ISAAC N. BANKMAN and WILLIAM J. GECKLE

GUEST EDITORS' INTRODUCTION

Since its early years, APL has been significantly involved in imaging and image processing. In 1945, Bumblebee ramjet vehicles were recorded in flight with motion picture cameras at 60 frames per second to synchronize the telemetry data with the speed and position of the vehicles. A pioneering achievement of APL was the historic composite aerial photograph taken in 1948 by a camera onboard a V-2 rocket, showing an area of 800,000 square miles extending from Mexico to Nebraska, the first view of Earth from space. One of the first computational image processing applications at APL was a radar map-matching guidance system used in the 1950s to correct the midflight course of the Triton missile. A similar concept was later employed in the Tomahawk cruise missile's optical map-matching guidance system, which was developed with contributions from the Laboratory. The Adaptive Video Processor was a signal processing system developed in the late 1960s to increase the quality of radar images by suppressing electronic jamming and radar clutter caused by clouds and surface reflections. An APL camera onboard the Department of Defense Gravity Experiment (DODGE) satellite, used to study gravity-gradient stabilization, was the first to capture a full-view color picture of Earth from space. The photograph appeared in *National Geographic* in 1967.

In the past two decades, major programs have made imaging and image processing an area of active involvement throughout the Laboratory, with diverse applications of algorithms, software, and hardware. The articles in this issue highlight examples of numerous projects within major APL programs that rely considerably on imaging and image processing.

Innovative custom image processing hardware is often needed to satisfy the requirements of a specific application. Very large scale integrated (VLSI) technology offers a particularly appropriate option for high-speed, parallel, analog processing of image data using low power and small hardware size. Strohbehn et al. describe a custom-designed VLSI processor that performs biologically inspired image analysis functions such as edge enhancement, centroid computation, and image translation.

Fluid dynamics research and applications require reliable measurements of fluid velocities. Diamond describes a real-time image acquisition and processing system for particle displacement velocimetry based on imaging the motion of density-matched particles introduced in the fluid. The system is an efficient implementation of nonrigid body motion processing based on time-varying images.

The Midcourse Space Experiment (MSX) satellite, designed to demonstrate the state of the art in autonomous detection and tracking of targets as part of a space-based ballistic missile defense system, is equipped with a number of imaging devices and automated image processing algorithms. Murphy and Heyler describe the image processing algorithms they have developed to provide tracking and target recognition functions using the Ultraviolet and Visible Imagers and Spectrographic Imagers (UVISI) instrument onboard MSX. A range of analytical tools, from low-level image conditioning to high-level statistical classification, has been used to achieve the performance required by the mission of the MSX program.

The large amount of data involved in many image processing applications has introduced the need for compression techniques to relieve the data storage and transmission burden without eliminating relevant information. Data compression is particularly important in space-based applications where storage space and transmission time are critical. Beser presents an overview of the image compression requirements and approaches that have been adopted in major space missions. In addition, he discusses the vital role of image compression in the future of space-based imaging applications.

The dynamics of ocean waves and currents over large areas of the Earth are observed with spaceborne synthetic aperture radar (SAR), which can penetrate clouds. Tilley and Yemc discuss SAR image formation with a wave domain processor that provides higher accuracy and efficiency than conventional range-Doppler processing. The Laboratory has been involved in the development and application of SAR technology for many years. Forecasting ocean wave dynamics requires the directional energy spectra of waves at high spatial resolutions that can be obtained with spaceborne SAR. In another article, Beal et al. describe briefly the results obtained with an APL processor that transmitted a large number of spectra, in real-time, during a NASA mission.

New point source detection and tracking are important capabilities being developed at APL. Constantikes discusses the advantages of a coning scan imager and the demands it places on the image processing functions of the tracking algorithms. Experiments have demonstrated that reliable point source detection is possible despite the complex nature of the scanning involved.

Tomahawk, the well-known missile system used extensively in Desert Storm, relies heavily on advanced image processing technology developed at APL to achieve precise hits with minimal collateral damage.

Irani and Christ describe the scene-matching techniques used by the missile guidance system. They note that no other currently available means of missile target recognition is as precise as the Tomahawk guidance system.

Over the past 30 years, APL has collaborated with the Johns Hopkins Medical Institutions on a variety of projects to solve problems in medical imaging and image interpretation. A current project involves analysis of images obtained with positron emission tomography (PET), a relatively new imaging modality used to observe the metabolic function of the body. In a research note, Resch and Szabo describe progress in their effort to identify major functional regions in the brain using a neural network. Success in their work may lead to new uses of the emerging PET technology such as evaluation of drug potency.

The articles in this issue represent well the diversity of imaging and image processing applications at APL. In addition to their research and development involvement, Laboratory staff also serve as instructors for several image processing courses in the Johns Hopkins Part-Time Programs in Engineering and Applied Science. This established set of scientific, engineering, and educational activities in imaging and image processing provides an essential capability for the mission of APL. The horizon for image processing applications broadens with each advance in algorithms, hardware, and software. Image processing technology promises to have a significant impact on military applications such as surveillance, reconnaissance, missile guidance, and target recognition as well as civilian applications including environmental monitoring, biomedical research, diagnostic imaging, nondestructive evaluation, and advanced transportation.

THE AUTHORS

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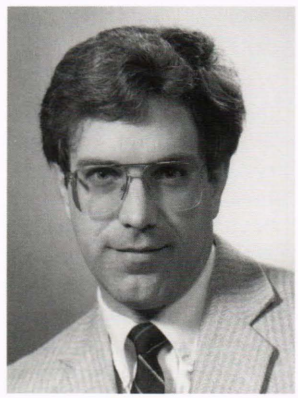

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