PriMera Scientific Engineering
Volume 2 Issue 3 March 2023
ISSN: 2834-2550

PriMera Scientific Publications

Expert System: A Fault Diagnosis Expert System for High-Power Industrial Production Platform

Type: Research Article
Received: November 30, 2022
Published: March 06, 2023

Citation:
Jagdeesh Patil S. "Expert System: A Fault Diagnosis Expert System for High-Power Industrial Production Platform". PriMera Scientific Engineering 2.3 (2023): 25-29.

Jagdeesh Patil S*

Nitte Meenakshi Institute of Technology, Bengaluru NMIT, Bangalore

***Corresponding Author:** Jagdeesh Patil S, Nitte Meenakshi Institute of Technology, Bengaluru NMIT, Bangalore.

Abstract

With the increasing size and complexity of high-power digital transmitters in the broadcasting network, their fault diagnosis has become cumbersome and time-consuming process. Meanwhile the breakdown transmission is not tolerated. These transmitters located in different parts of the country, are required to provide uninterrupted service round the clock. Sometime they develop faults which are complex in nature and call for services of the transmitter expert. However, the experts may not available all the time, and the fault diagnosis takes long time even for experts using manual techniques, it is highly desirable to provide a computer-based Fault Diagnosis Expert System.

Introduction

Developing and deploying expert systems has undergone a sea change right from its inception. Such an expert system can store the knowledge of several experts in the field and can greatly be useful for solving breakdown problems immediately. Keeping in mind, an attempt has been made to conceive, design and develop an expert system for high power digital broadcast transmitter system. Major aspects of the expert system are presented in this paper.

System Architecture

In designing the EXPERT SYSTEM for high-power broadcast digital transmitter, the following guidelines were kept in view:

- Faults in transmitter are best solved by applying expert knowledge and by using interactive methods.
- The more narrowly and specifically the fault is defined, the more powerfully and accurately can the knowledge base be applied to solve problems.
- All decisions making elements of an expert system must be incorporated to speed up fault diagnosis.

The basic components of any general expert system are shown in Fig. 1, and following this model, a block schematic of broadcast digital transmitter is shown in Fig. 2. As seen in here, the expert system consists of the following functional building blocks: - (a) Knowledge Base Module (b) Inference Engine Module (c) Explanation and Case Sheet Module, and (d) User Interface Module. A brief description of these modules is given below:

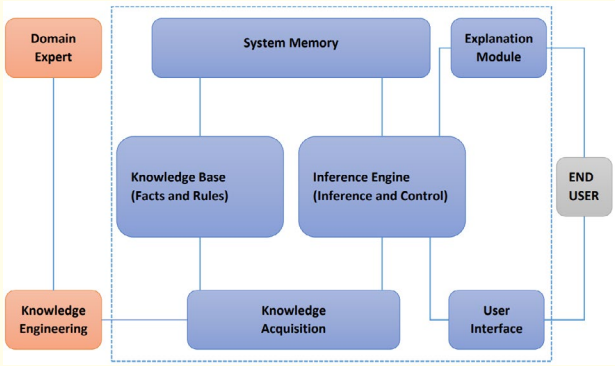

Figure 1: Components of an Expert System.

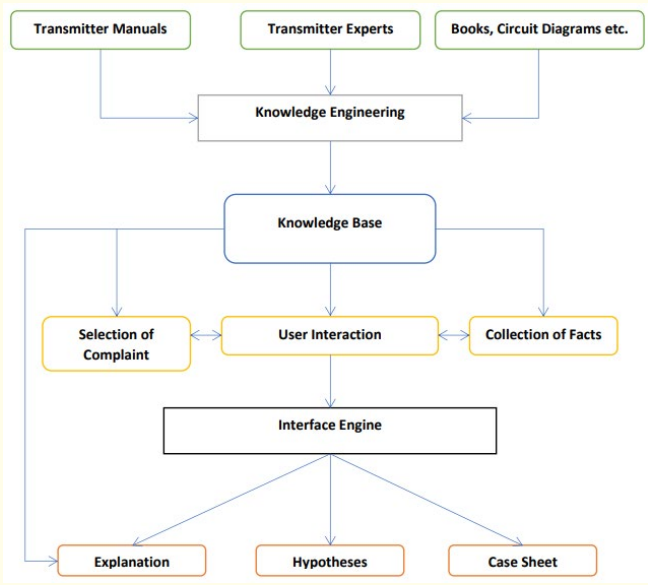

Figure 2: Block Schematic of Broadcast Transmitter Expert System.

