A LOW-COST, HIGH-SPEED VISION SYSTEM

HORSHAM, UK

A 10-year-old university research project has evolved into an affordable high-speed vision system that is attracting interest in many quarters, from industrial users to police departments to the U. S. Department of Defense. Called Clip, for cellular-logic image processor, the system uses a fine-grained parallel architecture that will process images up to 2,000 times faster than conventional, serial processors, according to its maker, Stonefield Systems plc.

Equally important, an extensive library of software has been developed for the machine. Clip comes with software for applications as diverse as fingerprint analysis, X-ray sorting, and aircraft identification. This is significant because only a handful of similar parallel image-processing systems have been built, and very little software for such machines exists.

Work on Clip dates back to 1976, when Michael Duff, now a professor at University College, London, started developing a large-scale parallel array processor. Seven years ago, his project culminated in a 96-by-96 array of 1-bit processors. "We believe this was the first one built in the world," says Bill Considine, Stonefield's managing director. Then Duff developed the system's software to the point where it has become viable as a commercial product, Stonefield believes. The Horsham company has licensed the Clip design from Duff and his university backers.

A 64-by-64-processor system can find one dropped stitch in a piece of textile in 0.1 s, a task that takes a DEC PDP-11/64 a full minute. When Clips with bigger processor arrays are built, they will do the job even faster, Stonefield says.

Few commercial parallel-processing engines have capabilities comparable to Clip's for the price. The Pixar Image Computer from Pixar, San Rafael, Calif., for example, has only four processors, so it is not a fine-grained, one-processor-per-pixel system like Clip. The Connection Machine from Thinking Machines Corp., Cambridge, Mass., could approximate Clip's capabilities—it contains 65,535 1-bit processors—but it is a $3 million general-purpose computer. Clip not only is designed for image processing, but is far less expensive. Stonefield expects most of its sales will consist of 32-by-32-processor systems, priced at about $142,000 each.

The processor array comprises a number of cards, each carrying processors for an array of 32 by 4 pixels. Usually, 32 bits or less of local image memory are associated with each processor. Extra image-store cards can extend this to up to 2,048 image planes.

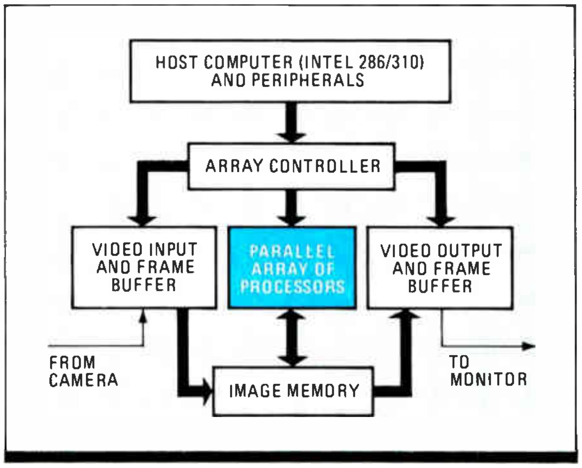

IMAGE ENGINE. Large arrays of 1-bit processors—32 by 32 and up—are the heart of Stonefield image-processing systems.

The system's video-input boards can take standard images from television-signal sources, charge-coupled-device or line-scan cameras, and satellite picture-data files. Video-output boards display the processed image on a monitor. The host computer is based on an Intel 286/310 system and runs under Xenix.

Clip's software lets it take small sections of a large, high-resolution picture and analyze it by sections. For example, a 32-by-32-processor Clip could analyze a 256-by-256-pixel picture in 64 sections.

A library of subroutines callable from the user's C-language program contains some 100 image-processing functions, including image enhancement using high-speed thresholding; feature enhancement and noise reduction; measurement of area, perimeter, and angles; and object recognition. Applications include pattern recognition, component inspection, surface inspection, target analysis, surveillance, seismological surveys, and X-ray classification.

From Stonefield's point of view, the most important applications will be industrial. The 13-year-old company specializes in industrial-control systems. "Machine vision has become a hot subject. People are building systems controlled entirely by robots," says Considine. "But there is little or no automation in the inspection systems," which is where Clip could be brought to bear.

Stonefield's beta-site applications include surface inspection of aerospace material, textile inspection, and checking of electronic components. The first production model, a 32-by-32-processor array, was delivered at the end of September to the U. S. Defense Department. The DOD has also ordered a 128-by-128-processor version. The Pentagon is believed to be experimenting with using Clip in aircraft-recognition systems.

–Steve Rogerson

GRAPHICS

IC ADDS HIGH-END GRAPHICS TO PERSONAL COMPUTERS

SAN DIEGO

The sophisticated color graphics that have helped make high-end work stations indispensable engineering tools are on the verge of spilling over into personal computers. The road to high-performance color graphics—which require video-data rates above 100 MHz and precise control of high-resolution bit-mapped displays—is being paved in large part by a single-chip back-end subsystem called a Ramdac.

The Ramdac—a proprietary design of Brooktree Corp. that combines random-access memory with digital-to-analog converters—vastly simplifies the design of the analog and digital circuits that stand between a graphics system's frame-buffer memory and the color monitor. This has been the toughest part of a graphics system for digital-oriented engineers to design. Now, the appearance of a low-cost Ramdac will likely hasten the penetration of personal computers into desktop publishing and other markets driven by high-resolution graphics.

