# A Rule Based Expert System for Vehicle Fault Diagnosis

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**ABSTRACT**

Vehicle usage in these modern times can no longer be considered as a luxury but a necessity. Vehicles, like any other mechanical devices, can develop fault during usage and in some circumstances it is very difficult in getting the services of an auto mechanic based on the location at which the vehicle developed fault. This work is aimed at the design and implementation of a rule-based expert system for vehicle fault diagnosis. The work is motivated by the need to guide car owners and inexperienced auto mechanics in making informed decisions when trying to provide solutions to various mechanical faults applicable to their vehicle. Essential part of this work is knowledge-based aspect of expert system consisting of production rules derived from facts and knowledge obtained from expert auto-mechanics and specialized car websites. Java development kit, NetBeans IDE and MySQL were used in the development of this work due to their easy syntax and features for developing Graphical User Interface applications. The result of the work displays interactive pages thereby making it easier for the user to interact with the software.

**Keywords:** Expert System, Fault Diagnosis, Java, MySQL, NetBeans IDE, Rule Based, Vehicle.

## 1.0 Introduction

Vehicle is used by very high numbers of households in various parts of the world in the transportation of people and their respective goods from one location to another and performing different varieties of tasks has made it to be an important factor in our daily lives [1]. Like any other mechanical equipment, these vehicles can develop faults. When an automobile develops fault, the driver usually calls for the service of an auto-mechanic or be taken to a mechanical workshop depending on the severity of the situation. Nowadays, as car technology and specifications are changing rapidly, this issue serves as a difficult task to automobile mechanics and vehicle drivers in dealing with car malfunctioning [2].

The advent of modern technology poses a challenge to inexperience auto drivers and mechanics. Therefore, success rates of car failure diagnosis greatly lie on the expertise of the individual.

This reliance can be reduced if experts' knowledge is captured and employed in developing a knowledge based system [3]. Expert system will assist car owners in troubleshooting vehicle faults at anywhere and any period of time in a rapid manner. As an important branch of Artificial Intelligence, the system can bring us great conveniences through collecting expert knowledge and using intelligent reasoning method to complete the fault diagnosis processes [3].

This work will assist drivers and inexperienced auto mechanics in speedy diagnosis of vehicular faults in addition to other benefits such as capturing the knowledge of skilled mechanical engineer who someday might retire or die after some years; using the expert system in the training of inexperienced auto-mechanical engineer and wide distribution of uncommon deposits of human knowledge devoid of human tiredness, fatigue and emotional disturbance [1].

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**2.0 Materials and Methodology**

A review of relevant literatures was explored in a bid to obtain needed information for the analysis. Based on the goals of this work, a design based methodology was employed. The following steps were employed in the design:

- Problem identification and analysis: the process of identifying the existing problem, analyze its deficiencies and describe how to improve on it.
- Review of the previous related research and suggested how the system can be design and implemented with an optimal solution.
- Design and implement the system based on the suggestions.
- Evaluate and experiments the part or completely successful implementation based on its functional specification.
- Document conclusion based on findings at design and evaluation phase.

In the methodology, production rules were employed in the design. These production rules consist of 19 rules which will enable the development of a rich diagnostic system. The following represents the rules employed in the development of these rule-based expert system for vehicle fault diagnosis [4,5,6]:

**Rule 1:** IF nothing happens when an attempt is made at starting the car AND the headlight lights up when it is switched on, then the vehicle symptom is Dead Battery.

**Rule 2:**IF the vehicle symptom is Dead Battery, THEN recommendation is Replace the Battery.

**Rule 3:**IF the vehicle cranks slowly when an attempt is made in starting and the headlight lights up when it is switched on AND the fuel tank is empty, THEN the vehicle has run out of gas.

**Rule 4:**IF the vehicle ran out of gas THEN refuel the vehicle.

**Rule 5:** IF the headlight displays light when switched on is true AND the vehicle cranks slowly when an attempt is made to start it AND the fuel tank is not empty AND the headlight dimming is true when starting THEN the battery is weak.

**Rule 6:** IF the diagnosis is weak battery THEN recommendation is recharge the battery.

**Rule 7:** IF the headlights displays light when switched on AND the car cranks slowly when an attempt is made in starting the car AND the fuel tank is not empty AND the headlights dimming when trying to start the starter THEN the symptom cannot be identified.

