Artificial Intelligence Based Online Vehicles Troubleshooting System

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Abstract : Maintenance and repair of millennium car (a car manufactured from year 2000 upward), is most times is the grand challenge for most people that have them because of their embedded and electronics system in them. Maintenances of vehicles start from ability to understand the cause of some minor problems and procedures to fix it up. To prolong the life of the vehicles, there is need for the vehicle users to understand some simple preventive and corrective maintenance even if he/she would need the service of a conventional mechanics. In this case vehicle owners must be able to diagnose some minor mechanical and other related faults in their vehicle. This research study proposed a conceptual model for development of an Artificial Intelligence based online system to assist in diagnosing mechanical and other related problems in the millennium cars. This system if developed and implemented it would reduce the congestion in a mechanical workshop, also save money on maintenances since the system could render solution and some of the offers solution could be carried out by non-conventional mechanics.

Keywords: Electronics System,Non-Conventional Mechanics, Millennium Cars, Artificial Intelligence,Mechanical Faults, Mechanical Workshop, Troubleshooting.

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1 INTRODUCTION

In computing, a web-based application is any application that uses a web browser as a client. The term may also mean a computer software application that is coded in a browser-supported programming language (such as JavaScript, combined with a browser-rendered markup language like HTML) and reliant on a common web browser to render the application executable.

An expert system is an advanced computer that is aimed at emulating human intelligence and reasoning. Expert systems can be used in decision making especially in a computer-aided system for monitoring and information processing [1].

There are no areas of human endeavor that expert systems are not applicable. Having a car excites everyone but at the same time, those who own a car definitely don't like to have problems with their cars as troubleshooting can be much of a headache to them especially, women [2].

Some of those who own cars don't know how to handle it, whenever it's having a problem. All they know is start the engine, drag the clutch, press the paddle and break when they need to. They won't know what to do when something happens to their cars. All they can do at least is, call the mechanic for help.

In this era of computer age and internet application, it would be nice if a web-based expert system can be developed to diagnose mechanical and other related faults in our vehicles.

If this research is completed and implemented, it will help vehicle owners to find solutions to some common faults in their vehicles without having to consult a motor vehicle specialist (Mechanic). Hence reduce the congestion in a mechanical workshop, also save money on maintenances since the system could render solution and some of the offers solution could be carried out by non-conventional mechanics, it will also reduce the time spent in troubleshooting the cause of the problems in a

motor vehicle. This will be substantiate in design and implementation of this work.

A. Statement of Problem

Dealing with motor vehicle problems are most times handled by mechanics. There are times when urgent help is needed and they might not be readily available or might cost time and expense to get them around; this is where this expert system bridges the gap. This expert system will serve as a first aid guide to enable users handle issues that may arise with their automobiles, thereby saving time and cost that would've been procured.

B. Aims and Objectives

This research work is aimed at achieving the following;

- To emphasize and represent the application of web-based expert system techniques in troubleshooting solving common faults in motor vehicles.
- Provide recommendations in cases of motor vehicles break down.
- Provide maintenance advices to users in order to prevent future faults from occurring.

C. Scope of Study

The research will cover the troubleshooting and recommendation of solution for millennium cars (case study Toyota, Nissan and Mercedes Benz vehicles).

2 REVIEWOF RELATED WORK

A. Expert system in various fields of study

Any successful decision-making is strongly dependent upon various capabilities that include the effective acquisition, storage, distribution, and sophisticated use of the knowledge of the human experts in the field. In the context of computer-aided systems for monitoring and information processing, these

capabilities would be achieved through developing an expert system [3].

Yang and Okrent [4] had also said that the most successful application of Artificial Intelligence (AI) in decision making so far is the development of Decision Support System (DSS), particularly expert system, which is a computer program that act as a _consultant' or _advisor' to decision makers [5]. Expert systems are cheaper compared to human experts in the long-term scenario. However, expert systems are relatively costly to develop but easy and cheap to operate [6].

