ISSN No. 2278-3091
Volume 2, No.2, March - April 2013
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://warse.org/pdfs/2013/ijatcse03222013.pdf

A Knowledge Based System towards Identifying Problems and Getting Instant Solutions about Our Personal Vehicles

Shah Murtaza Rashid Al Masud
Faculty of Computer Science and Information Systems
Najran University, Najran, Saudi Arabia
smramasud@gmail.com

ABSTRACT

Identifying our personal vehicle's problems and getting solutions is a complicated process which demands high level of knowledge and skills. Our goal is to develop a knowledge -based system (KBS) on vehicle conservation and troubleshooting that is capable of supporting vehicle's owner in dealing with their vehicle problems and troubleshooting them whenever the time is limit and the human expert, also known as mechanics is not available at that very point of time. This paper provides effective planning and design issues regarding the problems while driving the vehicle and will give a logical solution which would help in rectifying those problems. The system would contain various set of rules for detecting and distinguishing different category of failures which can be easily handled by the driver and will give their causes. This paper mainly deals with the starting problems of vehicle and detecting various other large scale problems. The research report explains the need for a knowledge based system and some issues on developing knowledge-based systems, the vehicle failure recognition process and the problems involved in developing the system. A rule-based, web enabled expert system shell: expertise2go was used to design the rules which involved a knowledge component, decision component, design component, graphical user interface component, and the user component. The system has been verified and tested and gave auspicious results.

Key words: Knowledge-Based System, Vehicle, Expert System, Rules.

1. INTRODUCTION

The terms knowledge-based system (KBS) and expert system are normally used identically. The four main components of KBS are: a knowledge base, an inference engine, a knowledge engineering tool, and a specific user interface. Some of KBS important applications include the following: medical treatment, engineering failure analysis, decision support, knowledge representation, climate forecasting, decision making and learning, and chemical process controlling. Knowledge-based system (KBS) is a branch of artificial intelligence (AI) which was developed by the AI community in the mid-1960s. It can be defined as "Knowledge-based System (KBS) - Typically a rule-based system for providing expertise. Identical to expert systems, except that the source of expertise may include documented knowledge [1] [2]". We can infer from this definition that expertise can be transferred from a human to a computer and then stored in the computer in a suitable form that users can call upon the computer for specific advice as needed. Then the system can make inferences and arrive at a specific conclusion to give advices and explains, if necessary, the logic behind the advice. KBS 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. Normally this system will guide a human technician through the entire service process, from the initial customer interview at the service desk to the diagnosis and repair of the vehicle in the garage.

A knowledge-based system for vehicle failure diagnosis is presented in this paper. The main objectives towards developing such a system are as follows:

- To help the vehicle's owner in making decision on action they should take in their attempt to troubleshoot the vehicle's problem.
- To save much time, cost and energy for the customer especially to those who are in urgency as they don't have to wait for the mechanics to repair the troubles of their vehicles.
- To get the peoples even more closely the world of computerization, technology, mechanization, and automation.
- To give the developer a chance to get involve directly into the development of knowledge based system synonymously expert system, and at the same time help to build the programming and software design skill, as well as problem explaining and solving capabilities.

As the proposed system is web-based, so at anytime from any place any user can access to it and get recommendations he needed.

This paper is organized in this way, Section 2 Problem identification. Section 3 Analytical model for the proposed KBS system. Section 4 Design of the proposed KBS system Section 5 Implementation of the proposed KBS system, and finally Section 6 Conclusion.

