Implementation of Certainty Factor Method for Expert System

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Abstract. PC computer is a flexible electronic device and can receive and process data quickly and accurately, and can also store data for a long time. There is a time when the PC hardware is damaged. So that it annoys the user. In connection with the problems that occur, the researchers aim to build an Expert System application to diagnose damage to PC computers using the Certainty Factor method by using Visual Studio 2010 applications and using Microsoft Access 2013 as a database. Applications that are built can be an alternative in knowing the type of damage and provide alternative solutions in handling damage to PC computer hardware.

1. Introduction
PC computers are electronic devices that can receive and process data quickly and precisely. Almost every activity carried out by humans is always related and dependent on PC computers, both doing work at school, working in the office, and as data processing in the company. Behind the use of PC computers that are very helpful to humans, PC computer performance is also not always functioning properly and optimally, there are times when the PC computer is damaged, both on the hardware and in the soft anchor, so that damage affects the performance and function of the PC. In overcoming the problem of damage to a PC computer, the user usually entrusts the repair of the PC computer by bringing it to a PC computer technician and costs a lot of money to fix it and repair time long enough. And even PC computer users or users tend to replace a PC with a new PC, even though the PC can still be repaired by replacing the hardware that is experiencing damage or having a problem on the PC. In connection with these problems, it is necessary to create an expected application. This application can serve as an alternative tool to help PC computer users in diagnosing damage to PC computer hardware. In building the application, the application made using the Certainty Factor (CF) method. This method is considered appropriate in symptom damage recognition, and determines the type of PC Computer damage. So it is expected that the application that is made can be used at any time, and anywhere when needed.
2. Research Methodology

2.1. Expert System

The Expert System is one of the branches of Artificial Intelligence which was developed around 1960. The term expert system comes from a knowledge-based expert system. The Expert System uses the knowledge of an expert that is entered into the computer. The definition of an expert system is a system that attempts to adopt human knowledge to computers, so that computers can solve problems as usual by experts. A good expert system, designed to solve certain problems by imitating the work of experts. There are two main objectives of developing an expert system, namely to replace the work of an expert or help the work of an expert. With this expert system, lay people can solve complex problems that can only be solved with the help of experts. For an expert this also helps his activities as a very experienced assistant.

2.2. PC Computer Hardware

Computer hardware or also called hardware is all computer devices that can be seen physically or can be tangibly touched, which serves to support the process of running the computer and work together to achieve the objectives of the computer operating system. In a computer consists of several devices that are needed to become one unit and carry out the functions of the computer according to the needs of the user. The types of hardware on the computer are not only focused on the inside of the computer, but all devices that support computer performance. Here are some components of computer hardware that are examined, namely damage to the Motherboard, Processor, RAM, VGA Card, Power Supply, Hard Drive, and Monitor.

2.3. Certainty Factor

Certainty Factor was introduced by Shortliffe Buchanan in the making of MYCIN. Certainty Factor (CF) is a clinical parameter value given by MYCIN to show the magnitude of trust. Certainty Factor is defined as the following equation:

\[ CF(H, E) = MB(H, E) - MD(H, E) \]

\[ MB(H, E) = \frac{\max[P(H|E), P(H)] - P(H)}{\max[1,0] - P(H)} ... P(H) = 1 \]

\[ MB(H, E) = \frac{\min[P(H|E), P(H)] - P(H)}{\max[1,0] - P(H)} ... P(H) = 0 \]

Information:

CF (Rule) = Certainty factor
MB(H, E) = Measure of belief (measure of trust) to the H hypothesis, if given evidence E (between 0 and 1).
MD(H, E) = Measure of disbelief (measure of distrust) of evidence H, if given evidence E (between 0 and 1).
P(H) = Probability of the H hypothesis.
P(E) = Probalance that H is true because of fact E.

