

Expert System For Training Of Power Plant Operators

Professor Mohammed Zeki Khedher
University Of Jordan
Amman - Jordan

Abstract:

Operation of power plant has become an important task for safe, reliable and efficient performance of both power plant and power systems. Newly employed operators suffer from lack of experience for proper response in emergency cases. Theoretical background and academic courses are not enough to train such operators. Power station simulators are expensive and are not usually available for specific power plant under consideration.

Building an expert system which simulates the usual problems occurring during power plant operation and remedies of such problems seems to be a proper solution of the task of power plant operator training. The knowledge required for building such system has to be collected from experienced operators and power plant parameters, layout and specifications.

An expert system for training of Al-Huaain Thermal Power Station at Al-Zarqa has been built and tested. Such a knowledge based system can serve not only to train the less experienced operators but also to help other operators in some difficult circumstances. Although this knowledge base operates in an off line mode, however is fast enough to respond and interact for normal circumstances.

The VP-Expert shell was used for this knowledge based system.

1.Introduction:

Artificial Intelligence (AI) is the subfield of computer science that is concerned with symbolic reasoning and problem solving by knowledge manipulation rather than data. Non-intelligent computer program can not solve any problem that the programmer did not foresee when he wrote the program. Intelligent programs however is expected to do things that have not been explicitly programmed. Such programs may contain sets of rules which may be used to solve the problem and to reach the goal. The program has to use these rules with the available data to reach the aim of the problem.

AI is divided into subfields: Expert System, Natural Languages, Speech Processing, Vision, Robotics and some others.

AI has its own well developed programming languages. The most widely used languages are LISP and PROLOG.

2. Expert Systems:

Expert systems are software designed to deliver the expertise of human expert or group of human experts to other people who need expert advise. Expert systems may substitute the human expert without suffering from usual human habits of becoming tired, sleeping, going for holiday or retirement. It may include the expertise of several human experts who collected their expertise over very long period of time. Usual computer software makes a separation between data and programming statements. Expert systems too makes such separation but between rules and data. Rules are themselves stored as data as well. Hence for specific problem the data are processed using the set of rules towards the goal of the problem.

Expert systems hence consists of three main parts: User interface, Inference Engine and Knowledge base.

2.1 Inference Engine:

Inference engine is a software that performs inference reasoning tasks for the expert system. This software uses the knowledge base information and any other information provided by the user to reach the new knowledge.

2.2 Knowledge Base:

It is the data base where the knowledge in a particular topic is stored. Such knowledge may have been obtained from the human expert by the knowledge engineer.

2.3 User interface:

It is the software necessary to make the user interaction with the system more friendly. It may provide graphic facilities, explanation facilities, justification etc.

Expert system shell hence is a ready made software which provides the facilities for the user to build his own knowledge base and then utilise this knowledge to solve unlimited number problems in the field of knowledge base.

Rules of the inference engine are usually in the form of:

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Rule Label
IF          condition
THEN       conclusion
           (clauses)
(ELSE      conclusions
           (clauses) )
(BECAUSE  "Text" )
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There are now in the market quite a number of expert system shells. Among them are EXSYS, VP-EXPERT, LEONARSO and others. VP-Expert was used in this paper since it provides some extra facilities which makes the interfacing easy.

3. Expert Systems In Power Plant Operation:

Power plant control and operation has become more and more complicated with the increase of sizes of power generating units and increase in plants capacities. The task of the plant operators has become more difficult. With the increase of automation, the task of the operator has become more centralized. Hence the actions and responses of the operators have become far more important. Negligence and irresponsible actions have far much more consequences than ever before. Newly employed operators suffer from lack of experience for proper response in cases of emergencies. Theoretical background and academic studies are usually not enough to train such operators. For power systems sometimes power system simulators can be used for training. But such simulators are also expensive and available only in some training centres.

The use of software for power plant operators training may be one of three types: Computer aided instruction, expert systems and expert training systems.

Comparison between such software may be referred to in some literature (1). The task of training of operators has been the subject of recent papers (1,7,8). Power plant operation may include variety of applications ranging from scheduling, diagnosing faults, analysing of actions, etc. Hence expert systems may include these among others. However these tasks may be included for teaching purposes and as an aid to the inexperienced operator also. Operators may need an advisor or an aiding program. Such expert systems had been referred to in references 1,2,3,4,5,6 and 11. This aid may be more important in nuclear power plants. Some literature concentrated on this issue specifically e.g. references 8,9 and 6. The operators task in substation is somehow similar to the power plant operators. Support expert system for operation of substations has been discussed in references 4 and 10.

4. Al-Husain Thermal Power Station Operation Expert System:

Expert systems in power plants are usually tailored to specific need at the power plant circumstances. It is a difficult task, if not impossible to build an expert system which serves in any power plant. Hence for the Al-Husain Thermal Power Station (HTPS) an expert system had been built to help the plant operators in these tasks as well as training the less experienced operators. The information fed to the system were collected from manuals and experienced operators.

The system built using VP-Expert Shell starts with main menu which either helps in the start up procedure or in the synchronization process. At normal operation the trouble menu aids the operator for diagnosing any fault or trouble which occur. This menu has two submenus: one for normal alarm checking and the other for trip alarm checking. The system in all contains about 200 rules.

5. Discussions and conclusions:

Power plants operation has become a delicate task which need a highly skilled, experienced and quick acting operators. Development of such skill

is a slow and difficult process. Operators experience with specific power plant is an important issue. Hence building an expert system for specific power plant is a recommended method for training of inexperienced operators. Starting with expert systems which act as an offline system is not a bad idea. An on line system (which collects its information directly from the system) is a faster method. A standard desk top PC is quite suitable using a good expert system shell. The experience with this VP-Expert at HTPS was quite encouraging.

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