2. PROBLEM IDENTIFICATION

Vehicle failures can be divided into three major types: start-up state, run-stable state, and movement state. In our proposed system we took consideration only the start-up state, problems that may occur when a person try to start up the vehicle, for example; engine does not work, some sounds noticed, engine works ones and stops. These problems could be due to one or more failures; will happen, the battery needs to be recharged, the dynamo is dead, or the battery is dead. If the vehicle is in the start-up state and doesn't start, then the motive could be one of three main reasons: a bad gasoline mix, deficiency of compression or absence of spark. In addition, thousands of minor things can create problems, but these are the main three.
Bad gasoline mix: A bad gasoline mix can occur in several ways:
1. The vehicle ran out of gas, so the engine is getting air but no fuel.
2. The air intake might be clogged, so there is fuel but not enough air.
3. The gasoline system might be supplying too plentiful or too diminutive gasoline to the mix, meaning that ignition does not occur properly.
4. There might be an contamination in the fuel (like water in your gas tank) that makes the fuel not burn.
Deficiency of compression*:* If the air and gasoline cannot be compacted properly, the ignition process will not work like it should. Lack of compression might occur for these reasons:
1. Piston rings are worn
2. The intake or exhaust valves are not sticking properly
3. There is a hole in the cylinder.
Absence of spark*:* There are a number of reasons for what the spark might be weak.
1. If the spark plug or the wire leading to it is damaged or worn out.
2. If the wire is cut or missing
3. If the system that sends a spark down the wire is not working properly
4. The fuel will not burn properly if the spark occurs in different cycle.
Other Problems: The following problems are also taken into consideration in the system.
1. If the battery is dead, the engine cannot turn over.
2. If the bearings that allow the crankshaft to turn freely are worn out, the crankshaft cannot turn so the engine cannot run.
3. If the valves do not open and close at the right time or at all, air cannot get in and exhaust cannot get out, so the engine cannot run.
4. If someone sticks a potato up your tailpipe, exhaust cannot exit the cylinder so the engine will not run.
5. If you run out of oil, the piston cannot move up and down freely in the cylinder, and the engine will seize.
The proposed KBS with facts and rules would easily identify the vehicle’s problems and give us instant solutions.

3. ANALYTICAL MODEL FOR THE PROPOSED KBS SYSTEM

The knowledge-based system (KBS) developed for this work depends on the structure of expert system. The structure of expert system has five main components: user interface, working memory, inference engine, knowledge base, and explanatory facility [3][4]. The major components of KBS as shown in Figure 1 are briefly explained below.
Knowledge base - declarative representation of the expertise, often in IF THEN rules;
Working storage - the data which is specific to a problem being solved;
Inference engine - the code at the core of the system which derives recommendations from the knowledge base and problem-specific data in working storage;
User interface - the code that controls the dialog between the user and the system.
Explanation Facility-Illustrates to the user how and why the system gave a certain cause for the failure, i.e. explains the reasoning of the system to the user.
In this proposed expert system we used forward chaining (reasoning) method where an interpreter uses a set of rules and a set of facts to perform an action [5]. This method involves checking the condition part of a rule to determine whether it is true or false. If the condition is true, then the action part of the rule is also true. This procedure continues until a solution is found or a dead end is reached. Forward chaining is commonly referred to as data-driven reasoning. This method composed of three components. These are: The rule set; a working storage area which contains the current state of the system; an inference engine which knows how to apply the rules.
The rules are of the form: left hand side (LHS) ==> right hand side (RHS), in short: IF---THEN. The LHS is a collection of conditions which must be matched in working storage for the rule to be executed. The RHS contains the actions to be taken if the LHS conditions are met.
The execution cycle of the system is:
Select a rule whose left hand side conditions match the current state as stored in the working storage.
Execute the right hand side of that rule, thus somehow changing the current state.
The syntax of the rules is:

```
rule <rule id>:
   [<N> : <condition>,.......]
    ==>
   [<action>, ....].
```

Where: rule id - a unique identifier for the rule; N – optional identification for the condition; condition - a pattern to match against working storage; action - an action to take. The Figure 3 mentioned below represents the concept of the forward chaining algorithm.

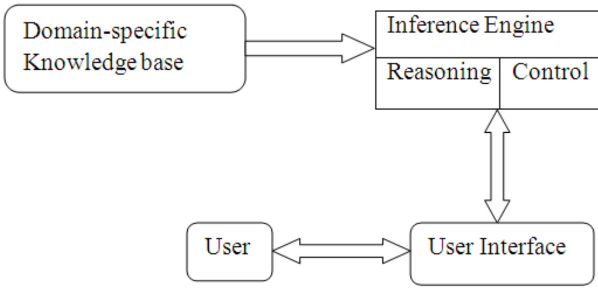

Figure 1: Main components of proposed KBS

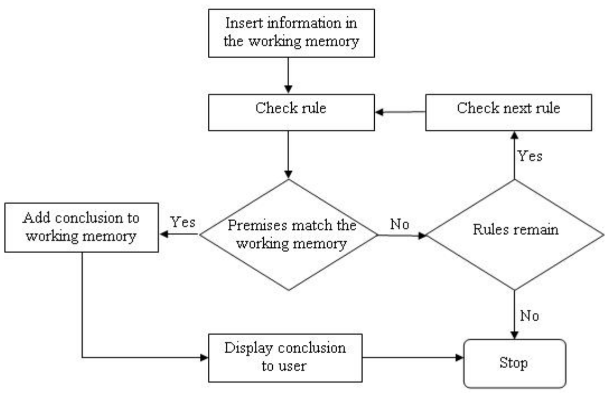

Figure 3: The forward chaining algorithm model for the proposed system.

