An Integrated Approach to the Study of Virtual Environments

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Abstract: Virtual Environment is aimed at providing nonprogrammers with an easy-to-use 3D “What-You-See-Is-What-You-Get” environment. It allows users to view and interact with objects displayed on a workspace similar to a tabletop workspace used in day-to-day life. The major challenge in these interfaces is to adopt 2D devices such as mouse and keyboard to perform 3D tasks, e.g. navigation. In this paper we discuss about an integrated approach to the study of various virtual Environments. These analytical studies provide distinct advantages in terms of ease of use and efficiency because they consider the tasks of Virtual Environments separately and investigated the performance of three virtual environments: immersive, non immersive and Desktop VE.

Keywords: virtual Environments, Immersive VE, Desktop VE, Virtual reality.

1. INTRODUCTION

Visualization is the ability to present complex data as multidimensional images and combined with direct control over that data in VR. In a VR environment the data is presented truly in 3D and users can interact with the data directly in the 3D space. The advance of computer graphics knowledge and technology, itself tied to the enormous increase in processing power and decrease in cost, together with the development of relatively efficient and unobtrusive sensing devices, has led to the emergence of participatory immersive virtual environments(VE), commonly referred to as "virtual reality"[3]. The concept of virtual Reality is a three-dimensional, computer-generated environment that allows for single or multiple users to interact navigate, respond, and experience a synthesized world modeled from the real world. Virtual environment is a high-end user-computer interface that involves real time simulation and interaction through multiple sensorial channels. It incorporates the interaction within a VE or virtual world by the help of various peripheral devices in order to achieve a multi-sensory and multi-modal experience. Although virtual reality has been popularized as a new form of entertainment, it has applications in business, industry, and medicine. Virtual reality also has practical applications in business, manufacturing, and medicine.

2. VIRTUAL ENVIRONMENT

Virtual Environment is a computer-generated, interactive, three-dimensional environment in which a person is immersed. The ability to navigate through a world seen only on your computer screen, or through a special headset or visor, opens the door for an incredible variety of experiences. It adds the ability to navigate through a virtual environment or the capability of picking up objects, or otherwise interacting with objects found in the virtual environment, and the basis for the enthusiasm for the technology becomes readily apparent. VEs provide an environment where 3D visualization objects can be viewed in their native three dimensions that give the users an opportunity to gain a more complete understanding of these complex objects. In addition, the ability to manipulate the data in an intuitive manner, move through the virtual world, and move around these complex objects allows users to focus their attention on the data and away from the interface. They are primarily visual experiences, displayed either on a computer screen or through special or stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers. Users can interact with a virtual environment either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove or the HMD. The simulated environment can be similar to the real world, for example, simulations for pilot or combat training.

*Figure 1: Virtual Environment*

Virtual environments are also used to reduce phobias, to develop skills, and to train those with disabilities. “Virtual environments as interactive, virtual image displays enhanced by special processing and by non visual display modalities, such as auditory and haptic, to convince users that they are immersed in a synthetic space”. Virtual environments provide an effective way to optimize performance when people interact with virtual environments. Figure 1 illustrate the working Virtual Environment. VE can be classified into Desktop VE, Non immersive VE and Immersive VE.

2.1 Desktop VE
Desk-top virtual reality is a computer programs that will support a user-friendly interface for complex data processing and simulation procedures, including image processing and real time 3D visualization. Although they lack the immersion quality, they consist of computer-generated environments which exist in 3 dimensions. Desktop VR is used to see a stereoscopic 3D view, on a regular monitor, through the use of special software. Because the worlds exist in 3 dimensions, users can freely navigate in 3 dimensions around in the worlds. Ex: Flight simulators where participants “fly” though models of real or fantasy worlds, watching the world on a 2-D screen. 2D interaction can also be regarded as a normal desktop system enhanced with 3D functionality. This implies that we can still use the common 2D desktop input devices as the keyboard and mouse [7]. In desktop virtual environments (VEs), there are still limitations on the number of objects that can be programmed to be interactive, usually due to restrictions on programming time and cost.

![Figure 2: Desktop Virtual Environment](image)

This form of VR completely lacks any feelings of immersion on the part of the user. The desktop VR approach does not allow the user to control and navigate within the virtual environment. It does not allow multi-user cooperation and communication.

Advantages of Using Desktop VE
- Virtualization is very cheap.
- Mobility and interaction simplicity.
- Realistic, flexible and interactive
- Hardware performance is huge.
- Easily controlled by the user.
- Reliability is very good.
- Reduce risk of exposing sensitive data.
- Provides stable and high resolution stereoscopic viewing to all participants.

The users manipulate what is perceived to be “real” objects in the same manner as they would manipulate them when you interact in other computer environments [9].

2.2 NON-IMMERSIVE VE

Non Immersive VE calls ‘artificial reality,’ requires no personal hardware. Rather, the person enters an People participating at once, it can combine quite ‘real’ objects - tree, whatever - with ‘unreal’ ones, such as animatronics figures, holograms, disguised objects, optical illusions, etc.

![Figure 3: Non Immersive Virtual Environment](image)

Advantages of Using Non-Immersive VE
- Do not require the highest level of graphics performance.
- No special hardware and software.
- It is cost-effective
- Easy to develop.
- System can be regarded as lower cost VR solution which can be used for many applications.
- It can be a communal experience, with many people participating at once

Non-immersive systems are a relatively new implementation of VR technology and borrow considerably from technologies developed in the flight simulation field. Using a wide field of view, these systems increase the feeling of immersion or presence experienced.
by the user. However, the quality of the projected image is an important consideration. It is important to calibrate the geometry of the projected image to the shape of the screen to prevent distortions and the resolution will determine the quality of textures, colors, the ability to define shapes and the ability of the user to read text on-screen which are more expensive.

