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Developing Knowledge-Based Systems: Car Failure Detection using Expert System

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Abstract
To develop an expert system describes the knowledge-base of the car failure detection. 19 rule-based of car fault diagnosis expert system using the Visual Basic and Microsoft Access as tools for helping inexperienced mechanic as the decision support system. During the test phase of system it never gave wrong detection according to the rules used. It can be concluded that car failure detection expert system is helpful although it might not give a complete guides and help as a human expert namely mechanical engineer do, but at least the expert system can give a temporary assistance to those who are in need of an instance help.
Keywords: knowledge-base system, car failure detection, expert system, rule-based

1. Introduction

Knowledge-Based Systems (KBS) is a dynamic engineering, systems analysis and software development. Knowledge engineers search for concepts (entity, attribute, or relationship) that characterize the expert's thinking about the problem. To avoid information overload, knowledge engineers should activate new processes until a prototype is built to provide a focus point for departure.

Whatever car is a problem, normally call mechanical engineer for help and it would be sent to an auto repair shop in case of high level of problem severity. Although, most car owners should be exposed to knowledge about car components, how each component works, and how small problems could be solved. Some problems require technical knowledge to analyze and understand the problems in order to allow car owners to apply a preliminary action or repair it immediately by themselves in uncertain situation. Correct preliminary action may substantially reduce a level of problem severity. In some cases, a car owner may diagnose a problem wrongly and it may cause more severe problems to their car. Also, in uncertain situation, car owners need to cope with the unexpected problems as fast as possible. Car fault identification is not easy for inexperienced mechanic or driver because it is needed a lot of knowledge for finding the fault.

An expert system (ES) provide flexible and powerful means for obtaining solutions to a variety of problems that often cannot be dealt with by other, more traditional and orthodox methods is a system that employs human knowledge captured in a computer to solve problem that ordinarily require human expertise. Expert system seeks and utilizes relevant information from their human users and from available knowledge bases in order to make recommendations. With the expert system, the user can interact with a computer to solve a certain problem. This can occur because the expert system can store heuristic knowledge. Then the system can make inferences and arrive at a specific conclusion to give advices and explains, if necessary, the logic behind the advice. ES provide powerful and flexible means for obtaining solutions to a variety of problems that often cannot be dealt with by other, more traditional and orthodox methods. The terms expert system and knowledge-based system are often used synonymously.

The main objective of this study is to develop knowledge-based systems for car failure detection using expert system. The rules which relate symptoms to problems those are helpful for those who are in need of guides to deal with their car's problems.

2. Methodology used

The Knowledge-Based-System Development Life Cycle is a methodology that uses expert system shells and programming environments that there are 3 stages as following:

2.1 Definition stage

In dealing with car's problem, mechanical engineers are straightforward to define and are those who can help to solve them. Inexperienced mechanic wrongly diagnosing the problem of the car can cause the loss of customer and income of an auto repair shop. Moreover, many cars' owners never know how to check their cars in order to keep them in a good condition. Thus, a car owner would have to pay more for maintenance cost. So it is believed

that the use of expert system can be benefits in this situation by giving a temporary and instance guides to car's owner

