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# Study on Real-Time Streaming of 3D Objects and Movies with Virtual Reality

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## Abstract

Throughout the past decade, the notion of Virtual Reality and its usage technique has influenced research in many application areas including Image Based Rendering, Medical, Military, Virtual health clinic, Simulation, Art, Archaeology, Distributed multimedia information systems, Architecture and more. Real-Time Streaming of 3D Objects And Movies with Virtual Reality provides an opportunity for readers to clearly understand the notion of Virtual Reality, 3D object modeling and Streaming in Real Time. A perfect reference for researchers, scholars, postgraduate students, and practitioners, this study aims to gather the recent advances and research findings of various topics in Virtual Reality and its use for different application areas such as real-time streaming of 3D objects and movies with VR.

**Keywords**: Virtual Reality, 3D Object Modeling, 3D/Virtual Reality Technology, 3D Image Processing,3D object streming, Virtual Reality Modelling Language (VRML).

## Introduction

Virtual reality (VR) is a term that applies to computer simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced, haptic systems now include tactile information, generally known as force feedback, in medical and gaming applications. Furthermore, virtual reality covers remote communication environments which provide virtual presence of users with the concepts of telepresence and telexistence or a virtual artifact (VA) either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove, the Polhemus, and omnidirectional treadmills. The simulated environment can be similar to the real world in order to create a lifelike experience—for example, in simulations for pilot or combat training—or it can differ significantly from reality, such as in VR games. In practice, it is currently very difficult to create a high-fidelity virtual reality experience, due largely to technical limitations on processing power, image resolution, and communication bandwidth; however, the technology's proponents hope that such limitations will be overcome as processor, imaging, and data communication technologies become more powerful and cost-effective over time.

Virtual reality is often used to describe a wide variety of applications commonly associated with immersive, highly visual, 3D environments. The development of CAD software, graphics hardware acceleration, and head mounted displays, database gloves, and miniaturization have helped popularize the notion. In the book *The Metaphysics of Virtual Reality* by Michael R. Heim, seven different concepts of virtual reality are identified: simulation, interaction, artificiality, immersion, telepresence, full-body immersion, and network communication. People often identify VR with head mounted displays and data suits. [*Citation needed*]

The term "artificial reality", coined by Myron Krueger, has been in use since the 1970s; however, the origin of the term "virtual reality" can be traced back to the French playwright, poet, actor, and director Antonin Artaud. In his seminal book *The Theatre and Its Double* (1938), Artaud described theatre as "*la réalité virtuelle*", a virtual reality in which, in Erik Davis's words, "characters, objects, and images take on the phantasmagoric force of alchemy's visionary internal dramas".[2] Artaud claimed that the "perpetual allusion to the materials and the principle of the theater found in almost all alchemical books should be understood as the expression of an identity [...] existing between the world in which the characters, images, and in a general way all that constitutes the *virtual reality* of the theater develops, and the purely fictitious and illusory world in which the symbols of alchemy are evolved".[3]

## Purposed and Scope

The purpose of this paper is to find Requirements and Solutions for the 3D objects rendering and modelling and Evaluation of virtual reality in this context. How VR useful for Movies and 3D objects modelling which types requirements needed for it. These could help the development of software by letting developers understand solutions to general problems in this field.

The scope of this Paper is to investigate what VR Based Applications really are and how they relate to other types of software's technology.

## Theoretical Background

- Distributed multimedia information systems
  - ✓ WWW - Based on Internet Standards (RFCs), e. g.:
    - Protocols - TCP/IP
    - Addressing Schemes - URL
    - Services - HTTP
    - Hypermedia Content - MIME, HTML, GIF, JPEG, MPEG, VRML, etc.
  - ✓ Client - Generic browser
    - Netscape Communicator, Microsoft Internet Explorer
    - Extension techniques - Helper applications, Plugins, ActiveX Control, Java
- 3D/Virtual Reality Technology - application areas
    - Ergonomic user interfaces
    - Method to navigate in an information space
    - Online presentation of virtual 3D scenes, for example:
      1. Reproduction of real objects
      2. Artificial scenes, such as Scientific Visualization of HPC results
    - ISO Standard: Virtual Reality Modeling Language (VRML97)
      1. Container format for multimedia content in the Web

Recently, VR is expected to contribute to knowledge sharing and reuse. It is, however, difficult to develop a well-organized VR because the principles of VR are not clear enough. Therefore, a methodology for VR based 3D objects design and Modeling needed more research.

