Commentary on High-Performance Computing and Human Vision II: Virtual reality and eyeball tracking

LYNNE K. EDWARDS

University of Minnesota, Minneapolis, Minnesota

and

STEPHEN W. LINK

Federation of Behavioral, Psychological and Cognitive Sciences, Washington, D.C.

Visualization of scientific data that are not normally visible can be greatly enhanced by understanding human visual perception. Mars the Movie illustrated the use of stereo resolution for producing realistic vistas of the Mars surface. The real-time recording and analysis of eyeball-tracking data is another example of human vision research which benefits from high-performance computing. Currently the bottleneck is not in the hardware but in the available software to transform data efficiently.

Scientific visualization is the graphical and visual presentation of scientific data. It allows researchers to view data that are not normally visible, such as the surface of Mars or the inside of human brain. An example of scientific visualization using the Mars terrain database was presented by Mary K. Kaiser (Kaiser & Montegut, 1997). One striking feature of this project is that rather than a large computer platform, a smaller platform enabled a faster more realistic rendering of the Mars terrain with more ease. Here bigger is not always better. Kaiser reported changes in personnel programming hours, from 2 months using the GLI kit, worldtool kit, and SGI performer down to 2 weeks. The ready-to-use software toolkits as well as a more powerful desktop such as a high-end Macintosh were reportedly the reason for faster, easier, and less costly production of virtual reality.

A presentation of Mars, the Movie made us acutely aware of the problem of vertical scaling. Without a vertical exaggeration, the Martian terrain would look flat and uninteresting. Being simultaneously presented with two pictures taken from two different perspectives, human eyes use binocular disparity and conversion to piece together these two different pictures as if observing one picture in "stereo." Such stereo resolution was used in Mars, the Movie, for example, to clarify two distinctively different distances between two objects: one in which both objects are far away from the viewer, and another in which one of the objects is close to the viewer. Stereo resolution helps in our apparent perception without introducing too much additional computational load.

Another research example involving massive amounts of data was reported by Jeffrey B. Mulligan (1997). In recording eyeball movements, aside from the massive nature of data, many parameters have to be manually set to assure the reliability of data recording. Future high-performance computers will need to include an artificial intelligence capability to screen out "anomalies" or "out of place patterns" in recordings so that researchers can record data reliably without facing an impossible task of examining each individual data frame.

The true problem for a future in eyeball tracking seems not to be in the data compression system or in its efficiency for handling real-time data, but in Fourier transformations, because the available software is based on very slow fixed-point arithmetic. It seems that a more efficient software should be developed which allows a real-time recording of eyeball movements as well as transformation of the data as they are recorded. This may be one of the areas in which the behavioral scientists can benefit from the software development in the physical sciences.

Mulligan also pointed out the problem of a data compression scheme being selected on the basis of convention rather than for scientific reasons. For example, FBI finger printing data are compressed according to the UPEG or MPEG system. Even though there may be more efficient technology available, such as a wavelet technology, currently there is no support for a new system.

REFERENCES

- KAISER, M. K., & MONTEGUT, M. J. (1997). Of red planets and indigo computers: Mars database visualization as an example of platform downsizing. *Behavior Research Methods, Instruments, & Computers*, 29, 48-53.
- MULLIGAN, J. B. (1997). Image processing for improved eye-tracking accuracy. *Behavior Research Methods, Instruments, & Computers*, 29, 54-65.

Reprint requests should be sent to L. K. Edwards, Department of Educational Psychology, 323 Burton Hall, 178 Pillsbury Dr. SE, Minneapolis, MN 55455 (e-mail: ledwards@msi.umn.edu).