Comparison of CPU Damage Prediction Accuracy Between Certainty Factor and Forward Chaining Techniques

Perbandingan Akurasi Prediksi Kerusakan CPU Antara Teknik Certainty Factor dan Forward Chaining

Tri Ginanjar Laksana[1)]*, Ade Rahmat Iskandar[2)], Wan Nooraishya Wan Ahmad[3)]

[1] Computer of Science Departement, Bhayangkara Jakarta Raya University
[2] Information System Departement, Telkom University Jakarta
[3] Computing and Informatics Departement, Malaysia Sabah Universty (UMS)

[1]Jl. Harsono RM No.67, Ragunan, Ps. Minggu, Kota Jakarta Selatan, Daerah Khusus Ibukota Jakarta 12550, Indonesia
[2]Jl. Raya Daan Mogot No.KM. 11 1, RT.12/RW.4, Kedaung Kali Angke, Kecamatan Cengkareng, Kota Jakarta Barat, Daerah Khusus Ibukota Jakarta 11710, Indonesia
[3]Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia

tri.ginanjar.laksana@dsn.ubharajaya.ac.id

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Abstract *– CPU plays a vital role in determining the performance of a computer system in contemporary computing. If the CPU sustains damage, it may result in significant interruption to the computer's functioning. This study presents a computational technique that aims to enhance the accuracy of CPU damage predictions. The system utilizes fundamental knowledge of damage diagnosis and is validated by evaluating 11 early damage symptoms that are often seen. The Certainty Factor and Forward Chaining approaches ascertain CPU damage by quantifying the degree of truth in the expert's opinion conclusions by comparing the harm symptoms. The second algorithm assesses the confidence level in a development by considering the value assigned to the system by two parties: the user and the expert. The suggested algorithm yields the mean accuracy of the certainty factor approach in diagnosing computer damage utilizing the constructed system. The diagnostic system has a precision rate of 84.9%, indicating that 9 out of 10 diagnoses made by the system align with those made by an expert. Next the outcomes of the Forward Chaining algorithm test. All questions about symptoms were answered affirmatively, except for one test which had a negative response. A total of 39 diagnoses were obtained, with an average value of 82.9%. The study findings indicate that the suggested Certainty Factor method is more suited for use in embedded systems or web-based applications, however it is constrained by low processing.*

Keywords: *Comparison, Prediction, Damage, CPU, Centainty Factor, Forward Chaining.*

Abstrak – CPU memainkan peran penting dalam menentukan kinerja sistem komputer dalam komputasi kontemporer. Jika CPU mengalami kerusakan, hal ini dapat mengakibatkan gangguan signifikan pada fungsi komputer. Penelitian ini menyajikan teknik komputasi yang bertujuan untuk meningkatkan akurasi prediksi kerusakan CPU. Sistem ini memanfaatkan pengetahuan dasar diagnosis kerusakan dan divalidasi melalui evaluasi 11 gejala awal kerusakan yang sering terlihat. Pendekatan Certainty Factor dan Forward Chaining memastikan kerusakan CPU dengan mengukur tingkat kebenaran kesimpulan pendapat ahli melalui perbandingan gejala kerusakan. Algoritma kedua menilai tingkat kepercayaan dalam suatu pengembangan dengan mempertimbangkan bobot yang diberikan pada sistem oleh dua pihak: pengguna dan ahli. Algoritma yang disarankan menghasilkan akurasi rata-rata pendekatan Certainty Factor dalam mendiagnosis kerusakan komputer menggunakan sistem yang dibangun. Sistem diagnostik memiliki tingkat presisi sebesar 84,9%, yang menunjukkan bahwa 9 dari 10 diagnosis yang dibuat oleh sistem selaras dengan diagnosis yang dibuat oleh pakar. Selanjutnya hasil pengujian algoritma Forward Chaining. Semua pertanyaan tentang gejala dijawab dengan positif, kecuali satu tes yang memberikan respon negatif. Didapatkan total 39 diagnosa dengan nilai rata-rata 82,9%. Temuan penelitian menunjukkan bahwa metode Certainty Factor yang disarankan lebih cocok untuk digunakan dalam sistem tertanam atau aplikasi berbasis web, namun terkendala oleh rendahnya pemrosesan.