- **Model engineering**

Now that we can explore quite large virtual world models in real time, we find that acquiring, cleaning, updating, and versioning even static world models is itself a substantial engineering task. It resembles software engineering in magnitude and in some, but not all, other aspects. My own rule of thumb is that managing a model of $n$ polygons is roughly equivalent to managing a software construct of $n$ source lines.

**Model acquisition:** VR practitioners acquire models in one of three ways: build them, inherit them as by-products of computer-aided design efforts, or acquire them directly by sensing existing objects.

In spite of a variety of excellent COTS tools for model building, it is tedious and costly work, especially when accuracy is important. We have found it takes several man-years to make a model of an existing kitchen that aims at quarter-inch accuracy. (We do not actually aim for that resolution where a textured image will serve as a substitute, such as the spice rack and contents, or stove knobs.)

I have found a breadth-first iterative-refinement strategy best for modelling. First, make a simple representation of each major object, then of each minor object. Then do a level of refinement on each, *guided by the eye*—what approximation hurts worst as one experiences the world?

Textures are extremely powerful, as SGI's Performer Town first demonstrated. Image textures on block models yield a pretty good model rather quickly. Moving through even a rough model wonderfully boosts the modeller's morale and enthusiasm, as well as guiding refinement. **Buying models:** Several firms offer catalogs of models, at different levels of detail, of common objects including people. It is cheaper, and faster, to buy than to build these components of a custom world model.

**Inheriting CAD models:** By far the simplest way to get superbly detailed models of designed objects, whether existing or planned, is to get the computer assisted design (CAD) data. But even that rarely proves simple:

- We have found it very difficult to get the original computational- solid-geometry data, which best encapsulates the designer's thoughts about form, function, and expected method of construction. We usually receive an already tessellated polygonal representation. Quite often, it will be severely over-tessellated, needing polygonal simplification to produce alternative models at different levels of detail.

- Formats will almost always have to be translated. Do it in an information-preserving way.
- CAD models often require substantial amounts of manual cleaning. In some CAD systems, deleted, moved, or inactive objects stay in the database as polygonal ghosts. Coincident (twinkling) polygons and cracks are common.
- AutoCAD does not capture the orientation of polygons. Orienting them takes automatic and manual work.
- If any of the subsequent processing programs requires manifolds, making them from CAD data will take much work.
- CAD models, particularly of architectural structures, typically show the object as designed, rather than as built.

**Models from images:** For existing objects only, as opposed to imagined or designed objects, imaging can yield models. Imaging may be done by visible light, laser ranging, CAT and MRI scans, ultrasound, and so forth. Sometimes one must combine different imaging modalities and then register them to yield both 3D geometry and visual attributes such as colour and surface textures. Recovering models from images is a whole separate technology and an active research area, which I cannot treat here.

- **3D Image Processing**

Nonlinear filters have enabled novel image enhancement and manipulation techniques where image structures such as strong edges are taken into account. They are based on the observation that many meaningful image components and desirable image manipulations tend to be piecewise smooth rather than purely band-limited. For example, illumination is usually smooth except at shadow boundaries [Oh et al. 2001], and tone mapping suffers from haloing artefacts when a low-pass filter is used to drive local adjustment [Chiu et al. 1993], a problem which can be solved with nonlinear filters [Tumblin and Turk 1999; Durand and Dorsey 2002].

