Using Database System Designed to Diagnosis Engine Cars Error Working

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Abstract: This work presents a design and implementation of Database System for Vehicle Fault Diagnosis using mix of many knowledge representation forms. The scheme for knowledge representation uses both procedural and declarative knowledge representation formalisms through the application of relational database. So the rule base, case base and frame base formats have been converted into tables. The scheme facilitates combination of forward and backward chaining reasoning, using the problem reduction method for solving problem, and the heuristic search technique. All the editing facilities of system; inserting, deleting and updating of a rule, case, and frame are present. In this work, visual studio 2008 (VB.Net) have been used for the implementation of the system and suitable user interface design. The implementation is an application for the system in the domain vehicle fault diagnosis. Therefore, the Database System for Diagnosis engine cars error working tested for many cases and the results, from different cases, matched the results of the vehicle mechanic.

Keywords: Database System, Diagnosis, cars error working.

Introduction

Most of the artificial intelligence (AI) books state that there are many definitions of AI and this is due to the fact that authors came from different schools of thoughts and backgrounds. Owaied and Abu Arr’a (2007) defined Artificial Intelligence as “A.I. is a concept of study and research for finding relationship between cognitive
science and computation theories in order to represent these relationships as either data structures, search techniques, problem solving methods or representation forms for knowledge and the final goal of AI is to build an intelligent machine”. (1) The Intelligent Databases (IDBs) are originated from the integration of databases technologies with artificial intelligence technologies. The IDBs are characterized by the presence of stored rules in a rule base and facts stored in a fact base. (2) Altogether conforms to the knowledge base, in which different forms of reasoning are applied (Ana & Jose, 2007). The Intelligent Databases are developed for variety of domains like medicine, mathematics, engineering, chemistry, geology, computer science, business, law, defense and education. This work deals with types of problems related to diagnosis field and the implementation for the car error. A large segment of the vehicle driving population is constituted by drivers who have little or even less information regarding the diagnosis of a vehicle. (3) Vehicle fault identification is not easy for a driver because it needs a lot of knowledge for finding the fault. Therefore, they extremely depend on expert mechanic. In this work, mix of knowledge representation formats and the knowledge about the vehicle diagnosis have been acquired from vehicle’s mechanics. (4) By using two methods to elicit knowledge from human, these are interviewing and observing. Using both methods for collection of knowledge related to vehicle systems and malfunctions that occur for vehicles and the reasons for the malfunctions. This knowledge is included in the Database System for car error work Diagnose. (5)

Knowledge Base Schemes

Since the knowledge bases, Rule base, Case base, and Frame, are converted into tables and usually the Databases were built in relational database systems. Therefore, relational database systems have been used for the implementation of knowledge bases schemes for the Intelligent Database System for car error Diagnosis. The implementation consists of twelve tables, and they are: case table, condition table, case and condition table, seven tables for frames, rules table, and condition–frame.

Case Base for Car Diagnosis

The proposed Scheme to organize the cases will be in three tables which are Cases table, Conditions table and Case-Condition table. While the case is a malfunction and condition is a cause of the malfunction. Cases table contains two columns, the first column labeled by Case-No, while the second columns labeled by Case-Name,
a set of cases were stored in the Case-Name column as shown in figure 1. The Column Case-Number is assigned as primary key. (6) Conditions table contains two columns, the first column labeled by Condition- No while the second column labeled by Condition-Name, a set of conditions were stored in the Condition-Name column as shown in figure 2. The Column Condition-Number is assigned as primary key Case-Condition table contains three columns, the first column labels by case number. The second column labeled by condition number and the third column labels by condition priority as shown in figure 3. The columns (case number, condition number) are Primary key. (7) The column (case number) and the column (Condition number) are foreign key.

Figure 1: Cases Table
<table>
<thead>
<tr>
<th>conno</th>
<th>conname</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Welding Radiator</td>
</tr>
<tr>
<td>2</td>
<td>Radiator cap</td>
</tr>
<tr>
<td>3</td>
<td>A break in the hose</td>
</tr>
<tr>
<td>4</td>
<td>Incision in the water tank</td>
</tr>
<tr>
<td>5</td>
<td>Incision in Water pump</td>
</tr>
<tr>
<td>6</td>
<td>Water loss</td>
</tr>
<tr>
<td>7</td>
<td>Rust in the water</td>
</tr>
<tr>
<td>8</td>
<td>Damage the thermostat</td>
</tr>
<tr>
<td>9</td>
<td>Relaxant in the belt of the fan</td>
</tr>
<tr>
<td>10</td>
<td>Broken fan blades</td>
</tr>
<tr>
<td>11</td>
<td>Fuse fan</td>
</tr>
<tr>
<td>12</td>
<td>The electric wires of the fan</td>
</tr>
<tr>
<td>13</td>
<td>Broken pump blades</td>
</tr>
<tr>
<td>14</td>
<td>Relaxant in the belt of the pump water</td>
</tr>
<tr>
<td>15</td>
<td>Heat Index</td>
</tr>
<tr>
<td>16</td>
<td>Continued operation of the fan</td>
</tr>
<tr>
<td>17</td>
<td>check air valve</td>
</tr>
<tr>
<td>18</td>
<td>Check water temperature sensor</td>
</tr>
<tr>
<td>19</td>
<td>Increase Fuel in Tank</td>
</tr>
<tr>
<td>20</td>
<td>Leaks of gasoline due to Carburetor</td>
</tr>
<tr>
<td>21</td>
<td>Dirt in the carburetor</td>
</tr>
<tr>
<td>22</td>
<td>Fuel leakage outside injection</td>
</tr>
<tr>
<td>23</td>
<td>Float injection corrupted</td>
</tr>
<tr>
<td>24</td>
<td>Low fuel in the Tank</td>
</tr>
</tbody>
</table>