Kata Kunci: Perbandingan, Prediksi, Kerusakan, CPU, Certainty Factor, Forward Chaining.

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INTRODUCTION

Computers have become an integral component of daily life in order to stay abreast of the advancements in the field of information technology (Awad, 2021), (S. Khan, 2022). The level of computer use is negatively correlated with the user's familiarity with IT technology matters (Gou, 2021), (Roh, 2021). CPU damage scenarios need the intervention of skilled specialists who can resolve issues using their specialized expertise (Shahbazian, 2022).

The CPU is a crucial element in determining the overall performance of a system (Putro, 2022), (Plancher, 2021), (Ghasemi, 2021). If the CPU sustains damage, it may lead to significant interruption in the functioning of the computer (Mittal, 2022). Enhancing the capacity to anticipate CPU breakdowns is crucial for early detection and resolution of issues before they escalate.

Enhanced projections enable more effective execution of repairs and maintenance. Improved projections enable more effective execution of repairs and maintenance (Ghadikolaei, 2023). By preemptively detecting possible harm, we may proactively implement the essential measures to guarantee the CPU's optimum functioning (Hirata, 2021). CPU damage can cause slow system performance, frequent crashes, freezes, or even total system failure. In some cases, CPU damage can cause irrecoverable data loss (Chinnam, 2022).

Presently, professionals have significant delays in resolving issues that arise on consumers' computer systems. (Zhao, 2022). A software-based expert system was developed for the purpose of resolving instances of computer hardware failure in this study. This software-based expert system enhances the efficiency of personnel in diagnosing computer hardware faults by providing more accurate and expedited solutions, resulting in time savings. The software used is a web-based expert system programme developed by specialists in the domain of diagnosing and resolving issues related to computer hardware (S. A. Khan, 2021).

Expert Systems are a subdivision of artificial intelligence (Rogulj, 2021). An expert system is a computer system designed to use human knowledge in order to solve issues in a manner consistent with that of an expert (Issa, 2022). A sound expert system is designed to solve a specific problem by imitating the work of a professional (S. A. Khan, 2021). Various proficient systems or machine learning algorithms, such as AHP (Analytic Hierarchical Process), have been used for the purpose of forecasting or evaluating damage (Li, 2021), (Pagano, 2021), (Zhu, 2022), Fuzzy MCDM (Büyüközkan, 2021), (Sathyan, 2023), (Boyacı, 2022), Topsis Algorithm (Çalık, 2021), (Roy, 2023), (Khatari, 2021), and Fuzzy AHP (Unal, 2022), (Goyal, 2021), (Younes, 2022). These strategies depend on a pre-training procedure and need adaptive learning skills in order to optimize the prediction of CPU crashes.

Forward Chaining is a method that may enhance the accuracy of predicting CPU breakdown (Garcia, 2021), (Aisa, 2021), (Hafizal, 2022). This methodology uses logical principles to establish connections between established data and to develop novel inferences or forecasts based on such information. Forward Chaining is a method that may be used to detect certain patterns or symptoms that suggest potential harm (Messing, 2021). Through the use of this methodology, we may enhance our comprehension of the CPU's well-being and detect prospective issues in advance of their escalation. Additionally, forward chaining helps us to uncover patterns and symptoms that may not be immediately obvious (Naryanto, 2022). By using logical criteria and linking established data, we may enhance the precision of our forecasts about CPU breakdown. This enables us to implement suitable measures and mitigates the likelihood of more profound harm.

