

# Electronic Engineering TIMES

This week:

## Technology Trends

Interconnects are reaching new plateaus. Liftout supplement, after page 52.

Monday  
September 11, 1989  
Issue 555

A CMP Publication

THE INDUSTRY NEWSPAPER FOR ENGINEERS AND TECHNICAL MANAGEMENT

## Fuzzy logic put in ROM

By R. COLIN JOHNSON

*Kyoto, Japan* — Mycom Inc. has pioneered a way of wiring digital memory chips to emulate fuzzy logic. Mycom's approach is not "true" fuzzy logic, according to its critics, because its chips do not have an infinite number of responses; rather, responses are looked up in a finite-sized ROM.

Nonetheless, Mycom claims the largest number of design wins for fuzzy logic in Japan, estimating 100 today and 300 by the end of 1990. The company has 10 design centers working on custom fuzzy chips.

The method used by Mycom was invented by Kaoru Hirota of Hosei University (Tokyo) and Haruhiko Arikawa, a design engineer at Mycom. The method partitions the solution space into fuzzy rules called virtual pages. Each page embodies a different response (hence its fuzziness),

Mycom's approach results in the same processing speed regardless of the number of rules, whereas other designs trade off the number of rules for processing speed. "The only trade-offs are between the number of inputs and outputs needed and the number of memory chips that must be used," said Arikawa.

Chips typically run at 6 million fuzzy logic inferences per second (Mflips), though special, high-speed versions could be produced to run as fast as 60 Mflips since the only restraint to speed is the speed of the ROM used.

Mycom's approach does not commit the user to any particular style of doing fuzzy logic, as do other approaches. Any shape membership function can be chosen, as can any type of "defuzzification" method. And any precision membership function can also be used since it is represented internally as floating-



**Haruhiko Arikawa: Neural-net emulations are next.**

tem are systematically applied, though only one ROM is required if the number of inputs and outputs is small. Mycom's standard chip uses 100-ns (access time) 512-kbit CMOS ROMs in 28-pin DIPs with 16 digital input pins and eight outputs).

The two are needed together to design and debug a fuzzy application. After debugging is complete, the FBEN is replaced by a custom ROM. The FCAS, however, is typically still needed to control access to the ROM and can be embedded for small jobs. For large-volume systems, Mycom can supply an optimized chip that eliminates the need for the FCAS.

Though most of its customers are still developing their products, Mycom's first successful application will be a multi-axis robot controller with 9 degrees of freedom. It uses two to three chips per axis, plus a master controller chip. The robot weaves fishnets and replaces the old mechanical cams that had to be changed over for each weave. Said to be the world's first non-mechanical fish-net controller, the robot will be shown in the October Textile Machine Show in Osaka.

For the future, Mycom is dabbling in neural-network emulations.

"If instead of using ROM you use RAM, it is possible to create a learning capability like that of any neural network," Arikawa said.