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SPATIAL DATA MANAGEMENT SYSTEM (SDMS)

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Abstract:

The Spatial Data Management System (SDMS) is a testbed for retrieval and display of spatially related material. SDMS permits the linkage of large graphical display objects with detail displays and explanations of its smaller components.

SDMS combines UNIX workstations, MIT's X Window system, TCP/IP and WAIS information retrieval technology to prototype a means of associating aggregate data linked via spatial orientation. SDMS capitalizes upon and extends previous accomplishments of the Software Technology Branch in the area of Virtual Reality and Automated Library Systems.

1. INTRODUCTION

In early 1993, training systems supporting the Hubble Space Telescope rescue mission were being engineered and deployed throughout the Johnson Space Center and divisions within NASA began augmentation of training for flight personnel and the Hubble flight crew. To accomplish the training, detailed familiarization with the vast array of pieces ranging from large assemblies to tiny subcomponents, their location on the satellite and their orientation was required. Spatial Data Management System (SDMS) is a prototype conceived to fulfill the need for spatial linkage of large graphical images with component images and text. The ISAT team's recent experience in the production of an automated electronic library system (NELS [1]) suggested a novel approach to the solution of this problem.

The approach was to couple previous work combining large images of the satellite from a modest distance with text, and highly detailed photographs of the bays and equipment with the recently completed alpha version of an automated library system -- thereby providing a combination macro/micro view with automated information retrieval of text.

Previous coding furnished by Mr. Lac Nguyen [2] in conjunction with his virtual reality project provided the visual "macro" views of the satellite, while high-detail, high-quality photos of components were obtained from Van Steinburg [3] for "micro" views of the satellite and subcomponents. The text portion of the system was composed from detailed debriefings of the crew who originally placed the satellite in orbit.

The virtual reality mockup images of the Hubble Space Telescope were joined with high quality photographs of the telescope and the descriptive text recorded from deployment crew debriefings and features of the X Window System. This union was accomplished using Wide Area Information Service (WAIS) as the information retrieval engine. Detail photographs consisted of complete spans of all bays, compartments and components of the telescope.

2. METHODOLOGY

The initial framework of "macro" views of the satellite provide the user with a profile view of the satellite from a generous positive Y-distance, and a small control panel. The control panel consists of the following buttons and associated actions:

- Prev - Move to previous macro image
- Next - Move to next macro image
- Quit - Exit program
- Help - Provide context sensitive help

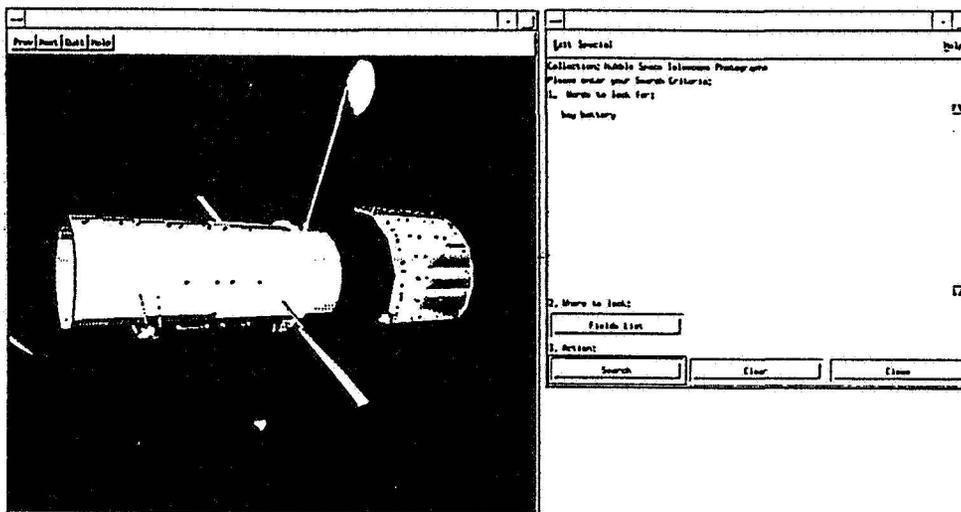


Figure 1.