4. DESIGN OF THE PROPOSED KBS SYSTEM

The Knowledge Engineer acquires knowledge from experts in specific field, through standardization process, and sorts out the collected knowledge from experts to formed rules. In vehicles' problems identification system, the way of knowledge representation is production rule. The production rule uses the presentation way of "IF P THEN Q", P is precondition, and Q is conclusion [6]. Some of the rules of the proposed KBS are:

Rule 1: IF the vehicle does not start,
THEN check for the fuel.
Rule 2: IF the vehicle does not start,
AND the fuel is not empty,
THEN check the battery.
Rule 3: IF the vehicle does not start,
AND the battery does not have a problem,
THEN check whether the engine is overheated or is very cold.

The proposed knowledge-based system is developed by decision table or knowledge base table. Where the condition part of the decision table is called the condition stub and the action part the action stub shown in Figure 3 as mentioned below. Each column represents a rule, and when all of the conditions in a column are satisfied, the action or actions designated in that column represent the recommended decision [6].

	Rule1	Rule2	Rule3
Condition1			
Condition2			
Action1			
Action2			

Figure 3: A decision table.

The connection between decision Tables and rules in a rule-based expert system is easily seen in the following decision table. "Y" and "N" in the condition stub represent "Yes" and "No" ("T" and "F" could be used representing "True" and "False") and an "X" in the action stub means the action is recommended. "-" in a cell means the condition or action is irrelevant, shown in Table 1 [7]. Using the concepts getting from the Table 1 we developed a new table 'Table 2', which shows the combination between decision table rules for our proposed system. A decision table towards vehicles' problems identification is shown in Table 3.

Table 1: Combination between decision table rules in rule based KBS

	Rule1	Rule2
Condition1	Y	Y
Condition2	-	-
Condition3	Y	Y
Action1	X	
Action2		X
Action3		

Table 2: Combination between decision table rules in KBS for our proposed system

	Rule1	Rule2	Rule3
Does the starter run?	Y	Y	N
Do you smell gas when the starter cranks?	Y	N	-
replace the dead battery	-	-	X
refuel the vehicle	-	X	-
wait 10 minutes, restart flooded vehicle	X	-	-

Table 3: A decision table towards vehicles' problems identification

	Rule1	Rule2	Rule3
the result of trying the starter	the vehicle cranks normally	the vehicle cranks normally	nothing happens
the smell of	present while	not present	-

gasoline	trying the starter	while trying the starter	
the recommended action	wait 10 minutes, restart flooded vehicle	refuel the vehicle	recharge or replace the battery

Although either decision table form is easily mapped into knowledge-based system rules, the extended entry form is probably most effective for this purpose as the following rules extracted from the three columns of the table illustrated in Table 4 as shown bellow.

Table 4: Extracted format of a decision table towards vehicles' problems identification

Rule1	Rule2	Rule3
If the result of trying the starter = the vehicle cranks normally and the smell of gasoline = present while trying the starter	If the result of trying the starter = the vehicle cranks normally and the smell of gasoline = not present while trying the starter	If the result of trying the starter = nothing happens
Then the recommended action = wait 10 minutes, restart flooded vehicle	Then the recommended action = refuel the vehicle	Then the recommended action = recharge or replace the battery

Therefore, the three rules are equivalent to the following single rule that could be generated for a knowledge-based system:

IF Condition1=true OR
Condition2=true OR
Condition3=true
THEN Action1=true

5. IMPLEMENTATION OF THE PROPOSED KBS SYSTEM

To implement this KBS, web-enabled, knowledge-based e2gRuleWriter decision table software and Java applet-based e2gRuleEngine Knowledge-based shell that provides an interactive user interface are used. All of these above mentioned software are free for private, educational, and commercial use [6].

The proposed web-enabled KBS utilizes a combination of qualitative and quantitative procedures for our vehicles' problems identification. The mixture of both provides reliability to the technical process and facilitates knowledge interaction and analysis. The proposed KBS for vehicles' problems identification has been successfully implemented and validated. The results show that basic decision making procedures are very satisfactory. KBS starts by displaying its main window as shown in Figure 4. The user is expected to click the button to choose the option for getting the solution of his vehicle's problems.

