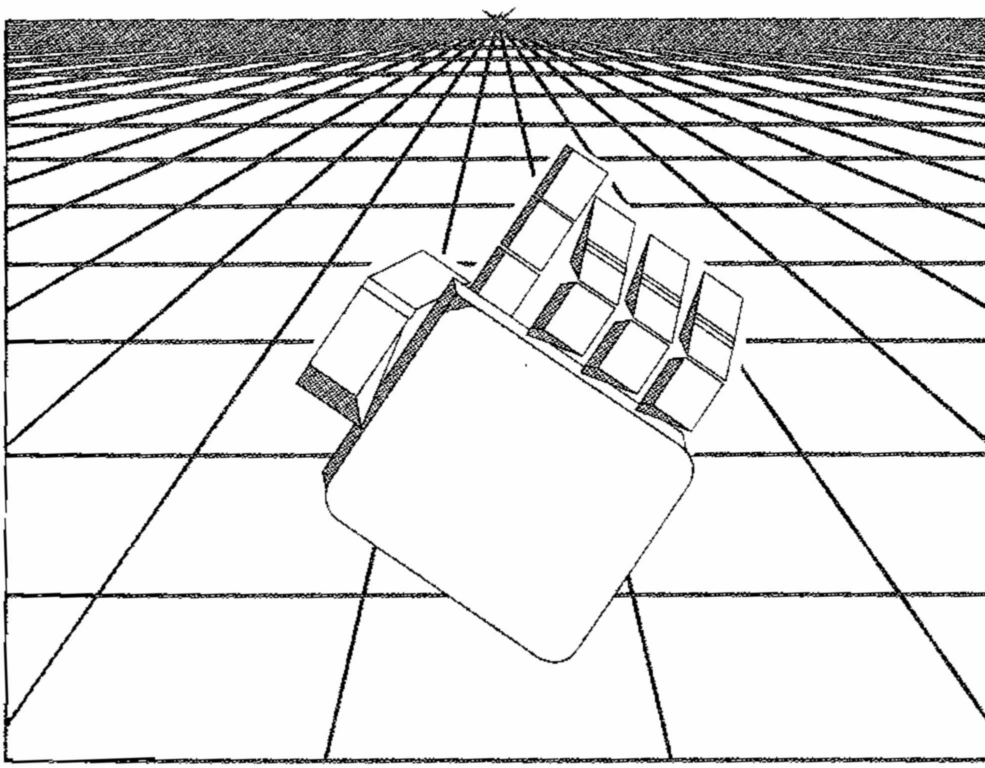
Virtual Reality



Research Report
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Merrill Lynch

VI. Limitations and Drawbacks of VR Technology

Research and development in virtual reality is proceeding in universities and at individual vendor sites. However, the technology is still in the early stages. Indeed, if it is to be assimilated into the business marketplace, it must become part of the standard suite of desktop computer mainstream technologies now available to the "average" user, and be thought of as just another human-computer interface. Just a few years ago, 20 inch color monitors delivering 16 million colors were considered futuristic technology; users did not dream that such technology would be available to them. When users begin to order virtual reality equipment with the same ease as they order other personal computer hardware, then this technology will have arrived.

In the meantime, there are several problems with virtual reality technology which must be addressed if it is to succeed. This section will outline the major limitations and drawbacks to the technology including design issues and cost factors.

Design Issues

Inadequate Image Resolution

A virtual reality system has been defined as a general purpose simulator, i.e., something that simulates what your sense organs would perceive in various environments. However, at the present time, the technology lacks the realism it purports to deliver. A major reason for this is its inability to deliver high resolution images to the user.

Users receive virtual world images through head mounted displays (HMDs). Because of weight and energy consumption, the HMDs currently available have LCD screens. These screens offer low resolution resulting in grainy, pixelated images. Indeed, using a virtual Snellen eye chart, Warren Robinett and Jannick Rolland of the University of North Carolina showed that a user wearing a VPL EyePhone, a widely used HMD, is legally blind, having approximately 20/250 vision. In addition, the current HMDs provide a narrow field of vision. In order to project a realistic simulation, HMDs with wide angle views for two eyes need to be developed. Current projections are that the industry is one to two years away from an HMD that approaches the clarity of a low end monitor, much less a high end workstation.

One of the major problems associated with image resolution is the limited rendering capabilities of most graphics computers. Rendering is the technique used for drawing virtual reality environments in which the computer creates each virtual object from joining one or more two dimensional polygon shapes to create three dimensional objects in the computer's memory and display. Aside from the Pixel Planes 5 graphics computer developed at University of North Carolina which renders 2 million polygons a second, most computers do not have the capacity to render high resolution images.

Another problem which is especially apparent in applications in televirtuality (the ability to interact with others through remote presences) is the inadequate bandwidth that is currently available for transmitting such images across large distances. In order for this "remote conferencing" to succeed, sufficient data rates must be provided. With new developments in telecommunications technology, this issue should be resolved in major cities in the next three to five years.

