Implementation of Certainty Factor Method for Diagnoses of Photocopy Machine Damage

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Abstract. Photocopying machines are machines that make paper copies of documents and other visual images quickly and cheaply. PT. TRITANU has a copy machine product, such as the Fotocpy Sharp machine Type B201D. The rapid development of photocopying technology at this time can be seen that adult photocopying machines are now not only operating copier but can scan, print, and even fax. The rapid development of photocopying technology does not necessarily provide complete convenience to users. This can be seen from the high cost of consultation in the event of damage to the photocopy machine, requiring time to check the damaged machine, and not to mention other procedures in the repair that exist at PT. TRANANU. So from to provide solutions to these problems, the researchers made an Expert System for Handling Print Results Problems on Sharp Photocopying Machines Type B201D Using the Certainty Factor Method. System testing shows that the system is able to diagnose damage to the B201D copy machine based on the symptoms in the printout, even though these symptoms contain uncertainty. The results of the diagnosis are accompanied by Certainty Factor values that indicate the level of truth, accuracy of possible damage to the B201D copy machine.

1. Introduction
Photocopying machines (also known as copiers or photocopying machines), quoted from Wikipedia, are machines that make paper copies of documents and other visual images quickly and cheaply. PT. TRITANU has a copy machine product, such as the Fotocpy Sharp machine Type B201D. The rapid development of photocopying technology at this time can be seen that adult photocopying machines are now not only operating copier but can scan, print, and even fax. The rapid development of photocopying technology does not necessarily provide complete convenience to users. This can be seen from the high cost of consultation in the event of damage to the photocopy machine, requiring time to check the damaged machine, and not to mention other procedures in the repair that exist at PT. TRANANU. So from to provide solutions to these problems, the researchers made an Expert System for Handling Print Results Problems on Sharp Photocopying Machines Type B201D Using the Certainty Factor Method. System testing shows that the system is able to diagnose damage to the B201D copy machine based on the symptoms in the printout, even though these symptoms contain uncertainty. The results of the diagnosis are accompanied by Certainty Factor values that indicate the level of truth, accuracy of possible damage to the B201D copy machine.
only owned by the manufacturer of the machine, then automatically the company that uses the machine must pay more for service to repair the machine. One option to overcome the printing results is not good on the B201D type sharp copy machine is to diagnose the symptoms that appear in the print results through the use of Artificial Intelligence (AI) study fields that are able to mimic the intelligence of an expert. One part of artificial intelligence (AI) is an expert system. Expert system is one branch of Artificial Intelligence that makes use of knowledge (knowledge) specifically to solve human-level problems that are experts (experts). An expert system or Expert System is commonly referred to as Knowledge Based System which is a computer application that is intended to help decision making or problem solving in a specific field [1]. Certainty factor is used to handle uncertainty in making MYCIN. Certainty Factor (CF) is the value of clinical parameters given by MYCIN to show the magnitude of trust [5].

Making an expert system for handling the B201D type copy machine with Certainty Factor method, and with this system later it is expected to facilitate users and technicians of the B201D sharp copy machine so that it can facilitate handling print problems and thus can cut costs to be cheaper and shorter time spent.

2. Methods

2.1. Expert system

Professor Edward Feigenbaum and Stanford University who are pioneers in expert systems technology define expert systems as a smart computer program that utilizes knowledge and inference procedures to solve problems that are difficult enough to require special expertise and human [2]. One of the first expert systems is Healistic DENDRAL. The DENDRAL project began in 1965 at Stanford University. This system was developed by J. Lederberg, an organic chemist and Nobel winner in the field of Chemistry [4]-[6].

2.2. Certainty Factor

The theory of certainty factor (CF) was proposed by Shortlife and Buchanan in 1975 to accommodate the inexact reasoning of an expert. An expert, (for example a doctor) often analyzes available information with phrases such as "maybe", "most likely", "almost certain". To accommodate this we use certainty factor (CF) to describe the level of expert confidence in the problem at hand [11].