Certainty Factor in CPU predictions plays a vital role in assessing the level of certainty of the predictions made (Fitri, 2023), (Satria, 2022). The Certainty Factor is expressed as a number between -1 and 1, where -1 indicates complete disbelief, and 1 indicates complete confidence in the prediction (Fajriani, 2023). Certainty Factors may be derived by several methodologies, including statistical analysis, machine learning, or prior expertise (Putri, 2021). The Certainty Factor enables the CPU to make more intelligent judgment by considering the confidence level in its forecasts. For instance, consider a scenario where an instruction has a diminished Certainty Factor. Under such circumstances, the central processing unit (CPU) may choose to abstain from predicting the command and instead await a more foreseeable instruction that carries a greater degree of certainty.

The proposed research aims to enhance the prediction of CPU damage by comparing the accuracy of Certainty Factor and Forward Chaining techniques. This is important for improving repair time efficiency, reducing dependence on technicians, and minimizing costs resulting from inaccurate predictions.

RESEARCH METHOD

This part provides a comprehensive overview of the research process, starting with a detailed description of data gathering methods for making predictions. It also discusses the methodology used and the instruments utilized in carrying out the study. The used techniques include expert interviews, literature selection, and data analysis using Forward Chaining algorithms and Factor Certainty algorithms. The data collecting process is followed by the creation of decision tables, rule construction, and decision tree generation. Next, the process of system design is conducted, followed by system implementation, and the evaluation of the used algorithm. In this research, the labeling process was carried out by means of discussions and interviews regarding damage and handling methods based on the experience of senior CPU technicians (experts) at the company. There are 3 senior technicians who handle repairs to damaged CPUs. If there are inconsistencies in the improvement suggestions then the prediction accuracy is low.

a. Material

The research involved gathering data through expert interviews using the CPU technique. The collected data consisted of symptoms and diagnosis results, which were then assigned MB (Measure of Belief) and MD (Measure of Disbelief) values to quantify the level of confidence. A specialist in the symptoms that prompted the diagnosis. Calculating the difference between the MB and MD values would get the CF (Certainty Factor) result. The CF value is derived from the expert's interpretation of the "term" using the approach of expert interviewing. This interpretation is then turned into a particular CF value based on the table provided.

Table 1 Certainty factor value

Uncertain Term	CF Value
Definitely not	-1.0
Almost certainly not	-0.8
Probability not	-0.6
Maybe not	-0.4
Unknown	-0.2 to 0.2
Maybe	0.4
Probably	0.6
Almost certainly	0.8
Definitely	1.0

The table below displays the data in the knowledge base.

Table 2 Certainty Factor value

No	Prediction	Manifestation	MB	MD
1	*Power Supply*	*The computer is completely dead*	*0.9*	*0.1*
2	*Power Supply*	*Unstable power supply voltage*	*0.8*	*0.2*
3	*Power Supply*	*The computer turns on but does not boot*	*0.9*	*0.1*
4	*Power Supply*	*With a multi tester, the power supply's red and black cables are below the PS voltage capacity (12 or 5 Volts)*	*0.8*	*0.2*
5	*Power Supply*	*The computer suddenly shuts down after turning it on*	*0.8*	*0.2*
6	*Power Supply*	*Computer crashes (hangs)*	*0.6*	*0.4*
7	*Power Supply*	*Power Supply lacks power*	*0.8*	*0.2*
8	*Motherboard*	*The computer is completely dead*	*0.9*	*0.1*
9	*Motherboard*	*The computer turns on but does not boot*	*0.9*	*0.1*
Etc.				

Tools

The study used a Core i5-6410M laptop with 8 GB of RAM to address the issue of memory speed in prediction-making. In order to execute Collaborative Filtering (CF) and Content Filtering (FC), a pair of computers is used. The first computer is equipped with an Athlon processor, while the second computer is equipped with a Data Process processor. The specs for both the hardware and software are as follows:

A. Hardware for pre-processing
   1. One Laptop: 3,5 GHz Intel Core i5-6410M
   2. Memory: 8 GB DDR2
   3. OS: Windows 7.0 Ultimate
   4. Hard Disk: 500 GB

B. Hardware for Prediction
   1. Two Computers: Intel Core i3 - 6.4 GHz.
   2. Memory: 4 GB DDR3
   3. OS: Windows 10 Profesional
   4. Hard Disk: 200 GB

C. Software
   1. Php My Admin
   2. Web Builder Visual (Wysiwyg editor)
   3. Dreamweaver
   4. PageBreeze
   5. Bluefish Editor

Fundamental Ideas

Each part provides concise explanations of all fundamental ideas. This approach is grounded on basic ideas that have been specifically devised to fulfil research aims.