2.2 Development stage
2.2.1 User requirement
Users who will use the system can be car owners, car drivers, inexperienced mechanical engineer, expert mechanical engineer and interested users, and students. Car owners may want to have the knowledge to know how to maintain their car in good condition. Drivers must have the knowledge to deal with the problem as fast as possible. Inexperienced mechanical engineer can use the system to gain more knowledge and improve their work performance. Experienced mechanical engineer can use the system to help them make better and faster decision making. Interested users who may not have their own car can use the system to study in their area of interest. Students could apply the system to be used as the supplement of their further studies. They may improve the system by adding more knowledge base.
2.2.2 Design knowledge base
2.2.2.1 Logical system design – serves the same purpose as it does in conventional SDLC.
2.2.2.2 Creates a framework for using knowledge representation – to develop an expert system that is capable of assisting car's owner in dealing with their car problem them whenever time is limited and the human expert, also known as mechanical engineer, is not available at that time. To do more in draw diagrams or build models for direct representations and identify and name slots for frames and scripts including name table entries for data.
2.2.2.3 Write English language rules for production rules – to collect the car problems from mechanical engineer experts, specialized books, and from different car websites. The three knowledge bases of car start problem, break problem, and cooling system problem are created after compiling enough information for each problem. The 19 rule-based system of car start problem is shown to be an example below:
Rule 1: IF the result of switching on the headlights is they light up AND nothing happen is the result of when you turn the key to try to start the car THEN car symptom is dead battery
Rule 2: IF car symptom is dead battery THEN recommended action is replace the battery
Rule 3: IF the headlights light up when switch on them AND the car cranks slowly when you turn a key to try to start the car AND the gas tank is empty THEN the car is out of gas.
Rule 4: IF the car is out of THEN refuel the gas.
Rule 5:IF the headlights light up when switch on them AND the car cranks slowly when you turn a key to try to start the car AND the gas tank is not empty AND the headlights dim when you to try the starter THEN the battery is weak.
Rule 6: IF the battery is weak THEN recharge the battery.
Rule 7:IF the headlights light up when switch on them AND the car cranks slowly when you turn a key to try to start the car AND the gas tank is not empty AND the headlights does not dim when you to try the starter THEN the symptom cannot be identified.
Rule 8: IF the symptom cannot be identified THEN recheck from the first step.
Rule 9:IF the headlights light up when switch on them AND the car cranks slowly when you turn a key to try to start the car AND the gas tank is not empty AND the headlights sometimes dim and sometimes don't when you to try the starter THEN the battery is weak.
Rule 10:IF the headlights light up when switch on them AND the car cranks slowly when you turn a key to try to start the car AND you're not so sure if the gas tank is empty or not THEN the symptom cannot be identified.
Rule 11: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 the gas tank is empty THEN the car is out of gas.
Rule 12: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 the gas tank is not empty AND the smell of gasoline is present when trying the starter THEN the car is being flooded.
Rule 13:IF the car is being flooded THEN wait 10 minutes, then restart flooded car.
Rule 14: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 the gas tank is not empty AND the smell of gasoline is not present when trying the starter THEN the symptom cannot be identified.
Rule 15: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 the gas tank is not empty AND the smell of gasoline is sometimes present when trying the starter THEN the 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're not so sure if the gas tank is empty or not THEN the symptom cannot be identified.
Rule 17:IF the headlights light up when switch on them AND the car cranks sometimes when you turn a key to try to start the car AND the gas tank is empty THEN the car is out of gas.
Rule 18:IF the headlights light up when switch on them AND the car cranks sometimes when you turn a key to

try to start the car AND the gas tank is not empty THEN the symptom cannot be identified.
Rule 19:IF the headlights light up when switch on them AND the car cranks sometimes when you turn a key to try to start the car AND you're not so sure if the gas tank is empty or not THEN the symptom cannot be identified.
2.2.2.4 Translates detail design into the language of the knowledge engineering tool – to develop the car fault diagnosis expert system using the Visual Basic and Microsoft Access as tools for helping inexperienced mechanic as the decision support system and reduce the need for skilled mechanic.

2.3 Installation And Operation stage
The expert system for car failure detection is developed using Visual Basic and Microsoft Access. The system is designed to meet user's needs in terms of ease of use and understandability and convenience that are the most necessary factors that attract users to use the system. Communication between the user and the system is done through the user interface which implemented in English languages. The user interface is represented as a menu which displays the questions to the user and the user answers with Yes/No or multiple choices provided to select. The entire question asked in the system is created from rule-based system that the authors have collected the information and built knowledge-based system.
The car failure detection expert system starts with the window showing three alternative ways for a user to choose as shown in Figure 1. Three buttons are "New Customer" button, "Login to the System" button, and "Exit Program" button. The user selects by clicking at "New Customer" button. For "Login to the System" button, the users can get access to the system without having to sign up a new customer to see how the system works and they can also gain the knowledge from the system. Users who do not want to use the system or they want to leave after them finishing using the system by clicking at "Exit Program" button.

Figure 1: Car failure detection expert system

After "New Customer" button is chosen, "Add New Customer" window will be shown up. The user needs to fill out the registered form to be stored in the database. The information required is Customer_ID, Name, Address, Telephone, E-mail, and Car make that they own as shown in Figure 2. The system requires each user to fill out all the text box and then press "Add" button to save and collect the information into the database.

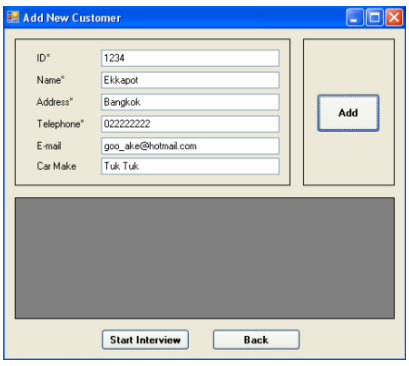

Figure 2: new customer window

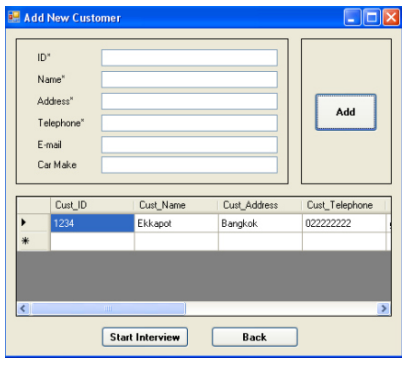

Figure 3: Add new customer window

Data grid view will display all the information filled out by the user as shown in Figure 3. It is arranged by order.