In particular, the bilateral filter is a simple technique that smoothes an image except at strong edges [Aurich and Weule 1995; Tomasi and Manduchi 1998; Smith and Brady 1997]. It has been used in a variety of contexts to decompose an image into a piecewise-smooth large-scale base layer and a detail layer for tone mapping [Durand and Dorsey 2002], flash/no-flash image fusion [Petschnigg et al. 2004; Eisemann and Durand 2004], and a wealth of other applications [Bennett and McMillan 2005; Xiao et al. 2006; Bae et al. 2006; Winnem¨oller et al. 2006]. A common drawback of nonlinear filters is speed: a direct implementation of the bilateral filter can take several minutes for a one megapixel image. However, recent work has demonstrated acceleration and obtained good performance on CPUs, on the order of one second per megapixel [Durand and Dorsey 2002; Pham and van Vliet 2005; Paris and Durand 2006; Weiss 2006]. However, these approaches still do not achieve real-time performance on high-definition content.

In this work, we dramatically accelerate and generalize the bilateral filter, enabling a variety of edge-aware image processing applications in real-time on high-resolution inputs. Building upon the technique by Paris and Durand [2006], who use linear filtering in a higher-dimensional space to achieve fast bilateral filtering, we extend their high-dimensional approach and introduce the *bilateral grid*, a new compact data structure that enables a number of edge-aware manipulations. We parallelize these operations using modern graphics hardware to achieve real-time performance at HD resolutions. In particular, our GPU bilateral filter is two orders of magnitude faster than the equivalent CPU implementation.

✓ This paper makes the following contributions:

- The bilateral grid, a new data structure that naturally enables edge-aware manipulation of images.
- Real-time bilateral filtering on the GPU, which is two orders of magnitude faster than previous CPU techniques, enabling real-time processing of HD content.
- Edge-aware algorithms. We introduce a number of real times, edge-aware algorithms including edge-preserving painting, scattered data interpolation, and local histogram equalization.

Our approach is implemented as a flexible library which is distributed in open source to facilitate research in this domain.

The code is available at http://groups.csail.mit.edu/ graphics/bilagrid/. We believe that the bilateral grid data structure is general and future research will develop many new applications.

## Requirements

- **Requirements (1)**
  **3D/Virtual Reality Technology – Applications**

✓ Information Spaces / 3D User Interfaces

1. Intuitive human-machine-human interface
2. Ergonomic navigation

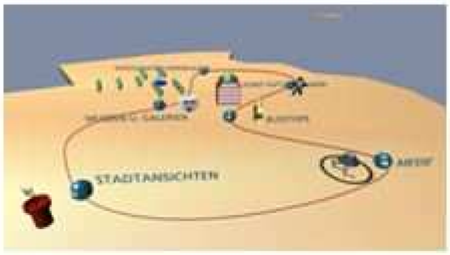
✓ Visualization of geometric objects (modeling / reconstruction)

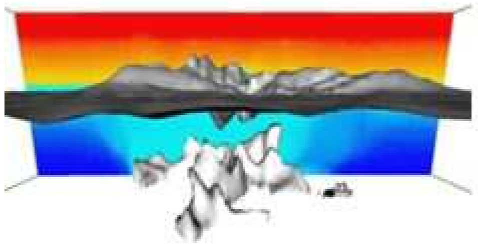
  - Design: „virtual prototyping“
  - Arcitecture, environment planning

✓ Visualization in scientific computing

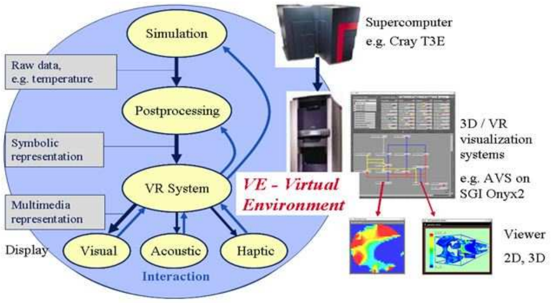
  - Experiment / Theory / Simulation

    - Virtual experiments
- ✓ Exploration and demonstration of results
    - Increase of insights / Teleteaching / Telelearning

