Printer Troubleshooting Expert System

Akhil Kaushik*   **Satvika**   **Manoj Barnela**
CSE Deptt,TIT&S Bhiwani   *IT Deptt,TIT&S Bhiwani*   *EI Deptt,TIT&S Bhiwani*
India   *India*   *India*

Abstract— The present era is the information age, where faster transfer and retrieval of information is the most vital need. The chief requirement of this era is that all communicating devices should be up and running. In the current world, the most popular communicating device is the personal computer and its downtime will prove fatal for the corporate competence. Apparently most of the computer users are amateurs when it comes to the area of troubleshooting, a predicament that arose in computer hardware. One such computer hardware that is essential part of every office is printer. If the printer in the office or at home is malfunctioning, then the situation requires a hardware specialist. However, using an expert system in this scenario will be an economic and rapid solution and will overcome the need of a hardware expert. This will help to increase individual's efficiency by diminishing his/ her downtime. This paper proposes a new expert system named "Printer Troubleshooting Expert System" for troubleshooting printer issues in MS-Window based Personal Computers.

Keywords— Artificial Intelligence, Expert System, Knowledge base, Subject Matter Expert (SME), Printer Troubleshooting Expert System(PTES).

I. INTRODUCTION

Since the beginning of 20th century man has tried to give acumen to its favourite servant i.e. the computer. This idea gave birth to the newest branch of science known as the 'Artificial Intelligence' which has revolutionized the whole concept of thinking. By definition, Artificial Intelligence is the area of computer science focusing on creating machines that can engage on behaviours that humans consider intelligent. Broadly speaking, Artificial Intelligence is the combination of computer science, physiology and philosophy. The grounding principle of Artificial Intelligence is to make computers more useful and independent. In this way, computers will achieve the capability to imitate the human thinking process and will be able for strategic decision-making [1][8].

AI is about generating representations and procedures that automatically (or autonomously) solve problems heretofore solved by humans. This aspect repeatedly enforced throughout the text by the many appearances of the terms knowledge representation and manipulation. The manipulation includes the creation of new facts, concepts, structures and so on. Finally a better understanding of AI is gained by looking at the component areas of study, such as robotics, memory organisation, knowledge representation, storage and recall, learning models, common sense reasoning, understanding natural language, speech recognition and synthesis and a variety of AI tools. The most integral branch of artificial intelligence is known as the 'Expert System'. It is defined as special software which attempts to replace the need of a human expert in any specified domain. For achieving human expertise, expert system replicates human reasoning process by deploying particular domain knowledge and techniques [5]. The following diagram lists all components of an Expert System:
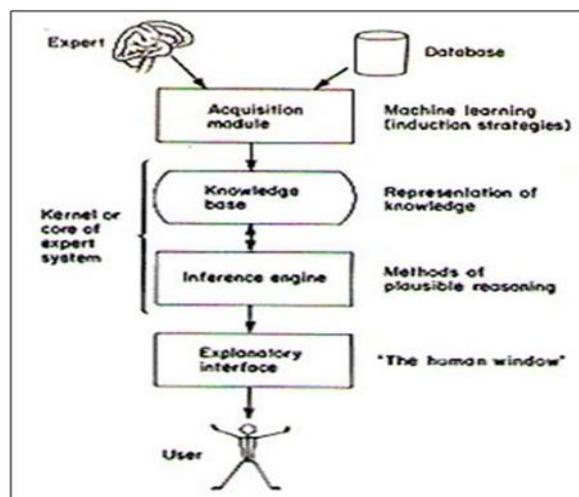

Figure 1: Components of Expert system

Traditionally expert systems were developed to replace human experts for any specific sphere, but practically, they are used to assist the human connoisseur[9]. However they prove as thriving technology in training new professionals by providing them more insight knowledge and bulk of experience extracted from various subject matter experts. Expert systems show great competence in doing routine processes and making short-term decisions for end users, thus indirectly increasing their efficiency.

Nevertheless the goal of any organization is accomplishing most gains with minimum expenditure. Currently where every association is cutting additional costs, downsizing employees and limiting resources; small-scale expert systems can be a tremendous gain. The focus of this paper is developing such a small PC-based expert system for solving printer-related issues. It is advanced software that is much more than just a stand-alone application. It is a web-based expert system that can be used over internet to provide service anywhere anytime across the globe. A foremost prerequisite for implementing 'Printer Troubleshooter System' (PTR) for any user will be the need of Internet to provide network connectivity across nodes. The next section explains the development procedure of PTS expert system.