2.3 Immersive Virtual Environment

Immersion originally depends on visual aspects implemented by 3D Computer Graphics, as users need to feel that they are located in a similar to real world. So far users could see, hear and manipulate objects through VR. Then the technology develops, users will be able to smell, taste, touch and feel object through VR in the near future. Immersion may lead to a sense of presence. This is refers to the participant's sense of "being there" in the world created by the VE system. Immersion describes a kind of technology, and presence describes an associated state of consciousness. People must carry out everyday activities in an unnatural or artificial way, for example, moving through the world by pointing. There is no sense of peripheral vision, limiting the user's ability to know what is happening around them.[5]. A VE is described as immersive when the computer-generated environment appears to enclose the user, and when the parts of the physical world are blocked from view. The user has no visual contact with the physical world. An immersive digital environment is an artificial, interactive, computer created scene or "world" within which a user can immerse themselves.

Immersive digital environments could be thought of as synonymous with Virtual reality, but without the implication that actual "reality" is being simulated. An immersive digital environment could be a model of reality, but it could also be a complete fantasy user interface or abstraction, as long as the user of the environment is immersed within it [10]. The definition of immersion is wide and variable, but here it is assumed to mean simply that the user feels like they are part of the simulated "universe". The success with which an immersive digital environment can actually immerse the user is dependent on many factors such as believable 3D computer graphics, surrounding sound, interactive user-input and other factors such as simplicity, functionality and potential for enjoyment. The feeling of "being there" that is experienced in some VEs. A VE user is immersed when he feels that the virtual world surrounds him and has to some degree replaced the physical world as the frame of reference. Immersion may take place in other media, such as films or even books. Immersive VR with HMD allows users to focus on display without distraction. The sense of inclusion within a virtual world which this technology creates a powerful personal impact.

The fully immersive VR initiated by HMD technology has today reached a very high degree of sophistication. Immersive VE can currently offer a convincing illusion of participation in a full-scale virtual world.[11] Immersive technologies can now include 3D head-gear with stereoscopic vision for look around and walk through, auditory input, voice activation, data gloves and other tactile or haptic tools for manipulation and control of virtual objects, and even body suits wired with biosensors for advanced sensory input and feedback. A man interacts with an immersive Environment as shown in Fig 4.

![Figure 4: Immersive Environment](image-url)

Advantages of Using Immersive Environment

- The user is provided with a 3600 which means that the user will receive the usual image if they can turn their head to look at any direction.
- Provides sense of immersion (being there).
- Provides the users with a richer and deeper experience [12].
- Play a crucial role in the determination of presence.
- Specialized 3D Audio used in immersive is advantage because the system can allow the user to localize sound. That is "home in “on it by turning the head, as one does in the real world.
- It will dominate in entertainment and in applications where the users need to wear special equipment (space application and medical applications).

<table>
<thead>
<tr>
<th>Feature</th>
<th>Desktop VE</th>
<th>Non-Immersive VE</th>
<th>Immersive VE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of evaluation</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Information Sharing</td>
<td>public</td>
<td>communal</td>
<td>solipsistic and private</td>
</tr>
<tr>
<td>Environment Type</td>
<td>Static (3D to 2D)</td>
<td>Static (2D)</td>
<td>Dynamic (3D)</td>
</tr>
<tr>
<td>Positioning Error rate</td>
<td>medium</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Interactive skills</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
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<tr>
<td>Lag</td>
<td>Low</td>
<td>Low</td>
<td>Medium to High</td>
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<tr>
<td>Performance</td>
<td>High</td>
<td>High</td>
<td>Low to Medium</td>
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Table 1 shows the characteristics in terms of use and efficiency because they consider the tasks of Virtual Environments separately and investigated the performance of three virtual environments: immersive, non immersive and Desktop VE. When we analyse these three virtual environments in the view of the sense of situational awareness or navigation skills, desktop VE was 13% non immersive VE taking 34% and Immersive VE got 53% (shown in Figure 5).

![Figure 5: A chart for measuring the sense of situational awareness which contrast on each Virtual Environment](image)

Results of comparisons show the performance differences with subjects under the non immersive virtual environment showing a consistent decrease in error rates across the task trials, while subjects under the immersive virtual environment had higher altitude error rates.

![Figure 6: A graph for evaluating the average error rates on each Virtual Environment](image)

Figure 6 shows the mean results for all virtual Environments. It is clear from this graph that immersive virtual Environment was significantly faster than raycasting with low error rate.

3. CONCLUSIONS

Although this has not been an exhaustive depiction of all possible comparisons, it provides a good exposure to many of the more common techniques currently in use. Therefore, it is important that we understand their strengths and weaknesses. In this paper, we have analysis all virtual environments and shown their characteristics and limitations through a user study. This study showed that it is important to consider VE as separate issues. The Immersive Virtual Environment takes the best aspects of the comparative study and combines them in a seamless way to maximize ease of use and efficiency. We plan to continue this analytical study by performing a more formal experiment using the best of these techniques on several specific tasks. It will also be important to determine in a quantitative and qualitative way the differences between these Virtual Environments which have sets of usability Characteristics. Therefore, it is important to examine the comparative study that are available and determine those that are best suited for the tasks that need to be accomplished.

REFERENCES