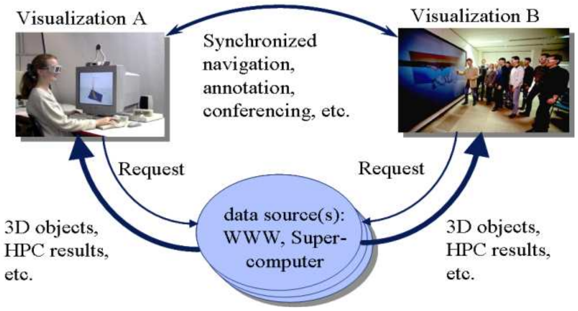




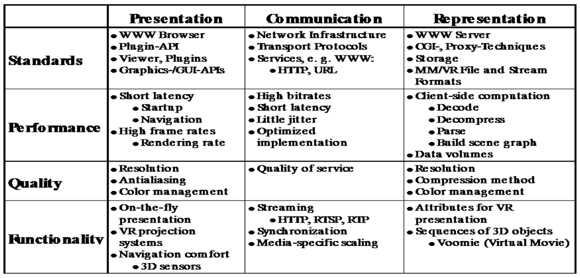
- **Requirements (2)**
  **Visualization in Scientific Computing**



- **Requirements(3)**
  **Tele-Immersive Distributed Virtual Environment**

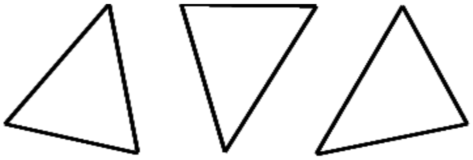


- **Requirements (4)**
  **Constraints of available Internet-based 3D systems**
- ✓ Several limits of VRML format and viewers
- ✓ Especially in the context of typical scientific and industrial research environments with
    - High quality application requirements, e. g.
      handling objects with high complexity (> 100,000 polygons)
    - Network infrastructure offering high bitrates, such as local networks
    - High performance server and client systems
- ✓ Constraints regarding performance, quality, and functionality aspects prohibit useful application
    - unacceptable delays
    - no progressive presentation
    - low frame rates
    - low rendering quality
    - little support of virtual reality presentation and interaction techniques
    - *no 3D streaming capabilities*
- **Requirements (5)**
  **Analysis and Classification**

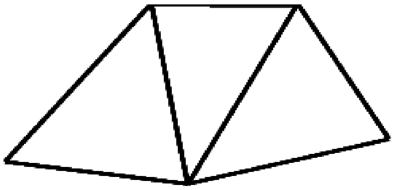


| | **Presentation** | **Communication** | **Representation** |
|---|---|---|---|
| **Standards** | • WWW Browser<br>• Plugin-API<br>• Viewer, Plugins<br>• Graphics-/GUI-APIs | • Network Infrastructure<br>• Transport Protocols<br>• Services, e. g. WWW:<br>  • HTTP, URL | • WWW Server<br>• CGI-, Proxy-Techniques<br>• Storage<br>• MM/VR File and Stream Formats |
| **Performance** | • Short latency<br>  • Startup<br>  • Navigation<br>• High frame rates<br>  • Rendering rate | • High bitrates<br>• Short latency<br>• Little jitter<br>• Optimized implementation | • Client-side computation<br>  • Decode<br>  • Decompress<br>  • Parse<br>  • Build scene graph<br>• Data volumes |
| **Quality** | • Resolution<br>• Antialiasing<br>• Color management | • Quality of service | • Resolution<br>• Compression method<br>• Color management |
| **Functionality** | • On-the-fly presentation<br>• VR projection systems<br>• Navigation comfort<br>  • 3D sensors | • Streaming<br>  • HTTP, RTSP, RTP<br>• Synchronization<br>• Media-specific scaling | • Attributes for VR presentation<br>• Sequences of 3D objects<br>  • Voomie (Virtual Movie) |

- **Requirements (6)**
  **Complexity of typical rendering primitives**



- N independent triangles with normals
- Volume: N * 72 byte
-

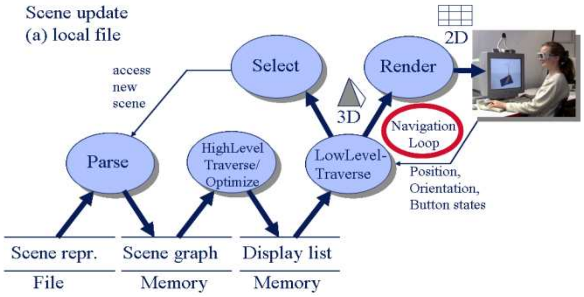


- N triangles as triangle strips with normal vectors
- Volume: (N+2) * 24 byte *4,3 Mio. triangles/s é*