II. DESIGNING AND DEVELOPMENT OF PTS

This paper primarily focuses on all common and rare issues that may arise in computer printers especially network printers. It will first study every single commonly occurring quandary in printers. The root cause and exact solution for every trouble will be noted down. PTS uses three Subject-Matter Experts (SMEs) to extract domain knowledge and precious experience. This is the trickiest and complex task because tacit knowledge is very hard to explain and extract. PTS will also try to uncover rarely happening tribulations never faced before which may prove fatal. This will be done only with the help of subject matter experts with their esteemed experience of years. PTS will build a knowledge base created with previous and newly gained knowledge. This knowledge will be revised at regular intervals to keep it up-to-date with the new horizons. Designing is the most important in expert system development. A good design ensures error-free software and with least amount of modifications required. The more time invested in the designing, the less effort and finance required to develop the system. The imperative steps involved in designing and development of PTS are as follows:

a) Studying and identifying the problem.
b) Knowledge acquisition.
c) Selection of PTS development tool.
d) Development of PTS and refinement.
e) Refinement and Maintenance.

A. Studying and identifying the problem

It is the first and most crucial step as it deals with identifying the real cause of unusual behavior of computer hardware. Once the problem is identified, the next immediate step is to localize the issue. Attaining this feature will require the need of expert system to behave like a computer hardware specialist. The basic and advanced information about the printers should be known to the knowledge engineer building the expert system. He/ she should be familiar with different vendor's printers, their data cables and power cables, etc. With this basic awareness of printer related devices, the knowledge engineer will be able to get familiar with the kind of issues that can be aroused in a printer[4]. Due to this, identifying the printer problem and corresponding solution will be smooth and easy. Another considerable issue to be taken care of is whether the problematic printer is a stand-alone printer or a network printer[3].

B. Knowledge Acquisition

Knowledge acquisition is indeed most critical and significant step of all. The major sources of knowledge acquisition are subject-matter experts, previously stored databases, journals and research papers. Except subject-matter experts, no other source has got tacit knowledge. This is where the problem occurs, because tacit knowledge is hard to explain[6]. Moreover human experts are quite busy and their time is very valuable. As their experience is their knowledge, they are unable to express it effectively. This step is very time consuming and may prove as a bottleneck in development cycle of PTS.
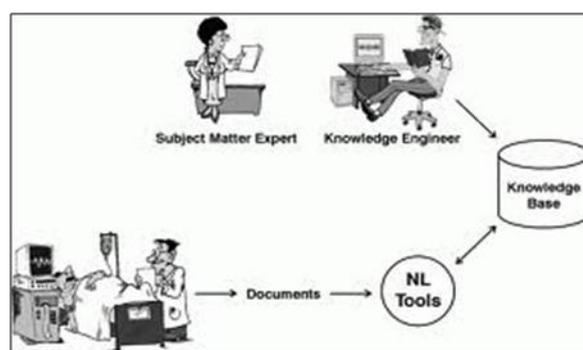

Figure 2: Knowledge Acquisition Process

Once knowledge is acquired, it must be formatted in one format. Then next intermediate step is to document the acquired knowledge. Documenting this knowledge will be helpful to state how given problems are solved. This documentation will explain how the expert system works, how to add new knowledge to the knowledge base and the best part of it is to use for training the new employees or system engineers[2][8]. Knowledge documentation will help decomposing bigger issues into small chunks, which will help them to manage better.

C. Selection of PTS development tool

The proposed expert system will be developed as a web-based expert system; hence it is mandatory to use a web programming language. The programming used here is ASP with .NET framework. The knowledge base is created in SQL. The Printer Troubleshooter System (PTS) on Compaq CQ60 Laptop Intel 1.66 GHz processor on Windows 7 (32-bit Operating System).