Figure 2: Conditions Table
Figure 3: Case-Conditions Table

Figure 4 presents the relationships between tables, table 1 and table 2, both present the key types used for tables and the relationships between tables respectively, table 3 presents the pseudo code used to create tables and relationship between tables. (8)
Figure 4: The Relationships between Tables

Table 1 (Cases)

<table>
<thead>
<tr>
<th>Case No</th>
<th>Case Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 (Conditions)

<table>
<thead>
<tr>
<th>Condition No</th>
<th>Condition Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 (Case – Condition)

<table>
<thead>
<tr>
<th>Case No</th>
<th>Condition No</th>
<th>Condition Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table (1) The Column (Case_Number) is Primary key

Table (2) The Column (Condition_Number) is Primary key

Table (3) The Columns (Case_Number, Condition_Number) is Primary key

Table (3) The Column (Case_Number) is foreign key

Table (3) The Columns (Condition_Number) is foreign key

Table 1: The Keys Types Used for Tables
Table 2: The Relationships between Tables

<table>
<thead>
<tr>
<th>Table 1) To Table (3)</th>
<th>One – To – Many</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2) To Table (3)</td>
<td>One – To – Many</td>
</tr>
</tbody>
</table>

CREATE TABLE [cases] (
    [caseno] [int] NOT NULL,
    [casename] [nvarchar](250) AS NULL,
CONSTRAINT [PK_cases] PRIMARY KEY [caseno] )

CREATE TABLE [conditions] (
    [conno] [int] NOT NULL,
    [conname] [nvarchar](250) AS NULL,
CONSTRAINT [PK_conditions] PRIMARY KEY [conno] )

CREATE TABLE [case_cond] (
    [caseno] [int] NOT NULL,
    [conno] [int] NOT NULL,
    [casepriority] [int] NULL,
CONSTRAINT [PK_case_cond] PRIMARY KEY [caseno], [conno])

ALTER TABLE [case_cond] WITH CHECK ADD CONSTRAINT [FK_case_cond_cases]
FOREIGN KEY ([caseno]) REFERENCES [cases] ([caseno])
ALTER TABLE [case_cond] CHECK CONSTRAINT [FK_case_cond_cases]

ALTER TABLE [case_cond] WITH CHECK ADD CONSTRAINT [FK_case_cond_conditions]
FOREIGN KEY([conno]) REFERENCES [conditions] ([conno])
ALTER TABLE [case_cond] CHECK CONSTRAINT [FK_case_cond_conditions]

Table 3: Present the Pseudo Code Used to Create Tables and Relationship Between Tables.

Rule Base for car Diagnosis

The rule base is a set of rules and the syntax of a rule is IF <conditions> THEN <actions>, while the action is a malfunction and condition is a cause of the malfunction.

A1, A2, A3... An C1, C2, C3... Cm
Relational database will be used to represent the rule as table. The rules will be stored in a table format with the maximum number of column 5. (9) The first column represents action (malfunction), and from column-2 to column-4 are used to represent the conditions (cause of the malfunction), while the last column is the same action. But if a rule has more than three conditions, the fifth column will be sub-action which has the reset of the conditions and so on. The following is the procedure for representing a rule in a table. (10) The number of rows required according to the number of conditions of the rule.

1) Applying the algorithm to calculate number of rows, n.

2) If n<=3, then, the representation in the table as shown in table 4.

<table>
<thead>
<tr>
<th>Col-1</th>
<th>Col-2</th>
<th>Col-3</th>
<th>Col-4</th>
<th>Col-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C1</td>
<td>C2</td>
<td>C3</td>
<td>C4</td>
</tr>
</tbody>
</table>

Table 4: The Layout of the Rule with Conditions <= 3

3) If n>3, then, the representation in the table as shown in table 5.

<table>
<thead>
<tr>
<th>Col-1</th>
<th>Col-2</th>
<th>Col-3</th>
<th>Col-4</th>
<th>Col-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C1</td>
<td>C2</td>
<td>C3</td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>C4</td>
<td>C5</td>
<td>C6</td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>C7</td>
<td>C8</td>
<td>C9</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>C13</td>
<td>C14</td>
<td>C15</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: The Layout of the Rule with conditions > 3
Based on that will be applied to the vehicle diagnosis system

Example:

Fan is not operating at high, temperature, Relaxant in the belt of the fan,

Fuse fan, the electric wires of the fan

This example, shown that the number to conditions is three which are stored in columns from Col-2 to Col-4 and the Col-5 not used, and the action will be stored in Col-1 as shown in table 6.