There are two ways to get the (CF) confidence level from a rule [11], namely:

a. The Net Belief Method proposed by E.H. Shortliffe and B.G. Buchanan.

\[
\text{\textit{CF(Rule)}} = \text{\textit{MB(H, E)}} - \text{\textit{MD(H, E)}}
\]

\[
\text{\textit{MB(H, E)}} = \max\left[\frac{P(H|E), P(H)}{\max[1,0] - P(H)}\right] - P(H) = 1
\]

\[
\text{\textit{MD(H, E)}} = \min\left[\frac{P(H|E), P(H)}{\max[1,0] - P(H)}\right] - P(H) = 0
\]

Where:

\text{CF (Rule)} = \text{Certainty factor}

\text{MB(H, E)} = \text{Measure of belief (measure of trust) to the H hypothesis, if given evidence E (between 0 and 1).}

\text{MD(H, E)} = \text{Measure of disbelief (measure of distrust) of evidence H, if given evidence E (between 0 and 1).}

\text{P (H)} = \text{Probability of the H hypothesis.}

\text{P (H | E)} = \text{Probalance that H is true because of fact E.}

b. By interviewing an expert

The CF value (rule) is obtained from the "term" interpretation of the expert, which is converted to a specific CF value according to the following table:

| Certainty Term           | CF\(_{\text{Akhir}}\) |
|--------------------------|------------------------|
| Definitely not           | -1,0                   |
| Almost certainly not     | -0,8                   |


Table 1. Expert belief factors
2.3. Expert System is built with the Certainty Factor Method

The expert system for handling the printed B201D type copy machine that will be built, uses the certainty factor method. So for the process of determining what causes the print results are problematic, data and rules are needed to be processed as a basis for determining the cause of the print problem.

a. Symptom Print Results

Symptoms of a printed B201D sharp copy machine are used to be questions that will come out when the user is consulting.

| Symptom Code | Symptom Name                                      |
|--------------|--------------------------------------------------|
| G01          | Toner is not attached properly                   |
| G02          | Speckled results on certain areas of paper       |
| G03          | Whole grainy results                             |
| G04          | Speckled and striped results                     |
| G05          | Dirty results like black piles                   |
| G06          | The results are spotted and scratched the same way down |
| G07          | Straight-line results from top to bottom of the paper |
| G08          | Scrubber results                                 |
| G09          | The result of the same coloring and the same goes back to the bottom |
| G10          | The result is plain white paper                  |
| G11          | The results of black out all the paper           |
| G12          | The results come out and there are wrinkles on the paper |
| G13          | Shaded writing                                   |
| G14          | Italics                                          |
| G15          | Blurry results / Not bright                      |
| G16          | The print on the black edge is uneven            |
| G17          | In certain lines of writing are overwritten and repeated |
| G18          | Dirty print on the edge of the paper             |
| G19          | Paper stuck in the Delivery Paper Guide          |
| G20          | Paper folds in the middle                        |

b. Data Damage to the B201D Photocopier

Damage data is used as a result of consulting users who have answered questions in the form of symptoms during consultation.

| Damage Code | Damage Name                                              |
|-------------|----------------------------------------------------------|
| K01         | Fusing Units are not normal                             |
| K02         | Drum blisters / expiration                              |
| K03         | Low / dirty developer                                    |
| K04         | Wire charger broken                                      |
| K05         | Dirty / problematic Table Glass                          |
| K06         | Glass Fixing Plate is dirty                              |
| K07         | Cleaning Blade expires                                   |
| K08         | The Unit Developer is obsolete                            |
| K09         | LSU has problems                                         |

| Certainty Term | CF\textsubscript{Akhir} |
|----------------|-------------------------|
| Probably not   | -0.6                    |
| Maybe not      | -0.4                    |
| Unknown        | -0.2---0.2              |
| Maybe          | 0.4                     |
| Probably       | 0.6                     |
| Almost certainly | 0.8                  |
| Definitely     | 1                       |

Table 2. Data table symptoms of printing products b201d fotocopy machine

Table 3. Table of b201d fotocopy machine damage data
The weight of the Certainty factor value is obtained from the level of expert confidence in a symptom of the type of photocopy machine damage. This value weight is used for the calculation process in determining the value of certainty factor.

