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1

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TITLE AN INTERPERSONAL MULTIMEDIA VISUALIZATION SYSTEM

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An Interpersonal Multimedia Visualization System

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Abstract

MediaView is a computer program that provides a generic infrastructure for authoring and interacting with multimedia documents. Among its many applications is the ability to furnish a user with a comprehensive environment for analysis and visualization. With MediaView the user produces a "document" that contains mathematics, datasets and associated visualizations. From the dataset or embedded mathematics animated sequences can be produced *in situ*. The mathematical content of the "document" can be explored through manipulation with Mathematica[®]. Since the "document" is all digital, it can be shared with a co-worker on a local network or mailed electronically to a colleague at a distant site. Animations and any other substructure of the "document" persist through the mailing process and can be awakened at the destination by the recipient.

Introduction

Once published in printed form any document, book or paper, dies a little — or at least ossifies. This is especially true with a scientific publication and is most pronounced in journals where an author is subject to stringent page count limitations. Forced to adhere to that, many papers become so taut as to sacrifice exposition. Figures or illustrations that might have helped to enlighten are omitted for the sake of brevity. Also, mathematical presentations are reduced to a bare minimum — clarifying intermediate steps in a development are often sacrificed due to space limitations. And, unless it's a highly specialized publication, the likelihood of finding important fragments of computer code in a paper is nearly nil. In an electronic publishing environment most of these limitations disappear. There is an opportunity to resuscitate the work and restore to it much of the vitality that accompanied its preparation and, perhaps, presentation.

Armed with modern workstation technology, we can provide an electronic reading environment that permits one to reach into this new form of publication and pull out the mathematics so that we can manipulate it to experiment with it, to derive new results, to simulate different situations with different parameters; we can take the illustrations and move the viewpoint, change the lighting conditions or use the model with our own algorithms; we can manipulate the animations and study the effects to learn and understand what has been accomplished; and we can make it possible for people to

extract useful material and incorporate it with their work.

MediaView, developed at Los Alamos National Laboratory, is the system that makes it possible to produce a document like this. MediaView is a computer program which provides a generic infrastructure for authoring and interacting with multimedia documents. With MediaView, documents can be developed for professional or personal use, technical or administrative. Because of its emphasis on mathematics and graphics, it is especially useful to scientists and engineers, or others, who have a need for analysis of data and visualization of information. For example, one application of MediaView has been to produce an interactive version of papers from recent SIGGRAPH proceedings [1]. Some of the potential components of a MediaView document are shown in Figure 1.

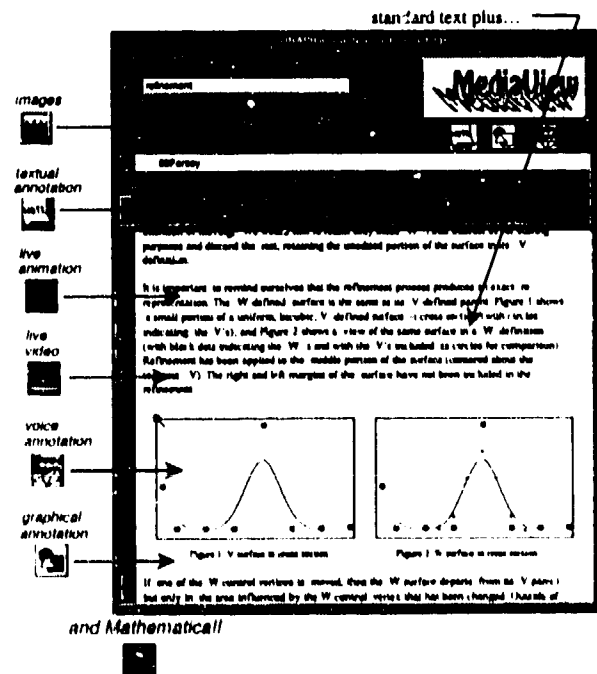


Figure 1. Components of a MediaView Document

How It Works

Taken individually, the components of multimedia technology appearing in MediaView are not new. There are already several programs which manipulate text and graphics, including high resolution digital color images. A few systems also provide for embedded voice messages, but most are experimental and require expensive add-on hardware. Animation too can be produced, by video add-in cards and videodisk players. Finally, textual annotation is even available through the Post-it™ metaphor in some word processing systems. What is not available, however, is a completely integrated system, hardware and software, that combines *all* of these features. This is one of the most important attributes that MediaView brings to digital publishing, but there many more.

As suggested in Figure 1, MediaView documents have the following features:

- Keyword retrieval of any word or phrase in the volume and random access to that part of the document. Any collection of text can be copied and then pasted into a text editor or word processing program.
- Figures that accompany text can be viewed and, if desired, extracted for processing by another program. This capability applies to simple drawings or 24 bit/pixel full color images.
- Another icon style indicates that an audio insert is available for listening, e.g. part of the question and answer session. The sound fragment can be played back through a built-in speaker or it can be captured by a sound editor for incorporation in another multimedia document.
- The reader may wish to make notes in the "margin" of the document. These can be voice annotations or could be in the form of textual or graphical "stick-on" notes which are logically attached to a position in the document. Subsequent readers can, if permitted, hear and see those comments. Thus, a teacher who is using MediaView in a course can expand on points in a document *in situ*.

