Exclusive: High-Speed Model-Free Adaptive Control

CyboSoft's CyboCon HS
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Complex, high-speed systems usually require immediate adaptive capability and there is not enough time and data for a model-based system to learn a new model during the process, so all the models must be developed ahead of the application. "Traditionally, high-speed adaptive control systems are specially designed by control experts with precise process models requiring significant financial and time investments," says George Cheng, chairman and chief technical officer, CyboSoft, Rancho Cordova, Calif. "In a testing environment, it is not practically feasible to develop all these models. Model-free adaptive [MFA] control products provide cost-effective and user-friendly solutions."

Cheng says his company's new CyboCon HS package combines MFA control with fast response. "This is the first and only high-speed, general-purpose adaptive control software capable of handling applications that demand a control response in the one to 10 millisecond range," Cheng says.

The software was developed for materials testing in the aerospace industry where there are many different types of new materials and it is difficult to develop test models. There may only be a few specimens available, so engineers cannot run repetitive tests to generate data for process identification or model building.

Furthermore, the test conditions are often under high temperature or high pressure or in environments that change quickly. "Imagine that you want to simulate a situation where the material used for the space shuttle is going through the atmosphere," Cheng says. "This changes the process dynamics at a very rapid speed. Even though the test sequence may last only a minute or two, the process is going through major changes."

Finally, there can be a large dead time in this kind of system. In high-speed applications, a one-second dead time can be very significant. This is because the [Tau]/T ratio can be very large (where [Tau] is dead time and T is the time constant of the process). "If the time constant is only 100 milliseconds and you have a one-second dead time, the [Tau]/T ratio equals 10," Cheng adds. "Standard PID can only control a process where the [Tau]/T ratio does not exceed one. In this case, CyboCon HS's Anti-Delay MFA is perfect for the application."

Product specifications include a one-millisecond model-free adaptive control output update rate. Actual speed depends on the number of loops and the hardware used. Typically, CyboCon HS can offer a 10 millisecond control update rate with 16 to 32 MFA controllers.

No special hardware is required. The company recommends running the software on a PC with Windows NT or Windows 2000, with a 700 or higher MHz CPU and 256 MB of RAM. High-speed I/O boards supported in the first release include Advantech and APIX. Other high-speed I/O boards such as the ones in the VXI system standard can also be supported.

Included CyboNet real-time network software provides a single-digit-millisecond update rate depending on the network speed. It offers high-speed redundant adaptive control over multiple CyboCon control stations and facilitates remote monitoring and control of the high-speed objectives.

The package includes various MFA controllers:
* Single-input, single-output (SISO) MFA controller.
* Anti-Delay MFA controller capable of controlling systems with large [Tau]/T ratios.
* Nonlinear MFA controller that deals with significant gain changes.
* Robust MFA controller that can force the process variable to stay within the defined bounds.
* Multiple-input, multiple-output (MIMO) MFA controller for multivariable systems.

Other components to make the software a complete system include I/O drivers for Advantech and APIX I/O boards that provide high-speed input/output between the controlled environment and the MFA controllers, and CyboLog software that can record data at the one-millisecond resolution rate. The collected data is saved in a file online and can be trended and analyzed using Microsoft Excel.

Since its introduction at the ISA show in 1997, CyboCon model-free adaptive control software has been deployed in process industries around the world. "CyboCon has solved many of the toughest industrial control problems easily without having to develop first-principle process models or identification-based models," says Cheng. "General-purpose MFA controllers are so easy to use that on-site engineers often launch them with no special assistance. A number of systems have been running for three years without any maintenance or retuning of controller parameters.

"We are very excited about introducing this unique product. It allows CyboSoft to enter the high-speed continuous control market, where most applications involve complex control for mission-critical systems. With the ever-increasing system complexity and changing working environment, high-speed adaptive control products will be highly in demand. Our high-speed MFA controllers serve this market well."

For more information call 916/631-6313, or visit **http://www.cybosoft.com**.

Model-based adaptive control is one of the most advanced control strategies and has gained broad acceptance for optimizing large operation units in the process industries. But it hasn't been practical to generate models for applications like rolling mills, metal casting, and turbine controls that require fast response.
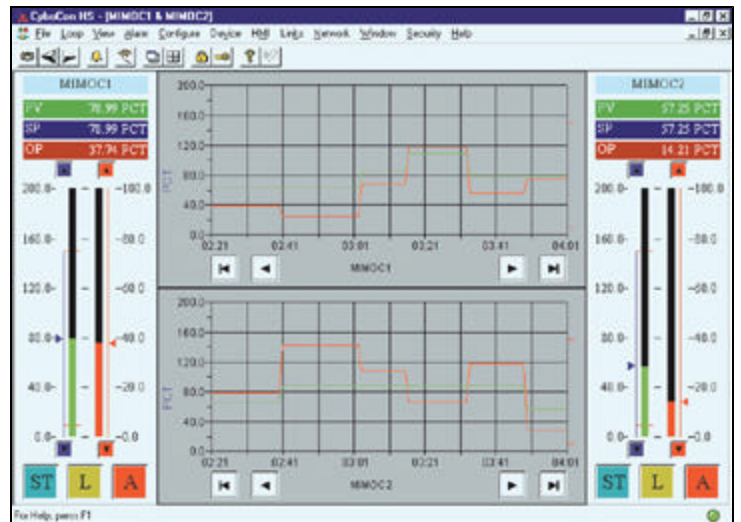
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