2.4. The Expert System uses the Certainty Factor method.

In the system that will be built, identification has been made of the users involved in this expert system. In addition to identifying users or users, the author also describes things that can be done by the user. The system can also describe things that can be done by the admin of this expert system, starting from identifying data input, data processing and data output generated from the built system. In data processing and decision making diagnosis of computer damage, Certainty Factor has a rule IF E THEN H is as follows:

\[ CF(H,e) = CF(E,e) * CF(H,E) \]
\[ CF(combine)CF[H,E]1,2= CF[H,E]1 + CF[H,E]2 * [1-CF[H,E]1] \]
\[ CF(combine)CF[H,E]old,3=CF[H,E]old + CF[H,E] 3 * (1-CF[H,E] old] \]
CF(E,e) = Certainty Factor E evidence that is influenced by evidence e
CF(H,E) = Certainty Factor hypothesis assuming evidence is known with certainty, namely when
CF (E, e) = 1
CF(H,e) = Certainty Factor hypothesis that is influenced by evidence e

Table lists the types of damage and symptoms of damage to PC computer hardware in general:

**Table 1.** Types of Damage

| Code Damage | Type of Damage |
|-------------|----------------|
| K1          | Motherboard    |
| K2          | Processor      |
| K3          | RAM            |
| K4          | VGA Card       |
| K5          | Power Supply   |
| K6          | Harddisk       |
| K7          | Monitor        |
| K8          | Overheat / Panas |

Table of general computer hardware in general symptoms of damage to PC:

**Table 2.** Table of Symptoms For PC Computer Damage

| Symptom Code | Symptom Name |
|--------------|--------------|
| E01          | There is no display on the computer screen |
| E02          | The indicator light on the front panel lights up |
| E03          | Long beeps when the computer is turned on |
| E04          | A short circuit occurs when the computer is turned on |
| E05          | The operating system is off, the cursor does not appear on the screen |
| E06          | The processor fan is not running and the processor is not hot |
| E07          | The system sounds at startup |
| E08          | OS doesn't want to boot |
| E09          | Computer performance is slowing down |
| E10          | Computers often restart themselves without restarting |
| E11          | The monitor suddenly becomes bluescreen |
| E12          | The computer fails to boot and beepscomputer filed and sounds beep |
| E13          | Often fails when installing new software |
| E14          | Graphic performance is slow when playing games or image editors |
| E15          | Can enter bios, but VGA does not work after entering the operating system |
| E16          | The resolution and color quality of the monitor is not optimal |
| E17          | Windows is often not responding and graphics performance feels heavy |
| E18          | The PC does not react anything and the power indicator does not turn on |
| E19          | The message "Harddisk Error, Hard Disk Failur" appears on the monitor |
| E20          | The message "Operating System Not Found" appears on the monitor |
| E21          | There is no round sound and activity on the hard drive |
| E22          | The display on the blank monitor is white |
| E23          | The monitor doesn't turn on at all |
| E24          | Color contrast on the monitor is blurry |
| E25          | The computer dies suddenly while in use |
| E26          | Computer blank / Freezy |
| E27          | Computer loading starts slowly after being used several hours nonstop |
| E28          | The temperature on the PC becomes very hot from normal conditions |

**Table 3.** Rule Symptoms Table

| Symptom Code | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 |
|--------------|----|----|----|----|----|----|----|----|
| E01          | X  |    |    |    |    |    |    |    |
| E02          | X  |    |    |    |    |    |    |    |
| Symptom Code | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 |
|--------------|----|----|----|----|----|----|----|----|
| E03          | X  |    |    |    |    |    |    |    |
| E04          |    | X  |    |    |    |    |    |    |
| E05          |    |    | X  |    |    |    |    |    |
| E06          |    |    |    | X  |    |    |    |    |
| E07          |    |    |    |    | X  |    |    |    |
| E08          |    |    |    |    |    | X  |    |    |
| E09          |    |    |    |    |    |    | X  |    |
| E10          |    |    |    |    |    |    |    | X  |
| E11          |    |    |    |    |    |    |    |    |
| E12          |    |    |    |    |    |    |    |    |
| E13          |    |    |    |    |    |    |    |    |
| E14          |    |    |    |    |    |    |    |    |
| E15          |    |    |    |    |    |    |    |    |
| E16          |    |    |    |    |    |    |    |    |
| E17          |    |    |    |    |    |    |    |    |
| E18          |    |    |    |    |    |    |    |    |
| E19          |    |    |    |    |    |    |    |    |
| E20          |    |    |    |    |    |    |    |    |
| E21          |    |    |    |    |    |    |    |    |
| E22          |    |    |    |    |    |    |    |    |
| E23          |    |    |    |    |    |    |    |    |
| E24          |    |    |    |    |    |    |    |    |
| E25          |    |    |    |    |    |    |    |    |
| E26          |    |    |    |    |    |    |    |    |
| E27          |    |    |    |    |    |    |    |    |
| E28          |    |    |    |    |    |    |    |    |

