

## PAPER 148 – EXPERT SYSTEM FOR TROUBLESHOOTING AND REPAIR OF COMPUTER ENGINEERING LABORATORY EQUIPMENT

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### ABSTRACT

Technologists and Technicians in Computer engineering Laboratories have been conducting practicals for students with a number of equipment, maintenance of such equipment and detection of faults on them are being carried out with a conventional approach. However, with advancement in Computer Technology and Artificial Intelligence, there exists few or no expert system that can be used in troubleshooting and repair of equipment in Computer Engineering Laboratories. This research proposed expert system for the maintenance and repair of equipment in the Computer Engineering Laboratories. Data was collected on five (5) equipment in the three (3) Computer Engineering Laboratories: Computer Technology Laboratory, Control Engineering Laboratory and Basic Electricity/Masurement and Instrumentation laboratory from three (3) higher educational institutions in southwestern areas of Nigeria. The data was encoded into If-then -rules, programmed with Python programming language and My Sql. A user interface was designed to guide users through the use of the system and display appropriate outputs. A test was carried out by four (4) users in one of the institutions to get their remarks and feedback on the Expert System. It was concluded that the expert system can be used to troubleshoot, repair and maintain computer engineering laboratory equipment by the Technologists and Technicians.

**KEYWORDS:** Computer Engineering, Equipment, Expert system, Laboratory, Technologists

### 1. INTRODUCTION

Expert Systems are artificial intelligence technology designed to mimic the judgment skills of human decision-makers. An expert system is created to record the knowledge and skill of human experts, then use it to give wise counsel or make choices in a certain field (Jackson and Peter, 1998). Expert Systems are utilized in many different industries, such as health, finance, engineering, and others, to automate decision-making and solve complicated problems.

The creation of expert systems for equipment diagnosis and repair in computer engineering labs has the power to completely alter how equipment is maintained and repaired. These solutions can reduce machine downtime, lower repair expenses, and improve system maintainability. Expert systems can quickly and accurately diagnose faults, suggest fixes, and even foresee equipment problems before they happen by utilizing artificial intelligence and machine learning. Expert Systems are utilized in many industries, such as health, finance, engineering, and others, to automate decision-making and solve complicated problems. Systems for knowledge automation offer a very effective and efficient approach to give customers, staff members, and even advisors themselves access to top-tier expert decision-making information and counsel for particular challenges (Exsys Corvid, 2011).

Every laboratory in the world has an expert when it comes to the detection of faults and providing solution to those faults but over the years the world has seen those experts die with such knowledge. Hence it is against this backdrop that this research seeks to implement an expert system for the maintenance, repair and troubleshooting of equipment in Computer Engineering Laboratories. There is a need to build a computer program that represents and reasons with knowledge of experts in the computer engineering field with a view of maintaining computer laboratory equipment by detecting and analyzing faults related to the equipment. This is justified by the importance of such expert system in the field of computer engineering as there are fewer or no expert system available. Another importance reason is that the expert system will make maintenance of computer engineering laboratory equipment more efficient by reducing the time needed to solve problems.

The research therefore proposed an expert-based system for the troubleshooting, repair and maintenance of equipment present in Computer Engineering Laboratory. This paper will specifically design and implement a prototype expert system and assess the efficiency of the system in identifying and fixing equipment issues.

Amanuel (2016) worked on the computer troubleshooting expert system that self-learns, He introduced an expert system that is specialized to detecting computer errors and suggesting viable solutions for the faults found. The expert system's conceptual model was created utilizing a decision tree form, which makes the reasons involved in computer troubleshooting simple to understand and analyze. The expert system was built using 'if – then' rules based on the conceptual model. Backward chaining was utilized to infer the rules and make relevant recommendations in the produced system.

Youssef (2012) developed an expert PC troubleshooter by employing rule-based methods and fuzzy systems to identify POST beep faults. He also employed an intelligent agent that aids in self-learning and knowledge acquisition. Using the MS.NET Framework 4.0 and MS Visual Studio 2010, ASP.NET 4.0 and C#.NET 4.0 are used to develop the Expert PC Troubleshooter. Using MS Office Access 2010, the rule-base is implemented as a relational database.

