RESEARCH SUMMARY

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This summary outlines a research program which over the past seven years has been oriented towards developing new methodologies to solve challenging engineering problems. The emphasis is on the integration of qualitative and quantitative reasoning. As our work in diagnostics, monitoring and control depends on first principle models of the underlying designs, we have also included a brief summary of research in these fields as well.

Mechanical Design
- Qualitative Reasoning from First Principles
  - SYmbolic MONotonicity analyzer (SYMON)
  - SYMmbolic FUNctional Evaluator (SYMFUNE)
  - 1*PRINCE (First PRINCiple Computational Evaluator)
  - Monotonic Influence Diagrams (MIDs)
- Object-oriented data structures for reasoning about functionality, manufacturability and diagnosability (knowledge representations for mechanical systems)
- Interactive multiobjective optimization algorithms
- Expert systems applied to rehabilitative engineering
- Graphics and CAD/CAM - Design by features
- Expert interrogators for preference assessment
- Decision / design process management for life cycle design

Diagnostics, Monitoring and Intelligent Supervisory Control
- IDES - Influence Diagram Based Expert System
  - Allows three hierarchical levels of specification: symbolic, functional, and numerical
  - Makes use of multivariate logic (e.g., probability and fuzzy logic)
  - Efficient symbolic algorithms that makes real-time diagnostic applications feasible
- Reasoning by analogy and machine learning
- Qualitative reasoning in mechanical failure prediction by audible sound
- Integration with adaptive neural networks
- Integration with AI/Expert system environments
- Architectures for sensor fusion and sensor validation
- Real-time diagnostic decision making for process control
- Applications to machining operations (milling and drilling), assembly line testing, electric power generation, and the space vehicles.

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Selected Relevant Publications