Expert System has been applied in many ways and various fields which are mean to make human's life simple and even easier. The application of expert systems technology in the domain of environmental management is particularly appropriate in order to preserve and disseminate efficiently valuable and scarce expertise at reasonable costs. For example, Nigeria's NigComSat-1R Satellite is a critical ICT backbone infrastructure to drive the National ICT revolution in providing revenue diversification for the Nation and offering cost effective solution and affordable access to meet Nigeria's telecommunications, broadcast, aviation, maritime, defense and security needs. Once an expert system is developed, it is necessary to make them easily updateable, as opposed to conventional algorithms which are static in the sense that, governing relationships, once determined, stay fixed [7] Also, some expert systems are able to a give reasons towards the given answer.

B. History of Expert system for vehicle Troubleshooting

The first diagnostic Expert System for technical fault troubleshooting in motor vehicles was developed at MIT in the early 1970's [8]. Kadarsah proposed and designed a decision model for car fault troubleshooting in which an Expert System (ES) was utilized to help inexperienced mechanics and drivers. The model consisted of inference engine, knowledge base, database, user interaction and adaptive mechanism. The Inference engine used backward chaining as a result of a small number of outputs with many possible inputs. In addition, the adaptive mechanism was utilized in the user interaction section in order to receive feedback about system troubleshooting result. The feedback results were stored in a database. The adaptive system then processed the stored data and extracts additional rules with the goal of improving the knowledge base [9].

Car failure detection KBS was proposed by Ricardo Nurzal. In this system, car faults were divided into three states: Start-up state, Run-stable state and Movement-state. Shell Rule based expert system (CLIPS), with forward chaining inference engine were used in the implementation. CLIPS stored the knowledge in rules form, which had logic-based representation as well as the production rules. The system interacts with the user through an interface and gave the troubleshooting result with illustration. The rule-based expert system contained 150 rules for car failure causes. However, improvement in the domain knowledge and applying adaptive technique for knowledge creation were required in such system. In the work of Peter Nabende and Tom Wanyama, Heavy Duty Diesel Engines (HDDEs) troubleshooting was proposed. HDDEs maintenance required high technical skills and extensive experienced mechanics that were scarce. As a result, employing an expert system in such domain was highly useful.

The HDDE faults troubleshooting Expert System (ES) was able to successfully detect malfunctions in the engines and give recommendation of corrective actions.

However, the proposed prototype was not promoted to be used as a complete application due to time and resources limitations. Further surveys were done by [4] for developing Moto cultivator fault troubleshooting model. This model was based on the hybridization of Expert System (ES) and Decision Support System (DSS) in which ES outcome represented the input to the DSS. The supplier selection for faulty component replacement was made by DSS based on ES outcome. In practice, the designed hybrid system was applied in a small Moto cultivator importer and distributor company for servicing purposes. It proved to be a very useful tool for equipment servicing needs with low development cost. It increased the efficiency of labor and workers'satisfaction.

C. Millennium Cars

There are some technical and design aspects that differentiate millennium cars from old ones. Without considering the future of the car, the modern era has been one of increasing standardization, platform sharing, and computer-aided design [10]. Some particularly notable advances in modern times are the widespread of front-wheel drive and all-wheel drive (4-wheel drive), the adoption of the diesel engine, and the wide use of fuel injection [11]. Other things that characterize modern day cars are; automated indicators/alert and sounds. Some examples are;

- Continuous "pong" sound indicating that the seat belt is not strapped
- A light indicator on the dashboard to show that the door is not properly closed or open
- Cameras at the back of cars with an LCD screen within, to enable drivers see what is behind them when reversing
- GPS navigation system with voice guidance while all of these advances were first attempted in earlier eras, they have dominated the market today that it is easy to overlook their significance. Nearly all modern passenger cars are front-wheel drive, with transversely mounted engines [12]. Body styles have changed as well in the modern era. Three types, the hatchback, sedan, and sport utility vehicle, dominate today's market, yet are relatively recent concepts. All originally emphasized practicality, but have mutated into today's high-powered luxury crossover SUV, sports wagon, two-volume Large MPV. The rise of pickup trucks in the United States, and SUVs worldwide has changed the face of motoring, with these "trucks" coming to command more than half of the world automobile market [13].

The modern era has also seen rapidly rising fuel efficiency and engine output. Once the automobile emissions concerns of the 1970s were conquered with computerized engine management systems, power began to rise rapidly. In the 1980s, a powerful sports car might have produced 200 horsepower (150 kW) – just 20 years later, average passenger cars have engines that powerful, and some performance models offer three times as much power.