**Rule 8:**IF the vehicle symptom cannot be identified THEN recheck again from the beginning.

**Rule 9:**IF the headlights displays light switched on AND the car cranks slowly when an attempt is made in starting the car AND the fuel tank empty is false AND the headlights dims occasionally when an attempt is made in trying the starter THEN the diagnosis is weak battery.

**Rule 10:** IF the headlights displays when switched on AND the car cranks slowly when attempt is made in starting the car AND you are not so sure if the tank is empty THEN the diagnosis cannot be identified.

**Rule 11:** IF the headlights shows light when switched on AND the car cranks normally when an attempt is made in starting the car AND the fuel is empty THEN diagnosis is car out of gas.

**Rule 12:** IF the headlights displays light when switched on AND the car cranks normally when an attempt is made in starting the car AND the fuel tank is not empty AND the small of gasoline is observed when trying the starter THEN the diagnosis is car is being flooded.

**Rule 13:** IF the diagnosis is car is being flooded THEN recommendation is wait for 10 minutes, then restart the flooded car.

**Rule 14:** IF the headlights displays light when it is switched on AND the vehicle cranks normally when an attempt is made in starting the car AND the fuel is not empty the small of gasoline is not present when trying the starter THEN the diagnosis cannot be determined.

**Rule 15:** IF the headlights displays light when switched on them AND the car cranks normally when an attempt is made in starting the car AND the fuel tank is not empty AND the smell of gasoline is observed occasionally when trying the starter THEN the diagnosis is car is being flooded.

**Rule 16:** IF the headlights light up when switch on them AND the car cranks normally when you turn a key to try to start the car AND you are not so sure if the gas is empty or not THEN symptoms cannot be identified.

**Rule 17:** IF the headlights displays light when switched on them AND the car cranks occasionally when an attempt is made to start the car AND the fuel tank is empty THEN the car is out of gas.

**Rule 18:** IF the headlights displays light when switched on them AND the car cranks occasionally when an attempt is made to start with car AND the fuel tank is not empty THEN diagnosis cannot be determined.

**Rule 19:** IF the headlights displays light when switched on them AND the car cranks occasionally when an attempt is made in starting the engine AND you are not sure if the gas tank is empty THEN the symptom cannot be determined.

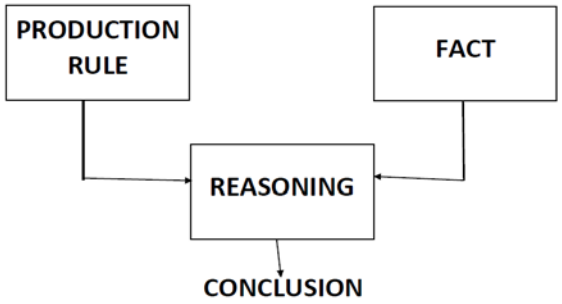


**Fig 1:** Production System Model

The figure 1 above shows how conclusion is reached from the available facts and rules. The production rules consist of IF---THEN rules present in the computer's long term memory and the inference engine matches the facts supplied by the user and generates an inference.

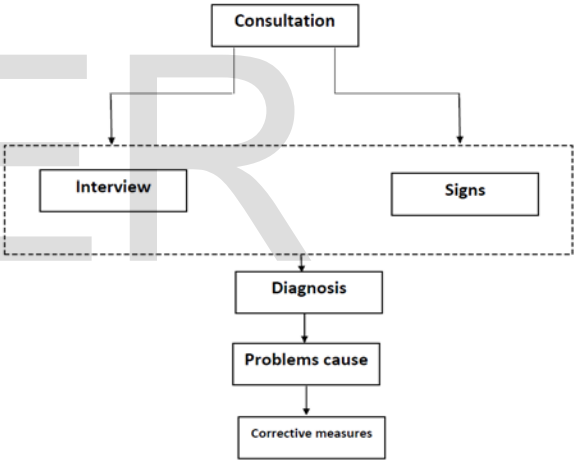


**Fig 2:** Structural Representation of the Rule Based Expert

**System for Vehicle Fault Diagnosis**

Figure 2 above shows how the developed expert system will provide solutions to various car faults. The system asks several questions from the user through interviews and ask probable faults applicable to the vehicle and arrive at diagnosis and also provides recommendations to the user.

