates voice commands into computer instructions. Gesture recognition devices interpret body movement by visual detection (or from sensor embedded in a peripheral device- wand, stylus, pointer, glove or body wear). The software includes image processing devices (computer vision algorithm), real world coordinate system, and registration algorithm for fixing/tracking.

3.1 AR/VR Applications and Trends

The combination of real and virtual (computer-generated) objects in 3D and users' perception of their interaction in the real world opens many new venues for the utilization of this technology. "Intelligence amplification" or the use of these virtual objects to help perform real world tasks represents one example. Additionally, real world task applications offer new venues for innovative design.

While new applications are being explored, current applications include the areas of disaster mitigation/rescue, medical surgery training and support, complex system repair/ system maintenance, object annotation, robot path planning, entertainment and applications in defense industry (drones). With the provision of portability expected in new AR devices, system developers are investigating newer and innovative applications for the technology.

4 AR/VR Products, New and in Development

4.1 Space Glass

In this design, "the users sculpt objects such as vase digitally, take the rendering to a 3D printer, then physically place the end product on the mantle in their home". Two players can play a chess game on a table- provides a look as a piece of furniture. [aka Steve Mann's Digital Eye Glass or Eye Tap][4] [5]. Eye Tap (aka generation -2 glass) captures ray of light passing to the center of eye and substitutes each ray with synthetic computer controlled light. Its infinite depth of focus causes the eye itself to function as both a camera and a display by way of exact alignment with the eye and re-synthesis of rays of light entering the eye.

4.2 Google Glass or Project Glass

It is a wearable computer with optical HMD which displays information in a smart phone (like hands-free format) that can communicate with the internet via natural language voice command[7][8]. It is claimed to be soon integrated into man's normal eye wear. It translates voice, answers without having to ask, is light and strong, records what user sees, acts on command to send message. Google glass was not meant originally for AR experience. Developers recommend using CrowdOptics technology by Google glass users for such application. CrowdOptics [Smartphone App] uses algorithm and triangulation technique to photo metadata (GPS position, compass heading and time stamp) to arrive at a photo object. In principle, eye glass has eye wear cameras that intercept real world view and re-display its augmented view through eye piece and the devices used by AR.

Usage of Google glass has been documented with a real time surgery broadcast..

4.3 Avegants Virtual Retinal Display (VRD)

VRD[6] technology uses the user's retina and has the following characteristics: It projects two discrete images directly onto the retina (closely compared to Oculus Rift), sees display floating in space, has a full field wearable display- presenting a 3D image to the wearer, it requires precise alignment and optical focusing (frame adjustable, optics adjustable individually). It acts as head tracking VR device during game play but developers claim it's use for TV shows and browsing the web and are looking for use as mobile video entertainment, watching movies on planes.

4.4 Bionic Contact Lens

While it is in the development stage, it may prove to be one of the high tech AR product utilizing RF, RFID, Nano and display technologies. This bionic contact lens will be designed with embedded integrated circuitry, LEDs, and an antenna. It will be used with AR spectacle and provide focus for both close objects as well as distant real world at the same time. Applications are being investigated for military usage in the field.

5 Conclusion

New developments in AR technology show great promise in diversified applications in research, academics, and industry towards common service to humanity. With the mobility factor and enhanced perception, this technology has the potential to revolutionize our world and application of technology in our daily lives.

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