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The Efficiency Enhancement in Non Immersive Virtual Reality System by Haptic Devices

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Abstract: Current immersive Virtual Reality (VR) system strategies do not fully support dynamic Human Computer Interaction (HCI) and since there is a growing need for better immersion. While feedback in Virtual Environments (VE) is predominantly provided to the user through the visual and auditory channels, additional modalities such as haptics can increase the sense of presence and efficiency in VE simulations. Haptic interfaces can enhance the VE interaction by enabling users to "touch" and "feel" virtual objects that are simulated in the environment. This paper illustrates how the haptic devices enhance the performance of non immersive virtual reality system.

Keywords: virtual reality,haptic devices ,immersive ,non immersive vr system,vr interfaces.

I. INTRODUCTION

Virtual reality is a technology which allows a user to interact with a computer-simulated environment, whether that environment is a simulation of the real world or an imaginary world. It is an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment. On a computer, virtual reality is primarily experienced through two senses they are sight and sound. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Virtual reality can be divided into, the simulation of a real environment for training and education and the development of an imagined environment for a game or interactive story.

II. VIRTUAL REALITY ENVIRONMENT:

Other sensory output from the VE system should adjust in real time as a user explores the environment. Sensory stimulation must be consistent if a user is to feel immersed within a VE. An immersive experience suffers if a user becomes aware of the real world around him. Truly immersive experiences make the user forget his real surroundings, effectively causing the computer to become a non entity. In order to reach the goal of true immersion, developers have to come up with input methods that are more natural for users. As long as a user is aware of the interaction device, he is not truly immersed.

TYPES OF VIRTUAL REALITY

Immersive virtual reality

Non immersive virtual reality

Semi immersive virtual reality

IMMERSIVE VIRTUAL REALITY:

In a virtual reality environment, a user experiences immersion, or the feeling of being inside and a part of that world. He is also able to interact with his environment in meaningful ways. The combination of a sense ofimmersion and interactivity is called telepresence. Computer scientist Jonathan Steuer defined it as "the extent to which one feels present in the mediated environment, rather than in the immediate physical environment." In other words, an effective VR experience causes you to become unaware of your real surroundings and focus on your existence inside the virtual environment

Two main components of immersion:

Depth of information

Breadth of information.

Depth of information refers to the amount and quality of data in the signals a user receives when interacting in a virtual environment. For the user, this could refer to a display's resolution, the complexity of the environment's graphics, and the sophistication of the system's audio output. Breadth of Information as the "number of sensory dimensions simultaneously presented." A virtual environment experience has a wide breadth of information if it stimulates all your senses. Most virtual environment experiences prioritize visual and audio components over other sensory-stimulating factors, but a growing number of scientists and engineers are looking into ways to incorporate a users' sense of touch. Systems that give a user force feedback and touch interaction are called haptic systems.

NON IMMERSIVE VIRTUAL REALITY:

Fig 1. VR in desktop monitor

Non-immersive systems are the least immersive implementation of VR techniques. Using the desktop system, the virtual environment is viewed through a portal or window by utilizing a standard high resolution monitor. Interaction with the virtual environment can occur by keyboards, mice and trackballs or may be enhanced by using 3D interaction devices.

SEMI-IMMERSIVE VIRTUAL REALITY:

A large screen monitor
A large screen projector system
Multiple television projection systems

similar to the IMAX theatres sing a wide field of view, these systems increase the feeling of immersion or presence experienced by the user Semi-immersive systems therefore provide a greater sense of presence than non-immersive systems and also a greater appreciation of scale. In addition, images can be provided that are of a far greater resolution than HMDs and this implementation provides the ability to share the virtual experience. This may have a considerable benefit in educational applications as it allows simultaneous experience of the VE which is not available with head-mounted immersive systems.

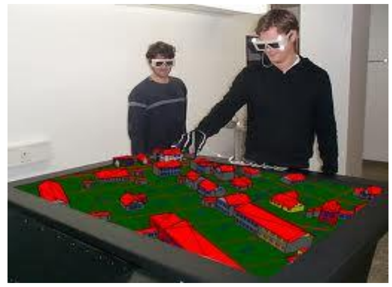

Fig 2. Semi immersive VR in city model

VIRTUAL REALITY INTERACTIVITY:

Immersion within a virtual environment is one thing, but for a user to feel truly involved there must also be an element of **i**nteraction. Early applications using the technology common in VE systems today allowed the user to have a relatively passive experience. Users could watch a pre-recorded film while wearing a head-mounted display . They would sit in a motion chair and watch the film as the system subjected them to various stimuli, such as blowing air on them to simulate wind. While users felt a sense of immersion, interactivity was limited to shifting their point of view by looking around. Their path was pre-determined and unalterable.