Data Rules

Data rules contain tracking of symptoms that have been obtained from experts to produce diagnosis results and treatment solutions. This search uses “yes” and “no” conditions to search for symptoms. Data on regulations can be seen in the following table :

Table 3 Rules Data

No.	Rules	Diagnosis Code	Solution Code
1	IF G01 AND G02 AND G08	D03	S03
2	IF G01 AND G08	D03	S03

3	IF G01 AND G03	D01	S01
4	IF G01 AND G02	D03	S03
5	IF G01	D02	S02
6	IF G04 AND G09 AND G13	D05	S02
7	IF G04 AND G06 AND G07	D03	S03
8	IF G04 AND G09 AND G13	D05	S08
9	IF G04 AND G05	D04	S04
10	IF G04 AND G06	D03	S05
11	IF G04 AND G07	D03	S06
12	IF G04 AND G08	D01	S07
13	IF G04 AND G10	D06	S09

Analysis of the Forward Chaining Method

Based on the rules in the table, steps will be made to prepare an inference motor that will search the information contained in knowledge and form conclusions. The preparation of the inference motor in this expert system uses the Forward Chaining method. The decision tree from the search can be seen in Figure 1 below:

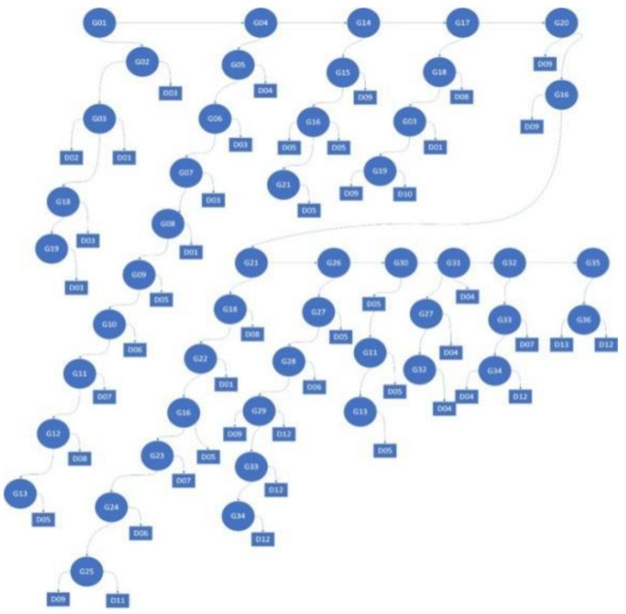

Figure 1 Decision Tree

The following is an example of a tracing process using the Forward Chaining method :

1. Internet cafe operators conduct consultations using this system, and the symptoms selected are as follows:
   - Computer completely shut down (G01) : SELECT
   - Power cable connection to Power Supply is not installed properly (G02): NOT SELECTED
   - Unstable mains voltage (G03) : SELECT

   IF G01 AND G03 THEN D01 (there is a problem with the power supply) will be obtained . In other conditions, you can use the following example:
   - Computer completely shut down (G01) : SELECT
   - Power cable connection to Power Supply is not installed properly (G02): NOT SELECTED
   - Unstable mains voltage (G03) : NOT SELECTED

   IF G01 **THEN D02** will be obtained (there are general problems such as wiring problems).

   With all conditions selected, you can see the following example:
   - Computer completely shut down **(G01) : SELECT**

   Power cable connection to Power Supply is not installed properly **(G02): SELECT**, stable mains voltage **(G03) : SELECT**

   So, based on the decision tree that has been created, you will get the rule IF **G01 AND G02 AND G03** THEN **D03** (there is a problem with the power supply).