Hence, the first customer registered would be on the top of the list and then second user would be under the first. Each customer has a unique ID used to get into the system. Then, the user clicks at "Start Interview" button.

The user would be sent to "Login" window to enter their ID and name that must be the same as what the user filled out in the registered form to ensures that that user has already registered as shown in Figure 4. Then, the user press "Login" button to confirm that ID and name is correct.

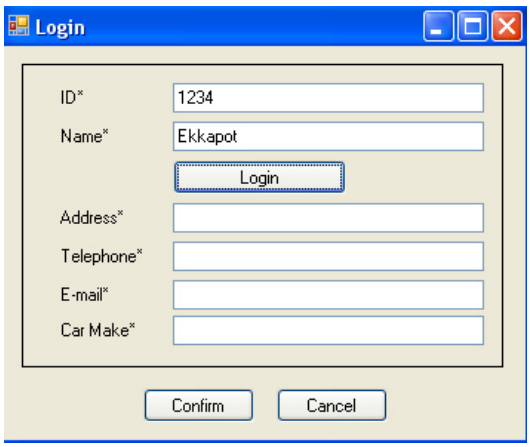

Figure 4: Login window

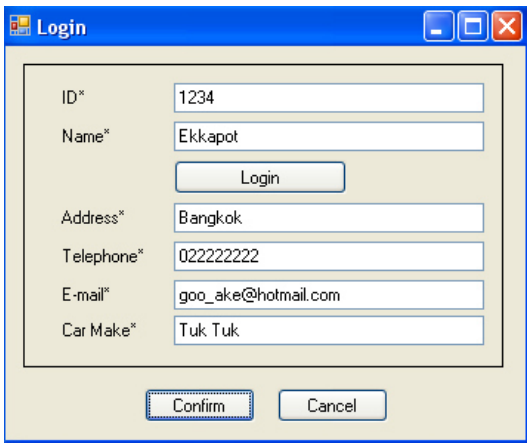

Figure 5: result from Login window

IF the ID and name are correct, information of address, telephone, E-mail, and car make will be shown up as shown in Figure 5. At this point, the login process is accomplished. Then, the user select "Confirm" button to start interviewing. From Figure 6, the user has to choose the problem the user wants to be interviewed by clicking at a radio button. In this case, car start problem are selected and the user then press "Enter" button. The user can exit the system by selecting "Exit" button.

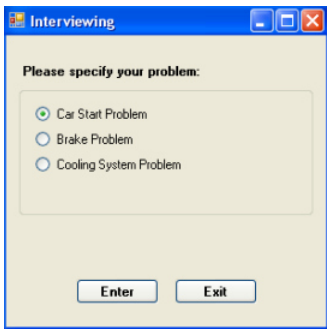

Figure 6: Interviewing window

3. Results and discussion

Knowledge-Based Systems for Car Failure Detection Using Expert System is to compile experience, information, and knowledge coming form as many experts as possible into the system. To allow the mechanical engineers work without stopping. As a human, expert mechanical engineer would be tired if he works continuously.

The first question comes out for the user to make selection as shown in Figure 7. The user may choose the answer based on what the user encounters with their car start problem. After the user select the answer, press "Enter" button to go to the next question.

Figure 7: Car start problem

The next question of car start problem will be shown up for the user to choose as shown in Figure 8. This will narrow the problem down to find the car symptom and provide the recommended action as shown in Figure 9.

Figure 8: Car start problem

Figure 9: Car symptom and recommended action

In Figure 9, when finishing interviewing, the system will diagnose car symptom and provide the recommended action to the user. “First Page” button will bring the user back to the first page of the system or “Exit” button will bring the user out of the system. The user can choose whether to save or not depending on each user decision, because sometime the car symptom can not be determined, so there is no need to save it as shown in Figure 10.