D. Conventional Motor Mechanics

Motor mechanics are involved with the servicing, maintenance and repair of cars and light vehicles. The work is wide ranging and includes routine servicing in accordance with manufacturers' recommended procedures and the testing and approval of the structural, mechanical and electrical systems of the vehicle [14]. A vehicle may be due for a service after it has travelled a certain number of kilometres or after a certain period of time, according to instructions set out by the vehicle's manufacturers. Mechanics also repair vehicles that have broken down or been involved in accidents servicing involves;

- Making routine checks according to a list,
- Finding faults or problems,
- Overhauling or replacing worn or faulty parts, and
- Using special equipment and road tests to make sure the vehicle performs as it should

Sometimes customers take their vehicles to mechanics to investigate a particular mechanical fault. Solving these problems may involve stripping down the affected part of the car in a workshop area, finding the faulty components and replacing them, and then putting all the parts together again [15]. Mechanics tend to replace parts rather than repair them because this is quicker and therefore less costly. Mechanics also deal with electrical and electronic systems, which are becoming more and more sophisticated on modern vehicles. For example, mechanics may connect laptop computers to a vehicle's electronic control unit, using an on-screen menu to choose the part of the vehicle they want to investigate. The computer is able to find and report back information on the fault, for example, a break in circuit wiring. With older vehicles, mechanics use electrical testing equipment like voltmeters and ammeters to test electric circuits/components. Mechanics use specialized equipment to measure things like engine and brake performance, transmission and the accuracy of dashboard indicators.

E. Troubleshooting of Cars

Troubleshooting means to determine or analyze the cause or nature of a problem or situation. Motor vehicles are bound to develop fault(s) at one point in time and it is desirable to detect severe faults in order to protect the vehicle from damage. Early detection of faults can lead to avoidance of serious damage of the vehicle [16].

Troubleshooting section can be divided into three parts: fault detection, fault isolation, and fault size estimation. It is important to determine if a fault has occurred or not (detection); when a fault is present, the location of the fault is needed (isolation); and we also desire to know where applicable the size of the fault (identification). Another approach that is described in Literature that should apply to troubleshooting and troubleshooting of Motor vehicles would be Failure Mode and Effects Analysis (FMEA) [17].

When designing any troubleshooting system whether a hard copy service manual or an elaborate troubleshooting expert system, models of device failures are used to trace the root cause of the system and component failures.

F. Advantages of Expert Systems over Conventional Mechanics

The use of Expert systems provides many advantages over conventional mechanics.

Conventional mechanics would sometimes result in low performance and reliability (in the case of one that is not well equipped with car diagnostic knowledge). Some reasons given by [18] as to why Expert systems have been developed to replace a human expert include:

- To make available expertise after hours in other locations.
- To reduce on expenses associated with a human expert.
- To provide expertise in a hostile environment.
- To aid an expert in some routine task to improve productivity.
- To aid an expert in some difficult task to efficiently manage complex problems.
- To make available human expert information that is difficult to remember.

III. RESEARCH METHODOLOGY AND FRAME WORK

A. Data Collection Method

The form of data collection method to be used will be as follows:

- Several interview sessions with automobile engineers, conventional motor mechanics, automobile electrician, and other relevant stake holders in automobile industry.
- Studying of automobile manual and documentation for Toyota, Nissan, and Mercedes Benz.

Through the period of data collections, we shall collect information's relating to millennium cars faults as in: problem summary, causes, possible solution and precaution to avoid re-occurrence.

B. Analysis and Design of the Proposed System

The system shall be a database driven web application that is completely updateable by a privileged personnel (Administrator), the information will be stored or updated based on manufacturers brand, year and model.

The application user will obtains required information through links to each category of vehicles they want, in addition, searches are carried out extensively as well through search boxes and category selection boxes ensuring proper accurate results are obtained by the user.

To promote easy access to information, searches can be done straight from the home page reducing stress to the user therefore improving user experience to some degree.

