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DIAGNOSIS AND TROUBLESHOOTING OF COMPUTER FAULTS BASED ON EXPERT SYSTEM AND ARTIFICIAL INTELLIGENCE

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Abstract: The expert intelligent system is introduced to develop hardware fault detection for any computer system. Different hardware system or electronics devices usually face application fault as well as hardware fault. This application oriented formal reasoning applies to determine the problem in computer system. This paper emphasizes an automated system that accepts the defects of any system and then after consulting with an intelligent database, diagnoses and advises for probable rectification. This is the extensions of the already published work by the authors implemented by Turbo Prolog programming language. This paper extends that concept exploring the boundary of Expert System targeting the implementation using Object Oriented web based programming approach. It proposes lot of new technological changes and in-

clusion to make the system more perfective and efficient data handler.

AMS Subject Classification: 60A05
Key Words: expert system, hardware fault diagnosis, turbo prolog, knowledge-base

1. Introduction

The proposed system is meant to automate the maintenance, repair, and operations process, and free-up human technicians from manually performing routine, laborious, and time-consuming maintenance tasks. Computer systems typically include a combination of hardware and software components, application programs, System programs, processors, buses, memory, input/output devices etc. As advances in semiconductor processing and computer architecture push the performance of the computer higher and higher. More sophisticated computer software has evolved to take advantage of the higher performance of the hardware, resulting in computer systems that are much more powerful than just a few years ago. In a computer system in different parts different fault may arise. Expert system is able to detect those faults and also to suggest for the probable rectification. Generally, when user consults an expert system, the system interviews (ask questions of) the user and gets the facts about the problem at hand. During the interviews, questions appear on the computer display screen and the user responds by keeping in answers or important data. Then, utilizing the user's response the system searches its knowledge base. It systematically searches through the various paths for a solution without becoming lost in the vast numbers of possibilities. Eventually the program comes up with the advice and communicates it to the user. The system also explains its reasoning process and remedy. Before demonstration of the proposed model it is required to understand the knowledge domain based on Artificial Intelligence and its application, i.e., Expert System.

1.1. Expert System

An Expert system is a computer system that emulates the decision making ability of a human expert, i.e., it acts in all respect of human counterpart.

An expert system sometimes referred to as knowledge-based system is a computer software that emulates the decision-making ability of a human expert [1]. Expert systems do not use traditional programming paradigms to

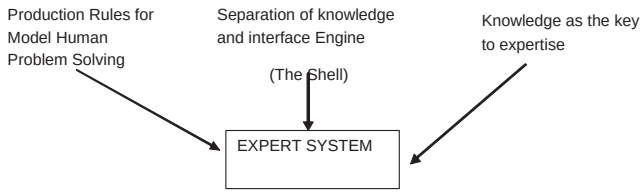


Figure 1: Expert System based on AI equivalent to Human Brain

solve problems; rather, they use knowledge which they reason about to draw conclusions and provide solutions. Expert system is a subfield of artificial intelligence (AI), and was first conceived by Edward Feigenbaum, now considered the father of expert systems, who with other colleagues and associates built the first successful expert system in the late 60's at Stanford University [2]. It was called the "Dendral" system, a portmanteau of the term "Dendritic Algorithm". Dendral was meant to emulate organic chemists to help automating the process of identifying unknown organic molecules [3, 4]. The advantage of expert systems over conventional programs is that their core algorithm is not encapsulated in the programming code but stored as knowledge in an independent database called knowledge-base or KB. In consequence, there is no need for the expert system to be reprogrammed and recompiled every time the knowledge changes. Practically, expert systems have significant applications including medical diagnosis, fault diagnosis, question-answering, industrial process controlling, climate forecasting, manufacturing failure analysis, decision support, and decision making [5, 6].

1.2. Expert System Structure

Complex decisions involve intricate combination of factual and heuristic knowledge. Expert systems are organized in three distinct levels: 1. Knowledge base consists of problem-solving rules, procedures, and intrinsic data relevant to the problem domain. 2. Working memory refers to task-specific data for the problem under consideration. 3. Inference engine is a generic control mechanism that applies the axiomatic knowledge in the knowledge base to the task-specific data to arrive at some solution or conclusion [7].