Figure 4: Index page for our proposed KBS

Click the button labeled **"Start the consultation"** as shown in Figure 4 the knowledge base will be loaded. We should see the first PROMPT as shown in Figure 5.

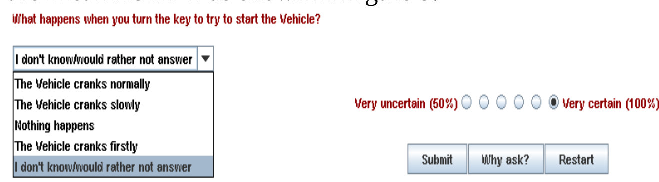

Figure 5: The first PROMPT appeared after clicking the **"Start the consultation"**

Click the '**Why ask?**' button to see the inference engine's explanation as shown in Figure 6 of why this question has been asked.

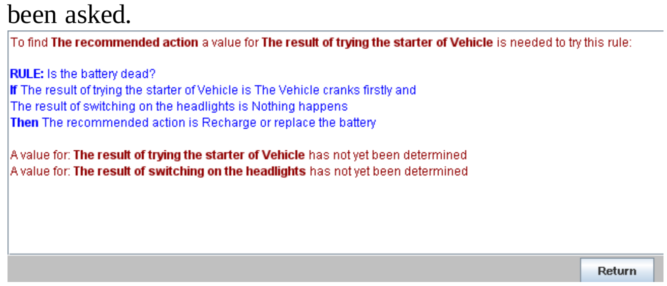

Figure 6: The inference engine's explanation when we click on the button '**Why ask?**'

The following figures: Figure 7, Figure 8, Figure 9, and Figure 10 will show how we can input values to get instant solutions about our vehicles problems.

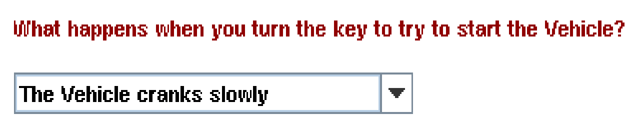

Figure 7: Process of input (1) value in our KBS

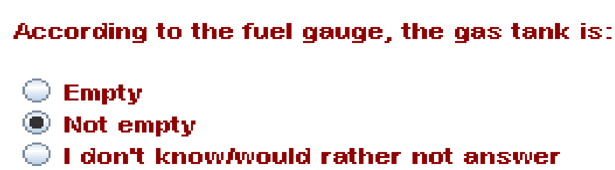

Figure 8: Process of input (2) value in our KBS

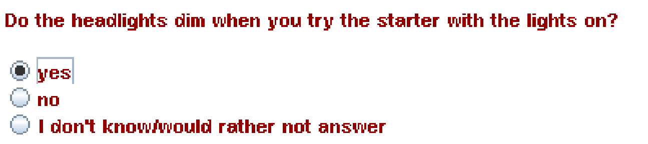

Figure 9: Process of input (3) value in our KBS

Figure 10: Process of input (4) value in our KBS

The result or action taken by the system is shown in the following Figure 11.

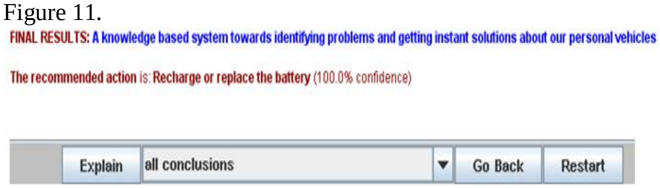

Figure 11: The result we obtained after giving the input values to our KBS

If we click the **Explain** button with **all conclusions** showing in the drop down list of resolved attribute values we will see the following detailed explanation of the recommendation for the rule 5 from our research as shown in Figure 12.

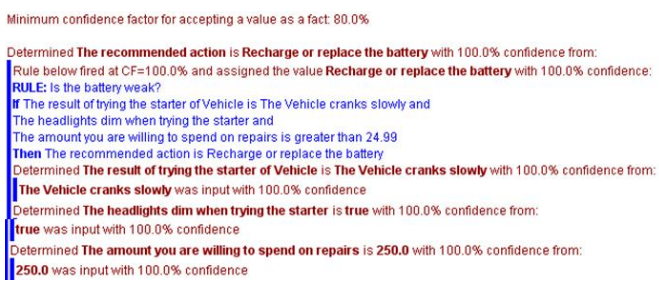

Figure 12: The explanation procedure of the proposed KBS

The following Figure 13 shows how the knowledge base is produced and kept place on knowledge base table by using the knowledge base software e2gRuleWriter.jar. The rule writer software is compiled and managed by another software namely e2gRuleApplet.jar [7].

