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Apple QuickTime VR: White Paper (7/95)

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TOPIC -----

This article contains the QuickTime VR White Paper.

DISCUSSION -----

Putting the Reality in Virtual Reality

An Overview of Apple's QuickTime VR Technology

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Walking through the corridors of the Louvre, you suddenly find yourself held in the captivating gaze of the Mona Lisa herself... Toes in the shallow tide pool, your daughter picks up a bright orange starfish and turns it every which way there is, to see what it's all about... Strolling down San Francisco's Lombard Street, you become dizzy on what you are surely convinced is the world's most crooked street... Your clients nod in approval after walking down the corridors of their planned office building from the comfort of their own boardroom.

And you do all of this from your personal computer.

Welcome to the new promise of virtual reality. Thanks to an exciting new software technology in development at Apple Computer called QuickTime VR, real-world experiences like these are now possible on an ordinary personal computer. They require no special hardware or accessories, nor any special software.

In this paper we explain the concept of virtual reality for the rest of us, and introduce the innovative new QuickTime VR software technology that makes it possible.

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I. QuickTime VR: An Overview

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Just what is Virtual Reality?

Virtual Reality describes a range of experiences that enable a person to interact with and explore a spatial environment through a computer. These environments are typically artistic renderings of simple or complex computer models. More often than not, VR applications require specialized hardware or accessories, such as high-end graphics workstations, stereo displays, 3D goggles or gloves. As an alternative to virtual reality, video has been used to view real world spaces.

Apple's QuickTime VR is system software that allows Macintosh and Windows users to experience these kinds of spatial interactions using only a personal computer, with a mouse or trackball, and a keyboard. Furthermore, through an innovative use of 360° panoramic photography, QuickTime VR enables these interactions using real-world representations, as well as computer simulations.

QuickTime VR has two components: a panoramic movie technology that allows users to explore spaces, and an object movie technology that allows users to examine objects close up and interactively.

With QuickTime VR, viewers can explore "real" spaces and objects as if they were there. As users change their view of a scene—turning left or right, looking up or down, or zooming in or out—correct perspective is always maintained, providing the effect of actually looking around. Users can also manipulate objects, looking at them from the front, back, top, bottom, or any other angle of interest.

The three defining characteristics of QuickTime VR are

- 1) it can use real-world images as well as computer-generated images;
- 2) it does not require additional hardware; and
- 3) it is an extension of the QuickTime architecture.

II. What You Can Do with QuickTime VR

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QuickTime VR is a technology that Apple is planning to license to third parties in the form of a runtime engine and authoring tools. It enables content developers, production companies and software developers to create exciting new multimedia products, typically in the form of CD-ROM titles, in a wide range of

markets. These opportunities can include:

- Education -- An application that can allow students to explore Mayan ruins, or the habitat of a beaver.
- Engineering -- Airplanes and buildings that have not been built yet can be explored and analyzed.
- Museums -- Tour museums in parts of the world you can't visit in person, and see works not normally on public display.
- Kiosks -- Malls and theme parks can use QuickTime VR to provide interactive, real-world directions to help orient a shopper or visitor.
- Architecture -- QuickTime VR can enable an interactive walk-through of a new house or office building.
- Surrogate Travel -- If you can't go there on a tour, QuickTime VR can bring a tour of Venice to you.
- Games -- Exploration and mystery games can use QuickTime VR to allow people to go through a fun house or visit a crime scene.

III. The Advantages of QuickTime VR

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The biggest difference between QuickTime VR and most virtual reality systems is its ability to use high-quality photographic representations of a space, in addition to computer-rendered representations. This, along with other innovations, results in significant advantages for both developers and users of QuickTime VR versus competing multimedia formats.

Advantages for Developers

Easy panoramic image capture Using only a standard 35mm camera and tripod, a real-world 360° scene can be photographed in a few minutes, eliminating the need for expensive panoramic cameras or long video-taping sessions. Because of the increased resolution that film offers over video, the images that QuickTime VR uses will have richer colors and sharper details. Alternatively, computer-generated scenes can be rendered using any off-the-shelf rendering package.

Faster performance QuickTime VR incorporates a revolutionary new compression/decompression algorithm that for the first time delivers the performance necessary to make the photographic-based experience realistic. The performance is independent of the complexity of the scene. And since there are no frame boundaries, QuickTime VR allows for smoother panning as well.

Small file size The capture of a single 360° view of a real scene using video techniques, such as navigable movies, would require tens of megabytes. The QuickTime VR process can store the complete 360° photographic representation in less than one megabyte. The storage required for a computer-rendered scene is even smaller.

Flexible interaction QuickTime VR provides built-in "hot spots" that enable the content developer to make any part of the 360° scene interactive. When the user clicks on a hot spot, a wide variety of actions can be triggered, including the

presentation of a photograph, an audio recording, display text, or another QuickTime VR scene.