Analysis And Visualization

Some of the most important features offered by MediaView are associated with mathematical analysis and visualization. These are described in detail below. In reading of them one should bear in mind that any of the analyses or visualizations can be shared with a co-worker on a local network or mailed electronically to a colleague at a distant site, making MediaView a true interpersonal visualization tool. Animations and any other substructure of the "document" persist through the mailing process and can be awakened at the destination by the recipient.

Linking to Mathematica

Equations that appear in a MediaView document have a backing format that is compatible with the Mathematica [2]

language. Thus, by clicking on an equation, its semantics are conveyed to Mathematica, where the user can perform a variety of symbolic and numerical operations. Figure 2 is an example of symbolic mathematics manipulation and graphical visualization using equations appearing in a recent SIGGRAPH paper [3]. A portion of the paper is shown in the window at the left. After clicking on a Mathematica icon the outline format for a Mathematica notebook appears, as seen in the upper right. By manipulating entries in the notebook, the user produced the density diagram in the lower left and the filter function plots to the lower right. Equations that were used in their production appear close by.

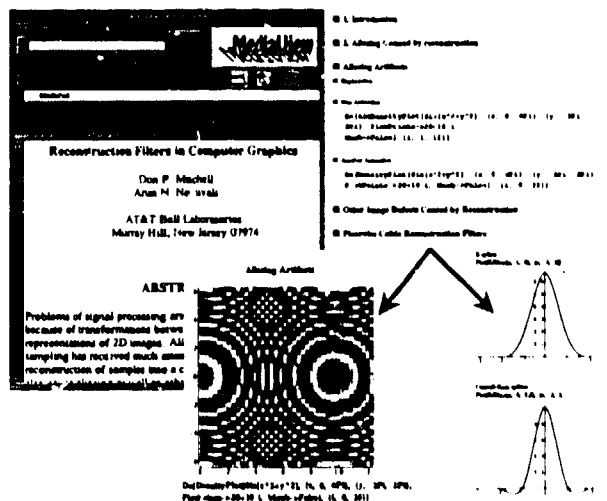


Figure 2. Mathematical Analysis and Visualization with Mathematica

Locally Derived Animations

Another possibility for analysis and visualization is to perform a simulation wholly within MediaView and use its dataset animation facility to view the results. Once the simulation is complete a window will open and the animation will be displayed there. Controls attached to the window allow single stepping and selective freezing and extraction of frames. Figure 3 shows an example of this using data from a paper from the 1989 SIGGRAPH conference [4].

Visualization of remotely-produced datasets

MediaView also provides a facility for visualizing datasets that were produced on another computer, say a supercomputer that is accessible through a network connection. These data can be rendered to produce a single frame of output or an animated sequence. Figure 4 is one frame from a simulation of global warming that was performed on a Cray Y/MP. In MediaView an entire year's worth of data can be shown as an animation.

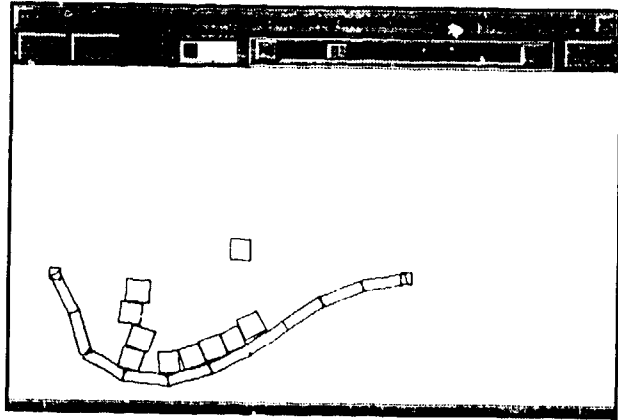


Figure 3. The MediaView Dataset Animation Facility

Implementation Details

MediaView is an application for the NeXT Computer that integrates text, mathematical notation, illustrations, color images, animations, video segments and audio annotations, as well as textual and graphical annotations.

The heart of the application is a custom multimedia object, which is based on the NextStep Text object [5]. Support was added to accommodate arbitrary NextStep views. This allowed the incorporation of custom multimedia control and display objects into a document. Several control panels were constructed with the Interface Builder and a considerable amount of Objective-C code was written to accomplish the various user interface objects and to build the multimedia documents. While the application builds upon some multimedia building blocks already available on the NeXT system, notably sound and Display PostScript[®], MediaView provides unique scope and capability for manipulating electronic documents.

