

Analysis of Home Appliances Functional Failure on Certainty Factor-Based Engineering ACS

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Abstract

Technological developments are currently experiencing very rapid changes along with human needs that are increasingly numerous and complex. Not only in the fields of health, education, agriculture, and so forth. However, the electronics industry has also been affected by the development of this technology. The production of household electronic devices or home appliances that combine sophistication of technology and modern designs has emerged and is much in demand by the public, one of which is the refrigerator. Even with the development of this technology, it does not mean that the refrigerator can function properly forever if it is used continuously. Because the refrigerator requires maintenance and repair if there is damage. In diagnosing damage to a 2-door no frost home appliances refrigerator, limitations in information, knowledge, and experience from the public and technicians cause delays in recognizing the damage that has occurred, which also affects decision-making in handling it. Then a system will be formed using an expert system computer program with the *Certainty Factor method*. The *Certainty Factor* method is a method for accommodating statements from an expert in their delivery. where a website-based expert system is created that can be used without any space and time limitations to help new technicians and the public. The result of testing this method is the resulting accuracy rate of more than 90% of the data has been tested so that it can assist technicians in diagnosing damage to the *no frost 2 door refrigerator*.

Keywords: Expert System, *Certainty Factor*, Diagnosis, Home Appliance, Technician .

1. Introduction

Technological developments are currently experiencing very rapid changes along with human needs that are increasingly numerous and complex. Not only in the fields of health, education, agriculture, and so forth. However, the electronics industry has also been affected by the development of this technology. The production of household electronic devices or home appliances that combine sophistication of technology and modern designs has emerged and is much in demand by the public, one of which is the refrigerator. According to [1] the refrigerator is a household appliance that is used to store food and so on.

There are many brands and types of refrigerators produced, each brand and type has its own advantages and disadvantages. One of the refrigerators that people are interested in is the two-door refrigerator [2]. But in this case the focus is more on the no frost 2 door refrigerator. A no-frost 2-door refrigerator is a type of refrigerator that has 2 storage areas, namely the freezer and fridge which has a sophisticated system that can defrost automatically without having to bother turning off the electricity to the refrigerator first or cleaning the ice manually.

Even though with the development of this technology, it does not mean that the refrigerator can function

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properly forever if it is used continuously. There are times when the refrigerator is damaged or malfunctions, and the user will of course try to fix it by visiting or contacting an electronics repair shop or trying to do it himself [3]. Therefore the refrigerator requires maintenance and repair if there is damage [4].

In the diagnosis of damage to home appliances refrigerator 2 doors no frost, limited information, knowledge, and experience of the community and technicians causes delays in recognizing the damage that has occurred so that it also influences decision making in handling it

An expert system is a computer program or software that has the knowledge of an expert in dealing with a problem . [5]

An expert system is a system that seeks to adopt human knowledge into computers, in order to be able to solve problems that are usually done by experts [6]. In analyzing information in the form of expressions, such as maybe, most likely, and almost certain, the certainty factor (CF) method can be used to overcome this uncertainty. Because CF is a method that defines a measure of the degree of certainty of existing facts or rules. [7]

An expert system (expert system) is a system that seeks to adopt human abilities or knowledge into a computer, so that the computer can work in solving a

problem like an expert or someone who has expertise in a particular field, namely an expert who has special knowledge or abilities. unknown and owned by other people.[8]

There are many advantages to using an expert system, including [9]:

1. Makes knowledge and advice more accessible
2. Increase output and productivity
3. Save the ability and expertise of an expert
4. Improve specific problem solving
5. Improve reliability
6. Provide a fast response
7. Is a smart guide
8. Can work with incomplete information and contains uncertainty
9. As an intelligent database, that expert system can be used to access the database in an intelligent way

Certainty Factor is part of *certainty theory* , which was first introduced by EH Shortliffe and BGBuchanan in making MYCIN (is an early expert system application designed to identify infections in the blood) noting that experts often analyze existing information with expressions such as: maybe, most likely, and almost certain. This made the MYCIN team use *the Certainty Factor* to describe the level of expert confidence in the problem at hand [10].

Certainty Factor (CF) theory is to accommodate the inexact reasoning of an expert proposed by Shortliffe and Buchanan in 1975. An expert (eg a doctor) often analyzes information with expressions of uncertainty, to accommodate this the Certainty Factor is used. (CF) to describe the level of expert confidence in the problem at hand. Certainty Factor expresses confidence in an event (fact or hypothesis) based on evidence or expert judgment. Certainty Factor uses a value to assume the degree of confidence of an expert in a data. Certainty Factor introduces the concept of belief and uncertainty [11].

Certainty Factor is a method to accommodate statements from an expert in their delivery. The results of the analysis describe the level of expert confidence in the problem at hand. *Certainty Factor* serves to accommodate the uncertainty of thought (inexact reasoning) of an expert. *Certainty Factor* expresses belief in an event (facts or hypotheses) based on evidence or expert judgment [12]. *Certainty Factor* is used to express how accurate, honest, or reliable it is in assessing a predicate. Certainty factor uses a value to assume the degree of confidence of an expert in a data. The certainty factor method is used to deal with a problem whose answer is uncertain. This uncertainty can be a probability. Certainty Factor uses a value to assume the degree of confidence of an expert in a data [13].