The 454's introduction signals an important new phase for graphics, says market consultant William I. Strauss of Forward Concepts Inc. in Tempe, Ariz. "It's the first round of sophisticated chips for personal-computer color graphics. Within six months, we'll see a lot more." The boom in desktop publishing is inspiring users to apply graphics in ways they never thought of before, says Strauss.

Brooktree, of San Diego, introduced the first Ramdac last year. Called the Bt451, it is a monolithic CMOS device that operates at up to 125 MHz and replaces 20 to 30 parts, mostly expensive and power-hungry emitter-coupled-logic chips for multiplexing, interface logic, and control circuitry. The 451 has been snapped up by makers of high-resolution graphics gear, a large percentage of whom use it in their latest-generation hardware. But the 451's tab of about $100 per chip remains far too costly for personal-computer makers and suppliers of add-on graphics boards.

However, these vendors badly want sophisticated color graphics. Brooktree is accommodating them with a CMOS Ramdac that at 110 MHz runs almost as fast but costs only $40. The new Bt454, now being produced in sample quantities, supports fewer simultaneous colors, 17 from a palette of 4,096 colors, compared with 259 from a palette of the same size for the 451. But otherwise it retains most of the important features of the 451, notes Jeffrey R. Teza, director of product marketing.

Brooktree had been reluctant to develop a chip for the personal-computer market, preferring instead to devote more design energy to higher-performance Ramdacs. But potential users would not give up. "They pried it out of us," says Teza. "It's truly a market-driven part." The attraction, besides the price and functionality, is its architecture, which is pin-compatible with the 451.

A Ramdac provides circuitry for the fastest part of graphics: controlling the color monitor and refreshing the screen at the same time that the system's frame buffer is updated. The 454 chip carries a 16-by-12-bit bank of RAM used as a color palette, or color-lookup table, and three 4-bit DACs.

DUAL-PORT RAM. The Ramdac architecture supports a display of 1,280 by 1,024 pixels, with up to 4 bits of image data per pixel, plus another bit for overlay data. A special 1-by-12-bit overlay palette simplifies designing in cursor and screen-grid functions, solving what is said to have been a ticklish problem for graphics designers. Another of the 454's major advantages is that it has a dual-port color-palette RAM: there are separate paths for pixel and microprocessor data, so screen refreshing can continue while new palette selections are entered into the RAM.

The frame buffer interfaces with the 454 at up to 28 MHz through four TTL-compatible pixel-data input ports. Internal multiplexing of the pixel data allows the Ramdac to maintain the 110-MHz video-data rates that Teza says are needed for sophisticated color graphics.

Brooktree knows it could be poised to have its first chip to find a volume market, Teza says. The firm's other products address markets with volumes in the tens of thousands, far less than the potential of the personal-computer business. In addition to makers of graphics systems, several add-on personal-computer graphics-board suppliers are discussing buys of 50,000 devices and up. *–Larry Waller*

SMART SCANNER READS ROUGH DRAWINGS

MUNICH

Coupling artificial-intelligence techniques with a scanning camera yields Siemens AG a setup that can enter even rough drawings into a computer-aided-design system. What's more, the high speed of the operation means that graphics can be entered in as little as 10% to 20% of the time required by conventional graphics-input techniques. The Siemens technique—so far unnamed—also considerably reduces the chances of human error during the input process, says Eckart Hundt, a laboratory manager at the West German company's Corporate Research Center in Munich.

The experimental setup developed by Hundt's team can take a rough sketch of a circuit diagram, drawn by hand without attention to detail, and reduce it to its symbolic elements. The lines don't have to be straight and precisely terminated, nor do the circuit symbols need to be drawn or oriented exactly in the diagram. Accompanying text, such as component designations and specifications, can be handwritten as well.

Siemens is demonstrating the technique for recognizing circuit diagrams, but the company says it is easy to load the system with symbols for other types of graphics, such as flow diagrams, construction drawings, or maps. The technique could replace keyboards, mice, and digitizing pads as input devices for computer graphics in such applications, Siemens says.

Conventional graphics-input methods rely on commands from a keyboard or a mouse. Entering them takes time, and so does the method in which a stylus is used to pick off the coordinate points of lines on a drawing placed on a tablet or pad. Not only are these methods slow, they are also subject to human error.

With the Siemens technique, human intervention is kept to a minimum. First, a charge-coupled-device camera scans the rough sketch—typically, a page measuring about 8½ by 11 in. The camera outputs a digital signal that is fed line by line to a computer and stored as a bit map in the computer's random-access memory.

HUNDT: Cameras and AI software may replace conventional ways of entering drawings into CAD systems.

The program that Hundt and his associate Gerd Maderlechner have devised runs on a Digital Equipment Corp. VAX computer. Using pattern-recognition methods, the computer separates the text from the graphics. If the text is machine-readable, such as hand-printed block letters and figures (but not script), the computer identifies each character in the text by means of optical character recognition, converts the characters into ASCII code, and stores the code in the same bank of RAM as the drawing data. This memory has a typical capacity of 2,000 by 3,000 bits or pixels—sufficient for the amount of graphics and text that can fit on a letter-size sheet.

The program's main task is to transform the raster image into a symbolic description. It does this by breaking down the graphics into individual line elements and determining the coordinates of their ends.

Defining a line with just two coordinates results in a big reduction in data, which, Maderlechner points out, "significantly raises the technique's processing speed." The system also specifies the points at which lines branch off or join each other.

Next, the software determines whether the line elements repre-