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Title:

ADVANCED VISUALIZATION TECHNIQUES

Investigator:

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Significant Accomplishments

I was brought on-sight to NASA Marshall Space Flight Center's (MSFC) Earth Science and Application Division (ESAD) in June 1990, in order to evaluation the existing visualization environment at ESAD and to implement efforts to correct any deficiencies within this environment. Part of this year's efforts has concentrated on evaluating the scientific computing needs of the division scientists and determining whether the existing visualization environment provides the proper tools for meeting these needs. Some of the deficiencies have been corrected using "off-the-shelf" software available for the Silicon Graphics computer from various NASA facilities. Other deficiencies will need to be corrected by intense development efforts in the upcoming year. Much energy has been spent preparing for this development effort, so that development will occur in a highly directed fashion and within an integrated, flexible, and expandable environment.

a. Evaluation of Visualization Environment at ESAD. The visualization environment at ESAD consisted primarily of the McIDAS turnkey image display system (mainframe & PC), with minor supplemental application programs running on I^2S, Stardent, and PC platforms. Although some scientists were satisfied with the present visualization environment, many expressed moderate to extreme frustration with the lack of adequate visualization tools to meet their needs. The findings, as reported in Botts [1], are summarized below:

1. McIDAS provides many visualization needs, but not all;
2. Many scientists have abandoned McIDAS because of difficulties of use, or because it does not meet their needs;
3. Scientists often turn to uncoordinated and generally inadequate development on PC's to try to meet their needs;
4. Some advanced prototype tools have been developed on Stardent, but development has never progressed to a stage of a general useful tool;

Ineffective use or abandonment of existing visualization tools has resulted from:

1. Lack of Integration of Tools
2. Lack of User-Friendly Interfaces
3. Lack of Coordination & Archiving of Software Development
4. Incompatible Data File Formats
5. Lack of Simple Output to Video or Print
6. Tools Not Available to Meet Many Visualization Needs

b. Definition of Science Needs. Outside of specific needs by various scientists, general needs of scientists at ESAD include:

1. Ability to Easily Move Data Between Visualization and Analysis Tools;
2. Easy to Learn/Easy to Use Applications;
3. Ability to Integrate Different Data Types from Various Sources;
4. Ability to Interactively Probe and Analyze Data, Not just Visualize;
5. Flexibility to Quickly Add New Features into Existing Tools;
6. Balance of Hardware Environment Between High-Powered & Personal Workstations;
7. 3D important in Many Applications, Overkill in Others;

In addition, four major application needs have been recognized:

1. A general Image Processing toolkit, with easy links to other applications;
2. Ability to link and compare various multidimensional & multispectral datasets (see LINKWINDS program below);
3. Ability to integrate, and interactively visualize, compare, and probe various datasets related in 3D space and time (see MASS project below);
4. Ability to interactively visualize, correlate, and analyze time sequences of large global data sets (see GloVE project below);

c. Evaluation of Available Software/Hardware. It was determined that some of the immediate needs of scientists at ESAD might be met using "off-the-shelf" software running on the Silicon Graphics (SGI) computer platform. A SGI 4D/50G was obtained under lease in order to evaluate the feasibility of the SGI platform for future visualization development, as well as to evaluate the following available software:

1. ELAS - an image processing package developed at NASA Stennis;
2. LINKWINDS - a linked windows application, developed at NASA JPL, for evaluating and correlating multidimensional, multispectral datasets;
3. FAST - a Computational Fluid Dynamics (CFD) package developed at NASA Ames;
4. 4Dgifts - general purpose image manipulation routines provided by SGI;

In addition, Stardent Computer's Advanced Visualization System (AVS) was evaluated to determine its usefulness for meeting some of ESAD's visualization needs. Two prototype programs, Vis5D and VisGI, developed under contract at the University of Wisconsin's Space Science Engineering Center (SSEC), were also evaluated.

Some of these programs have proven useful as either long or short-term visualization solutions, whereas others provide conceptual models and sources of usable code for future development at ESAD.

In addition to hardware and software issues, much energy has been expended in evaluating solutions to data input/output between computers and video/hardcopy devices. An Abekas A60 video frame store unit, capable of grabbing or playing 720 frames at video rates, was brought into ESAD for evaluation (Meyer and Botts [3]). For color printing of computer generated images, the TOYO TPG3100 Thermal Printer and the Mitsubishi S340 Sublimation Printer, have undergone testing with Stardent, SGI, and McIDAS generated images.

d. Definition of Software Development Environment. The importance of developing within a flexible, integrated visualization environment (DAVE) was discussed in Botts [1]. In order that software

development at ESAD result in flexible, extendable, and portable code, much effort has concentrated on defining the standards and tools under which this development will proceed. Transfer of data between various file formats (e.g. McIDAS, SGI, X, PC-based, and YUV) has been accomplished. Candidates for Common File Formats (e.g. CDF, netCDF, and HDF) have been evaluated. Common Data Structures to be used at ESAD are being development and implemented (Botts [4]). Standards have been evaluated and selected for operating systems (ATT UNIX V), windowing systems (X/Motif), programming languages (ANSI C, C++, and FORTRAN 77), and 3D graphics libraries (SGI GL). A tool for building Graphical User Interfaces (GUI), UIM/X, has been evaluated and selected.

Focus of Current Research and Plans for Next Year

Intense development efforts will begin in June 1991, to solve some of the immediate and long-term needs of scientists at ESAD, as well as any scientist working with EOS data sets. Two primary efforts include the Multidimensional Analysis of Sensor Systems (MASS) and Global Visualization Environment (GloVE) programs.

GloVE is an extension of previous prototype development efforts at SSEC, and will allow the visualization, correlation, and statistical analysis of time sequences of large global data sets (e.g. MSU, SSM/I, ECMWF, ERB, ERBE, CCM, LAMPS, RAMS). MASS will provide 3D visualization and analysis of various data sets associated with ER-2 flights (e.g. MAMS, AMPER, LIP) and allow correlation of these data sets with SSM/I, GOES, MSU, and ground-based RADAR data.

In addition, future efforts will concentrate on the integration of UNIX McIDAS (Meyer and Botts [2]) and general image processing routines into the visualization environment at ESAD. Input and output between workstation and video/print devices will be simplified through the development of user-friendly modules, also to be integrated into the environment.

References

1. Botts, M. (January 1991). *Recommendations for Establishing a Data Analysis and Visualization Environment (DAVE) at the Earth Science and Applications Division, NASA Marshall Space Flight Center*, white paper submitted to NASA/MSFC/ESAD.

2. Meyer, P. and M. Botts (January 1991). *Summary report to Division on Video Capabilities and Needs*, report to NASA/MSFC/ESAD.

3. Meyer, P. and M. Botts (September 1990). *Suggestions for a UNIX Based McIDAS*, report to NASA/MSFC/ESAD.

4. Botts, M. (March 1991). *The Importance of Data Abstraction and Standard Data Structures in Visualization Development*, to be submitted to visualization conference.