C. Description of its Components

This web-based automobile expert system will not completely replace engineers and conventional mechanics, whose expertise and experience are still the base of the applications development and required in field work, it is only an update for technology. The system will comprise of an administrative section and a user section. The administrative section consists of the administrator login panel for user authentication and the administrator dashboard which contains tools for creating, viewing and consequently editing vehicle related information based on predefined categories in car parts and sub car parts where necessary, associated problems, and solutions. The administrative section utilizes form elements for

collection of data from the application administrator, this data in turn will be sent to PHP snippets created to handle the tasks of obtaining such data validating them where necessary and sending them to the database application for storage. These snippets make up the backbone of the application as they are responsible for all interactions from the administrator to the database.

The user section will comprises of the application home page containing information on how to use the system, and a chief search input element which the users utilize in launching a pilot

search on the problem they are experiencing with their vehicle. Upon user search data submission, a search is carried out based on the car-part, sub car-part, problem description, and solutions, the user is redirected to the main user dashboard containing the tools they would need to take advantage of the application, should their search yield no result at first, the user dashboard allows them view all the problem information the system has to offer. Figure 1 illustrate model of the proposed database for the proposed system, while figure 2, illustrate the flowchart for the proposed system.
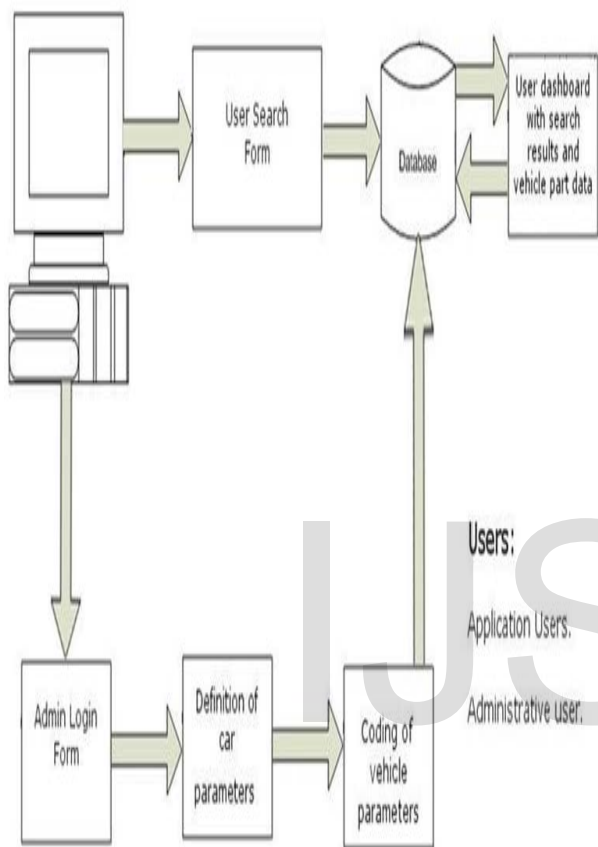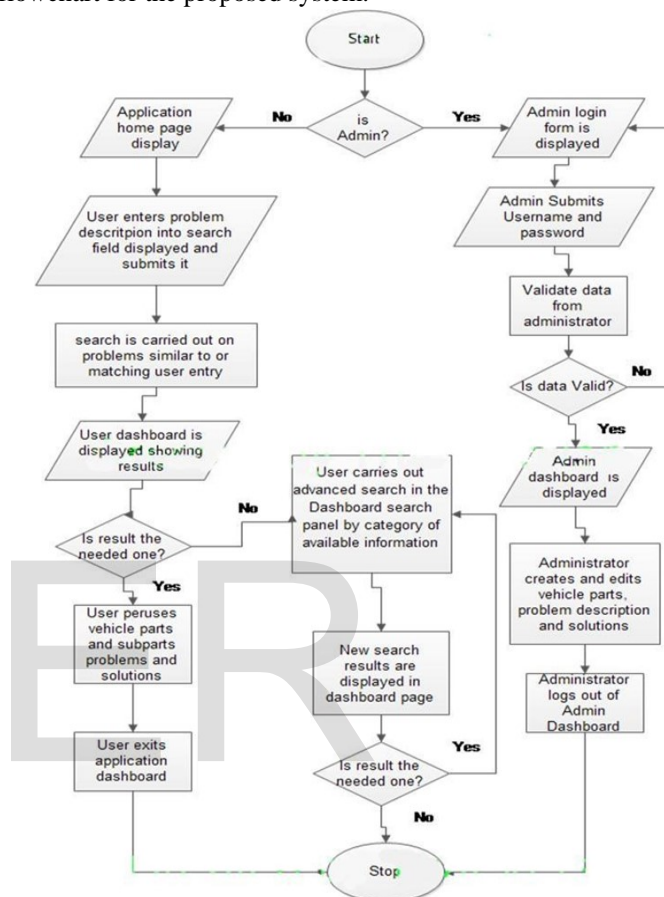

