The Radio Amateur Digital System
Artificial Intellegence Project

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Abstract

This paper outlines information on the Radio Amateur Digital System
Artificial Intcllegence Project from it's conception to current
capabilities and ongoing development. The platforms used in this
project include amateur radio. facilities management and weather.
Many more applications could be used. One of the areas could be radio
frequency propagation. The applications chosen are intended to support
amateur radio, weather service. emergency management and ultimately the
public.

Background

Applications in artificial intellegence have been explored in a variety
of degrees by many nations including the Japanese. From experiments in
The Fifth Generation Attempt to todays medical and financial applications
which are currently in use. This interest is no stranger to NASA and many
other institutions. Applications in this area today serve as a vital tool
by providing solutions to the problems facing everyday decisions.

1.0 INTRODUCTION

The purpose of this paper is to assist in understanding some
of the issues involved in successfully applying expert systems technology
otherwise known as artificial intelligence and neural network systems
to the applications in the areas of ham radio, facilities management
and weather. It is my intent to only provide a basic definition of
expert systems capabilites. limitations and benefits.

2.0 EXPERT SYSTEM CAPABILITIES

In order to understand how expert systems can be used
advantageously, you must first understand how knowledge processing in
expert systems differs from conventional data processing. Expert systems
are unique in their ability to process [knowledge], not just data. Knowledge
processing differs front data processing in the type of information used,
the techniques used to analvze the information, and in the form that the
results of the knowledge processing are presented to the [user].

Conventional systems limit the developer to data representation
using only numbers and text (parameters). They process data using complex
[algorithms] that complete a discrete number of steps to reach a predetermined
conclusion. Expert systems permit knowledge representation -- the encoding
of human decision-making processes using symbolic terms or [symbols].
Because expert systems process knowledge, they are often referred to as

[knowledge-based systems].

The ability to represent knowledge in symbolic terms expands the range of analysis techniques that computers can apply to information thus enabling a system to emulate some aspects of human performance. The expert system uses problem solving procedures such as pattern-matching to reason about the symbolic terms. An example of [symbolic reasoning] by an expert system that determines the daily forecast is, "if the sky is cloudy, then the forecast might include rain." This phrase could be used within an expert system. A conventional system would require that the symbolic terms such as "sky" and "cloudy" be defined concretely as numbers or text. The expert system uses pattern-matching on the phrases "sky is cloudy" and "forecast might include rain" to reach a conclusion about the forecast without requiring definition of each of the terms within the phrases. A conventional system would require that the developer define a set number of steps to determine the daily forecast. The expert system examines all possible solutions using the problem solving procedure that has been programmed into it.

The combination of problem solving procedures that are built into expert systems, together with the developer's ability to define problems using symbolic terms, gives expert systems the capability to store and manipulate more complex relationships between individual pieces and groups of information than can be accomplished with the processing supported by conventional systems.

In addition to knowledge representation, expert systems also provide the capability to simplify the user/computer interaction. Expert systems can be programmed to employ more of the conventions that people use when communicating with each other. Expert systems can be designed with the ability to explain the "reasoning" used in reaching a recommendation and to justify their approach to a problem, much as people do. The more sophisticated expert systems employ a [natural language] processor to permit users to consult with the system using near-English rather than structured query languages or menus.

3.0   EXPERT SYSTEM BENEFITS

Expert system applications take advantage of the above capabilities in two ways. First, information becomes more accessible so people can make better decisions. Second, where useful information is accessible, people can be more productive. We can be more productive in the use of controlling station facilities management, early warning notification and information resources through the application of expert systems. The two major benefits associated with expert systems are better decision making and increased productivity resulting in better facilities security, accurate environment control, increased awareness and faster notification.

3.1 BETTER DECISION MAKING

Expert systems improve the quality of decision making by providing a mechanism for pooling the knowledge of multiple experts and making that knowledge available to the control operators. This leveraging of knowledge

results in improved quality of complex work products such as. technical reports, and analyses that recommend actions.