Aaron (2011) proposed an expert system algorithm for diagnosing faults in computer systems. The system uses a knowledge-based approach, where the knowledge is represented as a set of rules that capture the expertise of human experts in the field of computer engineering. The system is designed to be user-friendly, where the user can interact with the system using natural language, and the system provides recommendations for fault diagnosis and repair based on the symptoms reported by the user. The authors evaluated the effectiveness of the system using a dataset of computer system faults, and reported an accuracy rate of 90.5%, indicating the potential of the system to improve the efficiency of fault diagnosis and repair in computer systems. The authors also compared the performance of their system with other existing diagnostic tools and reported that their system outperformed the other tools in terms of accuracy and speed.

(Sourav et al., 2013) proposed an expert system for diagnosing and fixing computer faults using a knowledge-based approach that captures the expertise of human experts in computer engineering. The system is user-friendly and provides recommendations for fault diagnosis and repair based on reported symptoms. The study evaluated the system's accuracy using a dataset of computer faults, reporting an accuracy rate of 91%. Additionally, the study compared the system's performance with other diagnostic tools, demonstrating its superior accuracy and speed.

(Piotr & Przemyslaw, 2015) studied the application of expert systems in aircraft maintenance. The authors developed a knowledge-based system that collected the expertise of human maintenance personnel to provide recommendations for diagnosis and repair of faults. The system used a rule-based approach to identify faults based on symptoms and provides detailed instructions for repair. The effectiveness of the system was evaluated using a set of maintenance tasks, which reported a high success rate in identifying and fixing faults. The authors concluded that the system has been successfully implemented in the maintenance of the M-28 aircraft and has resulted in improvements in maintenance efficiency and accuracy.

(Sylvester and Adeola, 2015) presented an expert system called the Computer Fault Diagnosis and Troubleshooting System (CFDTS) designed to help non-expert users diagnose and repair computer faults. The system used a knowledge-based approach to diagnose computer faults, relying on a set of rules generated from expert knowledge of computer troubleshooting. The CFDTS has a user-friendly interface that guides users through the troubleshooting process. Additionally, the system has a database of known computer faults and solutions which can be updated as new faults are identified. The study evaluates the effectiveness of the CFDTS using a set of test cases and reports a high success rate in diagnosing and fixing computer faults. The authors concluded that the CFDTS could improve the efficiency of computer maintenance.

## **2. THEORETICAL BACKGROUND**

The process of building expert systems is often called knowledge engineering. The knowledge engineer is involved with all components of an expert system. Building expert systems is generally an iterative process. The components and their interaction will be refined over the course of numerous meetings of the knowledge engineer with the experts and users. The various components of expert system are presented in Figure 1.

- i. Knowledge Base
- ii. Inference Engine
- iii. User Interface

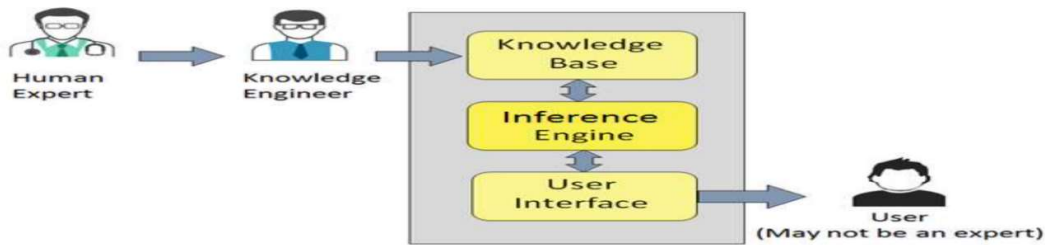


Figure 1: Component of Expert System Source: Tutorial Point

**Knowledge Base:** It contains domain-specific and high-quality knowledge. Knowledge is required to exhibit intelligence. The success of any ES majorly depends upon the collection of highly accurate and precise knowledge.

**Knowledge Acquisition:** The knowledge acquisition component allows the expert to enter their knowledge or expertise into the expert system, and to refine it later as and when required. Historically, the knowledge engineer played a major role in this process, but automated systems that allow the expert to interact directly with the system are becoming increasingly common.

**Representing and Using Domain Knowledge:** Expert system is built around a knowledge base module. Expert system contains a formal representation of the information provided by the domain expert. This information may be in the form of problem-solving rules, procedures, or data intrinsic to the domain. To incorporate this information into the system, it is necessary to make use of one or more knowledge representation methods. Three common methods of knowledge representation evolved over the years are IF-THEN rules, Semantic networks and Frames.