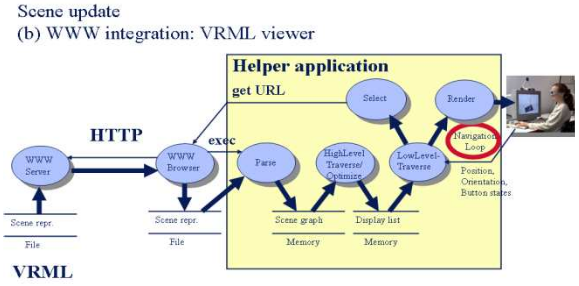
  *800 Mbit/s (SGI Onyx2 Infinite Reality)*

## Solutions

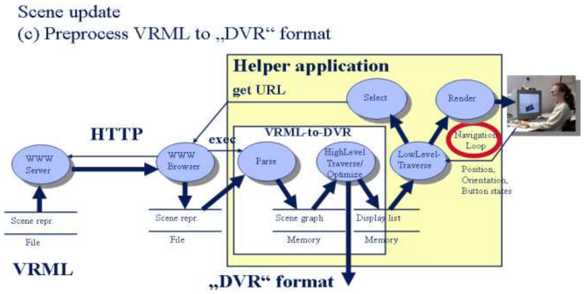
- **Solution (1a)**
  **Partitioning/Distributing a Virtual Reality system**



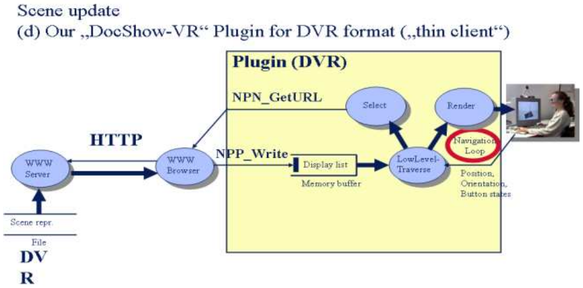
- **Solution (1b)**
  **Partitioning/Distributing a Virtual Reality system**



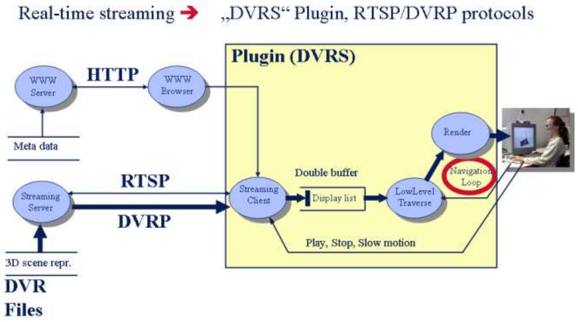
- **Solution (1c)**
  **Partitioning/Distributing a Virtual Reality system**



- **Solution (1d)**
  **Partitioning/Distributing a Virtual Reality system**



- **Solution (2)**
  **Play-out of 3D animations: streaming system**



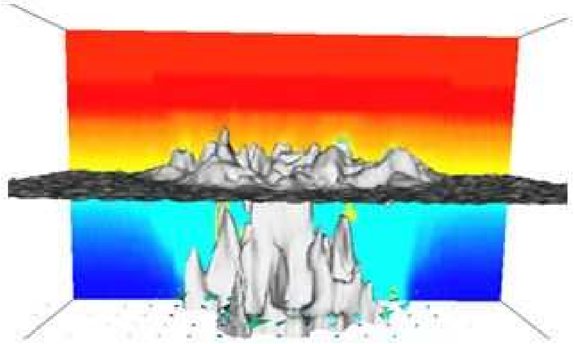
- **Solution (3)**
  **Performance issues**
- Optimized 3D file format
  - ✓ Binary representation - IEEE format / network byte ordering
  - ✓ Preprocessing of VRML data, e. g.:
    - ASCII cleartext to binary format
    - Linearization of scene graph (objects, attributes, transformations, lights)