**Table 4. Rule Symptoms Table**

| No | Type Damage | Symptoms Code | Value MB | Value MD |
|----|-------------|---------------|----------|----------|
| 1  | Motherboard | E01           | 0.80     | 0.50     |
|    |             | E02           | 0.85     | 0.40     |
|    |             | E03           | 0.90     | 0.50     |
|    |             | E04           | 0.70     | 0.50     |
|    |             | E05           | 0.80     | 0.50     |
|    |             | E06           | 0.90     | 0.70     |
| 2  | Processor   | E07           | 0.80     | 0.60     |
|    |             | E08           | 0.85     | 0.60     |
|    |             | E09           | 0.85     | 0.50     |
|    |             | E10           | 0.90     | 0.50     |
| 3  | RAM         | E11           | 0.85     | 0.50     |
|    |             | E12           | 0.85     | 0.50     |
|    |             | E13           | 0.85     | 0.50     |
|    |             | E14           | 0.95     | 0.60     |
|    |             | E15           | 0.90     | 0.50     |
| 4  | VGA Card    | E16           | 0.85     | 0.60     |
|    |             | E17           | 0.80     | 0.50     |
|    |             | E02           | 0.85     | 0.5      |
| 5  | Power Supply| E04           | 0.90     | 0.70     |
|    |             | E18           | 0.95     | 0.50     |
|    |             | E17           | 0.85     | 0.50     |
|    |             | E19           | 0.95     | 0.60     |
| 6  | Harddisk    | E20           | 0.90     | 0.50     |
|    |             | E21           | 0.95     | 0.70     |
| 7  | Monitor     | E16           | 0.75     | 0.50     |
|    |             | E22           | 0.95     | 0.60     |
3. Results and Discussion

Here is an example of a case, with the following damage:

- Long beeps when the computer is turned on
- A short circuit occurs when the computer is turned on
- Computer performance slows down
- The computer often restarts itself without restarting
- The monitor suddenly becomes blue screen
- The computer fails to boot and beep

Table 5. Table Example Case

| No | Symtoms                                      | Damage  |
|----|----------------------------------------------|---------|
|    |                                              | K1      |
| 1  | Long beeps when the computer is turned on    | E03     |
| 2  | A short circuit occurs when the computer is turned on | E04     |
| 3  | Computer performance slows down              | E09     |
| 4  | The computer often restarts itself without restarting | E10     |
| 5  | The monitor suddenly becomes blue screen     | E11     |
| 6  | The computer fails to boot and beep          | E12     |
| 7  | The PC does not react anything and the power indicator does not turn on | E18     |

**CF Motherboard Damage (K1):**

\[
\text{E01} \quad \text{CF}(H,e) = \text{CF}(E,e) \times \text{CF}(H,E) = 0 \times 0 = 0
\]

\[
\text{E01} \quad \text{CF}(H,e) = \text{CF}(E,e) \times \text{CF}(H,E) = 0 \times 0 = 0
\]

\[
\text{E03} \quad \text{CF}(H,e) = \text{CF}(E,e) \times \text{CF}(H,E) = 0.80 \times 0.50 = 0.40
\]

\[
\text{E04} \quad \text{CF}(H,e) = \text{CF}(E,e) \times \text{CF}(H,E) = 0.70 \times 0.50 = 0.35
\]

Combine the CF value on Motherboard damage:

To count CF[H,E]1

\[
\text{CF}[H,E]1 = \text{CF}[H,E]1 + \text{CF}[H,E]2 \times (1-\text{CF}[H,E]1) = 0 + 0 (1-0) = 0
\]

To count CF[H,E]2

\[
\text{CF}[H,E]2 = \text{CF}[H,E]1 + \text{CF}[H,E]2 \times (1-\text{CF}[H,E]1) = 0 + 0 (1-0) = 0
\]

To count CF[H,E]3

\[
\text{CF}[H,E]3 = \text{CF}[H,E]2 + \text{CF}[H,E]3 \times (1-\text{CF}[H,E]2) = 0 + 0.40 (1-0) = 0.40
\]

To count CF[H,E]4

\[
\text{CF}[H,E]4 = \text{CF}[H,E]3 + \text{CF}[H,E]4 \times (1-\text{CF}[H,E]3) = 0.40 + 0.35 (1-0.40) = 0.61
\]

So, the percentage of confidence in Motherboard damage is:

\[
\text{Percentage of Belief} = \text{CF} \times 100\% = 0.61 \times 100\% = 61\%
\]