2. The Present Expert Computer Fault Troubleshooter

The authors of the paper already developed an expert system on this subject based on prolog programming language and database management system. The published work is described below [8]. The proposal of the new system that is web based and following object oriented technology. The design phase and implementation overview is described after describing the previous published work.

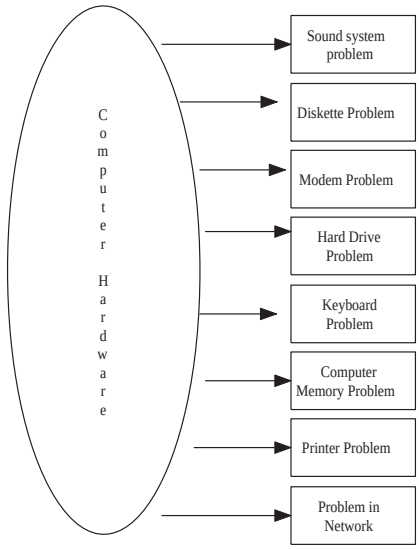


Figure 2: Different Problem Modules of Computer Hardware Faults

Different types of Problem Module in Computer Hardware: There are many types of computer hardware faults in a computer system. Due to the simplicity of the program these faults are divided into different problem modules. Those problems which are discussed here are Sound system problem, Diskette problem, Modem Problem, hard dive problem, keyboard problem, computer problem, printer problem, problem in network etc. Causes and Probable Rectification of those part's faults are stated in chart below.

SYMPTOM	CAUSES(FAULTS)	PROBABLE SOLUTION
No sound from speakers	This fault may be for audio has been turned off or muted	1.Double click the speaker icon on the window bar.The volume control box is display. 2. Check that mute option is not selected.
Volume is too low	Press the volume up button on your easy access of keyboard.	Double click the speaker icon on the window taskbar. Set the speaker volume to the higher level
No sound at all	This fault may be for the cables are not connected.	Refer to the quick setup poster for instruction on how to connect speakers to your computer.
Sound is distorted	The volume is too high.	1. Press the volume down button on your easy access keyboard. 2.Double click the speaker icon on the windows taskbar. Set the speaker volume to a lower level.
No sound in windows	Check the fault in volume control.	Double click the speaker icon on the window taskbar.Click the slider and drag it up.
Windows does not detect the audio drivers	Detect audio driver.	1. Click start and point to settings Click control panel. Look for sound ,Video and game controllers. 2. Select device manager, remove both plug and play audio driver, game port the joystick driver on startup position and sound is probably available then.

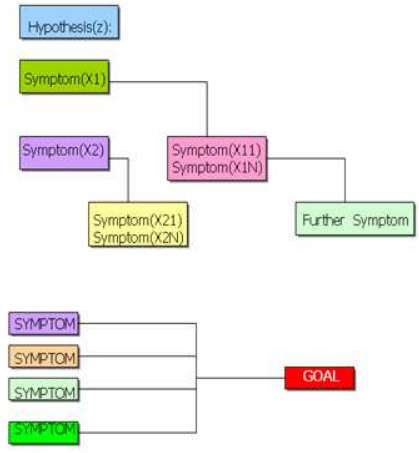
Table 1: Sound system problem

2.1. Sound System Problem

Remark: The data sets given above are not consisting of all the probable faults. Those are taken as sample to create knowledge-base required for the proposed expert system.

3. Flow Chart & Design

In the flow chart of the program the system first enters into symptom(X1).If it finds any symptom there then it will search for the symptom(X11) and then up to symptom (X1N) and then it will search for the further symptom. But if the system does not find any symptom in (X1), then it will directly enter into the symptom (X2) and it will continue the same process. After collecting sufficient symptoms it will find out the exact Goal.