Extension to the QuickTime family QuickTime is currently available for Macintosh and Windows personal computers, and is also being developed for consumer electronics devices, such as game players and interactive TV. Because QuickTime VR is part of the QuickTime family of products, it can be delivered on nearly 10 million QuickTime capable machines worldwide, enabling QuickTime VR authors to develop content once and deliver it many times.

In addition, QuickTime VR files can be embedded in hundreds of applications that support QuickTime. A few examples are multimedia authoring tools, presentation packages, word processors, and databases.

Advantages for Users

Realistic simulations Thanks to the use of panoramic photography, scenes built with QuickTime VR enable users to experience 360° real-world simulations. The software provides correct perspective of every view in a scene in real time, giving the user the sense of being there and looking around. Similarly, QuickTime VR maintains correct perspective with complex rendered scenes. QuickTime VR also offers the user the simulated experience of turning an object with their hand.

Intuitive usage Prior to QuickTime VR, video has been used to capture real world spaces, with the limitation that the user must view the scene in the sequence in which the video was recorded. QuickTime VR frees the user to look directly at any view of a scene or an object through a simple, intuitive user interface.

Accessibility In contrast to most virtual reality systems, which require high-end computers or specialized hardware, QuickTime VR runs on most QuickTime-capable Macintosh or Window computers and requires no specialized accessories, making it accessible to a much wider range of users. QuickTime VR requires a system running QuickTime 2.0, which makes the VR files available to any application that uses QuickTime 2.0, and ensures that all VR files may be used with a wide variety of user applications.

IV. Building QuickTime VR Applications

There are three discrete steps in creating a QuickTime VR file: capture, image input, and authoring/composition.

Capture

For real-world representations of scenes, QuickTime VR uses 360 degree panoramic photography. For rendered scene representations, standard, off-the-shelf rendering packages are used.

A 360° panoramic photograph represents the view that one would see by standing in a single spot and turning full circle. Until now, taking such a photograph

required an expensive, special purpose camera. With QuickTime VR authoring tools, that same 360° panoramic view can be captured using a standard 35mm camera to take a series of adjacent photographs. In addition to enabling many more developers to create applications, the use of commercially available 35mm cameras allows for much greater exposure control over the 360° view. The use of standard cameras also permits a wider range of effects due to the large number of existing lenses and filters that may be employed. The actual number of panoramic photographs taken for a particular scene depends on the type of experience the content developer wants to provide the end user. Capturing more panoramic images within a fixed space will yield a smoother navigational experience within that space, but will generate larger storage requirements.

For a 360° rendered view, the panorama may be created directly by the rendering package, or by generating rendered scenes equivalent to the series of photographs used in capturing a real-world panorama.

The representation of virtual objects requires that images of the object be captured from all viewpoints. These images can be rendered or photographic.

Input

Once the photographs have been taken, they are input into a personal computer using a Photo-CD scanner or other standard, commercially available image input devices.

Authoring/Composition

QuickTime VR authoring tools incorporate proprietary software that can automatically stitch together a series of photographs to produce a single, seamless digital panoramic photograph on the Macintosh. Developers can also use an interactive stitching mode, for greater control. The source images can be photographic or computer rendered. Rendering applications that can output panoramic views directly, bypass this step.

Once the panoramic image has been created, it can be post-processed using standard, commercially available painting applications.

With QuickTime VR's pixel-accurate "hot spot" technology, the content developer can enable certain objects within a scene to be interactive. This allows the user to select the object for close up viewing, and view all sides of it by turning it around using a standard pointing device such as a mouse. The combination of scenes and objects simulates to a very high degree the experience of actually being there.

QuickTime VR objects can be used independently of the panoramic scene technology as well.

V. The Run-Time Engine and Software Tools

Apple is planning to license to third-party developers both the QuickTime VR run-time software (for Macintosh and Windows), and authoring tools

(Macintosh-based). The availability and license structures for these tools is anticipated to be disclosed before the end of 1994.

QuickTime VR will support 8-, 16-, and 24-bit video.

VI. Platform Requirements for QuickTime VR

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The minimum Macintosh system required for the run-time software is

- QuickTime 2.0,
- System 7.1 or later,
- QuickTime-capable Macintosh with a 68030, 25 MHz processor,
- 8-bit video,
- 5 MB available RAM.

Double-speed CD-ROM is recommended for CD-based software titles.

The minimum Windows system required for the run-time software is

- QuickTime 2.0 for Windows,
- Windows 3.1,
- MPC 2 configuration:
 - . - 80386, 33 MHz processor,
 - . - 8-bit video,
 - . - 8 MB available RAM.

Double-speed CD-ROM is recommended for CD-based software titles.

VII. The State of the Software and Next Steps

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In developing the QuickTime VR software, Apple Computer worked closely with Simon & Schuster Publishing to develop an interactive CD-ROM application based on "Star Trek: The Next Generation," released in the Fall of 1994.

As of this writing, QuickTime VR technology is in the final stages of completion. More specific disclosures concerning the availability and opportunities for evaluation and licensing of QuickTime VR are anticipated prior to the end of 1994.

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