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Research News

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A NEW STRATEGY FOR COMPUTING:
SPECIALIZED MICROPROCESSORS MAY BRING
WIDER USE FOR COMPUTER EYES, EARS AND VOICE

Embargoed for Release
February 19, 1990
Photography Available

How can a frog be so good at catching flies when its brain is no larger than a pea?

The answer lies in specialized signal processing. Neural devices near the frog's eyes filter out all but the most critical information before it reaches the brain, dramatically reducing the amount of information it must process -- and allowing the frog's tiny brain to handle the fly-catching job.

Applying that same concept to computing may bring about a fundamental change in the way computers are designed, leading to widespread use of a relatively new type of device known as the digital signal processor. The devices could help bring computerized ears, eyes and voices to a broad range of consumer applications, including:

* telephones that translate the spoken word to a different language,

* security devices that unlock doors after recognizing their owner's voice,

* sophisticated medical imaging done on inexpensive computers,

* real-time navigation equipment to keep pilots or drivers apprised of their location,

* automated pattern scanners to help radio astronomers search for life elsewhere in the universe,

* image recognition systems to help aircraft pilots spot targets, and

* practical low-cost speech recognition systems that could understand any speaker -- and recognize sentences instead of single words.

"During the past few years, the electronics industry has evolved a family of specialized and often parallel processors which are optimized to carry out the kind of operations used in signal processing," said Dr. Richard J. Higgins, director of the Microelectronics Research Center at the Georgia Institute of Technology. "These processors can provide the eyes, ears and voice for computers, and eventually other senses, as well."

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Specialized signal processors tailored to specific computer applications could open a bottleneck that has slowed conventional microprocessors for 30 years, said Higgins, who will discuss the impact of these new digital signal processing chips February 19 at the annual meeting of the American Association for the Advancement of Science.

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"The software instructions telling the computer what to do, and the data upon which it operates, now co-exist in the same memory and have to be transported in the same set of wires," he explained. "That's awkward, and if we humans had to do that ourselves, we'd never get anything done."

The new generation of digital signal processors provide separate memory storage for the data and instructions, and separate wire buses for transporting the information. The devices can also operate in parallel, splitting a big job into pieces which can be handled simultaneously by different processors.

Working upstream from the computer's central processing unit (CPU), they reduce the amount of data sent to the CPU -- just as Mother Nature's processors reduce the amount of data sent to the frog's brain. "It's like going from a one-lane road to a superhighway," Higgins said.

Digital signal processors have already found application in specialized speech and image processing. Existing processors must be trained to the speech patterns of individual speakers, however, and can recognize only single words. Higgins believes they will ultimately be able to recognize entire sentences and become speaker-independent.

As long as the signal processors remain relatively expensive, their use is limited. But Higgins expects that mass production of the specialized chips will lower the cost and open new consumer applications in much the same way that very large scale integration (VLSI) devices allowed the mass production of personal computers.

Widespread use of the processors will also have to wait for more "user-friendly" software which will be developed only when the devices are mass marketed.

An early consumer application of digital signal processing came in a product developed by Texas Instruments called "Speak 'N Spell." The device, which Higgins called "visionary," combined a speech synthesizer, keyboard and display in a "spelling drill" teaching toy.

The author of a new book, Signal Processing in VLSI, Higgins warns that the expanded role of specialized digital signal processing devices will demand more cooperation between hardware and software designers. It will also pose a new challenge for university educators trying to collaborate among critical disciplines such as digital signal processing and computer engineering.

"The ability to do these computations with the speed necessary for real time requires that the hardware configuration be matched to the application," he explained. "You must tailor the hardware architecture to the software algorithm."

EDITOR'S NOTE: This presentation will be part of "Physics Instrumentation for Science and Technology," held February 19 as part of the Physics, Astronomy and Engineering Section of the AAAS meeting. For assistance during the meeting, John Toon may be contacted at the New Orleans Hilton.