Knowledge Base Module

This module stores the information gathered from transmitter manuals, transmitter experts, and other sources in the form of production rules. These parameter values, logical assertions, and text are centred around this. The process of organizing information in the knowledge base is called here as knowledge engineering. A production rule has two component parts: the left-hand side (LHS) is known as the antecedent, premise, condition, or situation, and right-hand side (RHS) is known as the consequent, conclusion, action, or response. In simple form, the LHS is known as IF part and RHS as the THEN part of the rule. The knowledge base the transmitter mainly comprises the following items:

i. *Complaints*: The component of a complaint are its name and explanation. Each complaint has asset of hypotheses.
ii. *Hypotheses*: The constituents of the hypothesis are its name, a set of actions as well as explanations.

iii. *Parameters*: All parameters related to a hypothesis are collected, and the values of these parameters are passed through the input/output interface by the use of menus. The detailed descriptions also include prompt messages to collect the data, options for the values, ranges of the values, and help messages to assist in answering queries for the data value, and explanations for collecting data.

Inference Engine Module

The inference engine of the transmitter expert system accepts user input queries and responses to the questions through the input/output interface and uses this dynamic information together with static knowledge stored in the knowledge base. The inference process is carried out in three stages- (i) match, (ii) select, and (iii) execute. When a rule is executed, it places new facts in the working memory. Now it may request for additional information from the user, or simply stop the searching process and result in a conclusion to be found and reported to the user. Both exhaustive and depth-first search techniques are incorporated in the software.

Explanation and Case Sheet Module

The explanation module provides a user with the explanation of the reasoning process when requested. It gets its input from the inference engine. The information provided by this module allows a user to determine if the expert system's reasoning process is sound or not. With the help of the explanation's mechanism, the different inferencing steps can be followed at any time during a consultation process. The case sheet function of this module provides a list of hypotheses checked and their confidence factors.

Input / Output Interface

This provides the user a means of communicating with the system in a more natural way through a simple selection menu. This also permits the user to select the parameter values in three different modes: -

i. *Batch Mode*: In this mode all parameters for the selected problem are collected initially and then the inference engine is invoked.
ii. *Interactive mode*: Here the inference engine is active throughout the consultation process. As soon as a new parameter is available to it through the input / output interface, the inference at this stage is displayed and the user can stop the consultation process at that stage or continue further.
iii. *Batch Interactive mode*: In this mode, the user has the options to start the consultation session starting from any parameter, which is often the case in the transmitter fault diagnosis process.

The parameter selected by the user may appear in more than one hypothesis. The inference engine then collects the other relevant parameters of the hypothesis before reaching a conclusion. A block schematic of a typical system fault diagnosis sequence is shown in Fig 3. As seen here, for every hypothesis, the expert system goes through a sequence of inference steps before arriving at conclusions and providing explanations. Also, if a hypothesis is not confirmed, the knowledge base is updated accordingly for use in fault diagnosis.

