AN EMBEDDED TEMPORAL EXPERT

FOR CONTROL OF A TANDEM ACCELERATOR

By

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ABSTRACT

Many process control applications are best solved by heuristic, or rule-based, control. Unfortunately, conventional expert systems are generally large and slow, centralized on workstation computers, and incapable of continuous operation. Furthermore, few expert systems are able to process time-varying data, or to reason about temporal relationships. Thus they are ill-suited to process-control, which is inherently a continuous and temporal problem, and which increasingly relies upon distributed networks of small embedded processors.

A new expert system has been developed to overcome these limitations. This system achieves extremely high inferencing performance on "low end" microcontrollers, and requires very little memory. A new "cooperative/advisory" model of distributed problem solving allows networks of processors to cooperate on a problem, while remaining able to work independently on distinct subproblems. Knowledge, in the form of facts or rules, may freely migrate around the network. The system incorporates a new algebra for time-valued data, and a formal temporal logic for reasoning about this data.

The capabilities of this system were demonstrated by automating, for the first time, the terminal charging subsystem of a model FN Tandem particle accelerator: a problem which is resistant to an analytic solution. Using the expert system, cooperating 68HC16 microprocessors have successfully operated the accelerator, performing as well as, or better than, an experienced human operator. During the course of these experiments, new techniques for technology insertion were devised, and a new local-area network for microcontrollers was invented.

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