

Expert System For Power System Dispatch Aid

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Abstract

Expert System has become an effective tool for storage of expertise in many fields. The task of operation, maintenance & design of power equipment using expert system has attracted a lot of attention. Power system control, during normal operation and at emergency conditions can be effectively governed by the aid of expert system. In order to restore normal conditions a lot can be learned from expert systems specially by inexperienced operators. A literature survey for status of the art is given. An expert system for Jordanian National Control Center is presented. It has been found that such a system can be of great help for effective and efficient power dispatch especially in developing countries where highly specialized and experienced personnel is rare and difficult to train.

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 advice. 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:

Rule Label

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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. References:

1. Pack, Randal W. Lazar, Paul M. Schmidt, Renata V. Gaddy and Cathrine D., "Expert Systems for Plant Operations Training and Assistance", 1988 IEEE 4th Conference on Human Factors and Power Plants, June 5-9, 1988 p. 142-145.
2. Forzano, Paolo Perini & Cristina, "An Expert System as Operator Guide", 1988 IEEE 4th conference Human Factors and Power Plants, June 5-9, 1988 p. 74-85.
3. Musgrove, John G.D. Domenico, Peter N., "Operator Advisor for particulate control equipment". ASME/ IEEE Power Generation Conference, Sept 25-29, 1988.
4. Oki Michio, Nishimori Toshiro, Hiyoshi Minoru, Takaoka Yoshiyuki, "Substation Operation Support System with Event Driven Processing", Future Generations Computer Systems V.5 No. 1 Aug. 1989 p. 41-49.
5. Valiquette Benoit, Torres Germano Lambert, Mukhedkar Dinker, "An expert system based Diagnosis and" Advisor Tool for Teaching Power System Operation Emergency Control Strategies", IEEE Transactive on Power Systems V.6 No.3 Aug 1991 p. 1315-1322
6. Fujita Yushi, Tohyama Makoto, Yanagisawa Iehiro, Ida Toshio, Arikawa Hiroshi, "Designing a knowledge Based Operator Support System", Nuclear Technology V. 95, No. 1, July 1991 p.116-128.
7. Liebowitx J., Lightfoot P., "An expert System for Subsystem Contingency operations", Computer Engineering Proceedings, 1988 July 31-Aug 4 p. 85-90.

8. Anon, "Expert System Training to deal with Steam Generator Tube Rupture", Nuclear Engineering International V. 34 No. 424 Nov, 1989 p. 35-36.
9. De Vlaminck Michel & Murphy Lucas, Operator Advisor, "An Expert System to Help Deal with Emergencies", Nuclear Engineering international V. 34, No. 424 Nov. 1989 p. 32-33.
10. Kumano S., Ito H., Goda, T., etel, "Development of Expert System for Operation at Substation", IEEE Trans on Power Delivery Vol.8, No.1, Jan 1993 p. 56-65.
11. Bagnara S., Nicoletti R, Maini M & Zardetto G. "Design Process of an Expert System to Support Power Plant Operators"., Proc of IFAC Symposium in Control of Power Plants and Power Systems. No. 9, 1992, p. 199-203.
12. Kan'an, Osama, "Expert System in Power Plant Operation" Jordan University, Final year project, Jan 1994.

Control and operation of large power systems has been the subject of many attempts to introduce expert systems (33.)

Such systems should be able to cope with unforeseen conditions Most of these systems solve wide range of power system problems e.g. control, operation, emergency tasks, stability & security problems (63,30,39,48.)

Economic dispatch including control of real and reactive power has been the subject of many literature (10,16,37,51,62,9,15,3,41,45). Such expert systems may be used with SCADA systems as well (37). Some expert systems were developed specifically for alarm emergency (11,14,32,42,43,44,59,46). Faults were analysed by some other expert systems (5,8,23,50,54,61). Such analysis were taken further to give a guide for steps to be taken for load distribution networks and substation operation (55,64,24,49,53,60,4). Power systems for space vehicles were supplied by on-line expert systems (17,21,22,28). Nuclear power plant has been supplied with expert systems too (26,27,29,52,56). While other plants has received also a good attention in the field (65-75). Power Industry in general had been assisted by some expert systems such as those in literature 35,36,40,57 and 38.

Expert System for Jordan Power Control Center

For a small power system like the Jordanian, tasks to be controlled by the operators are quite limited. It has been found that the tasks could be classified into 3 categories:

Generating units shut down, Transmission lines trips and Transformers trips.

If the total load at the event instant is known, then the source of the power and its path is to be managed by the expert system.

The required information were supplied to the expert system. Such information were either to be taken from experienced operators or from manuals and system specifications.

More than 200 rules were deduced and included in the expert system both for normal operation and emergencies.

Discussions of Conclusions

With the shortage of highlylyghly experienced personal in developing countries, use of expert system has higher merit than industrial countries. Development of expert systems for power plants as well as other industrial enterprises should be highly encouraged. Such systems can be used for training and aid for less experienced

operators and may be introduced as ON-line at later stages. Knowledge engineers development hence is needed to help in developing such expert systems.

3- Expert Systems In Power System Dispatch.rrroormal operation and emergencies(76)5-nen6566676869701727374.75

Al-Khawaldeh S., "Expert System for Jordan Power System Events", A final year project , Jordan University , June 1994. Enterprises should be highly encouraged. Such systems can be used for training and aid for less experienced operators and may be introduced.