A profile of the Hubble. The spacecraft may be rotated about its longitudinal axis, permitting views of various bays and subcomponents.

From this vantage point, the user may rotate the satellite about its longitudinal axis a full 360 degrees by manipulation of forward/backward buttons available on the control panel. The motion is accomplished by a rapid projection sequence of a previously processed set of X Window images, providing the user with a smooth transition between views. The number of views has alternately been coded at 4 views (90 degrees) and 6 views (60 degrees). These parameters are purely platform-dependent, as the processes involved are very memory-intensive.

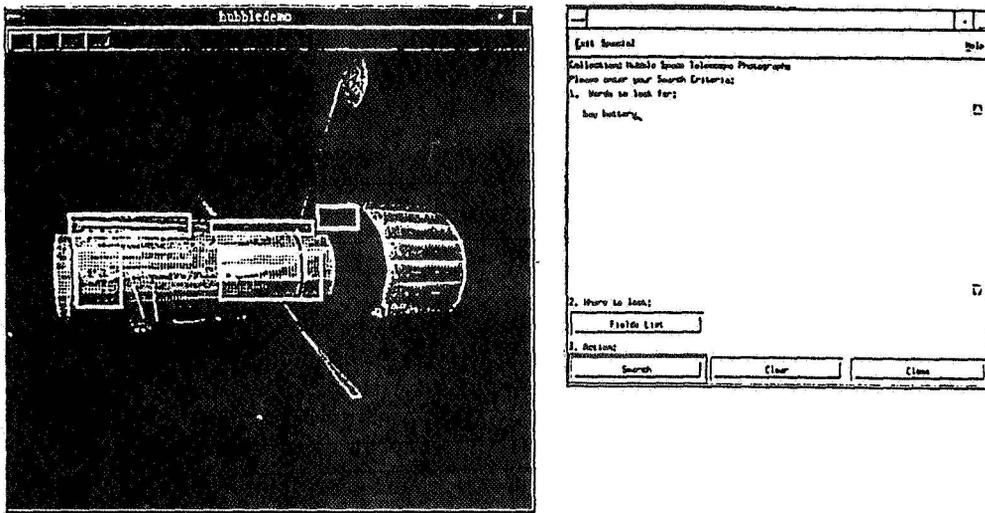


Figure 2.
 Bays and subcomponents are highlighted by the right mouse button. Clicking upon the regions activates an independent viewer which brings up a highly detailed view of selected component.

The next feature is activated by pressing the right mouse button. (See figure 2.) When this button is pressed, the image displays "outlines" of regions on the satellite which are mouse-sensitive. By clicking upon one of the sensitive regions with the left mouse button, the user activates an independent pop-up viewer, providing a close-up "micro" view of the desired component. Text associated with the specific region is available through a NELS/WAIS query presently. This must be operated by hand in the prototype, but would be automated in a full implementation of the project. Access to spatially related items, their metadata, or further queries are available via the familiar NELS/WAIS interface.

- Distributed information via WAIS - Distributed text, image, sound and graphical user interface are provided through client/server model.

4. AREAS FOR FUTURE ENHANCEMENT

- Full integration of sound - Training may be enhanced with aural components added to the present textual presentation of information.
- Integration of motion/video - Full motion video could be applied to the detail image presentation.
- Mosaic/Wide World-Web interface - Integrating the current spread of Mosaic/HTML technology into the interface may produce an interactive teaching tool capable of accepting text, multi-answer questions, or other forms of computer based training.
- Generalized 3 dimensional view - Permit the user to translate, or navigate around the satellite rather than providing a fixed view from a specific orientation.

5. CONCLUSIONS

Demonstrations of SDMS astonish and fascinate its viewers. The incorporation of sound, or other multimedia and the completion of several other features would make it a most appropriate and adaptive training tool suited for linkage of graphical objects with component objects.

