Digital Compression: Playing Tricks On The Eye

Tek's Ali Tabatabai Is A Top Expert In The Field

As the information superhighway begins making inroads into homes and businesses, a requirement for information and entertainment vendors will be the ability to economically transmit and store video images. To satisfy this need, Tektronix is playing a role in guiding aspects of digital compression technology, which employs algorithms to omit redundant visual information.

One person at Tek who's playing a key role is Ali Tabatabai, brought on board 18 months ago. Ali is a compression expert who has advanced both the technology and the international compression standards which will allow the free transfer of images around the world.

Born in France and raised in Iran, Ali completed undergraduate work at Tohoku University in Japan at the invitation of the Japanese government, which conducted competitive testing in a number of countries to identify the most promising science and technology students. He subsequently moved to the U.S. to pursue graduate studies in electrical engineering at Arizona State University and Purdue University, from which he received his Ph.D in 1981. Upon graduation he joined Bell Labs, and later Bell Communications Research. While at Bell, Ali was involved in digital video compression, packet video, image processing, and digital signal processing research. Among his professional distinctions, he was awarded the 1988 Darlington Prize by IEEE for the best paper in sub-band coding of still images. Ali was also a core U.S. member of the international standard organization ITUT (formerly CCITT), responsible for developing the H.261 compression standard for low-bit-rate videophone and video-conferencing applications.

"My interest in compression developed from the challenge of working in what was then a new area of electrical engineering," he recalls. "Those of us involved early on had an open research path." Ali was also part of the team which first demonstrated the H.261 standard using the international ISDN network. In this instance, videoconferencing images were relayed back and forth between the U.S. and Japan at rates of only 64 kilobits per second.

"With the aim of achieving interoperability, standards negotiations are becoming critical since many telecommunications, computer, and consumer electronics companies in participating countries fully expect to join the information superhighway," he says.

The Chance to Apply Technology to Products

Ali's decision to join Tektronix was based on the company's reputation for cutting-edge research, and his desire to have his work applied to products. "Few of us in compression research were involved in product development," he recalls. "I'd always felt a weakness in my arguments for or against particular coding algorithms since I lacked product experience. You need a solid standing supported by implementation skill to present your case in a business environment or in an international arena."

The opportunity to work at Tektronix and to routinely converse with other engineers about product and customer issues was especially important to him: "When Tek decides on particular compression algorithms for its products, you can be sure they will make good business sense."

Ali serves as manager of the compression group at the company's Communications Systems Research Laboratory. The group has a number of responsibilities, including:

- Developing the algorithms used in digital compression. "More than a formula," says Ali, "a compression algorithm is actually a series of steps to decode an image at a specified bit rate." The group also determines which algorithms will best suit particular application and viewer demands, and whether an algorithm should be compatible with existing standards, or remain proprietary.
- Influencing emerging international compression standards that increasingly rely on low bit rates.
- Serving as a resource for company businesses considering products that utilize compression technology. "We educate development teams about digital compression, and provide them with simulation resources so that they can judge the effects of compression on a product's visual output."

Ali believes that the essence of digital compression is to play tricks on the eye. "Depending on the type of motion," he notes, "the eye may be unable to lock on a moving picture's fine details." In such instances, digital information can be compressed, and the eye may not recognize that information affecting visual clarity has been omitted.

Tricks of the Trade

Compression is accomplished by first coding images from analog to digital. Algorithms are then used to remove visually redundant information and lessen the amount of digital data that needs to be transmitted or stored. Though an image of a sunny sky and shaded ground contain different intensities, for example, areas of nearly identical intensity can be coded with a single value, significantly reducing the amount of processed information.

Compression requires tradeoffs, however. "How well do you want to represent edges and colors?" asks Ali. Video conferencing, he suggests, requires less picture quality than broadcast- or studio-quality television. Choosing a compression rate, then, depends upon viewer expectations, and the realization that a decline in image quality closely follows the degree of compression.

To illustrate his point, Ali points to a video demonstration where a camera pans along a row of brick houses flanked by bright yellow and red flowers. At the original transmission rate of about 200 megabits per second, the image is striking in its sharpness. At 4 megabits per second, the edges of the flowers dull noticeably. At 12 megabits, however, the viewer becomes hard pressed to tell the original image from the compressed one, meaning that — excepting broadcasting quality applications — 188 megabits of redundant information need not be transmitted each and every second.

But how will digital compression match up with the alleged capacities of the information superhighway, which touts a fiber-optic bandwidth capable of handling large amounts of information? "A high bandwidth could mean that compression would be unnecessary," Ali notes. He adds, though, the historical precedent that no matter the bandwidth, never-ending uses have been found for it. "The information superhighway will actually accelerate the need for compression-based products," he forecasts, "since the information, communications, and entertainment industries will develop applications that will more than fill the road."

–By Charles Martin