Guest Editor's Introduction

Computer Graphics in Medicine and Biology

Judith M. S. Prewitt
National Institutes of Health and Ohio University

In this special issue of *IEEE Computer Graphics and Applications*, we recognize the new relationship between computers and the medical and biological professions. Computers—particularly through their graphics capabilities—are revolutionizing nearly every aspect of these fields. (As evidence, we can point to this issue's Professional Calendar, which lists at least five conferences devoted to computer applications in medicine.) Here, we present a sampling of recent achievements in computer graphics: techniques that let researchers and doctors see the human body and its processes, enabling more precise, more effective diagnosis and treatment.

The rapidly expanding use of digital imaging in medicine has focused attention on methods for describing an anatomical region succinctly. Our first article, by Cook, Dwyer, Batnitzky, and Lee, discusses the use of computer graphics for visualizing or reconstructing surfaces seen in cross-sectional scans as contours. The authors describe several medical applications of their techniques.

Recent work on computer representation of molecular surfaces is surveyed in Nelson Max's article. Max discusses several algorithms for producing vector or raster drawings of space-filling models formed as the union of spheres, and he also considers other, smoother surfaces. Max's illustrative computer-generated images are presented here in color for the first time, and one appears on the cover.

Several stereotactic systems using data from computed tomography for precise placement of neurosurgical instruments have been introduced during the last five years. Our third article, by Rhodes, Glenn, Azzawi, Howland, and Hibbard, introduces a second-generation stereotactic system that improves on the speed, image resolution, accuracy, and patient comfort of past and current systems.

In the field of medical imaging, the perception of spatial and temporal information about internal structures of the body can be critical to clinical decision making and treatment. In their article, Gabor Herman and Jayaram Udupa present a mathematical framework for the representation and display of the discrete surfaces of such structures, illustrated by current projects at the Hospital of the University of Pennsylvania.

Authors Robert Perlmutter and Stephen Friedland have explored various methods of producing computer-generated holograms, and in their article they report on a way to calculate a hologram by the superposition of the Fresnel pattern from the individual planes of a CT scan. Also applicable to NMR, PET, or ultrasonic scan data, this technique can provide considerable support to medical and biological procedures.

Our final theme article, by Steven Wixson, describes computer graphics tools under development for processing multidimensional cardiovascular data. The tools consist of a custom computer for processing and displaying three- and four-dimensional data, a medium-resolution grid model of the heart and any tissues lying between the heart and acquisition instruments, and processing algorithms.

Judith M. S. Prewitt is Stocker visiting professor of electrical and computer engineering for 1982-1984 at Ohio University, Athens, Ohio. She is on leave from the Division of Computer Research and Technology, National Institutes of Health, Bethesda, Maryland. Prior to joining NIH in 1971, she was on the faculty of the University of Pennsylvania, with appointments in the Departments of Radiology (1962-1971) and Mathematics (1960-1963).

A graduate of Swarthmore College (BA in mathematics, 1957), the University of Pennsylvania (MA in mathematics, 1959), and Uppsala University, Sweden (PhD in computer science and applied mathematics, 1978), Prewitt is well-known for her contributions to biomedical image processing and pattern recognition and automated microscopy. Her research interests combine algorithmic and optimized decision making and computer vision and intelligence, and she has published and lectured extensively on these topics.

Prewitt currently chairs the IEEE Computer Society's Computational Medicine Technical Committee and the IEEE Systems, Man and Cybernetics Society's Health Care Systems Technical Committee. She initiated Medcomp '82 and the Medgraph and Medpics portions of the International Symposium on Medical Images and Icons (ISMI) and collaborated on the Medpacs portion. She serves on the editorial boards of the Proceedings of the IEEE, *IEEE Computer Graphics and Applications*, Computer Vision, Graphics and Image Processing, the Journal of Medical Decision Making, the Journal of Medical Systems, and Analytical and Quantitative Cytology, and she is on the advisory board of *IEEE Transactions on Pattern Analysis and Machine Intelligence*. She is a SIAM and an IEEE Computer Society distinguished lecturer and a fellow of the IEEE.