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RESEARCH IN PROGRESS

Artificial Intelligence Research Capabilities of the Air Force Institute of Technology

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Abstract

The Air Force Institute of Technology [AFIT] provides master's degree education to Air Force and Army Officers in various engineering fields. It is in a unique position to educate and perform research in the area of applications of artificial intelligence to military problems. Its two AI faculty members are the only military officers with Ph D's in Artificial Intelligence. In the past two years, the artificial intelligence Laboratory of the AFIT has become a major focal point for AI research and applications within the government In this article, we describe our on-going applications research in the areas of automated cockpit systems, natural language understanding, maintenance expert systems, expert systems for planning, and knowledge based software design.

Education

In response to the need for rapid training of engineers in artificial intelligence, AFIT has developed a Master's degree curriculum for AI. Our philosophy is to offer an engineering oriented sequence of courses in the applications of artificial intelligence. We stress techniques for building expert systems and natural-language interfaces. The later courses include projects that are useful in the student's thesis research. Rather than emphasize theoretical advances, we concentrate on the techniques of AI that can be used to build systems today. This effort is itself viewed as a research project. Can AI be taught as an engineering discipline? How best to do it? We are also interested in transporting our curriculum to other universities, partially through having faculty visit and take the program back with them. We have several post-doctoral positions available and visitors are always welcome.

A five-course sequence has been offered beginning in the fall term, 1983. It consists of an Introduction to AI, covering all aspects of AI—not just the expert systems area. This is followed by an AI Systems Design course where each student develops the background needed to conduct a thesis project as well as the ability to understand and modify large existing AI programs. The third course—expert systems—concentrates on what expert systems can and cannot do. Techniques for building all types of expert systems are discussed and each team of students builds a simple system. The final course is a graduate seminar to discuss current outside research, as is common in most universities.

Additionally, we require the students to take a fifth course from one the following areas: computational analysis, pattern recognition, data base design, control engineering, or VLSI design. These courses are part of the Computer Engineering, Computer Systems, or Electrical Engineering master degree programs. A thesis (research conducted over three quarters) is required. The thesis always involves the application of AI technology to current military problems.

Automated Cockpit Tasks

The purpose of this research is to define an expert system architecture that is useful for planning, monitoring, and diagnosis tasks in a tactical flight environment. The research builds on Cross's Ph.D research in qualitative reasoning in the flight domain. Several candidate architectures have been identified. Important research questions are:

- how to integrate multiple knowledge representations
- how to acquire and represent common-sense knowledge

- how to implement script-based planning and meta-planning
- what is the role of qualitative simulation
- how to design of pilot-machine interfaces.

Several students, including a former F-16 instructor pilot, are working in this area. Another area of interest is adaptive tactical navigation. Areas of concentration are: navigation filter fault diagnosis, intelligent sensor selection, fusion, and interpretation, and computer aided design. In the last area, it may be possible to incorporate the experience of a Kalman filter designer in a design tool.

Contact: Dr. Cross

Natural Language Understanding and Speech Recognition

AFIT personnel are conducting research in the effects of various language grammar structures on the performance of speech recognition algorithms in cockpit noise environments. Data will be obtained of recognition accuracy versus grammatical structure versus cockpit noise level. This data will aid in the design and development of future recognition systems for use in military cockpits. The objective is to develop techniques to increase the accuracy of voice recognition in the cockpit beyond what is possible today. The technical approach is to use the constraints imposed on a possible utterance by the structure and meaning of natural language. For example one cannot say "ARM ARM" or "ARM FREQUENCY." The AFIT system uses an inhouse developed phoneme recognizer to propose possible phonemes. The grammar is then consulted to identify the possible words which may follow. This will restrict the number of words that the current list of phonemes can be mapped into, hence increasing the correct recognition probability. As each word in a command is entered, the grammar is consulted to identify the next possible word and the process continues. Several grammars have been developed for the advanced tactical fighter vocabulary in consultation with Avionics Lab personnel. These grammars have been encoded into the program, and the main control and manipulations of the program have been implemented. This portion of the system has been tested successfully. Other work by Milne includes the design of transportable natural language interfaces and the use of expectations in deterministic parsing.

Contact: Dr. Milne

Maintenance Expert Systems

The objective of this project is to design expert systems for trouble shooting, diagnosis, and repair of equipment. Such systems must utilize knowledge from many sources: the human expert's heuristic knowledge, circuit schematics, repair requirements, and maintenance history logs. The approach taken investigates a novel expert system architecture (structure and function) that combines two models of the circuit board. Milne is working on a method of reasoning about the function of the electronic circuit from "second principles," i.e., those that a circuit designer seems to use. Milne is an Air Force focal point for this research. A masters degree student is working on a depot level maintenance expert system. The USAF Rome Air Development Center is currently funding this effort. Additionally, a doctoral student from the Flight Dynamics Laboratory is designing a battle damage assessment expert system.

Contact: Dr. Milne

Expert Systems for Planning

Dr. Milne has conducted several research projects in the construction of expert systems for ground based planning. The "Target Priority Aid" was developed for RADC using OPS-5. This aid recommended the order of counter-air strikes against enemy air bases. SAMPLE was developed to plan the emplacement of surface to air missiles and uses the language ROSS. It knows the constraints by which SAM missiles can be placed. The commander merely inputs certain terrain data, and the system informs him as to where to place the missiles. Currently being developed is a system for cruise missile route planning using a hierarchical planning system.

Contact: Dr. Milne

Knowledge Based Software Design

AFIT has been engaged for a number of years in the development of a software lifecycle environment resulting in the Software Development Workbench [SDW]. We are starting to integrate knowledge based ideas with traditional software tools. Part of this effort is to develop an associated expert system to help in the generation of software throughout the lifecycle. Specifically, the expert system would support the development of complete and non-ambiguous requirements, evaluate design structures and code, and specify appropriate hardware architecture.

Contact: Dr. Milne

Facilities

Our research is supported by two Lisp machines, one funded by the Rome Air Development Center and the other by the US Air Force Avionics Lab. These machines are located along with seminar space in our Artificial Intelligence Laboratory. Our primary teaching computer is a traditionally overloaded VAX (UNIX) with FranzLisp and InterLisp.

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