Algorithm for system flow of present model:

Step 1: Select the error from a given list in a menu driven program.
Step 2: The user selection will be taken as predefined symptoms sated in above tables
Step 3: The program then connects with the database and send a SQL query to get knowledge of expected causes and faults.
Step 4: Database the expert that is already prepared on knowledge processing technique will display all relevant faults.
Step 5: The user selects appropriate fault and ask for solution by throwing query.
Step 6: database (knowledge base) will supply all possible remedies as program output to help manual servicing [8].

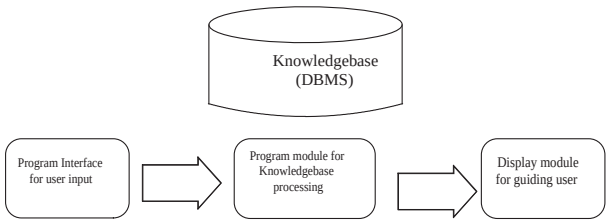


Figure 3: System Flow Chart of Present Model Implemented by Prolog

4. Obtained Results and Analysis

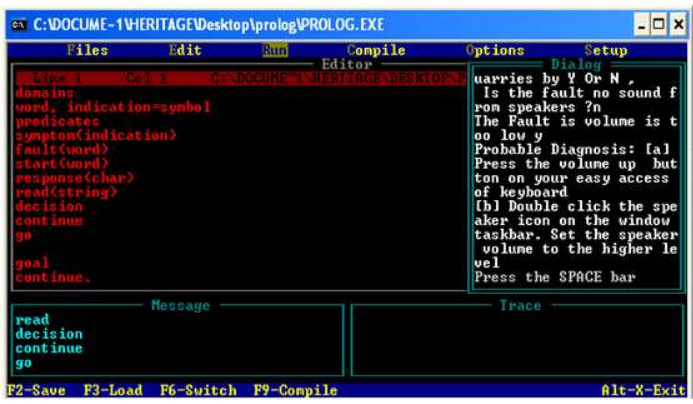
TURBO PROLOG is used here to develop this programming. PROLOG is useful for almost any application that requires formal reasoning. This includes applications in expert systems, natural language processing, robotics, and gaming and simulations. There are four windows are displayed in below: Editor, Dialog, Message and Trace. Editors are to create or edit the program, Dialogs are for showing the outputs, Message keeps up to data processing activity, and Trace window finds problems in programs [8]. The software is satisfactory to determine the faults and state relevant remedies, but it is lack of many performance parameters due to the constraint of Prolog programming language. Less user interactive, inefficient data handler, bad database integration, Insecure Data, limited programming features, bad user interfaces etc are the main problems. Those limitations of previous application has encouraged to incorporate object oriented principles and design stated later.

5. Few Sample Screenshots of the Output of Existing Program

In a speaker system of a computer volume may be Too low. This fault may arise for the problem in knobs of the speaker. The probable rectifications are: a) Press the volume up button on easy access of keyboard. b) Set the speaker volume to the higher level.

6. Design, Algorithm and Flowchart of Proposed Upgraded Model

The proposed Computer Fault Troubleshooter is a rule-based expert system for diagnosing and troubleshooting PC faults and hardware problems. It is



totally new design of previous concept based on object oriented programming principles. It is a web-based system that can be deployed in an Intranet environment. The actual knowledge of the system is represented as production rules in the form of if¡condition1¿ and¡condition2¿ then ¡conclusion¿ ' ¡solution¿, and stored in a rule-base. Characteristically, the proposed Expert PC Troubleshooter comprises six major modules: a GUI web user interface which allows human troubleshooters to easily operate and interact with the system; a knowledgebase more particularly a rule-base which houses and stores all PC troubleshooting knowledge as human-readable production rules; an inference engine which matches facts provided by human troubleshooters against rules in the rule-base, then produces a reasoning on these rules based on forward-chaining algorithm to derive conclusions and identify computer faults[9].

