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Built-In Test Expert System for Radar Using Drools

[1]Amit Havinal, [2]Dr. S. Meenakshi Sundaram
[1] PG Student, [2] Professor
[1, 2] Department of C.S.E., Don Bosco Institute of Technology,
Bangalore, India

Abstract—This paper presents the work carried out on the development of fault diagnosis of radar system that is, Built-in test expert system using rule based approach. Built-in test expert system is an important application which improves radar tests, maintenance and diagnostic capability. It monitors the status of radar system by detecting, isolating, monitoring failures and reporting the health status of each radar subsystem with the help of rules. With the use of rules, radar faults were found accurately and were feasible. Rules in the proposed expert system are represented in Drools. Drool is a Business Logic integration Platform. The scope of this paper is, effective monitoring and diagnosis to radar fault that bring out a higher fault detection rate and a lower false alarm rate.

Keywords— Expert System, Built-in Test, Rule-Based Approach, Drools.

I. INTRODUCTION

Radar **(Ra**dio **D**etection **a**nd **R**anging*)* is an object detection system which uses electromagnetic waves to find out different parameters of an object. The parameter includes object's range and direction, its altitude or speed. Radars are used into various fields like detecting terrain, retrieving weather formations, detecting ships and aircraft also for guided missiles. Microwaves or radio waves are transmitted by radar antenna which comes in contact with objects and gets reflected back towards the receiving antenna. A small part of the transmitted power is reflected back towards the receiving antenna which may or may not be located at the same place as that of transmitter. Secretly the Radars were developed by many nations before and while the World War II [1].

Now a day's radars are used for modern applications like air traffic control which keep tracks of commercial and defense aircrafts, air-defense systems that secures the airbase or any restricted area, radar astronomy that is used for forecasting, outer space surveillance which are used to monitor objects present at vary farther distance and rendezvous systems; meteorological precipitation monitoring, flight controlling systems, guided missile target locating systems; and ground-penetrating radar for geological observations [1]. Advanced radar systems uses efficient signal processors which are accomplished to filter out the noise from the desired information about target.

With the development and improvement of the technology of computer, software, large scale integration (LSI) and communication, the system of radar instrument has become more and more complicate, and the automation level of it is more and more higher. In order to ensure the normal operation of the radar, the highly efficient fault detection is also of great importance to keep the good operational status and enhance combat effectiveness. Nowadays, at home and abroad, there are many ways on fault diagnosis and detection for radar, but many of them have the problems of long test cycle, complex process, low efficiency, high cost, error-prone and so on[4].

Built-In Test Expert system provides various number of tests functions by putting it into an single software program which retrieves very fast and accurate results of faults occurred at radar and is been displayed. Expert systems is a fast growing branch of artificial intelligence which is been applied in various fields. Since 1970's it's been evolved as first successful form of artificial intelligence software. Expert systems are built using various techniques related to the requirement in different fields. When compared with other techniques which are available, Built-In Test is advantageous in multiple ways like, it gives better performance, efficiency is high, working continuously i.e. real time tool and so on.

The paper is organized as follows: Section II describes the working, characteristics, approaches and advantages of using expert system. Section III describes about the Rule based approach and the tool used to develop the rule engine for the expert system and Section IV describes the proposed system for the development of expert system.

II. EXPERT SYSTEM

Artificial intelligence consists of vast braches spread over various fields among which Expert system (ES) is the one which is getting more used now a days and its booming. Human is acquired with the knowledge into various fields, but expertise in multiple fields is not possible in this situation so expert system accomplishes these problems by acquiring all the knowledge from the experts or domain experts and is transferred to computer so as to get the complete expert system. The knowledge retrieved from domain experts are been transferred to computer for any advice in future as needed. Computer then perform operations and provides particular conclusion whenever any query is raised. The results retrieved is as same as human consultant which provides description or advice for specific query and explains it if necessary [7].

