

Preface

Presenting information in image form allows viewers to perceive patterns and relationships which may be missed in a table of numbers; graphics and images have been essential in the development of science and engineering. Medical research and clinical practice lead in the display and interpretation of two- and three-dimensional data. At first many 3D techniques were based on extracting and displaying a surface. However, as requirements of three-dimensional scanning systems and large-scale scientific computations increased, new imaging techniques evolved. In addition to an increased quantity of data, multidimensional outputs are often created. Methods of displaying volumetric data and vector fields have been developed which go beyond everyday vision. Data visualization is used in postprocessing to improve understanding of results; it is also used concurrently with processing to monitor and control computations, as well as to display system performance and utilization.

As computation productivity has increased, new imaging devices and systems have also improved markedly. Data visualization is at the apex of these two expanding technologies. It utilizes new imaging concepts and systems to visualize the information in complex data. It is similar to the biologist's microscope and the astronomer's telescope: We can see things which are not visible to the unaided eye.

Visual data interpretation is more than forming a three-dimensional representation of data, or animating colored images. The goal is to provide tools and a system which allow the user to extract information from the data. This involves a diverse set of tasks: data formatting and management, 2D image processing, display of three-dimensional data, user interface design, visual representation (opaque, transparent, color map, etc.), animation, and organization of the display and computation system. The objective of this issue of the *IBM Journal of Research and Development* is to present research which addresses these diverse aspects of data visualization.

Papers are grouped into six topic areas. Results in *Visualization of volumetric data* present methods of displaying and manipulating three-dimensional scalar and vector fields. Display and interpretation of two-dimensional data and image management systems are topics discussed in *Image display and interpretation*. Animation is a powerful tool for interpreting complex 3D data and visualizing the evolution of dynamic processes, as demonstrated in the third topic area, *Animation for data interpretation*. The effectiveness of various imaging tools depends on the relationship between display and computation functions, i.e., between the workstation and host computer, which are the subjects presented in *Visualization/computation environments*. In some

applications, the information is not numeric; it is a pattern in the data, as discussed in the papers under *Patterns in data*. The sixth topic area, *Special visualization methods*, presents useful imaging methods tailored to specific application areas.

The work presented here advances several areas of data visualization and interpretation. However, several topics require additional development. Most significant is the display of vector and tensor fields; these applications require display of three to six times the quantity of data that is present in a scalar field. Stereo imaging and sound for data presentation are significant options which extend the capacity of the display system. As display methods develop, new user interface techniques will be required. Virtual reality systems offer several promising areas for additional research.

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