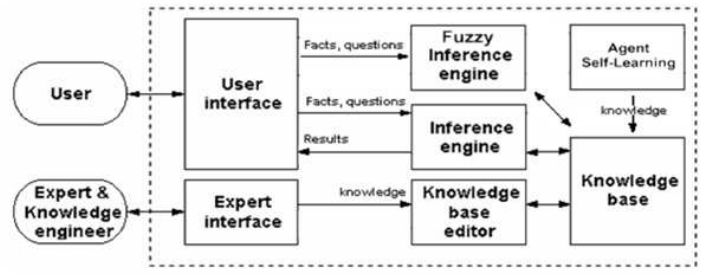


Figure 4: System Component Integration of Proposed Fault Troubleshooter

6.1. The User Interface

The user interface of the proposed Expert PC Troubleshooter is a web-based interface accessible from any compatible web browser and allows a communication between the system and the user. It is consisting of relevant diagnostic questionnaire containing a sequence of questions that are asked to the user who would have to answer them thoroughly, so that the cause of the fault is identified and a matching solution is provided. Basically, it is web data form through which the possible symptoms of hardware faults are presented to the user on the screen.

6.2. The Knowledge-Base

The knowledge-base is a human-readable rule-base in which troubleshooting knowledge is represented as production rules originally acquired from human experts in the PC troubleshooting field. It is a data repository which provides a mean for knowledge to be collected, organized, saved, and searched. Upon reasoning, the expert system loads rules from the rule-base to the working memory and tries to match them against user's facts submitted thru the user interface. Once a match occurs, the fault is identified and a solution is provided to fix that fault. Fundamentally, the rules of the proposed Expert PC Troubleshooter are in the form of if-then statements, more formally they can be represented as IF A AND B THEN C ' D where A denotes the first condition, B denotes the second condition, C denotes the conclusion, and D denotes the solution. The Knowledgebase is stated on the above tables of possible faults and solutions. A sample decision tree is given as fig 8[9, 11].

It is also planned to collect all standard system error codes of Microsoft Operating System and feed those data in to the knowledge base along with the possible solutions.

6.3. The Inference Engine

It is the brain of the system which performs logical reasoning on rules and problem-solving strategies to derive answers and conclusions, and infers new knowledge. It is fed by troubleshooting data and facts from users and produces results about the causes of the corresponding faults and their possible solutions (shown in above tables), keeping the reasoning process totally invisible from

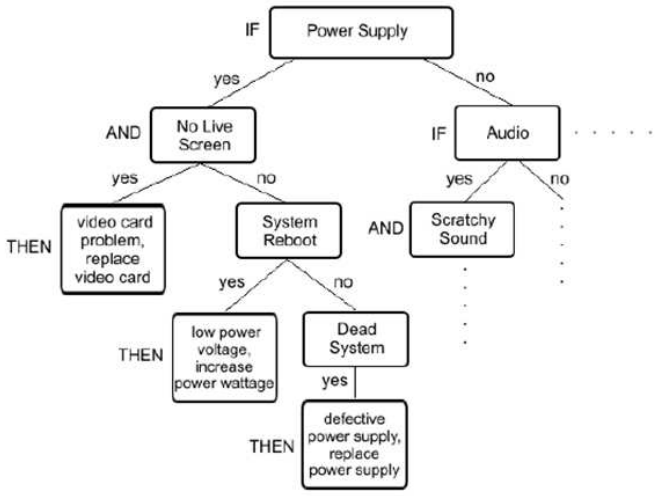


Figure 5: Sample Decision Tree for creation of knowledge-base

the user. The authors also include the standard operating system error codes and possible solution into this design. The knowledge-base for the new model will follow the data of above tables.

6.4. Algorithm for knowledge-base data processing

Step 1: Read initial facts via user interface and store.

Step 2: Check the condition part (left side) of every production rule in the rule-base.

Step 3: If all the conditions are matched, fire the rule.

Step 4: If more facts are present, do the following:

Step 5: Read next fact and update working memory with the new facts.

Step 6: Go to step 2 Step 7: If more than one rule is selected, use the conflict resolution strategy to select the most appropriate rules and go to step

4.

Step 6: Continue until all facts are verified.

6.5. The Fuzzy-Logic Inference Engine

The proposed Expert PC Troubleshooter features a fuzzy-logic inference engine and a fuzzy-logic rule-base to diagnose and analyze the BIOS POST beep error codes for the original IBM-PC[9, 11, 12].