**IF-THEN rules:** Human experts usually tend to think along: condition  $\Rightarrow$  action or Situation  $\Rightarrow$  conclusion Rules. "if-then" are predominant form of encoding knowledge in expert systems.

These are of the form: If  $a_1, a_2, \dots, a_n$  Then  $b_1, b_2, \dots, b_n$ : where each  $a_i$  is a condition or situation, and each  $b_i$  is an action or a conclusion.

**The Inference Engine:** This interprets and evaluate facts in knowledge base to provide answer.

**The User Interface:** The Expert System user interface usually comprises of two basic components:

- i. The Interviewer Component: this controls the dialog with the user and/or allows any measured data to be read into the system.
- ii. The Explanation Component: this gives the system's solution, and also makes the system's operation transparent by providing the user with information about its reasoning process.

### 3. METHODOLOGY

This research work involves data collection, data processing, expert system development. A standard validated techniques was employed in the procedure of collecting, measuring and analyzing data for this study. Human experts in three (3) higher institutions in Southwestern region of Nigeria were met in their various laboratories to gather enough raw data which are the symptoms, faults, causes and possible solutions for the equipment. Data was collected on five (5) equipment each of three (3) Computer Engineering Laboratories namely, Computer Technology Laboratory, Control Engineering Laboratory and Basic Electricity / Measurement and Instrumentation laboratory. The raw data gathered from the data collection phase were processed and analyzed to produce meaningful information for this study. The development of the expert system was implemented on Intel duo core computer with a minimum processor speed of 900 mHz. A minimum Random-Access Memory (RAM of 4MB) and A minimum hard disk space of 10MB. Web-based system for system for computer engineering laboratory equipment was implemented with web-based application for information storage, a middleware application and a client-side application. Specifically, a browser Graphics and text browser is preferable e.g Internet Explorer, A text editor and Windows Apache, Pycharm (WAMP server).

#### 3.1 System Design

This is the section that traps user input; the input will be supplied via a keyboard into the database. The following are the various forms that will be used to trap data from the user. The forms are admin registration form, application form, application status, user form and faults, symptoms and possible solution.

The output design varies based on the criteria of selection. The output data can be on screen display from the database (data storage). The output design comprises of the name of equipment search, list of fault display and

general information about the fault. The flowcharts used in the development of the proposed system are shown in Figures 3, 4, and 5 for Admin, user and fault search respectively.