2. Internet cafe operators conduct consultations using this system, and the symptoms selected are as follows:
   - Computer is on but not booting (G04): SELECT power light is off even though the power button has been pressed (G05): NOT SELECTED
   - Power cable connection and VGA cable not installed properly (G06): NOT SELECTED
   - Bent or broken VGA connector cable pin (G07) : SELECT With a multi tester , the red and black cables of the power supply have a voltage below the PS voltage capacity (12 or 5 Volts) (G08): NOT SELECTED
   - There is a message " DISK BOOT FAILURE " or something similar (G09): SELECTED
   - Repeated and long beeps are heard (G10): SELECTED
   - 1 or 2 beeps are heard (G11): NOT SELECTED
   - Processor overheat (G12) : SELECT
   - Hard disk or Windows Corrupt (G13) : NOT SELECTED

   So, based on the decision tree that has been created, the following rules will be obtained:

IF G04 AND G07 THEN D03
IF G04 AND G09 THEN D05,
IF G04 AND G10 THEN D06,
IF G04 AND G12 THEN D08.

Because there are four rules that occur, the diagnosis results are four problems. Possible diagnosis results obtained are general problems, hard disk problems, RAM problems, and processor problems.

Certainty Factor Method

Based on the Knowledge Base in Table 4 and Forward method analysis Chaining to sub-chapter 4.1, the next step is to calculate the percentage truth value of the diagnosis results based on an expert's belief using the Certainty Factor method. The following is an example of calculating the Certainty Factor method:

For initial symptoms of "Computer Totally Dead (G01)"

The conditions tested for calculation are all symptoms related to this initial symptom which will be selected by the Internet Cafe Operator. The rules contained in this symptom are as follows:

Table 4 G01 Symptom Rules

No.	Rules	Diagnosis Results	Handling Solutions
1	IF G01 AND G02 AND G03	D02	S02

The next step is to calculate each percentage of diagnosis results. Here are the calculations:

Diagnosis Result: D03 (common problem)

Step 1 : Take a knowledge base related to diagnosis results and symptoms.

Table 5 D03 Common Problem

Symptom	Expert CF (MB – MD)	User CF
G01	0.6 – 0.4 = 0.2	1
G02	0.9 – 0.1 = 0.8	1
G03	0.8 – 0.2 = 0.6	1

Step 2: calculate the CF value of each symptom from the diagnosis results. Calculate the CF value of each symptom from the diagnosis results.

$$CF\ (G01) = CF\ Expert \times CF\ User$$
$$CF\ (G01) = 0{,}2\ \times 1 = \mathbf{0{,}2}$$
$$CF\ (G02) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G02) = 0{,}8\ \times 1 = \mathbf{0{,}8}$$
$$CF\ (G03) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G03) = 0{,}6\ \times 1 = \mathbf{0{,}6}$$

Step 3: Calculate the CF value from the diagnosis results and the percentage value.

$$CF_{COMBINE}(CF_1, CF_2) = CF(G01) + \left(CF(G02) \times \left(1 - CF(G01)\right)\right)$$
$$= 0{,}2 + (0{,}8\ \times (1 - 0{,}4))$$
$$= 0{,}2 + (0{,}8\ \times 0{,}4)$$
$$= 0{,}2 + 0{,}32$$
$$= 0{,}52$$
$$CF_{COMBINE}(CF_{0ld}, CF_3) = CF(OLD) + \left(CF(G03) \times \left(1 - CF(OLD)\right)\right)$$
$$= 0{,}52 + (0{,}6\ \times (1 - 0{,}52))$$
$$= 0{,}52 + (0{,}6\ \times 0{,}48)$$
$$= 0{,}52 + 0{,}288$$
$$= 0{,}72$$
$$CF(D03) = 0{,}72 => \%\ = 0{,}72\ \times 100\% = \mathbf{72}\%$$

So the percentage value of *the certainty factor* for problem diagnosis in *the power supply* (D01) is 72%.