<table>
<thead>
<tr>
<th>Col₁</th>
<th>Col₂</th>
<th>Col₃</th>
<th>Col₄</th>
<th>Col₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan is not operating at high temperature</td>
<td>Relaxant in the belt of the fan</td>
<td>Fuse fan</td>
<td>The electric wires of the fan</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: The Layout of the Rule in Example (1)

**Frame Base for Vehicle Diagnosis**

In this Implementation we have seven frames which are: Cooling, Steering, Fuel, Electric, Engine, Gear Box, Brake. Each frame table contains three columns (slots), the first column is labeled by frame number. The second columns labeled by part (piece), and the third column labeled by indicator as shown in figure 4. The column frame number is the Primary key. Table 7 presents the pseudo code used to create frame tables. (11)

```
CREATE TABLE [frame_name]
    [frameno] [int] NOT NULL,
    [piece] [nvarchar](250) COLLATE Arabic_CI_AS NULL,
    [indicator] [nvarchar](250) COLLATE Arabic_CI_AS NULL,
CONSTRAINT [PK_engine_frame] PRIMARY [frameno]
```

Table 7: Present the Pseudo Code Used to Create Frame Tables
Conditions and Frames Table

This table contains three columns, the first column is labeled by condition number. The second column labeled by frame number, and the third column labeled by frame type as shown in Figure 8. The columns (condition number, frame number) are Primary key. (12) The column (Condition number) is foreign key. Frame type column represent frame table, if insert in frame number (one) this number means that the frame number follows the frame cooling.
Figure 5: Condition and Frame Table
User Interface

The implementation of user interface consists of many visual studio 2008 (VB.Net) forms, such as the main menu, which consists of eight forms in two components (Editing Facilities, Explanation facilities) as shown in figure 9., when the system starts, this menu will be displayed in order to allow the user to select one of the following forms. (13)

Editing Facilities for car Diagnosis System

This component is used to manage the facilities: inserting, deleting and updating process for knowledge base. Editing Facilities consists of four forms which are edit cases, edit conditions, edit frames, edit rules table as shown in figure 6

Figure 6: Main Menu, Editing Facilities
Edit Cases

This form is used to edit the cases, which means the user can insert a new case to be added to the case base knowledge, delete an existing case, or update existing case as shown in figure 7

![Figure 7: Editing Cases](image)

Edit Conditions

This form is used to edit the condition, which means the user can insert a condition to be added to the rule base knowledge, delete one, or update existing condition as
shown in figure 8, then the user has a capability of using editing facilities (insert, delete, and update) to the rule base knowledge. (14)

![Editing Conditions](image)

**Figure 8: Editing Conditions**

**Edit Frames**

This form is used to edit the frame, which means the user can insert a new piece to be added to the frame base knowledge, delete an existing piece, or update existing piece as shown in figure 9, then the user has a capability of using editing facilities (insert, delete, and update) to the frame base knowledge.
Figure 9: Editing Frames

Explanation facilities

Explanation facilities: Through conditions, cases and frames stored, the user can discover new facts and rules that make him able to get and take correct deduction. Editing Facilities consist of four forms which are Link Cases and Conditions, Link Conditions and Frames, Show Cases - Conditions and Frames, and Find Cases. As shown in figure 10. (15)
Figure 10: Explanation facilities

**Link Cases and Conditions** form: the user can create a link between a case and conditions by entering the case's name in the field cases list. A list will be displayed it contains all cases that were stored before. After selecting the case, a set of conditions stored before will be displayed, by selecting and moving the conditions desired. The link process will be determined. And through the use of arrows priority conditions can be arranged. **Link Conditions and Frames**: the user can create a link between the conditions and frame by inserting the condition name in the field conditions list. A list will displayed it contains all conditions that were stored before. By choosing the frame's name off the field frame list, a list contains all frames stored before will be displayed. A list of pieces will be displayed when the user clicks on Execute button. The next step is selecting the part and clicking the save button the link process will be determined. **Show Cases, Conditions and Frame**: the user can select case name from cases list. A list contains all cases stored before will be displayed. (16) Clicking on Execute button
will display a set of conditions related to the frame. **Find Cases**: The user can select a condition from the condition list. A list contains all condition stored before will be displayed. Clicking on Execute button conditions related to the following cases will be displayed: Exact Case, Match Case, No Match (New Case).

**Conclusion**

1) The system will perform better with each new case.

2) The system is accurate in its answers.

3) Ease of modification to the knowledge base.

4) Providing advice with no requirement for a human expert.

5) Ease of use by the user.

6) The implementation of knowledge base depends on knowledge representation forms of the, usually, represented knowledge in many different forms. Base has been represented in three forms which are rule base, case base and frame base.

7) Database system was designed for the normal user, who doesn't know programming, but can only add knowledge.

8) The end user can use all editing facilities like inserting, deleting and updating of knowledge base.

9) The system implementation in the diagnosis of fault vehicle and the results of this system were matched with the decisions taken by the car mechanics.

**References**