Implementation Overview
The Proposed web based system is planned to be implemented using J2EE with Oracle or PHP/ MySQL. The Design phase will consist of Data Flow Diagram (DFD), Use Case Diagram, Class and Sequence Diagram and Web Page Layout Design. The main Kernel of the program will catch the all exception possibly generated by hardware fault thrown by operating system or will take input manually. After analyzing the fault it will discuss with knowledge-base and act accordingly. The Program flowchart is given below. It is also targeted to integrate it with the dynamic link library (DLL) of Operating System so that the system activates when error occurs.

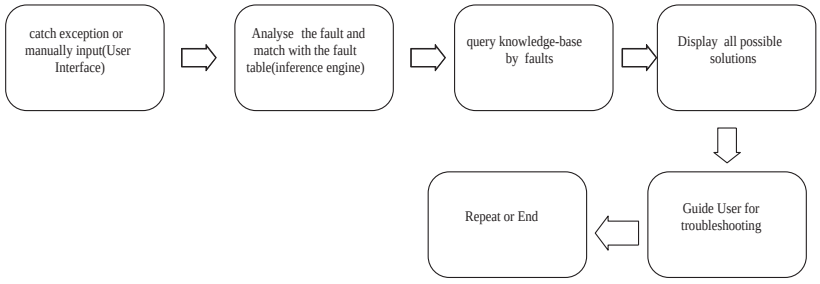


Figure 6: Program Flowchart for Proposed Model

7. Conclusion

This paper presents a novel expert system for troubleshooting and solving computer hardware problems and faults. The system is called ‘Expert Computer Troubleshooter‘ and it determines knowledge using an inference engine and troubleshooting production rules. After implementation of this concept one ex-

pert application software will be developed. The user or troubleshooter of the software will definitely get immense help to repair a computer system thus save time and cost.

References

[1] Jackson and Peter, Introduction to Expert Systems, *3rd ed, Addison Wesley*, (1998).

[2] Russell and Norvig, Artificial Intelligence: A Modern Approach, *2nd ed, Upper Saddle River, Prentice Hall*, (2003).

[3] Lederberg, Joshua, How Dendral Was Conceived and Born, *ACM Symposium on the History of Medical Informatics*, (1987).

[4] Lindsay, Robert K., Buchanan, Bruce G., Feigenbaum, Edward A., & Lederberg, Joshua, Applications of Artificial Intelligence for Organic Chemistry: The Dendral Project, *McGraw-Hill*, (1980).

[5] Shu-Hsien, Liao, Expert system methodologies and applications, a decade review from 1995 to 2004, *Expert Systems with Applications*, **28(1)**, (2005), 93-103.

[6] Lindsay, Robert K., Buchanan, Bruce G., Feigenbaum, Edward A., & Lederberg, Joshua, DENDRAL: A Case Study of the First Expert System for Scientific Hypothesis Formation, *Artificial Intelligence*, **61(2)**, (1993), 209-261.

[7] The Evolution of Expert Systems, *Griffith University, School of computing and Information Technology.*

[8] B. Neogi, P. Pradhan and A. Das, Expert System and Artificial Intelligence for Diagnosis of Computer Hardware Faults, *National Seminar on Frontiers in Electronics, Communication,Instrumentation and Information Technology*, **1**, 169-177.

[9] Bassil Y.,EXPERT PC TROUBLESHOOTER WITH FUZZY-LOGIC AND SELF-LEARNING SUPPORT, *International Journal of Artificial Intelligence & Applications*, **3(2)**, (2012).

[10] Giarrattano and Riley Expert Systems: Principals and programming, *3rd Edition, PWS publishing company, Boston*, (1998).

[11] Gupta, Kalyan, Case-Based Troubleshooting Knowledge Management, *AAAI Technical Report*, (1999), 99-04.

[12] Verma, Jindal & Aggarwal, Jain, An Approach towards designing of Car Troubleshooting Expert System, *International Journal of Computer Applications*, **1(23)**, (2010), 107-114.

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