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In recent years, professional are very much keen to know about the expert system technology for development of systems in various fields. Expert systems have already been captured or developed into fields like Medicine, Engineering, and Science. Practically the computer society and the experts or professionals have a special interest for the system. There are various advantages or uses as found by the organizations in solving practical and real-world problems [3]. Expert system can also be said as knowledge engineering. Interaction between knowledge engineer who basically contained with idea to get the information, domain experts who is expert in one or more problem area and the builder who combines these both to get expert system [6]. Expert system has various characteristics of the human expert:

Knowledge
Reasoning
Conclusion
s
Explanatio
n

Built-In Test exploits the expert system characteristics. Radar includes various subsystems which keep tracks of various parameters individually. The faults occurring at each subsystem vary according to the working of the system and each has its own uniqueness. Differentiating each and every fault may be a challenging task due to huge junk of information received at a time. Development of expert system resolves the task efficiently by collaborating the knowledge of multiple domain experts and knowledge engineers as it is known as problem-oriented domain. Expert system is used when we have to provide expertise that is expensive or rare, develop a solution faster than human experts can, provide expertise needed for training and development to share the wisdom of human experts with a large number of people, capture and preserve irreplaceable human expertise and provide expertise needed at a number of locations at the same time or in a hostile environment that is dangerous to human health [3].

Expert system is classified into various approaches like Rule based, Model based, Case based reasoning, fuzzy logic etc. Each approach has its own application and advantages over various fields. Built-in test is developed using rule based approach. There are two problem solving model for expert system basically,

Forward Chaining: Starts from a set of condition and move towards some conclusion.

Backward Chaining: Starts with the list of goals and works backward to see if there is any data that matches any of the goals.

Proposed model for developing built-in test is backward chaining model. It's actually meant as ―Goal Driven‖, meaning that we start with a conclusion which the engine tries to satisfy. If it can't then it searches for conclusions that it can satisfy, these are known as sub goals that will help satisfy some unknown part of the current goal. It continues thisprocess until the initial conclusion is proven or there are no more sub goals. The advantage of building expert system using rule based approach is, provides answers for repetitive decisions, processes and tasks, also reduce the time needed to solve the problems.

III. RULE BASED APPROACH

Rule based expert system is defined as the one which contains information obtained from human expert and represents that information in the form of rules such as IF-THEN. The rule is used to perform operations on the given data in order to reach appropriate conclusion [7]. There are various advantages of using rule based approach for developing built-in test, it explains problem solving procedures with such expressions as this, ―In such-and-such situation, I do so-and-so‖ where each rule is an independent piece of knowledge and the syntax of rule based approach enables them to be self-documented.

As rule-based systems strive to encompass the knowledge of a domain expert, in the form of rules (often hundreds or thousands), development and maintenance can be complex and time consuming, but faults anticipated during the design phase can be diagnosed easily. Conversely, their intuitive simplicity makes rules easy to understand and the inference sequence used for a particular problem can easily be traced. Additionally, the technique is well proven, with many rule-based systems having been deployed in real applications [7].

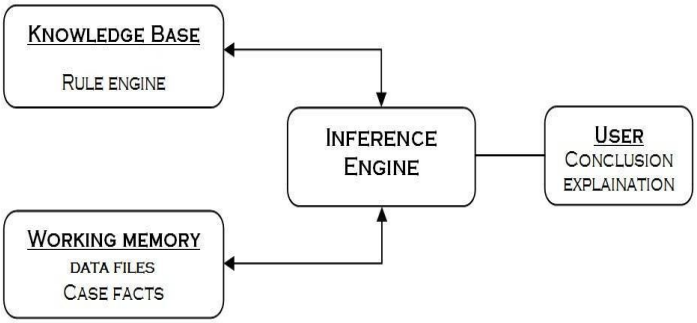

Fig 1: Expert system Structure.

The expert system structure is as shown in the fig 1. It includes three components,

Knowledge Base
Working

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Memory

Inference Engine

Knowledge Base contains the domain knowledge useful for problem solving. It is represented in the form of rules. Built-in test rules includes multiple conditions to be matched to retrieve exact fault occurring.