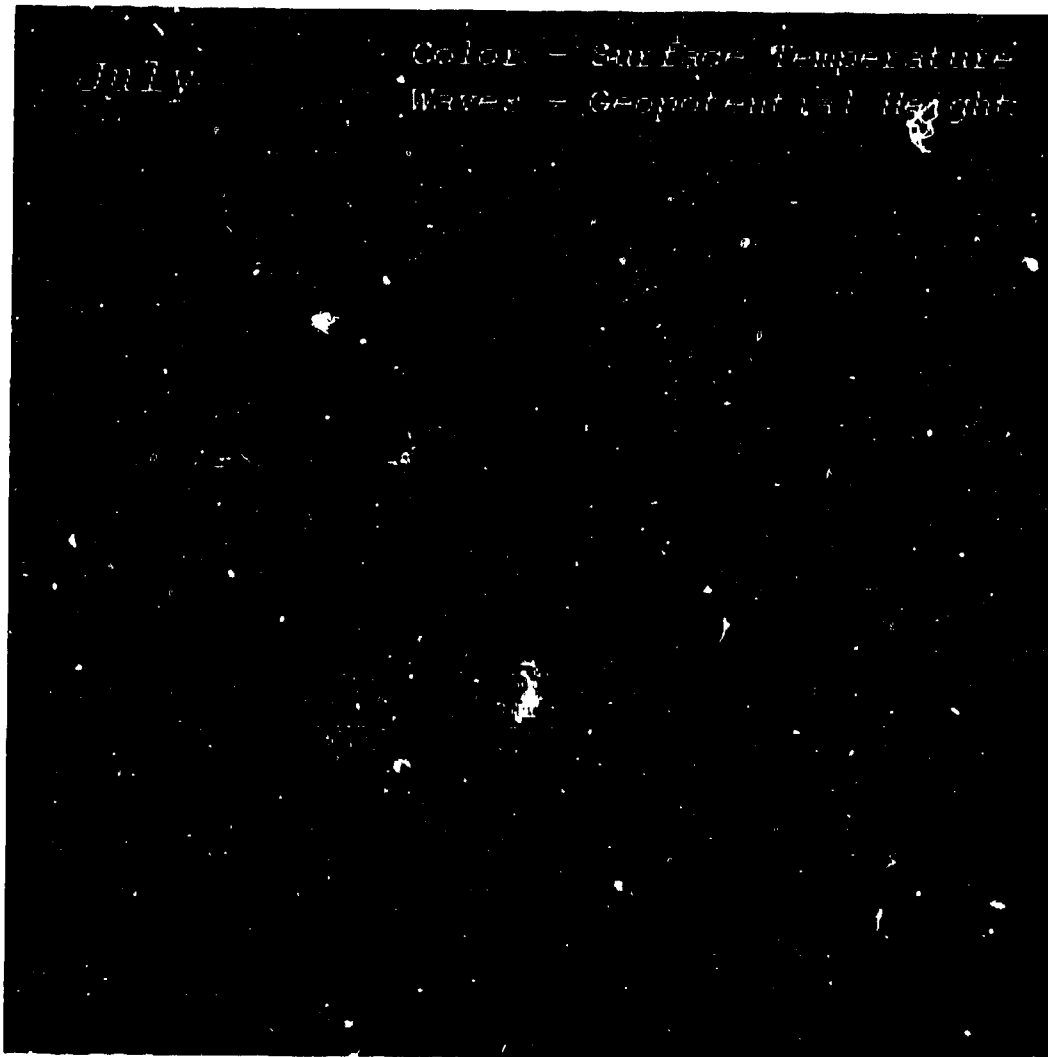


Figure 4. Visualization of Global Warming Data Produced on a Supercomputer

MediaView documents are originally built from a "source" format that comprises all the appropriate components. The text for MediaView documents is represented in the Microsoft Rich Text Format (RTF), which is produced, for example, by WriteNow and Microsoft Word. The NextStep text object parses RTF and visually restores the format of the paper. (That is, WriteNow is used as an RTF to RTF filter to ensure that subsequent use of the formatted paper conforms to the RTF conventions supported by NeXT software.) The positions of line art, math, and multimedia components are indicated by special symbols not normally found in a document, for example, the Japanese yen character. When the application first encounters such a symbol it gathers the appropriate entity from a related directory and inserts it in the proper place in the text, deleting the special symbol. Where appropriate, the symbol is replaced by an icon or button which can invoke the corresponding multimedia component when activated.

Once built, the paper's run-time data structure can be modified by the addition of the various types of annotations. The (possibly modified) paper is saved in a compressed archival format (a "compiled" form) and can be restored without going through the original build procedure.

Other Applications And Future Plans

Other uses for MediaView range from a customized multimedia newspaper to an interactive children's book. In addition, MediaView can accommodate maps, CAD diagrams and a custom component, which can be any multimedia entity that is not standard to MediaView, but is required for a particular application. Finally, anything that MediaView can display can be printed or saved as a PostScript file, which is how all the figures included here were captured.

While MediaView is currently available only for the NeXT computer, it can be ported to any platform that provides the NextStep programming environment. IBM recently announced the availability of NextStep for their PS/2 and RS/6000 computers. MediaView will be ported to both of those platforms when the software becomes available.

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