Each GOAL is defined on a single line that begins with GOAL followed by the name of the goal attribute enclosed in square brackets. The following figures (Figure14-16) show the development process of knowledge based system. **Condition mode:** The appearance of the condition mode data entry screen after entering data describing all the conditions as shown on the following Figure 14.

Action mode: Inputs that are accepted when defining conditions but not used by actions is shown in Figure 15.

Defining rules: The final knowledge base construction step involves entering condition and action values to form the rules as shown in Figure 16, then generating the e2gRuleEngine knowledge base.

```
REM Generated by v1.01 of e2gRuleWriter 01/30/2013 18:51 from: ourvehicle.kbt

RULE [Is the battery dead?]
If [The result of trying the starter of Vehicle] = "The Vehicle cranks firstly" and
[The result of switching on the headlights] = "Nothing happens"
Then [The recommended action] = "Recharge or replace the battery"

RULE [Is the battery dead (2)?]
If [The result of trying the starter of Vehicle] = "Nothing happens"
Then [The recommended action] = "Recharge or replace the battery"

RULE [Is the car out of gas?]
If [The gas tank] = "Empty"
Then [The recommended action] = "Refuel the Vehicle"

RULE [Is the battery weak?]
If [The result of trying the starter of Vehicle] = "The Vehicle cranks slowly" and
[The headlights dim when trying the starter] = True and
[The amount you are willing to spend on repairs] > 24.99
Then [The recommended action] = "Recharge or replace the battery"

RULE [Is the gas tank empty?]
If [The result of trying the starter of Vehicle] = "The Vehicle cranks normally" ar
[A gas or gasoline smell] = "Not present when trying the starter"
Then [The gas tank] = "empty" @ 90

PROMPT [The result of trying the starter of Vehicle] Choice CF
"What happens when you turn the key to try to start the Vehicle? "
"The Vehicle cranks normally"
"The Vehicle cranks slowly"
"Nothing happens"
"The Vehicle cranks firstly"

PROMPT [The headlights dim when trying the starter] YesNo CF
"Do the headlights dim when you try the starter with the lights on?"

PROMPT [A gas or gasoline smell] MultChoice CF
"The smell of gasoline of your Vehicle is:"
"Present when trying the starter"
"Not present when trying the starter"

PROMPT [The gas tank] MultChoice CF
"According to the fuel gauge, the gas tank is:"
"Empty"
"Not empty"

PROMPT [The amount you are willing to spend on repairs] Numeric CF
"How much are you willing to spend on repairs? (enter value 0->500)"
"0.0"
"500.0"

DEFAULT [The gas tank] = "empty" @ 90
DEFAULT [The amount you are willing to spend on repairs] = 30

GOAL [The recommended action]

MINCF 80
```

Figure 13: Production of knowledge base for the proposed KBS by using e2gRuleWriter shell software.