For the initial symptom "Computer turns on but does not *boot* (G04)"

The conditions tested for calculation are all symptoms related to this initial symptom which will be selected by the internet cafe operator. The rules contained in this symptom are as follows:

Table 6 Symptom Rules G04

No.	Rules	Diagnosis Results	Handling Solutions
1	IF G04 AND G05	D04	S04
2	IF G04 AND G06	D03	S05
3	IF G04 AND G07	D03	S06
4	IF G04 AND G08	D01	S07
5	IF G04 AND G09	D05	S08
6	IF G04 AND G10	D06	S09
7	IF G04 AND G11	D07	S10
8	IF G04 AND G12	D08	S11
9	IF G04 AND G13	D05	S12

The next step is to calculate each percentage of diagnosis results. Here are the calculations:

Diagnosis results: D04 (monitor problem)

Step 1: Take a knowledge base related to diagnosis results and symptoms.

Table 7 D04 (monitor problem)

Symptom	Expert CF (MB – MD)	User CF
G04	0.7 – 0.3 = 0.4	1
G05	0.8 – 0.2 = 0.6	1

Step 2: Calculate the CF value of each symptom from the diagnosis results. Calculate the CF value of each symptom from the diagnosis results

$$CF\ (G04) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G04) = 0{,}4\ \times 1 = \mathbf{0{,}4}$$

$$CF\ (G05) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G05) = 0{,}6\ \times 1 = \mathbf{0,6}$$

Step 3: Calculate the CF value from the diagnosis results and the percentage value.

$$CF(D04) = CF(G04) + \left(CF(G05) \times \left(1 - CF(G04)\right)\right)$$
$$= 0{,}4 + (0{,}6\ \times (1 - 0{,}4))$$
$$= 0{,}4 + (0{,}6\ \times 0{,}6)$$
$$= 0{,}4 + 0{,}36$$
$$CF(D04) = 0{,}76 => Persentase = 0{,}76\ \times 100\% = \mathbf{76}\%$$

Diagnosis results: D03 (common problems)

Rules for symptoms G04 and G06

Step 1: Take a knowledge base related to diagnosis results and symptoms.

Table 8 D03 (common problems)

Symptom	Expert CF (MB – MD)	User CF
G04	0.7 – 0.3 = 0.4	1
G06	0.9 – 0.1 = 0.8	1

Step 2: calculate the CF value of each symptom from the diagnosis results.

$$CF\ (G04) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G04) = 0{,}4\ \times 1 = \mathbf{0,4}$$
$$CF\ (G06) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G06) = 0{,}8\ \times 1 = \mathbf{0,8}$$

Step 3: Calculate the CF value from the diagnosis results and the percentage value.

$$CF(D03) = CF(G04) + \left(CF(G06) \times \left(1 - CF(G04)\right)\right)$$
$$= 0{,}4 + (0{,}8\ \times (1 - 0{,}4))$$
$$= 0{,}4 + (0{,}8\ \times 0{,}6)$$
$$= 0{,}4 + 0{,}48$$
$$CF(D03) = 0{,}88 => Persentase = 0{,}88\ \times 100\% = \mathbf{88}\%$$

Rules for symptoms G04 and G07

Step 1: Take a knowledge base related to diagnosis results and symptoms.

Table 9 symptoms G04 and G07

Symptom	Expert CF (MB – MD)	User CF
G04	0.7 – 0.3 = 0.4	1
G07	0.8 – 0.2 = 0.6	1

Step 2: calculate the CF value of each symptom from the diagnosis results.

$$CF\ (G04) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G04) = 0{,}4\ \times 1 = \mathbf{0,4}$$
$$CF\ (G07) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G06) = 0{,}6\ \times 1 = \mathbf{0,6}$$

Step 3: Calculate the CF value from the diagnosis results and the percentage value.

$$CF(D03) = CF(G04) + \left(CF(G07) \times \left(1 - CF(G04)\right)\right)$$
$$= 0{,}4 + (0{,}6\ \times (1 - 0{,}4))$$
$$= 0{,}4 + (0{,}6\ \times 0{,}6)$$
$$= 0{,}4 + 0{,}36$$
$$CF(D03) = 0{,}76 => Persentase = 0{,}76\ \times 100\% = \mathbf{76}\%$$

Diagnosis result: D01 (problem with *power supply*)

Step 1: Take a knowledge base related to diagnosis results and symptoms.