Interactivity depends on many factors**.** they are speed, range and mapping. Speed as the rate that a user's actions are incorporated into the computer model and reflected in a way the user can identify by means of senses. Range refers to how many possible outcomes could result from any particular user action. Mapping is the system's ability to produce natural results in response to a user's actions. Navigation within a virtual environment is one kind of interactivity. If a user can direct his own movement within the environment, it can be called an interactive experience. Most virtual environments include other forms of interaction, since users can easily become bored after just a few minutes of exploration. The poorly designed interaction can drastically reduce the sense of immersion, while finding ways to engage users can increase it. When a virtual environment is interesting and engaging, users are more willing to suspend disbelief and become immersed. True interactivity also includes being able to modify the environment. A good virtual environment will respond to the user's actions in a way that makes sense, even if it only makes sense within the realm of the virtual environment. If a virtual environment changes in outlandish and unpredictable ways, it risks disrupting the user's sense of telepresence.

III. VIRTUAL REALITY INTERFACES:

DATAGLOVES:

Data gloves offer a simple means of gesturing commands to the computer. Rather than punching in commands on a keyboard, which can be tricky if you're wearing a head-mounted display or are operating the BOOM, you program the computer to change modes in response to the gestures you make with the data gloves.

Fig 3. Data glove

Pointing upwards may mean zoom in; pointing down, zoom out. A shake of your fist may signal the computer to end the program. Some people program the computer to mimic their hand movements in the simulation; for instance, to see their hands while conducting a virtual symphony.

WANDS:

Wands, the simplest of the interface devices, come in all shapes and variations. Most incorporate on-off buttons to control variables in a simulation or in the display of data. Others have knobs, dials, or joy sticks. Their design and manner of response a re tailored to the application.

Fig 4. Wand

Most wands operate with six degrees of freedom; that is, by pointing a wand at an object, you can change its position and orientation in any of six directions: forward or backward, up or down, or left or right.

STAIR STEPPERS:

Stair steppers are an example of the limitless manifestations of interface devices. As part of a simulated battlefield terrain, engineers from an army research lab outfitted a stair stepper with sensing devices to detect the speed, direction, and intensity of a soldier's movements in response to the battlefield scenes projected onto a head-mounted display. The stair stepper provided feedback to the soldier by making the stairs easier or more difficult to climb.

Fig 5. Stair stepper

VIRTUAL REALITY SYSTEMS

HEAD-MOUNTED DISPLAY

Looking like oversized motorcycle helmets, head-mounted displays are actually portable viewing screens that add depth to otherwise flat images. If you look inside the helmet you will see two lenses through which you look at a viewing screen. As a simulation begins, the computer projects two slightly different images on the screen: one presenting the object as it would be seen through your right eye, the other, through your left. These two stereo images are then fused by your brain into one 3D image. To track your movements, a device on top of the helmet signals your head movements relative to a stationary tracking device. As you move your head forwards, backwards, or sideways, or look in a different direction, a computer continually updates the simulation to reflect your new perspective.

Fig 6. Head mounted Display

Because head-mounted displays block out the surrounding environment, they are favored by VR operators who want the wearers to feel absorbed in the virtual environment, such as in flight simulators. And as you might expect, these displays also are popular with the entertainment industry. Data gloves and wands are the most common interface devices used with head-mounted displays.

BOOM

The Binocular Omni Orientation Monitor, or BOOM, is similar to a head-mount except that there's no fussing with a helmet. The BOOM's viewing box is suspended from a two-part, rotating arm. Simply place your forehead against the BOOM's two eyeglasses and you're in the virtual world. To change

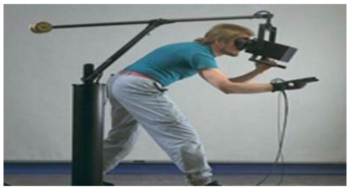

Fig 7. Boom

your perspective on an image, grab the handles on the side of the viewing box and move around the image in the same way you would if it were real: Bend down to look at it from below; walk around it to see it from behind. Control buttons on the BOOM handles usually serve as the interface although you can hook up data gloves or other interface devices.

CAVE: One of the most "immersive" virtual environments is the CAVE**.** It provides the illusion of immersion by projecting stereo images on the walls and floor of a room-sized cube.

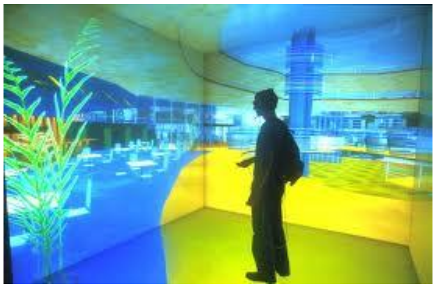

Fig 8. Cave

Several persons wearing lightweight stereo glasses can enter and walk freely inside the CAVE. A variety of input devices like data gloves, joysticks, and hand-held wands allow the user to navigate through a virtual environment and to interact with virtual objects. Directional sound, tactile and force feedback devices, voice recognition and other technologies are being employed to enrich the immersive experience and to create more "corporeal " interfaces. Three networked users at different locations meet in the same virtual world by using a BOOM device, a CAVE system, and a Head-Mounted Display, respectively. All users see the same virtual environment from their respective points of view. Each user is presented as a virtual human to the other participants. The users can see each other, communicated with each other, and interact with the virtual world as a team. The level of immersion is measured given below in the chart.

