

DIGITAL PROCESSING OF REMOTELY SENSED IMAGERY

William B. Green
Manager, Science Data Processing Systems Section
California Institute of Technology
Jet propulsion Laboratory

Caltech's Jet Propulsion Laboratory has been using digital image processing technology to support scientific analysis of remotely sensed imagery for over thirty years. Digital image processing was first applied to enhance imagery returned from the Lunar sulfate by Surveyor spacecraft in the 1960's. Video cameras on-board the Surveyor spacecraft were used to transmit analog video images to earth, and selected images were digitized and enhanced using software written for early computers. This early processing provided enhanced resolution imagery of the Lunar sulfate that was used to design the Apollo Lunar landing modules. In the late 1960's and early 1970's, NASA spacecraft returned digital imagery from a series of Mariner missions to Mars, Venus and Mercury. In 1976, four Viking spacecraft (two Landers and two Orbiters) performed detailed reconnaissance of the planet Mars, and two Voyager spacecraft returned digital imagery of the outer planets during the 1970's and 1980's. At the current time, the Galileo spacecraft is in orbit around Jupiter, transmitting daily imagery of the Jovian atmosphere and the many satellites of Jupiter. Mars Pathfinder is scheduled to land on July 4, 1977, and the Mars Global Surveyor spacecraft will orbit Mars later in 1977, and both spacecraft will also be returning digital imagery to earth.

Digital image processing has evolved continuously throughout this period of planetary exploration. In recent years, commercially available equipment has significantly reduced the cost of developing and operating digital image processing systems as the technology of digital image processing has been used to support a wide range of applications, examples of which include nondestructive testing, motion picture special effects, biomedical applications, and high definition television broadcasting. This talk will describe the basic methods used for digital image processing and digital image enhancement of remotely sensed images. Summaries of basic processing methods used for both subjective enhancement of imagery and quantitative processing of imagery will be presented. Examples will be drawn from both deep space and earth orbiting remote sensing missions.

This talk will also include recent updates from the Galileo mission to Jupiter and the Mars Pathfinder mission. The Galileo mission data system incorporates specialized data compression and transmission technology that has been developed to overcome the loss of the high gain antenna and the resultant loss of transmission bandwidth. The data processing methods being used on Galileo to maximize the scientific return from the mission will be described. The talk will be illustrated with examples of recent dramatic imagery of Jupiter and its satellites from the Galileo mission, and early results from the Mars Pathfinder mission (scheduled to land on July 4th) will be included. The talk will conclude with examples of terrain "fly y-overs" and other animation products generated from JPL's planetary exploration missions.

The research described in the paper was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under a contract With the National Aeronautics and Space Administration.

Biographical Sketch: William B. Green

Mr. Green is Manager of the Science Data Processing Systems Section at CalTech's Jet Propulsion Laboratory. He has responsibility for design, development, implementation and operation of ground based systems used to process science instrument data returned by NASA's planetary and earth observation spacecraft. Current activities include processing imaging and multispectral data returned by the Galileo spacecraft now in orbit around Jupiter, preparations for processing images of Saturn and its moons from the Cassini mission to be launched in 1997, and for processing of stereoscopic images of the surface of Mars to be acquired by the Mars Pathfinder lander in 1997. The Section is also involved in supporting flight and ground software development and development of data reduction systems for a variety of earth remote sensing instruments to be flown as part of NASA's Mission to Planet Earth. The Section produces a variety of digital, film and video products; these include CD-ROM and photoproduct archival data bases, and animations and "fly-over" sequences of planets and other solar system objects. The Section also develops and maintains a variety of Internet image data base browsers, providing public access to large planetary image data bases resident at JPL.

Prior to his current assignment, Mr. Green served as Vice President of Engineering at Terminal Data Corporation from 1986 to 1989, where he led design and development of electronic document scanning systems and micrographics equipment. Earlier, as General Manager of the Image and Signal Processing Division of Unisys Defense Systems, he managed development of systems for electronic signal processing of undersea acoustic data and implementation of systems that processed documents electronically for the National Archives and Records Administration and the U. S. Patent and Trademark Office. He is the author of two textbooks, "Digital image Processing--A Systems Approach" and "Introduction to Electronic Document Management Systems", and numerous technical papers. He has taught image processing at Harvard University, California State University at Northridge, and George Washington University. Mr. Green is a Senior Member of IEEE.