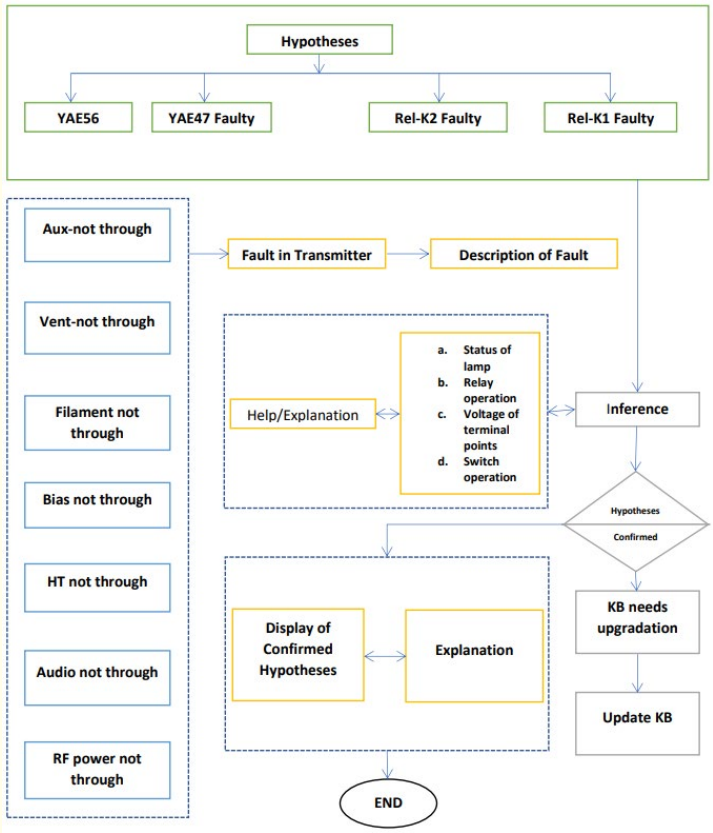

Figure 3: A Typical Broadcast Transmitter Fault diagnosis system.

Software Implementation

The Software package is using C++ programming language. The choice of C++ was made considering its many advantages as compared to LISP and PROLOG languages, even though these languages were used extensively while implementing EXPERT Systems, for their ability to process language texts. On the other hand, expert systems written in C++ are faster and can be easily interfaced with other APIs. Also, object-oriented programming, low level programming, and ease of up-gradation are other advantages in C++ in this application.

The software has been developed using the modular approach with individual program modules for knowledge base, inference engine, and user interface. The major programs in the package are as follows:

1. Aux-ON class /function definition program.
2. Vent-ON class /function definition program.
3. HT-ON class /function definition program.
4. Aux-ON rule / parameter function program.
5. Vent-ON rule /parameter function program.
6. HT-ON rule / parameter function program.
7. Knowledge base program.

8. Inference engine program.
9. User Interface program.
10. Main program.

In addition to above programs, several test programs have been provided to check the different functions of the expert system. Also, security program is incorporated to prevent unauthorised access to the package.

Field Trials

The major modules of the transmitter were subjected to field trials at Super power Transmitter service at Bangalore. The expert system is loaded on location centre computer, and was operated by an engineer on duty at the transmitting station. Faults were created in the transmitter without the knowledge of engineer on duty and who was asked to clear the faults with the help of installed expert system. The engineer was able to diagnose all the faults successfully, and the inferences drawn and explanation given by the EXPERT System were up to the satisfaction of the engineer. Some preliminary results / observations from the field trails of the Expert System are given below:

1. Comparison of time taken by the engineers in clearing faults with and without the use of EXPERT System provides a means of evaluating its performance, Usually, the engineers have to go through entire circuit diagrams, and after applying the parameter values derive the conclusions. Normally the time taken for this process is from few hours to days. In contrast, The EXPERT System takes few seconds or less than minute for parameter value entry, and provides valuable diagnostic information in much shorter time.
2. Sometimes, it may be found that the faults confirmed by EXPERT System are not exactly same as in actuality. In such cases, EXPERT System takes a user very near to the actual fault. However, in the background, the information about the faults are used to update / improve the knowledge base of EXPERT System. In future, when the same faults are handled by the EXPERT System, they are confirmed exactly. Thus, refinement and enlargement of EXPERT System is a continuous process.

The field trials have shown that many complicated faults in the transmitter can be diagnosed and cleared within a matter of less than minute with the user-friendly environment of EXPERT System.

Conclusion

The rapid evolution of industry has made problems related to maintenance, and particularly fault diagnosis, of very complex system such as broadcast transmitters and satellite launching stations difficult to solve. The use of EXPERT System presented in this paper can greatly simplify fault diagnosis in such systems. The major features of our EXPERT System are summarized below:

- Our Expert System is a modular software package with many user-friendly features
- Its knowledge base can be modified or augmented without affecting the structure of the entire program
- It can be easily adopted to different types of transmitters or any other type of engineering systems
- It can be used in training technical staff for acquiring the knowledge of broadcast transmitters and for generating useful database of transmitter faults.

The results of field trails of our EXPERT SYSTEM in a transmitting station have clearly shown its practical utility in Broadcasting Stations.

References

1. Jagdeesh Patil S. 'BTEX: A Fault Diagnosis Expert System for Broadcast Transmitter' at Indian Institute of Science Bangalore.
2. Robert A Edmunds. 'Guide to Expert Systems', Prentice Hall (1998).
3. MW – (500KW x 6] Brown Boveri Transmitter Manuals, vols 1 to 5 - Super Power Transmitting Station, Bangalore.