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Emerging technologies

Tomorrow's digital devices will finally see the light

Janet Rae-Dupree

For all the whiz-bang features digital devices offer, they still have one serious failing: They're blind.

Sure, we are surrounded by camera phones and security videos and Web cams, but none has the ability to figure out what any of the two-dimensional images it records represents. A human being still must make sense of it all.

But now, Canesta, a San Jose semiconductor startup, is bringing three-dimensional vision to even the smallest of gadgets. Dubbed "machine vision" or "electronic perception," Canesta's technology could make possible innovations that designers -- hampered by the existing slow, expensive and power-draining systems currently on the market -- could only dream of before.

Based on a single tiny silicon chip that Canesta calls Equinox, the technology measures how fast infrared light bounces back from various objects in its path, drawing a new series of images as frequently as 30 times every second. In addition to making entirely new classes of gadgetry possible, this new form of electronic-depth perception, expected to cost a few hundred dollars when it first hits the market, could eventually replace machine vision systems that don't function nearly as fast yet still today cost anywhere from \$5,000 to \$60,000.

"Machine vision has typically been the province of academia or very expensive factory-floor types of applications," says James Spare, Canesta's vice president of marketing. "Our approach brings it to bear in all types of devices, delivering it in a format that can be produced in mass volume."

The company two weeks ago began to ship a \$7,500 developer's kit that lets designers figure out how best to build 3-D vision into their next-generation devices. Academic institutions that promise to publish their research results can save \$2,500 on each kit. Canesta hopes Equinox chips will be produced in volume by early summer next year, which means that initial applications could become available by the end of 2005.

What those first applications might be is anyone's guess, Mr. Spare says. But interest has been particularly keen among automotive, security, gaming, logistics, medical and military suppliers -- although they are not yet willing to discuss their efforts publicly. Advanced airbag deployment systems and blind-spot monitoring on cars likely are more than five years away because of the automotive industry's long design cycles. But intrusion detection systems able to "see" the difference between a burglar and a young child getting up to use the bathroom likely will hit the market sooner. Natural game controllers, able to detect the user's karate kick accurately and render it onto a computer screen or television in nanoseconds, will enable entirely new categories of games.

As the chips gain power and accuracy, inexpensive keyless entry systems could differentiate quickly between employee faces and visitor faces, automatically opening doors only for those people it recognizes. Doctors doing endoscopic surgery could know exactly how far from vital vessels their instruments are. And a real-time electronic rangefinder, perhaps built into a cane, could guide blind users accurately down a crowded sidewalk.

"It's a solution that the world has been waiting for," says Tony Sun, a member of Canesta's board and general partner at venture firm Venrock in Menlo Park, which has provided a portion of the company's \$36 million in private start-up capital.

The basic idea behind the machine vision chip is similar to radar, except that it bounces light rather than radio signals off the target. A small infrared light source beams invisible pulses of light -- up to 100 million per second -- onto the area in front of the detector. Each of the 4,096 pixels on the Equinox's 64 pixel-by-64 pixel square of silicon measures how much reflected light comes back, and how fast. An image generator draws new wireframe images -- almost like perpendicular topographical maps -- up to 30 times per second. The current set-up can discern depths as shallow as two centimeters, Mr. Spare says.

Just as with other kinds of semiconductors, he notes, each new generation of Canesta chip likely will cram in more pixels that can process images even faster and in greater detail than the previous generation.

Until last year, Canesta had been showing off its first reference design for the technology, a "virtual keyboard" drawn by a tiny laser embedded in a PDA or cell phone and projected onto a conference table or briefcase or any other handy surface. Canesta's chip could feed text into the device by detecting the rise and fall of each fingertip.

But that, Mr. Sun notes, was a consumer product better implemented by a major consumer electronics manufacturer. "In our business, you have to focus. You can't do everything," he says. "The board members concluded that the 3D sensor had tremendously more upside than the virtual keyboard." Canesta still hopes eventually to license the virtual keyboard to cell phone and handheld computer makers.

Experts on machine vision are particularly intrigued by the technology's promise in robotics. Today's factory robots must be tethered to powerful computers able to interpret the data coming in through the stereoscopic cameras built into the robot's front. Even then, any parts the robot may need must be placed precisely where the robot expects to find it - or the work doesn't get done.

Carlo Tomasi, a professor of computer science at Duke University and former assistant professor at Stanford University, says Canesta's technology -- which he helped to develop -- untethers robots and lets them interact with their environment in much the same way a human being would. Rather than requiring a remote human operator to steer the robot around objects in its path, for example, a Canesta-equipped robot would be able to discern the most efficient path on its own and decide whether an approaching human intends to pass by, hand something to the robot or speak to it.

"This gives sight to robots to let them walk around more freely," he says. "And whether we're talking about a warehouse or a robotic device on Mars or a dangerous building where people shouldn't go, there are now many more applications for robots."

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