**CF Processor Damage (K2):**

There are no symptoms of damage fulfilled in K2

**CF RAM Damage (K3):**

\[
\text{E09} \quad \text{CF}(H,e) = \text{CF}(E,e) \times \text{CF}(H,E) = 0.85 \times 0.50 = 0.42
\]

\[
\text{E10} \quad \text{CF}(H,e) = \text{CF}(E,e) \times \text{CF}(H,E) = 0.90 \times 0.50 = 0.45
\]

\[
\text{E11} \quad \text{CF}(H,e) = \text{CF}(E,e) \times \text{CF}(H,E) = 0.85 \times 0.50 = 0.42
\]

\[
\text{E12} \quad \text{CF}(H,e) = \text{CF}(E,e) \times \text{CF}(H,E) = 0.85 \times 0.50 = 0.42
\]

Combine the CF value on RAM damage:

To count CF[H,E]9

\[
\text{CF}[H,E]9 = \text{CF}[H,E]9 + \text{CF}[H,E]10 \times (1-\text{CF}[H,E]9) = 0.42 + 0.45 (1-0.42) = 0.68
\]

To count CF[H,E]10
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CF \[H,E\]_9 = CF \[H,E\]_10 + CF \[H,E\]_11 \times (1 - CF[H,E]_10) = 0.42 + 0.45 (1 - 0.42) = 0.68
To Count CF \[H,E\]_11
CF \[H,E\]_3 = CF \[H,E\]_2 + CF \[H,E\]_3 \times (1 - CF[H,E]_2) = 0.68 + 0.42 (1 - 0.68) = 0.81
To Count CF \[H,E\]_4
CF \[H,E\]_4 = CF \[H,E\]_3 + CF \[H,E\]_4 \times (1 - CF[H,E]_3) = 0.81 + 0.42 (1 - 0.81) = 0.88
So, the percentage of confidence in RAM damage is:
Percentage of Belief = CF \times 100\% = 0.88 \times 100\% = 88\%

CF VGA Card Damage (K4):
There are no symptoms of damage fulfilled in K4

CF Power Supply Damage (K5):
E04 \ CF (H,e) = CF (E,e) \times CF (H,E) = 0.90 \times 0.50 = 0.45
E10 \ CF (H,e) = CF (E,e) \times CF (H,E) = 0.95 \times 0.50 = 0.47
Combine CF values on Power Supply damage:
To Count CF \[H,E\]_04
CF \[H,E\]_9 = CF \[H,E\]_4 + CF \[H,E\]_18 \times (1 - CF[H,E]_4) = 0.45 + 0.47 (1 - 0.45) = 0.70
To Count CF \[H,E\]_10
CF \[H,E\]_9 = CF \[H,E\]_10 + CF \[H,E\]_11 \times (1 - CF[H,E]_10) = 0.45 + 0.47 (1 - 0.45) = 0.70
So, the percentage of belief in Power Supplay damage is:
Percentage of Belief = CF \times 100\% = 0.70 \times 100\% = 70\%

CF Hard drive damage (K6):
There are no symptoms of damage fulfilled in K6

CF Monitor damage (K7):
There are no symptoms of damage fulfilled in K7

CF damage Overhead (K8):
There are no symptoms of damage fulfilled in K8

Based on the symptoms of damage to the PC computer above, it can be concluded that the damage to the computer is RAM. With a percentage of 88\%.

Form diagnosis is a form that has been provided as a place for the user to diagnose the damage to the computer by selecting the symptoms that have been determined, after selecting a number of symptoms, the user clicks the check button or diagnosis, so the conclusion will be made on the type of damage to the computer hardware and alternative solutions can be done.

![Diagram of Diagnosis Form]

**Figure 1. Diagnosis Form**

4. Conclusion

Based on the results obtained as well as the analysis carried out for the design of an expert application system for diagnosing damage to PC computer hardware, the following conclusions can be drawn:
a. This Expert System can facilitate users or users in knowing the symptoms and types of damage to PC computer hardware, and make it easier for users to repair damage and shorten repair time.

b. This Expert System diagnoses using the Certainty Factor method, by the way the user selects some of the symptoms of damage that has been displayed by the system, then symptom data is processed so as to produce the type of damage that occurs on PC computer hardware. After knowing the type of damage, the system provides alternative advice and solutions in handling the type of damage that occurs.

c. In addition to being able to provide information on the damage that occurs on PC computer hardware based on existing symptoms, the system also provides alternative solutions to overcome the problem, which in this case certainly helps the user or user in handling damage so that it saves time.

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