Laila Septiana (2016), in her work entitled "Design of an Expert System for the Diagnosis of ISPA Using the Android-Based CertaintyFactor Method". The application built can be used by users to diagnose Upper Respiratory Infection (ARI) before carrying out further examinations to the doctor. The application of Certainty Factor as a method for making final conclusions is in accordance with the results of manual calculations and the results given by the system. The knowledge acquisition process that has been carried out is quite effective, this is reinforced by the results of evaluating the accuracy of system output, both based on experts and users. The knowledge acquisition process is not easy, because there are various kinds of obstacles such as time problems, deep knowledge, difficulties experienced by knowledge engineers in understanding knowledge in the field of medicine [14].

2. Research methodology

The research framework created in this research methodology has the goal of getting results as expected and easy to solve problems and easy to understand. The steps to be made in this study are arranged systematically. Then a research framework is needed, where the research framework is carried out as shown in Figure 1:

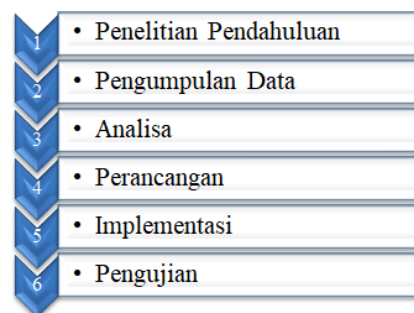


Figure 1. Research Framework

At the research stage based on the research framework, the authors carried out several steps, where all of these steps were systematically sequenced. Thus, it can be used as a clear reference to obtain optimal results. The stages of this research are as follows:

2.1 Preliminary Research

Before conducting research, researchers will first conduct preliminary research to explore whether or not a research can be carried out in the area and the intended object. With this activity, the researcher wants to know whether the research plan has the possibility to be implemented.

2.2 Data collection

In collecting data the authors obtain data from various sources, such as this research obtained from journals, and obtained from other references. And this research

was also conducted by applying the method of direct interviews with experts.

2.3 Analysis

Based on the preliminary research above, data analysis is carried out with the aim that problem solvers can find the right solution and avoid the emergence of new problems

2.4 Design

At this stage the author will make a system design that will be executed, starting from analyzing the running system, and designing the program that will be executed.

2.5 Implementation

System implementation is a stage that is carried out when the designed system is ready to operate. Implementation is carried out with the aim of confirming the results of the system design, so that users can provide input (feedback) on system development.

2.6 Testing

At this testing stage, monitoring or the use or function of the system that has been made is carried out, which will be periodically audited.

3. Results and Discussion

3.1 Analysis Data

The data analysis process is one of the important stages in this research, because it is at this stage that the damage to the no frost 2-door refrigerator will be identified, as well as analyzing the data obtained, where the data is used as material for making this application, the data obtained is data regarding the symptoms that allow damage to 2 door fridge no frost.

The following data was obtained to build an expert system for analyzing malfunctions of home appliances on a no frost 2 door refrigerator. The following data on damages in expert system research using the Certainty Factor method can be seen in Table 1 below:

table 1 1. Damage Data

No	Code Damage	Damage Type
1.	K01	Door Switch Malfunction
2.	K02	Timer Damage
3.	K03	Heater Damage
4.	K04	Compressor Damage
5.	K05	Condenser Damage
6.	K06	Damage to Capillary Pipes / Capillary Tubes
7.	K07	Evaporator Damage
8.	K08	Thermostat malfunction

In the table above it can be seen that there were 8 damages that occurred in the no frost 2 door refrigerator with damage codes from K01 to K08. Then

there will be data on the symptoms of damage which can be seen in Table 2 below:

table 1 2. Damage Symptom Data

No.	Code Symptom	Damage Symptoms
1.	G01	The light stays on
2.	G02	The light doesn't turn on
3.	G03	The lights turn on and off at a certain time
4.	G04	Defrost time is too fast
5.	G05	The unit does not turn on even though it is connected to the mains
6.	G06	Cold evenly but not maximal
7.	G07	Can't defrost
8.	G08	An ice buildup has occurred in the freezer
9.	G09	Condensation has occurred in the chiller or freezer
10.	G10	Not cold at all
11.	G11	The compressor or unit makes a buzzing sound
12.	G12	Compressor totally dead
13.	G13	The compressor runs for a while and then a "tick" sound is heard.
14.	G14	There was a loud and noisy sound coming from the unit
15.	G15	Smell of burning from PTC Relay
16.	G16	Not cold enough
17.	G17	Free Freon
18.	G18	The condenser is dry or no condensation occurs
19.	G19	Freon jammed / failed to condensate
20.	G20	Compressor failed to start
21.	G21	Hot compressor
22.	G22	Unit is active continuously
23.	G23	Evaporator not cold
24.	G24	The condenser does not feel warm
25.	G25	There is a collection of coolant in the evaporator / failure to evaporate
26.	G26	There was a hissing sound on the evaporator
27.	G27	The compressor keeps running
28.	G28	The compressor runs for a while then turns off
29.	G29	Uneven cold

