IMAGE MANAGEMENT RESEARCH

Andrew B. Watson
Perception & Cognition Group, NASA Ames Research Center

Space Station Human Factors Research Review
December 3-6, 1985

What is an Image Management System ?

To begin with, what is an *image* ? I will take as a working definition any picture originally captured from life, as opposed to pictures generated digitally, which I will call *graphics* . Thus images are typically the result of a photographic process, either conventional or digital. Another distinction is that images are typically *pixel oriented* , while graphics are *object oriented* (eg lines, circles, areas etc). Now what is an image management system? Computers today provide an extensive set of tools for manipulating text, and a somewhat smaller and newer set for dealing with graphics. The next revolution will be the provision of tools for manipulating digital images. An image management system is a computer-based facility for capturing, coding, processing, editing, storing, analysing and displaying images.

Space Station Applications

What is the need for such systems on board the space station and in the various space station supporting centers? The current Space Station Flight Operations Requirements document, dated November 1985, is replete with references to the need for video interfaces among the station, platform, shuttle, omv's, and various ground control centers. (2.1.7.1, 2.1.9.1, 2.1.10.1, 2.2.3.1, 2.2.4.8, 2.2.6.6, 2.2.12.4, 3.1.5.1). While perhaps originally concieved as analog video hook-ups, it seems highly likely that the advantages of digital video will eventually lead to its adoption, particularly in during EOC.

Elsewhere it is stated that these video links must be part of a highly reconfigurable "General Purpose workstation" (2.2.4.7, 2.2.4.8), which can only be done effectively via digital video. This integration of digital video into general workstations is itself an image management problem.

The requirements document also deals at some length with training, noting the need for video aids (2.1.11.3). This presumably refers to video disc, with its invaluable capacity for random access. It is further stated that comparable training must be provided on board the space station (2.2.9.1). We are thus lead to assume that the space station will include onboard storage for large random access libraries of training images.

Elsewhere it is stated that "Automated training shall utilize operational onboard equipment in a simulation mode." (2.2.9.4) Since most operations will require visual/video monitoring, this would seem to require an onboard library of imagery to accompany the simulation.

Other space station image databases can be imagined, such as parts directories, archives of scientific imagery, repair manuals, personnel directories, and so on.

Research Issues

What are the research issues involved in image management systems? They divide into two sorts: image processing research and image perception research. The image processing issues are the traditional ones of digitizing, coding, compressing, storing, analysing, and displaying, but with a new emphasis on the constraints imposed by the human perceiver. For example, the efficiency of a coding scheme is considered not with respect to statistical efficiency alone but also with respect to perceived fidelity. We have made some progress in this area and have developed two image coding algorithms that may greatly increase the efficiency of an IMS.

The second category, image perception research, involves a study of the theoretical and practical aspects of visual perception of electronically displayed images. We are interested in issues such as how rapidly a user can search through a library of images, and how to make this sort of search most efficient? Is it best to present each image at full size and full resolution, or is it better to present many images at once at reduced size and resolution? This raises a fundamental question, namely, what are the effects of size and resolution upon the speed and accuracy with which humans recognize images. We have experiments on this question underway at the moment.

Another set of issues relate to the optimal interface to an IMS. What image manipulations should the user be able to do? Zooming? Moving images about the screen? Accessing aditional textual data about the image? Subtracting two images? More general image processing operations? Some of these are no doubt useful in particular applications but is there a set which are highly useful in the "generic" setting?

Another large and fascinating issue is how to code images in a way that is optimal for the human perceiver. Recent research in our group suggests that an understanding of human spatial and color perception may provide ways to massively reduce data requirements without sacrificing visual fidelity. To give but one example, it is well known that color vision has lower spatial resolution than pattern vision, and an image coding method which could take adavantage of this would result in a massive data compression. One algorithm that we have developed, which separates an image into separate bands of resolution, provides a natural way of doing this.

IMS Test-Bed

We have designed a test-bed within which many image management issues can be addressed. It consists of a high performance UNIX workstation with a very high resolution color framebuffer and display. The workstation hosts a digitizer, an array processor, and an optical video disc recorder.

The typical scenario is that the user, comunicating through an interface resident on the workstation, requests an image or set of images. The locations of these images on the optical disc are determined by a database resident on the workstation. The images are played back and captured by a digitizer. The digitized images are processed by the array processor and displayed with desired size, location, and timing on the high resolution framebuffer. Images can be recorded on the optical disc (and entered into the database) either from a video camera or from the digitizer. This configuration sacrifices something in speed to obtain the high degree of flexibility suitable to a research, rather than production, environment. It is currently about 75% complete. When complete, it will have the following capabilities:

Capabilities of Test-Bed

rapid aquisition from large (24,000) image database

rapid digital processing of selected images

display of multiple images of arbitrary size on single screen

arbitrary presentation rate of full-size images

database management of image library

supervisory control of all functions from UNIX workstation

Conclusion

There is no question that image management systems will become an integral part of the information systems of the near future, and it is almost as certain that they will become part of the space station. We hope that our research will help make that system powerful and useful, and generally contribute to the efficiency of space station operations.

IMAGE MANAGEMENT RESEARCH TEST-BED