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Dempster Shafer for Computer Malfunction Detection System

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A R T I C L E I N F O	ABSTRACT
	Computers have helped humans work better and help in solving problems. Computers continued to evolve and innovation continued, starting with the first very large computers and evolving into the modern, commonly used desktops. When there is a problem with the computer device, such as damage to the computer components. Most people immediately take it to a computer repair service technician. An expert system is a component of artificial intelligence. In order for computers to solve issues in the same way that professionals do, expert systems attempt to incorporate human knowledge into computers. A single technique inside the expert system is the Dempster Shafer technique. The Dempster-Shafer technique is a mathematically based approach that incorporates uncertainty and features traits of expert thought. The research was carried out by detecting computer damage based on the sound that comes out when the BIOS performs a POST (Power On Self-Test) using the Dempster-Shafer method. Users can determine the kind of damage their machine has sustained without having to visit a computer repair service provider directly by using the Dempster Shafer approach.
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INTRODUCTION

There are many changes in all fields as a result of technological developments which continue to grow rapidly. This change can help humans because work that was previously done manually is now done with a computerized system. The use of computers or the internet as a tool to facilitate human work.

Computers have helped humans work better and help in solving problems. Computers continued to evolve and innovation continued, starting with the first very large computers and evolving into the modern, commonly used desktops.

Computers consist of three components, namely: (1) hardware such as processor, hard disk, RAM, CPU, and motherboard, (2) software such as applications and operating systems, and (3) brainware which functions to regulate how the computer system works. Accordingly, a

computer is an electronic device that can process, receive, and create various types of information, including text, voice, pictures, and video [1].

When there is a problem with the computer device, such as damage to the computer components. Most people immediately take it to a computer repair service technician. Because it requires special expertise to find out what damage has occurred and how to repair the computer damage [2]. It costs a lot of money to carry out repairs from a computer repair service.

The field of artificial intelligence can provide convenience for humans. In the study of computer science, artificial intelligence focuses on building computer systems with traits and intellect similar to those of humans [3]. Expert systems comprise a subset of artificial intelligence. To enable computers to solve issues like professionals typically do, expert systems attempt to incorporate human knowledge into computers [4].

Expert systems can help people who don't understand computer damage. This system diagnoses computer damage. Problems with computer components can be detected by the sound that comes out of the speakers when the BIOS performs a POST (Power On Self-Test) [5]. The sound varies depending on the problem. Users of computers can more easily recognize damage that has happened when detection is done by sound.

Dempster Shafer technique is one of the expert system's methods. Combining uncertainty and expert thought traits with a mathematical foundation is the Dempster-Shafer technique [6]. The system's queries and the user's responses to them are two of the elements that lead to uncertainty in the findings. The end result will be a wide range of potential diagnoses. High confidence is demonstrated by the Dempster-Shafer clinical parameter value [7].

The Dempster-Shafer method is one of the expert system techniques that the author is interested in using in his research to identify computer damage based on the sound produced during a POST (Power On Self-Test) by the BIOS.

METHODS
Data Collection
The author used the following method to collect data in this research, namely:

1. Observation
    The author made direct observations of users and providers of computer repair services. This was done to find out people's difficulties in diagnosing computer damage [8].
2. Interview
    Interviews were conducted with electrical engineering lecturers to find out ways that could be done before the computer was decided to be repaired by an expert.
3. Literature review
    The author collects references such as books, e-books, and journals to obtain theories related to the objectives of this research.

Dempster-Shafer method
Mathematical theory based on plausible reasoning and belief functions is known as the Dempster-Shafer method. Based on two concepts, this theory computes the probability of an event happening by adding disparate pieces of information (evidence) and determining degrees of confidence from several options [9].

With the Dempster-Shafer technique, the steps are as follows [10]:

1. Apply the belief value to determine the plausibility value. To calculate the plausibility value, use the formula below:

$$P_1(\theta) = 1 - Bel$$

2. Determine the Dempster-Shafer value using the following formula:

$$m_3 Z = \frac{\sum_{X \cap Y = Z} m_1(X) \cdot m_2(Y)}{1 - \sum_{X \cap Y \emptyset Z} m_1(X) \cdot m_2(Y)}$$

RESULTS AND DISCUSSION
Analysis of Types of Computer Damage
The author limits the problem to detecting computer damage through sounds/beeps only. Based on the results of data collection related to computer damage detection based on sounds (beep). These data can be seen in the table below:

Table 1. Diagnosis Based on Sounds (Beep)