Working memory includes set of facts used to match against the If (condition) part of rule stored in the knowledge base. There are data files of various faults of radar available, through which the facts are been loaded in working memory.

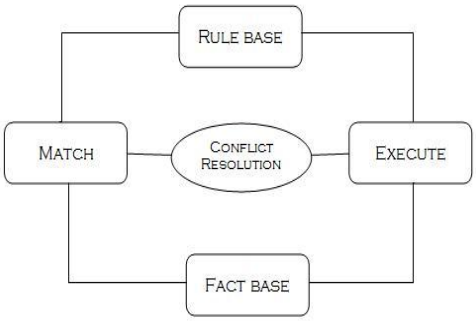

Fig 2: Inference Engine Structure.

The inference engine carries out the reasoning where expert system reaches the solution. It links the rule given in knowledge base with the facts provided in working memory. Inference engine basically executes the following into three-step loop i.e., Match, Conflict resolution and Execute. When all the conditions are matched, then rule is said to fire and then action part of it is executed. In this way a rule based expert system can exhibit human like performance in that knowledge that can seemingly be acquired through experience. The proposed rule based system is been built in Drools which is an open source rule engine written in java language.

A Drool is an enhanced implementation of Rete algorithm. Rete algorithm is a pattern matching algorithm for implementing production rule systems. A Drools rule language basically includes two sides i.e. Left hand side and Right hand sides which resembles a condition and statements respectively. Left hand side of the rule basically includes the set of conditions to be matched and Right hand side of rule includes the set of actions which will be executed. The LHS includes the logical operators like and, or, not, exists and also set operators. It can be either a pattern or any constraint. When the conditions in the left hand side matches then right hand side comes into action i.e. the code is been executed. Advantage of using drools is it can reduce complexity of components that implement the business rules logic in Java application, and it is easy to maintain or extend the business logic by declarative programming.

IV. PROPOSED SYSTEM

In the proposed system the concentration is basically on monitoring and recording the active status of each module in time, to judge the failure states of the radar, to indicate the positions of the fault and to analyse various causes of the failures which could help shorten the repairing time .At the same time we can analyse the monitoring data and make a prediction about the trend of the failure. It is an assistant to make a strategic decision about maintainability, so we can improve the war preparedness intact of the whole radar system.

We include few functions of several aspects as follows:

System self-testing: System self-testing is an additional function that the system carry on judgment through procedures and judge whether the diagnosis system itself is broken down according to the data coming from data collecting system.

Real time monitor: Collect the data of radar active status at interval of several minutes (Time can be draw up according to concretely request) and judge whether the radar system breaks down, give conclusion whether the status of the whole machine is normal; if the radar appears abnormal, then send out an alert.

Fault diagnosis: If the radar breaks down, the system can find the position of the fault in the replace units and concrete circuit boards according to the status data transmitted up to the system. The maintainers will quickly replace the breakdown part according to the suggestive conclusion of the system to recover the radar system.

Working state prediction: According to present monitoring data and historical data of the radar, combine electronics equipment macroscopic regulations about breakdowns and analyse the movement trend of the whole equipment's, subsystem and function unit, in order to understand the movement condition of radar in time, adopt correspond measures in time and support to establish maintain decision.

Information inquiry: The operator can expediently search the radar structure information, system current status information, history status information and alert information etc.

V. CONCLUSION

This paper describes the development of Built-in test expert system using Drools. Built-in Test expert system monitors and records the active status of each module in time, to judge the failure states of the radar, to indicate the positions of the fault and to analyse various causes of the failures which could help shorten the repairing time. Built–In test expert system works continuously which will be accepting the status message in equal interval of time. It provides full length description of the fault, either one or multiple faults along with its names uniquely and individually. Rule

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Based approach will be more advantageous as the logic is embedded in the rules and if any changes in future then it can easily be maintained. As a whole it has various advantages like System self-testing, Real time monitor, Fault Diagnosis, Work state prediction and Information Inquiry.

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