Figure 1: Proposed Model of the Database

Figure 2: Flowchart of the proposed system

IV. DESIGN AND IMPLEMENTATION

A. *Choice of programming language*

The choice of programming language will be PHP (Hypertext pre-processor) for server-side scripting, JavaScript and HTML5 for media content management and MYSQL as the back-end database. In addition, these technologies are open-sourced and are available for download for free of charge or come packaged with most if not all browsers, as they are the rendering interfaces for all web based applications.

B. *Input Design*

The input design depicts the means and methods through which users or the administrator passes data to the system for processing. It involves the GUI (graphical user-interface) which employs form tools such as textboxes, selection boxes, input fields and a host of other HTML and HTML5 form tools that allow the user or administrator to interact with the system without necessarily following a predefined order. The user interaction with the system starts at the home page search form where the user enters the vehicle related problem they are

experiencing in the search field. The popup suggestion box underneath the search input field displays problem names matching the text the user is currently entering into the search field obtained through the use of web 2.0 technology called AJAX(Asynchronous JavaScript And Xml) from the MySQL database, if no match is found it prompts the user about it but encourages them to still search. After the user searches, they are redirected to the applications dashboard and their search results are displayed for them. From here, the user can continue interaction with the system based on the predefined category they need information on such as the car-parts and sub car-parts. They can also carry out more searches.

C. *Output Design*

The output defines the way the system responds to users interactions. It shows the various means it uses to present information to the users for decision making. The system presents information to users based on their search obtained

from the home page's search form. The users obtain information about their search from the application's dashboard. The user can then view more information and perform more searches from there; they can as well choose the information that is relevant to their search criteria.

D. Implementation

This stage involves the various aspects that would be considered in order to put the new system to proper use and for it to deliver effectively and efficiently. It considers the factors that affect the successful running of the new system which includes: hardware requirement, software requirement, human ware (users), testing, and documentation.

E. Hardware requirement

The infrastructure needed to run the Automobile Expert System shall include high computation capability (i.e. CPU) due to client request and Asynchronous request processing referring to AJAX technology, minimal volume of storage device in gigabyte (GB) range to provide space for the impending large database of information, large bandwidth to compensate for high internet traffic and client connections. The aforementioned facilities are provided by the hosting service at a rent. However, the clients/users (the administrators and users) accessing the solution should have the following minimum requirements.

- A multimedia enabled Personal Computer (PC) or Personal Digital Assistant (PDA).
- A modem/DSL for internet connection
- Prior minimal knowledge in the case of the client on internet use and professional internet and application knowledge on the path of the administrator.

F. Software requirement

As mention above, the software platform to host the application will be provided by the cloud, but the clients/users'needs the following:

- An advanced operating system on personal computer or smartphones and devices such as windows, linux or macintosh OS, and for mobile devices Android OS.
- An updated web browser that supports HTML5 on personal computer, smartphones and related devices.

V.CONCLUSION

ProposedArtificial Intelligence Based Online Vehicles Troubleshooting System willassist Toyota, Nissan, and Mercedes Benz vehicle users have a better understanding of their automobiles. The system will be implemented with robust database system that will manage the various form of problems associated with vehicles as well as provides solution to those problems. Where a problem is identify and there is no match solutions. Such problem will be directed to a registered experts that will proffer solution for future users. Although, this software will provides solution to some categories of problems, it may not have all the problems and solutions but the good news is that it is subject to improvement and enhancement meaning that the web application administrators will continue working round the clock to keep it up-to-date in order to satisfy the needs of various users. The direction for future research and implementation will focus on robust and self-managed database design.

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