Table 4. Table breaking certainty factor value

| Symptom Code | Damage Type Code |
|--------------|------------------|
| G01          | K01 0.8          |
| G02          | K02 0.8          |
| G03          | K03 0.8          |
| G04          | K04 0.4          |
| G05          | K05 0.6          |
| G06          | K06 0.4          |
| G07          | K07 0.8          |
| G08          | K08 0.4          |
| G09          | K09 0.8          |
| G10          | K10 0.2          |
| G11          | K11 0.6          |
| G12          | K01 0.8          |
| G13          | K02 0.8          |
| G14          | K03 0.6          |
| G15          | K04 0.8          |
| G16          | K05 0.6          |
| G17          | K06 0.4          |
| G18          | K07 0.8          |
| G19          | K08 0.4          |
| G20          | K09 0.6          |

The rule of rule is used as a search rule for engine damage based on every symptom inputted.

Table 5. Settings table (rule)

| No | Symptom Name |
|----|--------------|
| 1  | IF Toner is not attached properly (G01) AND Gross results such as black pile up (G05) AND The results come out and there are wrinkles on the paper (G12) AND The printout is dirty on the edge of the paper (G18) AND Paper folds in the middle (G20) THEN Fusing Unit is not normal (K01) |
| 2  | IF Overall speckled results (G03) AND same speckled and scratched results repeatedly down (G06) AND Scratched and similar results repeatedly down AND (G09) AND Printouts on uneven black edges (G16) THEN Drum blisters / expired (K02) |
| 3  | IF Speckled results on certain areas of paper (G02) AND speckled and striped results (G04) AND Outcome of plain white paper (G10) AND blurry results / not bright (G15) THEN Developer low / dirty (K03) |
| 4  | IF Outcome of plain white paper (G10) AND frosted / not bright (G15) THEN Charger wire break (K04) |
| 5  | IF Gross results such as black piles (G05) AND Scratch-resistant results (G08) AND black results of all paper (G11) THEN Table Glass dirty / problematic (K05) |
| 6  | IF Straight-line results from top to bottom of paper (G07) THEN Glass Fixing Plate is dirty / problematic (K06) |
| 7  | IF Gross results such as black piles (G05) AND shaded writing (G13) AND Dirty print on the top edge of the paper (G18) THEN Cleaning Blade expires (K07) |
| 8  | IF Speckled and striped results (G04) AND Straight-line results from top to bottom of paper (G07) AND Printout on black edges is not evenly distributed (G16) THEN Developer Unit is outdated (K08) |
No | Symptom Name
---|----------------------------------
9 | IF Speckled results on certain areas of paper (G02) AND Results of plain white paper (G10) AND blurry results / not bright (G15) THEN LSU is problematic (K09)
10 | IF Italics (G14) AND Paper are printed on the Delivery Paper Guide (G19) THEN Slider Unit does not run normally (K10)
11 | IF Italics (G14) AND In certain posts are overwritten and repeated (G17) AND paper folds in the middle (G20) THEN Solenoid is not normal (K11)

3. Results and Analysis

3.1. Result

Sample case:
A customer comes to consult the expert system to find out the problem / damage to the photocopy machine based on the print results. The expert system has the following knowledge base:
If Toner is not attached properly
   And dirty results like black piles
   And the results come out and there are wrinkles on the paper
   And The printout is dirty on the edge of the paper
   And the paper folds in the middle
Then Unit Fusing is not normal
Step I: Experts give CF values for each symptom.
CF (expert) Toner is not attached properly = 0.8
CF (expert) Dirty results like stacked black = 0.6
CF (expert) The results come out and there are wrinkles on the paper = 0.8
CF (expert) Dirty print on the top edge of the paper = 0.2
CF (expert) Folded paper in the middle = 0.4.
Suppose the user chooses the answer when consulting as follows:
Toner is not attached properly = 0
Dirty results like black piled up = 1
The results come out and there are wrinkles on the paper = 1
Dirty print on the top edge of the paper = 0
Folded paper in the middle = 1
The rules or initial rules that have 5 premises (symptoms), are broken down into several single premises as follows:
Rule 1.1
If Toner is not attached properly
Unit Fusing is not normal
Rule 1.2
If dirty results like black piles
Unit Fusing is not normal
Rule 1.3
If the results come out and there are wrinkles on the paper
Unit Fusing is not normal
Rule 1.4
If the print is dirty on the edge of the paper
Unit Fusing is not normal
Rule 1.5
If the paper folds in the middle
Unit Fusing is not normal

The new rules or rules then calculate the CF value by multiplying CF (expert) by CF (user) to:

Rule 1.1 0.8 * 0 = 0
Rule 1.2 0.6 * 1 = 0.6
Rule 1.3 0.8 * 1 = 0.8
Rule 1.4 0.2 * 0 = 0
Rule 1.5 0.4 * 1 = 0.4

Combine CF1.1 with CF1.2 with the following formula:

CFcombine (CF1, CF2) = CF1 + CF2 * (1 - CF1), so that it becomes the following:

CFcombine (CF1, CF2)
= 0 + 0.6 * (1 - 0)
= 0 + 0.6 * (1)
= 0 + 0.6
= 0.6 (CFold)

CFcombine (CFold, CF1.3)
= 0.6 + 0.8 * (1 - 0.6)
= 0.6 + 0.8 * (0.4)
= 0.6 + 0.32
= 0.92 (CF1.3)

CFcombine (CF1.3, CF1.4)
= 0.92 + 0 * (1 - 0.92)
= 0.92 + 0 * (0.08)
= 0.92 + 0
= 0.92 (CF1.4)

CFcombine (CF1.4, CF1.5)
= 0.92 + 0.4 * (1 - 0.92)
= 0.92 + 0.4 * (0.08)
= 0.92 + 0.032
= 0.952

Percentase keyakinan
= CFcombine * 100
= 0.952 * 100
= 95.2

Thus it can be said that the Certainty Factor calculation of Fusing Unit damage on the photocopier owned by the user has a 95.2% confidence level. Weight of Certainty Factor Value

3.2. System Implementation
In the expert system handling the problem of print results on a Sharp photocopy machine Type B201D, in general the interface page design for the consultation process is as follows:

a. Consultation stages

The consultation stage is a consultative process by giving a check on the answers based on the symptoms that are in the printed B201D sharp copy machine
If seen from Figure 1, then the user performs a diagnostic process with 3 types of symptoms, namely:
- Dirty results like black piles
- Results come out and there are wrinkles on the paper
- Paper folds in the middle
Of the three types of symptoms that have been chosen by the user, the calculation of the 0.952 or 95.2% Certainty Factor value is obtained, which results in the calculation of the manual, the code and the name of the damage, and the solution to the damage.

b. Last stage
The final stage is an option provided by the system to print the results of the consultation after the consultation process is complete.

Figure 1. Stages of Consultation

If seen from Figure 3, then the user performs a diagnostic process with 3 types of symptoms, namely:
- Dirty results like black piles
- Results come out and there are wrinkles on the paper
- Paper folds in the middle
Of the three types of symptoms that have been chosen by the user, the calculation of the 0.952 or 95.2% Certainty Factor value is obtained, which results in the calculation of the manual, the code and the name of the damage, and the solution to the damage.

3.3. Discussion
After going through the stages previously explained, starting from login to obtaining the diagnosis, it can be concluded that the system that has been built is as expected, namely:

a. Users do not need to issue consultation fees. users only need to pay for the use of service technician services and the replacement of spare parts needed if the user is willing to make changes
b. The technician no longer requires a long time to overcome the problem on the machine because it has been diagnosed in advance by the user.
c. Technicians no longer have to go back and forth between offices to take out broken machine spare parts because the problem is already known from the user's diagnosis with the system.

4. Conclusion
After testing the system that has been built, namely the Expert System for Handling Print Results Problems on Sharp Photocopying Machines Type B201D By Using the Certainty Factor Method, the following conclusions can be obtained:
a. The system that has been built is able to provide easy consultation regarding information on damage that occurs on the B201D photocopy machine based on the symptoms in the printout.

b. The system that has been built is able to provide information on the damage that occurred on the B201D photocopy machine based on the symptoms in the printout, which in this case the system user no longer needs to issue consultation fees.

c. In addition to being able to provide information on the damage to the B201D photocopy machine based on the symptoms in the printout, the system also provides a solution that can be taken to overcome the problem, which in this case certainly helps the technician in repairing the photocopier so that it saves time.

d. The system that has been built can help technicians, especially beginner technicians, in diagnosing the problem of a Sharp Photocopy machine with type B201D.

e. With this system, the user of the B201D photocopier machine no longer only understands the operation, but also can diagnose itself if there is damage that results in the printing of a B201D copy machine is not good.

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