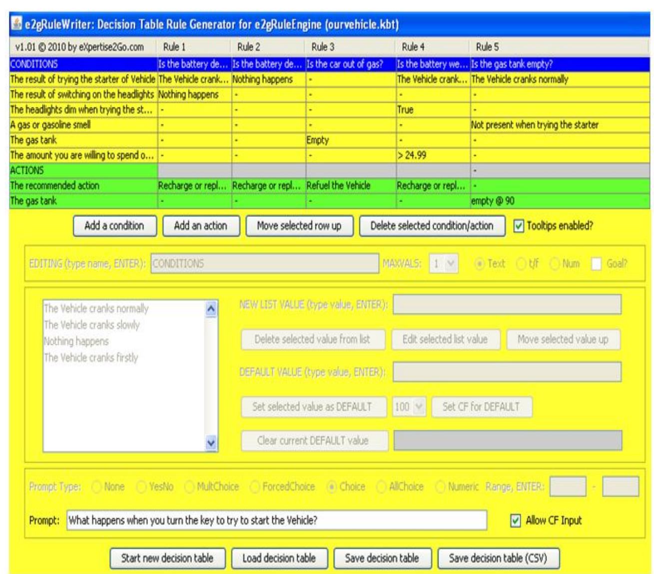

Figure 14: The conditions for the proposed system

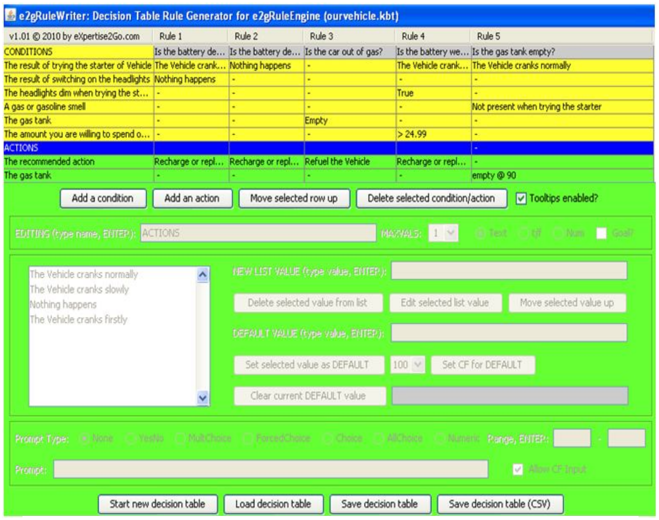

Figure 15: The steps used to define "the recommended actions"

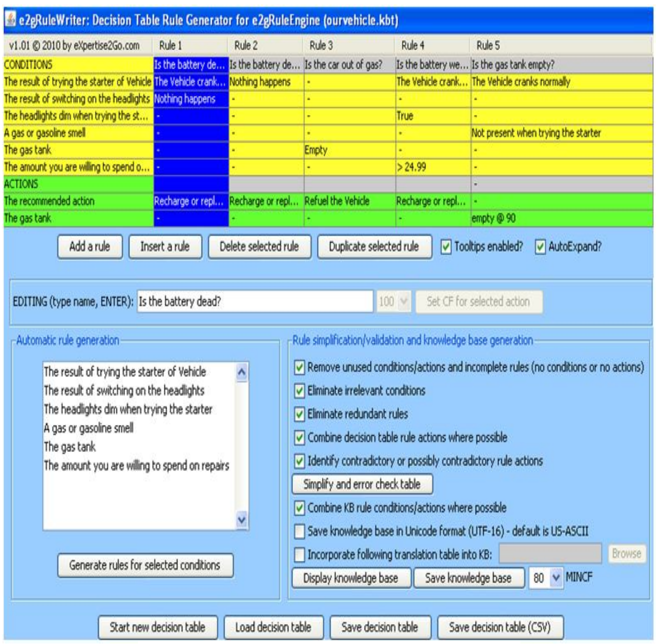

Figure 16: Steps used to build the rules

6. CONCLUSION

Getting the instant solution according to the vehicles problems is a complex process. In our proposed system we took consideration only the start-up state, problems that may occur when a person try to start up the vehicle. In designing part we used knowledge base table to represent the facts and rules for vehicles problems identification. The e2gRuleWriter and e2gRuleEngine provided us the environment to implement the system as discussed in implementation section. Rules and facts are stored as knowledge base on knowledge base table, and as the system is web enabled so any user can use the system whenever he wants. In future we will design and update our KBS for all types of vehicle failures like: start-up state, run-stable state, and movement state.

REFERENCES

1. Definition of KBS: http://www.bindichen.co.uk/post/AI/ ai-glossary.html
2. Shu-Hsien Liao (2005). Expert system methodologies and applications a decade review from 1995 to 2004, Expert Systems with Applications, 28, 93-103
3. Daoliang Lia, Zetian Fua, Yanqing Duanb (2002). Fish-Expert: a webbased expert system for fish disease diagnosis, Expert Systems with Applications, 23, 311-320.
4. Yu Qian*, Xiuxi Li, Yanrong Jiang, Yanqin Wen (2003). *An expert* system for real-time failure diagnosis of complex chemical processes, Expert Systems with Applications, 24, 425-432.
5. Forward chaining method: http://www.myreaders.info/ 07_ Expert_Systems.pdf
6. Production Rules: http://www.ijcaonline.org/journal/ number23/pxc
7. KB and KBT: http://www.expertise2go.com/ e2g3g/e2g3gdoc/e2gRuleWriterRef.htm