Time Lag Between the User and the Virtual Reality System's Response

Another problem in virtual reality systems is the time lag between the actual movements made by the user in the virtual world and the representation of those movements by the virtual reality system. The typical time lag ranges from 1/10 to 1/15 second. For some applications, such as architectural walkthroughs, the time lag is not a crucial factor for users because most do not spend that much time reviewing a building's interior and there is little if any manipulation of objects. However, in an application where the user is trying to perform real time operations such as using virtual controls to manipulate remote objects, immediate feedback is crucial and the time lag between movement and response should be minimized.

Limited Position Tracking Systems

A position tracker is a system that tracks the movements of parts of the body and sends information about the position and orientation of the body to the computer for processing. The sensors, which provide the digital signals generated by the user, are typically attached to an HMD, but can also be part of a data glove or joystick. Current position tracking systems are limited in range, i.e., the area in which they can detect movement and also contribute to the time lag problem discussed above. At the University of North Carolina, wide area position trackers are being developed .

Cumbersome equipment

The equipment used to interact with the virtual world, i.e., the data glove and the head mounted display have ergonomic and functional limitations associated with them. As Ben Delaney, publisher of CyberEdge Journal, an industry newsletter points out, "Currently comfort is a big part of creating the ideal head mount. After wearing one for about 15 to twenty minutes, they literally become a pain in the neck due to weight and generally poor ergonomics." Another cumbersome part of the virtual reality system is the cable which connects the computer to the display. It is invariably very short and thus restricts the user's movements to a limited circle. A possible solution to the issue of cumbersome equipment lies in the trend toward virtual reality experiences without special equipment. Some vendors are experimenting with this technology and believe that this trend will prevail in the future

Other Design Issues

Along with the problems cited above, other issues related to designing a virtual reality system have been identified. They include:

1. Interpretation of body movements - Some virtual reality system designers believe that the computer should interpret the participant's body motions in terms of their *implied* effects on the object in the virtual world. Thus, if there is an object in the virtual world, and the participant moves a hand toward it, the system should decide how the person will touch the object or if the person will touch it at all. Also, since the human body moves imprecisely, special techniques need to be designed for performing exact operations.

2. Total representation of the senses - To be effective, virtual reality must provide the participant with a complete synthetic representation of his or her senses. While sight, hearing, and touch are candidates for input into the virtual world, smell and taste may be very difficult to do and do not appear to be particularly useful except in the area of entertainment, where a particular smell could be associated with for example, a virtual amusement park.

3. Simulation sickness - While the side effects of extended participation in the virtual world are not really known, some people have suffered from what scientists are calling "simulation sickness." The symptoms include visual fatigue, spatial disorientation, and nausea. The cause of these symptoms is the conflict which occurs when there is a mismatch between a participant's reactions in real time to an artificial situation and the resultant visuals of the movements which are time delayed. Being affected by simulation sickness does depend on the kinds of interfaces a participant is using as well as tracking delays and how fully immersed the individual is within the simulated environment. Thus, an individual who participates in a five or ten minute virtual reality experience may not experience simulation sickness. However, a pilot training for several hours in a simulated environment, could be affected.

Cost Factors

Along with the fact that virtual reality technology is still in its infancy in terms of robust, available systems, there is the considerable cost of this technology which makes the average user shy away from even attempting to use it.

The cost of virtual reality technology has been linked to several factors. These include environmental reality, i.e,, the system's relative ability to simulate the intended application, and personal experience, i.e., how the person feels during and after participation in the virtual worlds system. In a home entertainment virtual reality system, for example. a driving simulator could include a motion platform, an imagery display on multiple windows, and a fully functional dashboard. The result would be a high level of personal experience and high end environmental reality at a price that few people could afford. On the other hand, some home virtual reality systems will have lower levels of environmental reality and thus lower costs because these users employ imagination to create environments only hinted at and don't need a full blown environment. In a business environment, there is the need to juggle the high cost of computational equipment such as 486 PCs and parallel processors against environment reality. The goal is to increase environmental reality while decreasing the cost of the equipment needed to create the reality.

Another factor related to cost is standardization. At the present time, there are few standards in the industry. Any standards which do emerge will be dictated by market demand and/or product superiority. As these standards emerge, the cost of virtual reality systems will decline because of mass production of certain components of the systems.

VII. Conclusion

The field of virtual reality technology is still evolving and it will probably be at least two years before it will be mature enough to be an "off the shelf" technology which can be installed on anyone's desktop. Clearly, the problems of high cost, the cumbersome nature of the equipment, and the inadequate image resolution delivered to the user remain to be solved. However, while we wait for this technology to mature, it is important to consider the implications of this technology for a firm such as Merrill Lynch. Indeed, such applications as virtual databases, teleconferencing, and "immersive" educational experiences can profoundly change the way many of us do our jobs and the way Merrill interfaces with its clients and other corporations. Moreover, by the turn of the century, it is predicted that this technology will be widely available for business and home use. The purpose of this report was to provide a broad based introduction to virtual reality technology. While it is hoped that the report will provoke members of the Merrill community to think about the potential impact it might have on the future business environment, if this research report does nothing but stimulate interest and enthusiasm for virtual reality technology, then it will have more than achieved its purpose.