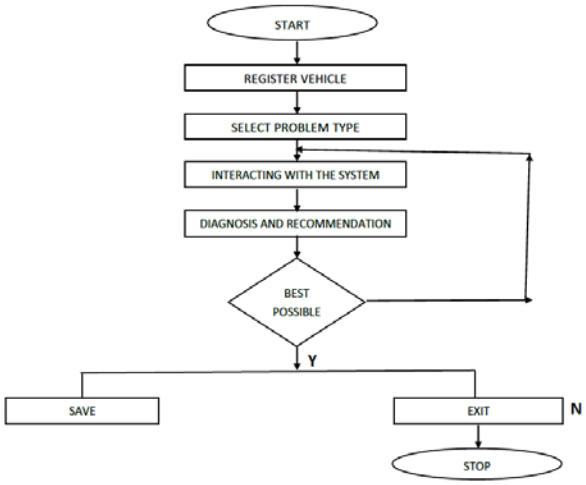


**Fig 3:** Data Flow Diagram of Expert System for Vehicle Fault Diagnosis.

### 3.0 Result and Discussions

After careful implementation of the codes written in Java, some operations of the expert system for vehicle fault diagnosis were shown below. The software design allows existing users to log on the system and also enables first time users to generate a login details by clicking the New User button.

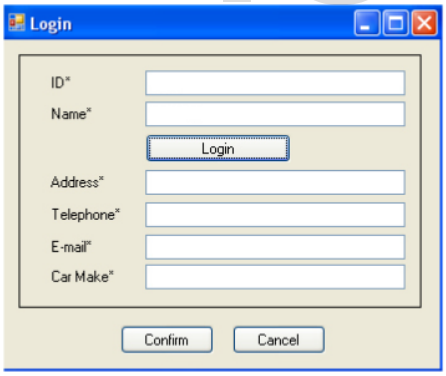


**Fig 4:** Login page for the Rule Based Expert System

By clicking on the New User button, user registration form where users input their information such as name, address, phone number, E-mail and password for capturing into the system will be displayed as shown in figure 4. displays showing the interaction between the user of the system and the expert system through the Graphical User Interface mechanism were shown in figure 4 - 8 including the final diagnosis and recommendation displayed to the user.

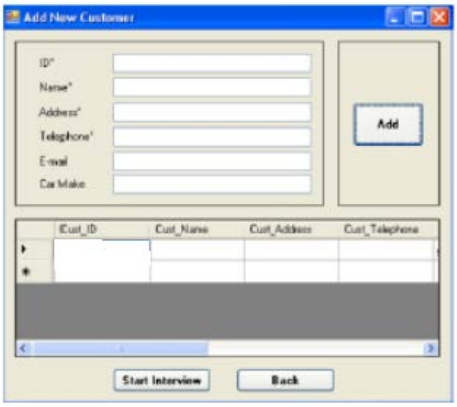


**Figure 5:** New User Details

After the user has successfully login and completed necessary registrations, the interaction with the system can begin. Figure 6 displays a form where user is asked to choose the kind of problem being encountered on the vehicle. User is asked to select from start up, run stable or movement state problem.

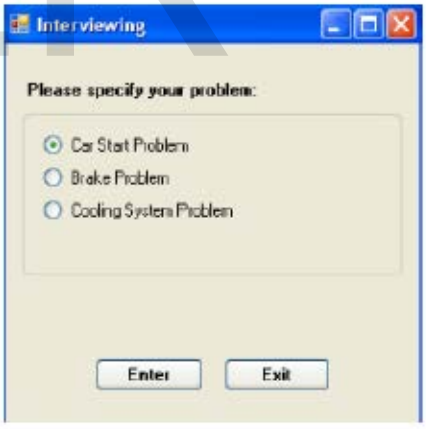


**Figure 6:** Interacting with the software


**Figure 7:** Interacting process with the system


**Figure 8:** Diagnosis and recommendation

## 4.0 Conclusion and Recommendation

The great impact of vehicle fault identification and diagnosis system is getting bigger in our day to day lives and cannot be denied. Its performance has shown some of its usefulness and made lives easier for its users. This also can serve as an aid to human expert in a situation where human involved has to cover many things.

This rule based expert diagnosis assistant system was developed as an application that is applicable in the commercial world of auto-mechanics. It is believed to be a good idea as another application of expert systems with diverse functions which can be utilized to solve vehicle faults. However, there are other domains which can be introduced to the implementation of the system and get maximum achievement with it. Although there are also some criticism and issues regarding the development of this development which relates to the issues of reliability and human social life, efforts have been discussed to overcome those challenges.

Having this Rule Based Expert System will allow users to do more work in less time, thus bringing in more revenue. And auto-mechanics will also gain through improved productivity.

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