Expert systems establish a basis for defensible decision-making by capturing and applying knowledge in verifiable form. For example. in developing Work products such as technical reports and environmental analyses, a given set of inputs, no matter how complex. should result in consistent results given by closely similar data, advice, or recommendations. In addition, the process of reaching a conclusion can be explicitly demonstrated. This will ensure consistency in many decision-making activities.

3.2 INCREASED PRODUCTIVITY

Expert systems offer significant, measurable increases in productivity by effectively capturing the knowledge of experts and by minimizing the loss of [expertise) and knowledge due to attrition. Expert systems provide a means of extracting, storing, and sharing knowledge in a variety of disciplines. Thus. more people have access to expertise. In turn, the experts are freed from relatively mundane tasks to focus on demanding ones.

4.0 EXPERT SYSTEM LIMITATIONS

Expert systems provide valuable new capabilities, but they also have clear limitations. As with all new technology. developers must weigh the limitations associated with the use of expert systems technology against benefits. Because expert systems emulate human performance'in decision making. they may be incorrectly thought of as having the capacity to make independent judgments. Expert systems are capable of communicating advice that has been coded into them. They are not capable of producing independent decisions. Their application is limited to strictly defined domains (i.e.. areas of expertise where boundaries on what expertise should be included in the system can be defined); their performance degrades dramatically when dealing with information that is beyond those boundaries.

Expert systems can manipulate only symbolic information. that is. all "real" information that is collected by observing an event. For instance. temperature and humidity in the case of weather forecasting must be translated into a form acceptable to the expert system. Any errors and biases incorporated in the translation process will be accepted by the expert system without question. An example of a translation bias is if temperature measurements input to the system are in Fahrenheit when the logic or knowledge encoded into the system is based on Celsius measurements. then the conclusions reached will be invalid.

5.0 PHASE IMPLEMENTATION STRUCTURE

The information provided below will provide an outline of what will take place with each phase of system installation.

PHASE I   SYSTEM PLANNING, PROCUREMENT AND CONSTRUCTION OF DIGITAL EQUIPMENT AND SOFTWARE BASED ON CONVENTIONAL PROGRAMMING

PHASE II   PRE-INSTALLATION TESTING AND EVALUATION

PHASE III   INSTALLATION OF DIGITAL, VOICE EQUIPMENT, CONVENTIONAL SOFTWARE AND OPERATIONS

PHASE IV   DIGITAL SYSTEM ENHANCEMENTS

PHASE V   EXPERT SYSTEM RESEARCH AND DEVELOPMENT

6.0 Current System Capabilities

The system is currently providing data information to storm spotters and ARES/RACES groups in the Dallas - Ft. Worth metroplex including adjacent counties. The sysop is also provided with facilities management information in the areas of station communications reliabilitity and power (voltage) management. Station security is also handled by the system as well. Weather alerts are disseminated by way of automaticaly paging a beeper, uploading data via packet, phone modem and generates alerts using a voice synthesizer in a voice repeater system. The sysop is first notified of an impending alert and given the opportunity to either allow the alert to take place or to intervene in order to alter or cancel the alerts. This is the same concept used in nuclear power facilities. A weather forcast knowlege based application also provides input into the system. This allows notification of conditions which are current and also provides information as to conditions as they are developing. Data input for the system is provided in a manner so that storm tracking can also be accomplished. The sysop is provided with an audit trail of all data and provided with information on how the system has reached it's conclusion.

7.0 Conclusion

The project is in a long term development phase with future applications and implementations of enhancements as they are developed and tested. It is important to realize that an expert system is not a replacement for the experts of a given field, but a supplement. The high profile nature of an expert system can be addressed by classifying it as an assistant or advisor. This sets the user's expectations to a more reasonable level. If people believe that they are receiving accurate, "expert" information, then they may act on it without the proper skepticism. The expert system is a tool and the liability for any outcome is held by the decision-maker. With proper use, many advancements can be made by the use of expert systems.

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