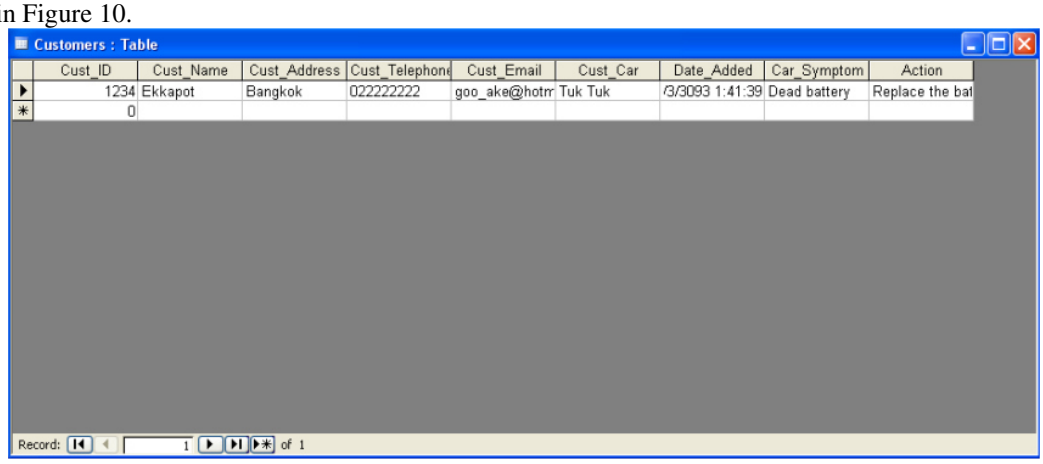

Figure 10: Table of customers

From Figure 10, the saved data is added in the database that contains the table of the customers who have used the system with their customer information, date_added, car_symptom, and recommended action. The user can check their data by going back to the first page of the system and select add customer. It will be displayed in the data grid view.

When the system is started, a main menu is displayed on the screen which asks the user to choose as shown in Figure 11, the system requires a user to specify their problem. In this case, car start problem is selected and then a user clicks "enter" to go forward to the next question.

The folder of car diagnosing system contains the database named CDS. The database is used for collecting the customer data. This database is connected to the system by applying a string connection which can not be changed.

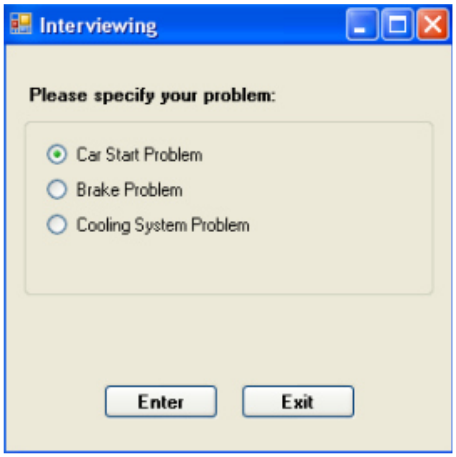

Figure 11: Interviewing question

The result from first question about car start problem is displayed as shown in Figure 12. The user has to choose one answer and the next question will be shown after clicking at "Enter" button. The more questions the authors create and use in the system, the more specific symptom of the problem the user would get with recommended action provided.

Figure 12: Car start problem

After the user passes all the questions, the system will diagnose the car symptom and recommended action to the user as shown in Figure 13.

Figure 13: Car symptom and recommended action

4. Conclusion and recommendation

Knowledge-based system for car problem diagnosis is presented in the paper. During the test phase of system it never gave wrong diagnosis according to the rules used. The system indicated that an expert system will be practical and can be useful in providing consistent car problem detection in just only three areas of problem which are car starting problem, brake problem, and cooling system problem.

The expert system can help the human by replacing the human expert function whenever the expert can't be accessed or by assisting the human expert in situations where it has to cover many things. In this case the expert system may be useful to execute the routine works and let the human expert to do the rest especially the more difficult jobs. The system is developed in a limited time and resources. Thus, some parts of the system are not compatible and useful enough to be implemented in the real world yet. There must be so many other works to be taken in refining the errors and rules before it can really be used in the real situation. When this is done, the Expert System is ready to be used to assist all the car owners out there in situation where they are having problem with their cars and they can do it by them. Time and distance is no more a constraints to them.

The system has the characteristics of good expert systems, such as high performance, adequate response time, and understandability. It can help inexperienced mechanic or driver in providing decision support system, interactive training tool and expert advice. Using this system, loss of customer and income due to lack of knowledge can be avoided. Having this system may allow mechanic to do more work in less time, thus bringing in more revenue and mechanical engineer gain through improved productivity. Further work is needed to improve the system by adding sufficient domain knowledge that represents domain knowledge thoroughly to cover all the car problems.

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