Table 10 D01 (problem with power supply)

Symptom	Expert CF (MB – MD)	User CF
G04	0.9 – 0.1 = 0.8	1
G08	0.8 – 0.2 = 0.6	1

Step 2: calculate the CF value of each symptom from the diagnosis results.

$$CF\ (G04) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G04) = 0{,}8\ \times 1 = \mathbf{0,8}$$
$$CF\ (G08) = CF\ Pakar \times CF\ Pengguna$$
$$CF\ (G08) = 0{,}6\ \times 1 = \mathbf{0,6}$$

RESULTS AND DISCUSSION

Test Results for Certainty Factor Values in Applications

This research uses the *Certainty Factor* method to determine the certainty value of the results of a computer damage diagnosis. The following are several samples of symptom consultation trials and diagnosis results :

Table 11 Certainty Factor Test Results

Initial Symptoms	Selected symptoms 1	Selected symptoms 2	Diagnosis	CF Percentage
The computer is completely dead	The power cable connection to the power supply is not installed properly	There isn't any	Common Problems	92%
	Unstable power supply voltage	With a multi tester, the power supply's red and	Power Supplies	72%

Initial Symptoms	Selected symptoms 1	Selected symptoms 2	Diagnosis	CF Percentage
		black cables are below the PS voltage capacity (12 or 5 Volts)		
		There isn't any	Common Problems	86%
	There isn't any	There isn't any	Mother-boards	84%
	The monitor power light is off even though the power button has been pressed	There isn't any	Monitors	76%
	The monitor power cable connection and VGA cable are not installed properly	The VGA connector cable pin is bent or broken	Common Problems	95.2%
		There isn't any	Common Problems	92%
	The VGA connector cable pin is bent or broken	There isn't any	Common Problems	76%
The computer turns on but does not boot	With a multi tester - the power supply's red and black cables are below the power supply's voltage capacity (12 or 5 volts)	There isn't any	Power Supplies	92%
	There is a message DISK BOOT FAILURE or something similar	Hard disk or Windows Corrupt	Hard disk	96.8%
		There isn't any	Hard disk	92%
	There were repeated and long beeps	There isn't any	RAM	92%
	You hear 1 or 2 beeps	There isn't any	VGA Card	92%
	Processor overheating	There isn't any	Processor	76%
	Hard disk or Windows Corrupt	There isn't any	Hard disk	84%
	There isn't any	There isn't any	Motherboards	80%
The computer boots but always goes into safe mode	Operating System Problem	There isn't any	Operating system	92%
	Hard disk capacity low space / data on the hard disk is fragmented / hard disk bad sectors	There isn't any	Hard disk	92%
	There isn't any	There isn't any	Hard disk	60%
The computer suddenly shuts down after turning it on	CPU is too hot/overheating	There isn't any	Processor	76%
	Unstable power supply voltage	There isn't any	Power Supplies	84%
	There is a problem with other hardware	There isn't any	Other Hardware	92%
	There isn't any	There isn't any	Operating system	20%
The computer turns on but only enters BIOS settings	There isn't any	There isn't any	Operating system	80%
Computer crashes (hangs)	CPU is too hot/overheating	There isn't any	Processor	92%
	Power Supply lacks power	There isn't any	Power Supplies	68%