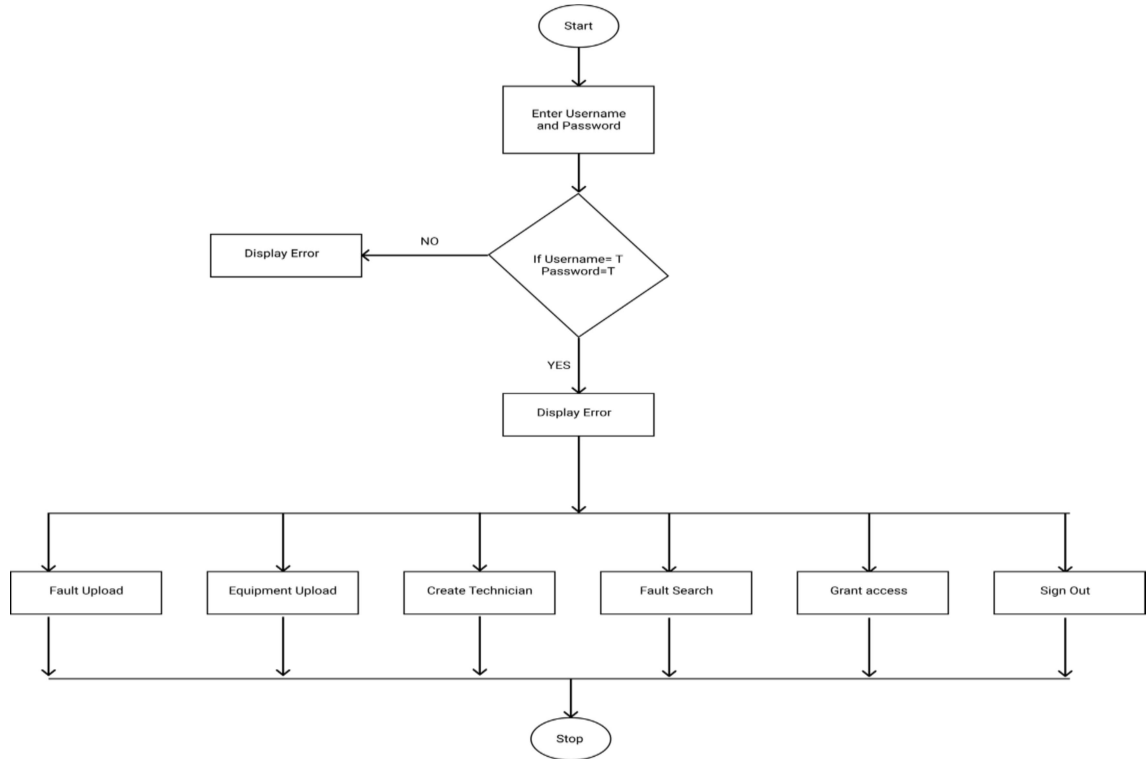


Figure 3: Admin Flowchart

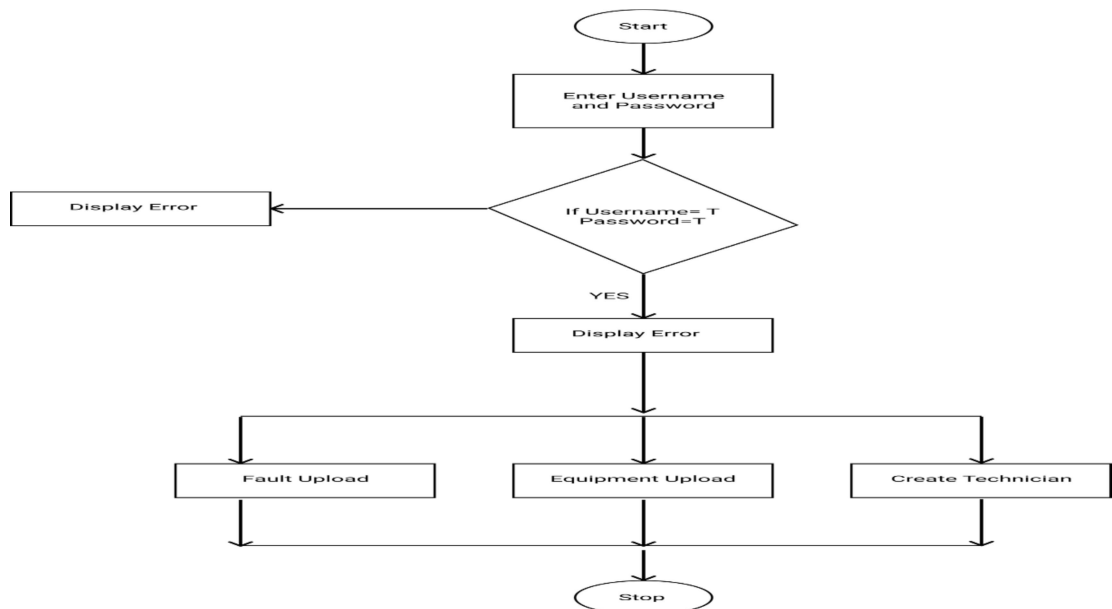


Figure 4: User Flowchart

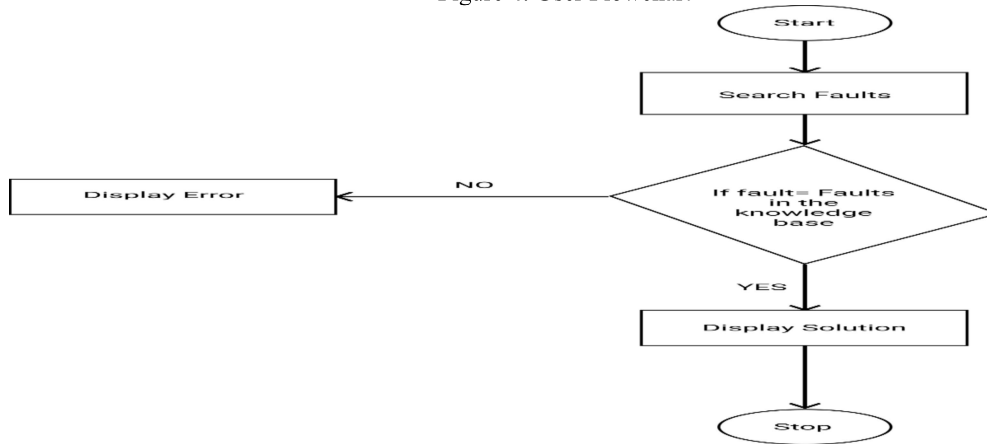


Figure 5: Fault Search

## 4. RESULTS AND DISCUSSION

### 4.1 System Output

The proposed web-based system is accessible to the users via any device that can be used to access the web. The steps taken for a user to search for faults are explained below in form of images. The figure 6 shows the sample output generated from the system.

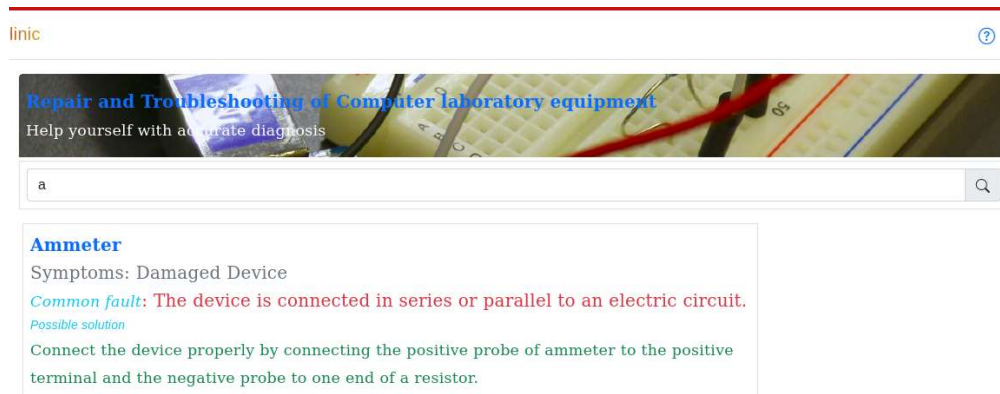


Figure 6: Results generated from the interface.

### 3.2. System Testing

Testing was conducted at different times taking records of the search inputs and observe the response from the system. It was observed that in as much as the search input matches what was in the knowledge base, a response will always be generated by the system. A continuous testing and adding of knowledge to the knowledge base over a long period of time will provide enough insight and data for troubleshooting and repair of computer engineering laboratory equipment.

The tests were conducted stage by stage. The first stage was conducted during the completion of the first draft. The second and third stage were conducted after the testing from the first stage and the last stage of the testing was conducted after final iteration has been made to the system. The recorded stages of the testing of the system are presented in Table 1.

Table 1: Recorded Stages of the Testing of the System

User	User Interface	Interactivity of System
User 1	Not Satisfactory	Not interactive enough
User 2	Slightly satisfactory	Not interactive enough
User 3	Satisfactory	Slightly Interactive
User 4	Satisfactory	Interactive

