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TOWARDS AN EXPERT CONTROL DESIGNER

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ABSTRACT

Recently there has been a tremendous increase of interest in the applications of artificial intelligence (AI) programming techniques. Such techniques include the use of heuristic, or rule-of-thumb information to deal with uncertainty in difficult software tasks. This information is frequently represented in simple if-then structures known as production rules. The collections of a set of rules referring to a specific area of operation is referred to as a knowledge base. The combination of a knowledge base with a mechanism to select and execute rules (usually

called an inference engine) is labeled a knowledge-based system. Such systems are considered to be expert systems if they reach a high level of expertise in a narrowly defined area of operation.

In applying these techniques to the field of control systems some good work has been done. Most current efforts seem to be aimed at using knowledge-based systems to extend the capabilities of current system controllers, filling much the same role as a human process control engineer.

Our research was intended to examine the applicability of AI techniques to the process of controller design itself. The control design process is an extremely difficult one to automate successfully. The characteristic problems of dealing with interacting subproblems, an uncertain knowledge base, conflicting multiple goals, and an extremely large search space pose a very significant challenge to the capabilities of current expert systems. Additionally, the control design task requires much more mathematical ability than most expert systems not specifically constructed for mathematical purposes. Our research investigates the needs of such a system and identifies an appropriate approach to the construction of an expert control designer.

Initially, the research focus was on the use of a small PC-based tool to develop the design concept and design a small prototype knowledge based system. The expert system development tool first used, the Personal Consultant from TI, was poorly supported and proved to be inappropriate to the task. This tool was based on EMYCIN, a classic expert system inference engine originally developed at Stanford, and primarily uses backward chaining to search through the rule base. The nature of the

control design problem, however, was found to rely much more on forward chaining.

A small prototype knowledge based system was eventually developed completely in Common LISP. This system is not intended to fulfill the requirements of an expert control designer, but to show the capabilities of the technology in a limited demonstration.

To reach the goal of a truly expert control design system, It will be necessary to use a powerful programming environment, both in software and hardware. One main drawback to a system based entirely in LISP is its inability to take advantage of the wide variety of system simulation and design aids available in conventional languages. Consequently, the final system will have segments of software running both on a LISP processor and on a conventional machine. This would allow the system to rapidly procede through iterations of the design-simulate-adjust cycle.

A more powerful expert system development tool should be used to speed construction, and allow easier system refinements. A tool such as ART, KEE, etc. would make it possible to greatly increase the performance of the system over time as more knowledge of different areas of control design was acquired through testing.

A demonstration of the use of a knowledge-based system to solve control design problems will be presented. The operation of system's reasoning will be traced and its performance discussed. A discussion of the important design issues for an expert control designer will also be given.

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