6. ACKNOWLEDGMENTS

The work described was supported by the Software Technology Branch of the Johnson Space Center. Dr. Mark E. Rorvig served as scientific monitor of the project and provided the motivation and stimulus for the broad combination of emerging technologies. Mr. Lac Nguyen of I-NET provided invaluable help and experience with the adaptation of his original model for the purposes of this prototype, design issues and the "everpresent" coding bug. Mr. Terry McGregor of I-NET participated in early design and algorithm issues, and many thanks to Ms. Stephanie Smith of Hernandez Engineering who championed user interface design issues and who diligently demonstrates this prototype.

7. REFERENCES

- [1] NASA Electronic Library System (NELS) 2.0 Product Specification, Software Technology Branch, NASA/Johnson Space Center, September 1993.
- [2] Virtual reality programming in progress by Mr. Lac Nguyen of Inet, Inc. in support of the NASA/JSC Software Technology Branch. Fall 1992.
- [3] High quality targa photographic images provided by Michael Van Steinburg, in support of Goddard Space Flight Center, Maryland, the Hubble Space Telescope project, and the Center for AeroSpace Information. Spring 1991.
- [4] The Wide Area Information Servers (WAIS) documentation. Public domain distribution of WAIS, version 8-b5. April, 1991.

8. GLOSSARY

- COSMIC:** NASA's Computer Software Management and Information Center (COSMIC). COSMIC controls the dissemination of NASA software available to the public.
- HST:** Hubble Space Telescope.
- ISAT:** Information Science and Technology team/group. The team of engineers employed by the Software Technology Branch of the NASA/Johnson Space center who developed NELS and SDMS.
- MIT:** Massachusetts Institute of Technology.
- Mosaic:** An Internet information browser and World Wide Web client developed at NCSA.
- NASA:** National Aeronautics and Space Administration.
- NELS:** NELS is the NASA Electronic Library System, is an information management tool for creating distributed repositories of documents, drawings, and code for use and reuse by the aerospace and other communities. The NELS retrieval engine loads metadata and source files of full text objects, perform natural language queries to retrieve ranked objects, and create links to connect user interfaces.
- NELS is designed for use on heterogeneous hardware and software systems, which may locally or remotely. Some of the key features of NELS are network operation, natural language support, object retrieval, interface.
- NCSA:** National Center for Supercomputing Applications. NCSA provides services and facilities to a variety of users and institutions. These users are involved in computational science research that complements the traditional methods of laboratory experimentation and theoretical investigation. Computational science allows researchers to recreate numerically, or simulate, natural phenomena on a high-performance computer. In many cases, such phenomena cannot be investigated in the laboratory or fully evaluated theoretically due to such constraints as safety, cost, speed, or time. In other cases, the supercomputer is being coupled directly to laboratory instruments or observational facilities for extensive data computing. The federal High Performance Computing and Communications Program, as well as the communications technology initiatives envisioned by the current administration, support the creation of a permanent national infrastructure for high-performance computing. NCSA's direction reflects these national initiatives.
- SDMS:** Spatial Data Management System The subject of this technical paper.
- STB:** Software Technology Branch of the NASA/Johnson Space Center (PT4)
- The Software Technology Branch is the home of the Software Technology Laboratory which demonstrates, evaluates, prototypes and develops new software technologies. Branch software is available to the NASA/Contractor community from PT4 and to the general public through the Computer Software Management and Information Center (COSMIC). Source code and documentation for programs may be purchased at a nominal fee for unlimited copies with no royalties.
- TCP/IP:** Transmission Control Protocol/Internet Protocol
- Targa:** One of the many electronic picture formats. Noted for high definition and color.
- UNIX:** Strange arcane operating system originally developed by Bell Laboratories.
- Virtual Reality:** An alternate reality provided by electromechanical means.
- WAIS:** Wide Area Information Service. WAIS is a product to help end-users find and retrieve information over networks.
- WWW:** Wide World Web.