The performance of the system was carried out in one of the laboratories by 2 technicians and 2 students, the results and outcome obtained are similar amongst all the testers, that is the expert system can troubleshoot and repair computer engineering laboratory equipment.

#### **4.3 Discussion**

From the test carried out, we discovered that there is a certain level of expectation from the user for the accurate result of the fault that was searched for. The remarks of these users were based on the complexity of the fault and the solution provided. For the first user, the remarks were not satisfactory because the system was not that easy to interact with because the search results were not that informative enough. The second user who was slightly satisfied with the system interface also complained about the interactivity of the system. The third and fourth user were pretty satisfied but still suggested that they would love if the results are well detailed for easy understanding. The test was taken in a similar format to an already existing expert system for troubleshooting which can be read in (Amanuel, 2016).

#### **CONCLUSION**

There are different types of expert system for troubleshooting of faults, but this study presents the design and implementation of expert-based system for the troubleshooting and repair of computer laboratory equipment. The system was tested and can be used in different computer engineering laboratories and still gives a satisfactory result. Therefore, it is concluded that the expert system can be used for the troubleshooting, repair and maintenance of computer engineering laboratory equipment by Technologists. Further research is needed to develop expert system for other equipment used in other computer engineering laboratories and support can be integrated into the system to allow users to contact specialists in case of any difficulty that may not be considered in the system.

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