Initial Symptoms	Selected symptoms 1	Selected symptoms 2	Diagnosis	CF Percentage
The computer experiences blue screen windows	Hard disk capacity low space / data on the hard disk is fragmented / hard disk bad sectors	There isn't any	Hard disk	88%
		CPU is too hot/overheating	Hard disk	95.2%
	The heatsink on the VGA Card is experiencing unusual heat	There isn't any	VGA Card	76%
	2 RAM installed and only 1 read or the RAM used is not identical	There isn't any	RAM	76%
	It feels heavy when accessing data from another computer	There isn't any	LAN	92%
	There isn't any	There isn't any	Operating system	60%
	A blue screen of death appears with a message in the storage section	The pins on the VGA Card are dirty	Hard disk	92%
		There isn't any	Hard disk	92%
	There is a RAM sector that has a physical defect	There isn't any	RAM	80%
	There is a problematic driver	VGA driver has not been updated	Drivers	92%
		There isn't any	Drivers	92%
	There isn't any	There isn't any	Operating system	60%
There was a strange sound from the hard disk	You hear 1 or 2 beeps	Hard disk or Windows Corrupt	Hard disk	80%
	Hard disk or Windows Corrupt	There isn't any	Hard disk	92%
	There isn't any	There isn't any	Hard disk	80%
Monitor flashes during use	A blue screen of death appears with a message in the storage section	There are lines on the monitor	Monitors	97.6%
		There isn't any	Montor	96%
	There isn't any	There isn't any	Monitors	90%
There are lines on the monitor	The pins on the VGA Card are dirty	There isn't any	VGA Card	84%
	VGA driver has not been updated	There isn't any	Drivers	68%
	There isn't any	There isn't any	Monitors	40%
All USB ports are not working	The hardware driver attached to the USB port has not been updated/installed	There isn't any	Drivers	76%
	There isn't any	There isn't any	USB ports	60%

Based on Table 11, the average percentage of diagnosis results from this application using the *Certainty Factor* method is 84.9%.

3.2 Comparison of System Diagnosis Results with Expert Diagnosis Results

To determine the level of accuracy of the system, system testing is carried out. The system testing results are compared with the diagnosis results of computer experts/technicians at the Jafar.net Internet Cafe.

Table 12 Comparison of System Output with Expert Testing

Initial Symptoms	Selected Symptoms 1	Selected Symptoms 2	System Diagnosis	Expert Diagnosis
The computer is completely dead	The power cable connection to the power supply is not installed properly	There isn't any	Common Problems	Common Problems
	Unstable power supply voltage	With a multi tester, the power supply's red and black cables are below the PS voltage capacity (12 or 5 Volts)	Power Supply	Power Supply
		There isn't any	Common Problems	Common Problems
The computer suddenly shuts down after turning it on	There isn't any	There isn't any	Motherboards	Motherboards
	CPU is too hot/overheating	There isn't any	Processor	Processor
	Unstable power supply voltage	There isn't any	Power Supplies	Power Supplies
	There is a problem with other hardware	There isn't any	Other Hardware	Other Hardware
	There isn't any	There isn't any	Operating system	Power Supplies

Out of the ten diagnostic data produced by the system, nine data correspond to or align with the findings of computer experts or technicians at the Jafar.net Internet Cafe. Therefore, the degree of system precision is completely precise.

CONCLUSION

The monitoring findings indicate that the diagnostic system has a precision level of 84.9%, meaning that 9 out of 10 diagnoses produced by the system are consistent with those provided by an expert. The following are the outcomes obtained from conducting tests on the Forward Chaining method. All inquiries about symptoms were affirmed, with the exception of one examination that yielded a negative result. A total of thirty-nine diagnoses were acquired, with an average value of 82.9%. This web-based Expert System application utilizes symptom analysis to diagnose computer damage and offers conclusions and solutions for efficient and cost-effective resolution of computer issues, thereby facilitating companies in addressing computer damage problems. Research limitations are not yet optimal in the data collection process to form a decision matrix, which can be influenced by perceptions and subjective assessments of CPU improvement suggestions. Further research might carry out further developments by comparing or collaborating with other methods for handling uncertainty that enable better representation of uncertainty in decision values.

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