D. Development of PTS and refinement

Printer Troubleshooter System (PTS) is a rule-based analytical system that works on forward chaining. Forward chaining starts with the data available and uses the inference rules to extract more data until a desired goal is reached. An inference engine using forward chaining searches the inference rules until it finds one in which the antecedent logic/ if clause is known to be true[1]. It then concludes the then clause and adds this information to its data. It continues to do this until a goal is reached. Because the data available determines which inference rules are used, this method is also classified as data driven. The forward chaining method takes use of the rulebase to find exact solution. Some expert systems required the entire rulebase to be stored since all the rules were, in effect, chained or linked together by the structure of the rulebase. An alternative way to access rulebase is to use 'segmented rulebase'. When the rulebase is segmented, preferably into contextual segments or units, it is then possible to eliminate the portions of the rulebase containing data or knowledge that is not needed in a particular application[7]. The segmentation of the rulebase also allows the expert system to be run on or with systems having much smaller memory capacities than was possible with earlier arrangements, since each segment of the rulebase can be paged into and out of the system as needed.

The Printer Troubleshooting Expert System consists of a finite set of rules composed of If-Else statements. It takes the form of "If this symptoms, then apply this solution". All the knowledge acquired from different sources is stored in the knowledge base in the form of 'If-Then' statements. This is a convenient way of representing tacit knowledge about the problem domain[9]. This knowledge is extracted from the knowledge base by the help of inference engine, Inference engine which acts as a brain of the expert system is the real workhorse. It has the responsibility of matching the entered question with a suitable answer and outputting it to the user. One such example of If-Then rule stored in the knowledge base is:

MakeRule (PrinterJam Problem, [1])

IF: Printer is unable to print & Light indicator is orange or blinking

Then: Paper jam or lack of papers to print

Figure 3: Sample Rule used in the system

The working of PTS is explained as the follows: The user is presented with a form that gives all common problems as options. If the user's problem is listed is the box, the user can choose it and submit that respected query. Then the expert system responds to the submitted query and provides the corresponding solution for the given problem. If the provided answer solves the issue, the user may click 'Yes' button and user is reverted back to homepage to submit any further queries. Else if the solution presented does not solve the issue, the user can click 'No' button and alternative solution will be offered to the user. If the problem still persists, the user will further be supplied substitute answers. Another situation arises when the user's problem is not listed in identified issues. Then the user may enter his problem into the text box presented in the form and then clicks on 'Submit' button. This question is then passed to the inference engine which looks for matching answer in the knowledge base and outputs that to the user. If the problem still persists, expert system offers every possible resolution to solve it. The expert system uses iterative searching in knowledge base to get to the end solution of the problem.

E. Refinement and Maintenance

Once the PTS is developed it is ready to implement in the real world with initial design and facilities. This section includes correction of fault and other possibilities. This step is very important because, this system must work properly without hanging and being stack at the certain points after the system has been running for a long time. This step ensures that the expert system is in accordance to the user demands and fulfills them appropriately. End users can give their valuable suggestions to the expert engineer and the system can be refined according to that.

The last step is maintenance and updating, which is extremely important if the system is looking for product of high quality and with potential commercial success. During this step one must pay attention to end user complaints and problem, correction of bug and error, updating of the product with new knowledge base and so on. The proposed expert

system for printer problems ensures that the system is portable and extendable for future needs. Updating the knowledge base will also be required regularly from time to time, hence proviso of it is provided in the system.

III. RESULTS

The following diagrams show the working of web-based expert system implemented on a site hosted on WAMP server:

Figure 4: The Input form for user's query

As described earlier, the user can submit his/ her query either from pre-provided options or he / she can submit their own question in the text box given. When the user clicks on the 'Submit' button, inference engine takes over and offers him a suitable solution. If the user is satisfied with the solution offered, he may go to homepage for next query or else he may click 'No' and will be provided with more deeper and alternative solutions until his problem is fully resolved.

Figure 5: Solution provided by the PTS

IV. CONCLUSION AND FUTURE WORK

This paper proposes a new expert system known as Printer Troubleshooter System (PTS) which is capable of handling all printer related predicaments. The experiments show that PTS works excellent with all kind of printers whether network or stand-alone ones. It is a web-based expert system which offers it great advantages over traditional expert systems like it may be used anywhere across the world, hence helping people not only at office but also at home. Moreover having this expert system online gives 24 * 7 availability for any user. It also gives portability capability to the system. The biggest pro of PTS is that it can also be utilized to train new technicians and computer users to diagnose and troubleshoot printers without any expert's assistance. Research shows that PTS is capable of updating knowledge base whenever required and software in accordance to future needs.
The prospect work of PTS includes the following:
- The expert system should be extended to troubleshoot sound and audio devices.

- To make the expert system portable for any other web based language that supports Unicode.
- To make the expert system capable enough to cope with unusual situations those have never been faced before.

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