From Table 2 it can be seen that there are 29 damage symptom data with codes G01 to G29. then the Rule data will be displayed from the expert system that we will do, it can be seen in the following table:

Table 3. Data Rules

No	rules	CF Rule
1.	Rule 1 : IF G01 AND G02 AND G03 THEN K01	CF=1
2.	Rule 2 : IF G04 AND G05 AND G06 THEN K02	CF=1
3.	Rule 3 : IF G07 AND G08 AND G09 THEN K03	CF=1
4.	Rule 4 : IF G10 AND G11 AND G12 AND G13 AND G14 AND G15 THEN K04	CF=1
5.	Rule 5 : IF G16 AND G17 AND G18 AND G19 THEN K05	CF=1
6.	Rule 6 : IF G20 AND G21 AND G22 AND G23 AND G24 THEN K06	CF=1
7.	Rule 7 : IF G10 AND G17 AND G25 AND G26 THEN K07	CF=1
8.	Rule 8 : IF G27 AND G28 AND G29 THEN K08	CF=1

3.2 Calculation of the *Certainty Factor method*

Based on the rules in Table 3, a trial calculation was carried out using the *Certainty Factor method* with a manual process. Where the certainty value of the type of damage to the user can be seen in Table 4 below:

Table 4. Expert System User Symptom Data

No	Damage Symptoms	Answer
1.	The light stays on	Possible
2.	The light doesn't turn on	Certain
3.	The lights turn on and off at a certain time	Most likely
4.	Defrost time is too fast	Not sure
5.	The unit does not turn on even though it is connected to the mains	Not sure
6.	Cold evenly but not maximal	Not sure
7.	Can't defrost	Not sure
8.	An ice buildup has occurred in the freezer	Not sure
9.	Condensation has occurred in the chiller or freezer	Not sure
10.	Not cold at all	Not sure
11.	The compressor or unit makes a buzzing sound	Not sure
12.	Compressor totally dead	Not sure
13.	The compressor runs for a while and then a "tick" sound is heard.	Not sure
14.	There was a loud and noisy sound coming from the unit	Not sure
15.	Smell of burning from PTC Relay	Not sure
16.	Not cold enough	Not sure
17.	Free Freon	Not sure
18.	The condenser is dry or no condensation occurs	Not sure
19.	Freon jammed / failed to condensate	Not sure
20.	Compressor failed to start	Not sure
21.	Hot compressor	Not sure
22.	Unit is active continuously	Not sure
23.	Evaporator not cold	Not sure
24.	The condenser does not feel warm	Not sure
25.	There is a collection of coolant in the evaporator / failure to evaporate	Not sure
26.	There was a hissing sound on the evaporator	Not sure
27.	The compressor keeps running	Not sure
28.	The compressor runs for a while then turns off	Not sure
29.	Uneven cold	Not sure

Description of each rule of new facts:

Rule 1 : IF G01 (CF=0.6) AND G02 (CF=1) AND G03 (CF=0.7) THEN K01 (CF=1)

$$CF1 = \text{MIN}(0.6; 0.7; 1) * 1$$

$$CF1 = 0.6 * 1 = 0.6$$

New Facts:

K01 : Damage to Door Switch CF=0.6

Rule 2 : Cannot be executed due to incomplete facts

Rule 3 : Not executable due to incomplete facts

Rule 4 : Cannot be executed due to incomplete facts

Rule 5 : Cannot be executed due to incomplete facts

Rule 6 : Cannot be executed due to incomplete facts

Rule 7 : Cannot be executed due to incomplete facts

Rule 8 : Cannot be executed due to incomplete facts

Table 5. New Facts for Expert System Users

New facts	Damage	CF
K01	Door Switch Malfunction	CF1=0.6

Conclusion: Damage to the door switch with a certainty level of 0.6 or 60%.

3.3 System Implementation

The following is an implementation of the *certainty factor method* using the PHP programming language supported by the MySQL database, as follows:

1. Login Page Display

Here you can see the Login Form that is used for system security, so that users can carry out consultations, the user is required to enter a *username* and *password*, then click the *login button*, as shown in Figure 2. below:



Figure 1. Login Page Display

2. Consultation Page Display

This display will appear when the user consults the system, as shown in Figure 3 below:



Figure 2. Consultation Page Display

3. Display Consultation Diagnostic Results Page

This display will appear after *the user* has consulted by selecting symptoms and entering a level of confidence, as shown in Figure 4 below:



Figure 3. Display Consultation Diagnostic Results Page

4. Conclusion

After conducting research on the ACS technique, based on the data obtained and the analysis that has been carried out, it can be concluded that an expert system for diagnosing damage to a 2-door refrigerator *without frost* can recognize existing symptoms and is in accordance with the application of the *Certainty Factor method*. Can assist technicians in detecting damage that occurs so that it is easy to overcome the damage that occurs.

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