New Technology for America's Electric Power Industry

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On-Line Plant Transient Diagnostics and Management

Opportunity

Artificial intelligence (AI) techniques in the form of knowledge-based expert systems could provide on-line decision-making support for plant operators during normal operating and transient conditions. However, limitations in the knowledge base hinder the use of AI to diagnose faults that occur in large-scale processes. The limitations include problems with knowledge acquisition and the event-oriented approach used for process-fault diagnosis.

Description of Work

Argonne National Laboratory is developing a real-time transient diagnostics and management system. Unlike a traditional event-oriented knowledge base, the knowledge structure used by Argonne is based on thermal-hydraulic first-principles. System functions (such as heat or mass transfer) are used in conjunction with equipment characteristics (such as pressure-versus-flow curves that define the operating ranges of pumps and valves). Together, a two-tiered approach to diagnosing process system faults is provided.

Benefits

Preliminary results indicate that Argonne's hierarchical diagnostic system overcomes many of the limitations encountered with past adaptations of AI to process fault diagnostics. The highly flexible system is capable of diagnosing an unforeseen event and handling limited instrument information. It will provide comprehensive verification and validation. Although it was developed to diagnose component failures in nuclear power plants, the system promises a wide range of process-industry applications.

Design Concept

The system is a two-level, hierarchical knowledge structure. At the first level, an expert system uses thermal-

hydraulic functions to determine physical occurrences (that is, water added or lost, heat added or lost). At the second level, artificial neural networks pinpoint the source of the transient by classifying the functional misbehavior of the system through specific component characteristics. The system then determines the optimal corrective action required to restore a stable configuration to the operating system.

Current Status

Commonwealth Research Corp. and Argonne are studying the feasibility of the system's diagnostic capabilities. Data from Commonwealth Edison's Braidwood nuclear power plant's full-scope operator training simulator are being used. Initial results indicate that the system has successfully diagnosed process faults in a realistic environment.

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