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New Technology Promises 'Camera on a Chip'

By ANDREW POLLACK

TOKYO -- The digital still camera that Toshiba will start selling this summer does not look much different from dozens of cameras that have flooded the market lately. But on the inside, the camera holds what could be the seeds of a revolution.

The camera is the first by a major Japanese electronics company to use a new type of image-capturing device that might one day make possible the exquisitely tiny camera-on-a-chip.

Such cheap micro-cameras could be plastered everywhere as security monitors or be placed in the rear bumpers of cars to help drivers back up. They might even make possible the camera in the glasses frame used by Tom Cruise in the movie "Mission: Impossible." And instead of highlighting a passage in a book with a colored marker, a student of the future might take a snapshot of the passage with a camera built into a pen.

Until now, camcorders and digital still cameras, which store images electronically rather than on film, have captured images using a chip called a charge-coupled device, or CCD.

But these devices have some drawbacks. They use a lot of power, requiring bulky batteries, and are made with a process different from that used to make other microelectronic circuits. That makes it difficult to combine a CCD with other circuits on the same piece of silicon.

The LSI Logic Corporation, for instance, will introduce a chip that has almost all the circuitry needed for a digital still camera -- but not the CCD, which must still remain separate.

The Toshiba Corporation's imaging chip, however, is made using a process known as CMOS (pronounced sea moss), the same process used for making many other integrated circuits.

That process could result in economies of scale by allowing the imaging chips to be made on big production lines used for other chips. It should make it possible to combine on a single piece of silicon the image sensor, timing controls, image compression and memory needed for a camera -- producing the camera on a chip. CMOS imaging chips also use far less power than CCD's.

One big application could be video cameras small and cheap enough to be built into every personal computer, allowing PC users to hold video conferences. Creative Laboratories Inc., the Singapore

company known for its Sound Blaster audio boards, is introducing a PC video conferencing system using a CMOS imaging chip from VLSI Vision Inc. in Edinburgh.

Sensors using CMOS, which stands for complementary metal-oxide-semiconductor, could also tilt the balance of power in the industry, allowing Americans and Europeans a chance to catch up with the Japanese, who now dominate the market both for CCD's and for the camcorders and digital cameras that use them.

"CMOS imaging allows other companies to get into the imaging business," said Bryan Ackland, a researcher for Lucent Technologies, the equipment spinoff of AT&T. Lucent has been doing research on CMOS imaging chips but has not yet decided whether to make a product, he said.

The Sony Corporation and the Matsushita Electric Industrial Company are the leading suppliers of the charge-coupled devices, about 20 million of which were produced for use in cameras and camcorders last year. Including simpler devices used in fax machines and other office equipment, the total market was estimated at about $650 million.

But the CMOS sensors have been pioneered by two start-ups, VLSI , in Scotland, and Photobit L.L.C. in La Crescenta, Calif., a spinoff from the National Aeronautics and Space Administration's Jet Propulsion Laboratory, which is nearby. Other start-ups include Omnivision Technologies in San Jose, Calif., and Suni Imaging Microsystems in Mountain View, Calif.

Numerous big American companies, including Kodak, Polaroid, Hewlett-Packard, I.B.M., Intel and National Semiconductor, are working on CMOS imaging chips, said Eric R. Fossum, chief scientist at Photobit, who introduced the technology to many of those companies when he was at the Jet Propulsion Laboratory. By contrast, he said, when he approached Japanese companies a few years ago, "the reaction was fairly uniformly uninterested."

That might no longer be the case. Toshiba has become a leader in the new imaging technology. "We've suddenty got a shot of credibility from Toshiba," said Peter B. Denyer, chief executive of VLSI.

Matsushita is also working on CMOS imagers that would be combined on a chip with circuitry for compressing the images, said Akira Matsuzawa, a researcher on the project.

Both types of imaging chips have an array of cells representing the individual picture elements, or pixels. When light falls on the surface of the silicon cells, it is converted into an electric charge in proportion to the brightness of the light.

The problem is to deliver these signals to a device that can read them. Connecting a wire to each pixel would cover the chip, blocking out the light. And the charges are so weak that they would be obliterated if put on a common wire, called a bus.

The CCD, invented in the late 1960's by Bell Laboratories, solved this problem by transferring the charges from pixel to pixel in an elaborate bucket brigade. But this requires three different voltages and a lot of time and power.

But with semiconductor features constantly shrinking, it has become possible to put an amplifier inside each picture cell to increase the charge, allowing it to be transferred off the chip on a common wire. This has made the CMOS approach practical.

Still, some attempts to develop such sensors have floundered because the images have been poorer in quality and resolution than those captured by CCD's. A particularly big problem has been noise, which produces unwanted lines or dots on the image.

So far, CMOS imagers have been used in only a few applications where low cost has been more important than image quality. VLSI Vision's sensor is used in the Kidcam, a black-and-white camcorder for children that is sold by Tyco Toys.

But now the quality is improving and the chips are starting to advance into mainstream products.

The Toshiba camera uses a CMOS imaging chip with 330,000 pixels, standard for consumer-level cameras. The camera, which is expected to sell for about $500 in the United States, can be plugged directly into a card slot in a personal computer to transfer the images for display on the monitor.

The Vivitar Corporation, a camera equipment maker based in Newbury Park, Calif., is introducing a digital still camera using a CMOS imaging chip from VLSI Vision. It will capture 800,000 pixels, the first such camera with that resolution to have a price of under $500, said Alexis Gerard, publisher of The Future Image Report, a Burlingame, Calif., newsletter on digital cameras.

At a technical conference in February, Toshiba announced that it had developed a CMOS imaging chip containing 1.3 million pixels, the highest resolution now supported by monitors.

Not everyone is so gung-ho on CMOS imagers. With CCD's, "the picture quality is much better than with CMOS image sensors," said Nobukazu Teranishi, a senior manager in the sensor research laboratory of the NEC Corporation.

Sony, which has produced 50 million CCD's to date and now churns out nearly a million a month, is increasing its manufacturing capacity to meet increased demand.

A problem for producers of CMOS imagers is the head start that CCD makers have. "The CCD is very mature technology, and they have a very strong marketing capability," said Junichi Nakamura, a researcher at the Olympus Optical Company, which has a small research project on CMOS imagers.

But Vern Klein, who is in charge of selling LSI Logic's new camera chip to digital camera makers,

disagreed. "All our customers believe that CMOS sensors will be the way forward," he said.