        - Restructuring, precalculation for efficient and progressive rendering support
            1. VRML: Coordinate lists / indexed references è Store and transmit direct values
            2. VRML: IndexedFaceSet - Polygons è Triangles è Triangle strip
            3. Calculation and storage of normal vectors
- High-performance viewer (Netscape inline plugin)
    - ✓ Tightly coupled into data delivery
        - Netscape Plugin API
        - Real-time streaming, initiated by special meta data MIME type („DVRS“)
    - ✓ Efficient 3D rendering implementation, based on OpenGL
    - ✓ Real-time streaming of sequences of 3D scenes: „Virtual Reality Movies“
        - Control protocol: RTSP (RFC 2326)
        - 3D data transport: „DVRP“
        - Multithreaded: communication, 3D rendering (multi-pipe)
- **Solution (4)**
  **Other issues**
- Quality of Presentation
    - ✓ Multisampling antialiasing support (HW-accelerated OpenGL extension)
    - ✓ Colour management support (device-independant presentation)
- Functionality
    - ✓ Stereoscopic viewing with shutter glasses or stereo projection
    - ✓ Tracking devices
    - ✓ Multi-platform support (Win32, UNIX)
- Interoperability to ***ISO Standard*** VRML97
    - ✓ Preparing files via VRML-to-DVR converter
        - VRML97 subset supported: static scenes
        - Command line tool / Web service via HTML form, VRML upload, DVR download
    - ✓ Caching proxy/gateway technique
        - transparent access to any VRML file

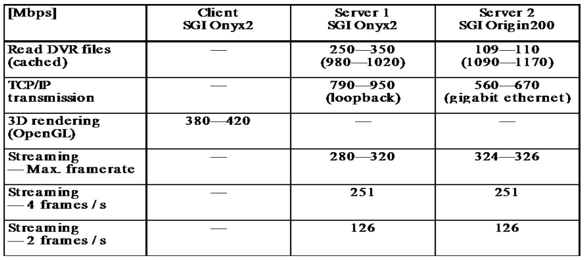
## Evaluation

### Evaluation (1)
### Testbed setup

- Client: SGI Onyx2 Infinite Reality (2x à 2 RM), 4xR10000, 195 MHz
- Server: SGI Origin200, R10000, 225 MHz via Gigabit-Ethernet
- Network: Gigabit Ethernet (back to back), Alteon Jumbo Frames
- Application scenario: Oceanic convection
    - ✓ Supercomputer simulation results
        - 161x161x31 grid
        - 740 time steps
    - ✓ Visualization of temperature, velocity
        - 100,000 primitives
        - 8 Mbytes / scene
- Frames 720-739 used for measurement



### Evaluation (2)
### Measurement

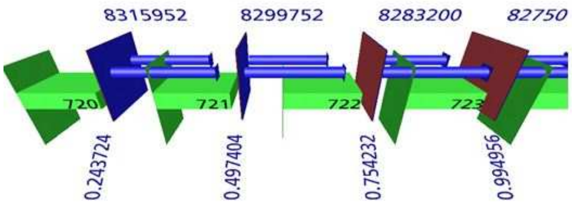


| [Mbps] | Client<br>SGI Onyx2 | Server 1<br>SGI Onyx2 | Server 2<br>SGI Origin200 |
|---|---|---|---|
| Read DVR files (cached) | — | 250—350<br>(980—1020) | 109—110<br>(1090—1170) |
| TCP/IP transmission | — | 790—950<br>(loopback) | 560—670<br>(gigabit ethernet) |
| 3D rendering (OpenGL) | 380—420 | — | — |
| Streaming — Max. framerate | — | 280—320 | 324—326 |
| Streaming — 4 frames / s | — | 251 | 251 |
| Streaming — 2 frames / s | — | 126 | 126 |