Damage Diagnosis Based on Beep	Problem
1x long continuous beep	RAM and VGA damage
Beep 1x long, 1x short	RAM damage and motherboard damage
2x short beep	RAM damage
Beep 1-3-1	RAM damage
Beep 1-3-4-1	RAM damage
Beep 1-4-1-1	RAM damage
Repeated short beeps	Damage to RAM, VGA, and Power Supply
Continuous beeping	Damage to Power Supply and RAM
Beep 1x long, 2x short	VGA damage
1x long beep, 3x short	VGA and Keyboard damage
Beep 1 time	VGA damage
Beeps 3-3-4	VGA damage

Based on the results from Table 1, data on types of damage is grouped into 5 types identified through sounds (beep), namely:
a. RAM damage
b. VGA damage
c. Power Supply Damage
d. Motherboard damage
e. Keyboard Damage

Dempster-Shafer Calculation
Furthermore, the data from the results of the previous analysis can be created into an expert knowledge base. The knowledge base consists of two forms of approach, namely rule-based reasoning and case-based reasoning [10]. In this research, the author created a rule-based knowledge base.

Dempster-Shafer's calculation to determine the type of computer damage based on the symptoms heard through sounds/beeps. Table 2 shows the symptoms of each type of computer damage with belief values.

Table 2. Belief Value of Computer Damage Symptoms

Damage Type Code	Damage Type	Symptom	Belief Values
P1	RAM damage	Continuous beeping	0.3
		Repeated short beeps	0.3
		Beep 1-4-1-1	0.3
		Beep 1-3-4-1	0.3
		Beep 1-3-1	0.85
		2x short beep	0.7
		Beep 1x long, 1x short	0.6
		1x long continuous beep	0.3
P2	VGA card damage	8 short beeps	0.85
		Beeps 3-3-4	0.6
		Beep 1 time	0.3
		1x long beep, 3x short	0.7
		Beep 1x long, 2x short	0.4
		Repeated short beeps	0.3
		1x long continuous beep	0.3
P3	Power Supply Damage	No beeps	0.3
		Continuous beeping	0.85
		Repeated short beeps	0.7
P4	Motherboard damage	7 short beeps	0.4
		11 short beeps	0.6
		10 short beeps	0.85
		9x short beep	0.8
		4x short beep	0.6
		Beep 3-1-1	0.3
		Beep 1-2-1	0.3
		Beep 1x long, 1x short	0.3
P5		6x short beep	0.85

Keyboard Damage	3 x long beeps	0.7
	Beep 1-3-1-3	0.3
	1x long beep, 3x short	0.4

Dempster-Shafer value calculation is according to the equation or formula explained in the previous chapter and applied to an example below with manual calculation of one of the symptoms of computer damage based on sounds (beep).

Example 1: A computer that is damaged has 9 short beeps and 1 long beep, 2 short beeps. The results of the types of damage based on symptoms and plausibility values are shown in table 3 below:

Table 3. Results Of The Type Of Damage Based On Symptoms And Plausibility Value

Symptom	Damage Type	Belief Values	Plausibility
9x short beep	P4	0.8	0.2
Beep 1x Long, 2x short	P2	0.4	0.6

The existence of new symptoms requires calculating new belief values for several combinations (m_3), to make the calculation easier, first, the subsets formed are brought to the form of Table 4 below:

Table 4. New Belief Value

	m_2 {P2} 0,4	m_2 {θ} 0,6
m_1 {P4} 0,8	{P2,P4} 0,32	{P4} 0,48
m_1 {θ} 0,2	{P2} 0,8	{θ} 0,12

Next, the new belief value (m_3) can be calculated using the Dempster-Shafer method formula:

$$m_3 \{P2,P4\} = \frac{0,32}{1-0,12} = 0,36$$

$$m_3 \{P2\} = \frac{0,8}{1-0,18} = 0,91$$

$$m_3 \{P4\} = \frac{0,48}{1-0,18} = 0,55$$

Based on the symptoms that appear in the example above, the new belief value (m_3) is largest in P2 with a value of 0.98 x 100% = 98%. Where P2 is a type of VGA Card damage.

Implementation Of Results
The final stage of this research was to develop a computer damage detection system based on beeps using the Dempster-Shafer method. The display for selecting the symptoms of computer damage experienced by the user can be seen in figure 1 below.

Figure 1. Display Symptoms of Computer Damage

After the user clicks on 'Damage Diagnosis Process', this system will provide the results of the type of damage from calculations using the Dempster-Shafer method and solutions for handling that type of damage. As seen in Figure 2 below.

Figure 2. Display Result

CONCLUSION

The Dempster Shafer method can help system users carry out early detection of computer damage based on beeps so that they know the type of damage experienced by the computer without meeting directly with the computer repair service provider. The detection system provides suggestions for improvements that should be made by users who utilize this system.

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