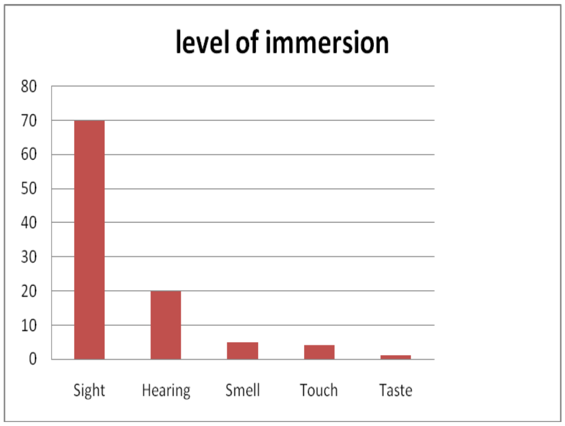

Chart 1. Various sense of immersion

VIRTUAL REALITY TRACKING SYSTEMS

Tracking devices are intrinsic components in any VR system. These devices communicate with the system's processing unit, telling it the orientation of a user's point of view. In systems that allow a user to move around within a physical space, trackers detect the user is, the direction of moving and speed. There are several different kinds of tracking systems used in VR systems, They can detect six degrees of freedom , these are the object's position within the x, y and z coordinates of a space and the object's orientation. Orientation includes an object's yaw, pitch and roll. From a user's perspective, this means that when you wear an HMD, the view shifts as you look up, down, left and right. It also changes if you tilt your head at an angle or move your head forward or backward without changing the angle of your gaze. The trackers on the HMD tell the CPU where you are looking, and the CPU sends the right images to your HMD's screens

Every tracking system has a device that generates a signal, a sensor that detects the signal and a control unit that processes the signal and sends information to the CPU. Some systems require you to attach the sensor component to the user (or the user's equipment). In that kind of system, you place the signal emitters at fixed points in the environment. Some systems are the other way around, with the user wearing the emitters while surrounded by sensors attached to the environment. The signals sent from emitters to sensors can take many forms, including electromagnetic signals, acoustic signals, optical signals and mechanical signals. Each technology has its own set of advantages and disadvantages.

IV. APPLICATIONS VIRTUAL REALITY

As the technologies of virtual reality evolve, the applications of VR become literally unlimited. It is definitly VR will reshape the interface between people and information technology by offering new ways for the communication of information, the visualization. Virtual reality has potential in architectural design. With virtual reality, designers can interactively test a building before construction begins. The military have long been supporters of VR technology and development. Training programs can include everything from vehicle simulations to squad combat. VR systems are much safer and, in the long run, less expensive than alternative training methods. Soldiers who have gone through extensive VR training have proven to be as effective as those who trained under traditional conditions. Virtual reality environments have also been used for training simulators.

Flight simulators is a good example of a VE system that is effective within strict limits. In a good flight simulator, a user can take the same flight path under a wide range of conditions. Users can feel what it's like to fly through storms, calm winds. Realistic flight simulators are effective and safe training tools, and though a sophisticated simulator can cost tens of thousands of dollars, they're cheaper than an actual aircraft. The limitation of flight simulators from a VR perspective is that they are designed for one particular task. You can't step out of a flight simulator and remain within the virtual environment, nor can you do anything other than pilot an aircraft while inside one. Virtual reality can be described as a cutting-edge technology that allows students to step through the computer or television screen into a three dimensional, computer-simulated world to learn.

V. CONCLUSION

Most of today's VR applications do not conform to reality and have poor quality, but are still very useful but must be improved a lot to allow more comfortable and intuitive . The big challenges in the field of virtual reality are developing better tracking systems, finding more natural ways to allow users to interact within a virtual environment and decreasing the time it takes to build virtual spaces. The major interest was paid to visual feedback and visual display technologies resolution is Significantly below eye's resolving capability, luminance and color ranges do not cover the whole eye's perception range and finally the field of View is relatively narrow. All these disadvantages make virtual worlds appear "artificial" and unreal, which severely contributes to the simulator sickness. Without well-designed hardware, a user could have trouble with his sense of balance or inertia with a decrease in the sense of telepresence, or he could experience cyber sickness, with symptoms that can include disorientation and nausea.

Not all users seem to be at risk for cyber sickness , some people can explore a virtual environment for hours with no ill effects, while others may feel queasy after just a few minutes Some psychologists are concerned that immersion in virtual environments could psychologically affect a user. Technology has transformed the world in which we live, changing how we spend our time, how we understand ourselves, and how we interact with others. Technological innovation results in social and economic change. Thus, VR will lead to the development of a Virtual World. And it is the Virtual World that promises to restructure human life and activity.

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