### Evaluation (3)
### Illustration

- Configuration
    - ✓ Client: SGI Onyx2 Infinite Reality
    - ✓ Server: SGI Origin200
    - ✓ Communication: Gigabit Ethernet, Jumbo Frames
    - ✓ Dataset: „Oceanic Convection“, frames nr. 720-739
- Graphic Pipe
    - ✓ Maximal frame rate

    - ✓ 4 frames per second
    - ✓ 2 frames per second
- Graphic Pipes
    - ✓ Maximal frame rate
    - ✓ 4 frames per second **è**
    - ✓ 2 frames per second



## Future work

- Preparation of scenarios in wide-area networks
- Presentation (Prepared 3D scenes, as described)
    - ✓ Exploration (Steering / High-Performance Computing - HPC)
    - ✓ Discussion (Computer-Supported Cooperative Work - CSCW)
- Support of an exploration scenario
    - ✓ Steering of a computation on a supercomputer
    - ✓ Dynamic scene generation
    - ✓ Low-latency, on-the-fly transmission and presentation
- Support of cooperative working
    - ✓ Synchronization of navigation
    - ✓ Telepointer, annotations
    - ✓ Synchronized play-out of 3D animations
    - ✓ Streamed, spatial video and audio integration
        - Video texture mapping on a rectangle in 3D space
        - e. g. SGI Onyx2 IR: DIVO/GVO - ITU-R 601 „D1“ digital video interfaces
        - e. g. SGI Onyx2 IR: ADAT - 8-channel digital audio interface

## Conclusion

Final conclusion of this study is that, first to examine if it is possible to find a definition of high-level implementation of virtual reality and examine how these application patterns relate to other types of software patterns. And second to investigate the strengths and weaknesses of this type application and how they could be used.

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## References

[1] Stephan Olbrich, Helmut Pralle RRZN/RVS, University of Hannover TERENA-NORDUnet Networking Conference (TNNC) Lund, Sweden, 07.-10.06.1999

[2] Erik Davis, *Techgnosis: myth, magic and mysticism in the information age*, 1998.

[3] *Antonin Artaud, "The Alchemical Theater", in* The Theater and its Double, *trans. Mary Caroline Richards, New York: Grove Press, 1958, p. 49, emphasis in original. See also Samuel Weber,* "'The Virtual Reality of Theater': Antonin Artaud", in *Theatricality as Medium*, New York: Fordham University Press, 2004, pp. 277-94.

[4] I.E. Sutherland, “The Ultimate Display,” invited lecture, IFIP Congress 65. An abstract appears in *Information Processing 1965*: *Proc. IFIP Congress 65*, Vol. 2, W.A. Kalenich, ed., Spartan Books, Washington, D.C., and Macmillan, New York, pp. 506-508. A similar, but quite complete, paper is Sutherland’s “Computer Displays,” *Scientific American*, Vol. 222, No. 6, June, 1970, pp. 57-81.

[5] F.P. Brooks, “Is There Any Real Virtue in Virtual Reality?,” public lecture cosponsored by the Royal Academy of Engineering and the British Computer Society, London, 30 Nov. 1994; http://www.cs.unc.edu/~brooks.

[6] N.I. Durlach and A.S. Mavor, eds., *Virtual Reality—Scientific and Technological Challenges*, National Research Council, Washington, D.C., 1995.

[7] G. Burdea and P. Coiffet, *Virtual Reality Technology*, John Wiley, New York, 1994.

[8] AURICH, V., AND WEULE, J. 1995. Non-linear gaussian filters performing edge preserving diffusion. In *Proceedings of the DAGM Symposium*.

[9] BAE, S., PARIS, S., AND DURAND, F. 2006. Two-scale tone management for photographic look. *ACM Transactions on Graphics 25*, 3, 637 – 645. Proceedings of the ACM SIGGRAPH conference.

[10] http://www.boloji.com/index.cfm?md=Content&sd=Articles&ArticleID=3247

[11] Castranova, E. (2007). Exodus to the Virtual World: How online fun is changing reality. New York: Palgrave Macmillan.

[12] Pimentel, K., & Teixeira, K. (1993). Virtual reality. New York: McGraw-Hill. ISBN 978-0-8306-4065-2