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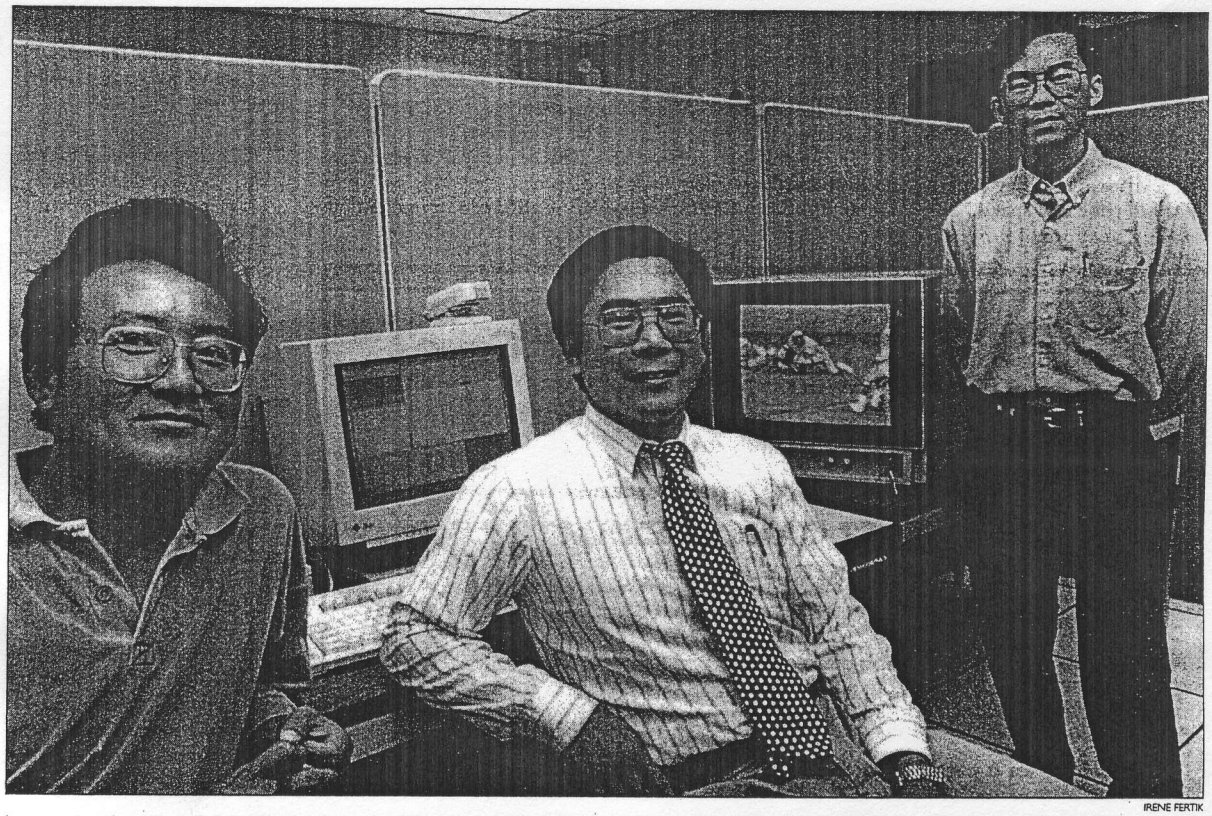

IRENE FERTIK

Image-processing expert C.C. Jay Kuo (center), with SIPI graduate students Sungook Kim and Junavit Chalidabhongse. Together, the researchers have developed a way to speed up the video-compression process by a factor of 100.

The art of video compression

Applied math:

by Eric Mankin

HASTE MAKES WASTE, AND NEVER SO MUCH AS IN THE TASK OF compressing video information, USC image-processing expert C.C. Jay Kuo has found.

By using a method that avoids jumping to conclusions about the motion found in successive video images, Kuo and two graduate students working at the School of Engineering's Signal and Image Processing Institute (SIPI) have created a way to speed up – by a factor of 100 – what is now the most computation-intensive part of the most widely used video compression process.

Recording full-sound color video in digital form generates huge amounts of data. With rising demand for software that transmits video over Internet connections and incorporates video capabilities in multimedia applications, scientists are looking for better ways to "compress" these data. Once compressed, the information can be stored more compactly and transmitted more quickly.

SIPI student Junavit Chalidabhongse delivered a paper last summer in San Diego describing the technique he developed with Kuo and fellow graduate student Sungook Kim. The technique is fully and immediately compatible with the widely used MPEG image-compression standard.

MPEG CAN REDUCE THE AMOUNT OF digital data needed to carry a video image by a factor of 50. A key element in the MPEG strategy is the use of "motion vectors," which economize data requirements by seeking to record only those elements of the video image that change from frame to frame.

Finding the best motion vector with which to compress an image can be computation-intensive and, therefore, time consuming and expensive. One widely used method looks at all areas in an image and its immediate successor (the video equivalent of successive images on a piece of motion picture film) and then uses what amounts to brute computer power to find a solution.

In a major breakthrough, the USC research team has exploited the fact that motion vectors display correlations in both time and space – meaning that large parts of the image move in sync with one another. By delaying the final computation until after the frame has been searched thoroughly for these correlations, the new method uses computational power much more economically and efficiently.

> *"We believe this technique will have real-world, commercial applications."*
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> – C.C. Jay Kuo

THE NEW TECHNIQUE FIRST IDENTIFIES, AT A COARSE LEVEL of resolution, a number of candidates for the best motion vector, just as a number of earlier algorithms have done.

But instead of immediately choosing one of these candidates on the basis of a comparison between the first frame and the frame immediately following it, the new algorithm reserves judgment and considers a third frame as well.

The additional information thus obtained by looking one step ahead makes possible a much better determination of the vector.

The algorithm takes a similar strategy in compressing different areas of a given image. The old full-search, brute-force technique treats all parts of an image as unrelated and calculates each part independently. The USC group's algorithm instead takes advantage of the fact that adjacent areas of an image are likely to have the same or very similar motion vectors. The new algorithm rapidly tests adjoining blocks of the image to see whether the motion vectors are alike. If they are, it uses the correlation to speed up the process.

The new method can reduce the computation time in motion estimation for MPEG compression by a factor of more than 100 with no degradation in performance.

"We've compressed actual video and have achieved even better economies in some cases – up to a factor of 140," said Kuo, an associate professor in the Department of Electrical Engineering/Systems. "We believe this technique will have real-world, commercial applications." ❖