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by Ali Khumaidi

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Development of The Application for Car Audio Parts Detection Damage Using Case Based Reasoning Method and Nearest Neighbor Algorithm

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ABSTRACT

PT. Denso Ten often accepts car audio parts that are damaged due to shocks during the trip or shipper error. Broken spare parts are collected and repaired manually with skilled maintenance. The limited number of maintenance operators and the frequent transfer of experts resulted in work delays due to insufficient spare parts. In this case, it discusses the application of the nearest neighbor algorithm and the Case-Based Reasoning (CBR) method, where the nearest neighbor algorithm is able to classify the problem of symptoms and car audio damage while CBR is able to solve problems that have been classified by the nearest neighbor algorithm. CBR is a method that works well in case-based reasoning, where the results of cases that have been analyzed are obtained from cases that have happened before. The application built can be run and used by users properly according to their needs and the results have 100% accuracy of 10 data testing with research data from 2019 totaling 1,620 data.

1. Introduction

In 2013, Denso Group, which is the largest producer of automotive spare parts, started opening its 4th factory in Indonesia, precisely in the Cileungsi area. The company with the name Denso Ten Mfg Indonesia produces car audio products including EPS (Electric Power Steering), EFI (Electronic Fuel Injection) and CD Tuner which are excellent for customers, including HPM, Suzuki, Mitsubishi, ADM, Toyota and others. In one day PT Denso Ten Mfg Indonesia is able to produce 500 units. Meanwhile, the actual damaged parts produced from the production reach 15 to 35 pieces per day.

In the manufacturing process, Denso Ten prioritizes quality from the machine to the raw materials used. This part is what Denso uses as raw material. Ten means imported products from various countries. In the process of supplying raw materials, Denso Ten received them in a damaged state. This can be caused by shocks during the trip or mistakes made by the sender. Damaged parts are collected and repaired by maintenance manually before being used again in the production area.

The maintenance division of PT Denso Ten said that the maintenance operators, which are only 5 people, often face difficulties in parts damage due to lack of adequate systems. The checking process until data processing is done manually. In fact, this situation is complicated by the frequent maintenance of the maintenance department changing new maintenance operators because the rate of employee resignation at PT Denso Ten is almost 75% each year. So that the maintenance team has to do training for new operators every time it changes.

Based on previous research conducted by Khumaidi (2016) to determine the location of the franchise using the Combination of Nearest Neighbor Algorithm and Case Based Reasoning (CBR) which produces an accuracy rate of up to 95% [1] and Salamun's research (2017) on an expert system on sexual behavior deviations using Nearest Neighbor and CBR can help psychologists find and analyze existing cases and provide advice [2]. Adib's research (2020) uses CBR and Nearest Neighbor to diagnose ginger plant diseases [3]. These studies with CBR and Nearest Neighbor have been good at solving problems. However, this research will try to take a different approach by entering new cases containing signs of damage to be detected into the system, then the indexing system is processed using the backpropagation method to obtain a new case index[4] [5]. After the index is obtained, the system then calculates the equation value between the new case and the previous base case. Where the Nearest Neighbor algorithm serves to classify existing problems and CBR serves as a tool to solve problems that have been classified with the Nearest Neighbor algorithm.

2. Research Method

3.1. Data

The research was conducted using data from PT Denso Ten Mfg Indonesia Summary Part NG in 2019 with a total of 1,620 data in building a system database. The data displays the Part Name, Part Number, the damage that occurred, the name of the maintenance that handled it, and so on. The following is a summary of the sample data on 7/1/2019 as a reference for research material and the system development process can be seen in table 1.

Table 1
Summary Damage Form

Date	P/No	P/Name	Damage Name	Damage Qty	Maintenance Name	Damage Variance
7/1/19	225834-0360A700	Heatsink	Equipment Problem	4	Roni S	Scratch
7/1/19	225834-0380A700	IC Power	Equipment Problem	5	Ahmad F	Broken
7/1/19	225834-0380A700	IC Flash Programing	Equipment Problem	2	Yunas A	Broken
7/1/19	225834-0390A700	Display Unit	Equipment Problem	1	Dedi I	Solder Bold
7/1/19	225834-04000700	Bluetooth	Equipment Problem	2	Roni S	Bending
7/1/19	225834-03000700	IC Audio	Equipment Problem	1	Akhmad F	Bending

Following an explanation of the description in choosing symptoms of damage, the authors classify the types of damage to the car audio section based on the symptoms experienced. Based on data obtained from direct interviews with 4 people in the maintenance section of the car audio section of PT. Denso Ten Manufacturing Indonesia in April 2020.

Table 2
Faults, Symptoms, and Solution

No	Damage	Symptom	Solution
1	IC Power	- totally dead - The display does not appear	Repair (Manual soldering, replace part)
2	IC Flash Programing	- totally dead - Blinking on display unit	Repair (Manual soldering, replace part)
3	Audio IC	- Loud beep - No beep sound appears	Repair (Manual soldering, replace part)
4	Display Unit	- Black dots appear on the display - A black line appears on the display unit	Repair (Manual soldering, replace part)

No	Damage	Symptom	Solution
5	Bloetooth	- Product cannot be paired - Bluetooth not detected	Repair (Manual soldering, replace part)

From the table 2 will be in the form of 3 tables, namely a table of symptoms and a table of cases in order to make it easier to analyze the problem of damage to car audio parts. The following table will be created:

1) Table of Damage

Below will be in the form of a table regarding damage by providing a code for each fault.

Table 3
Damage identification

Damage Code	Damage Name
K1	IC POWER
K2	IC FLASH PROGRAMING
K3	AUDIO IC
K4	DISPLAY UNIT
K5	BLUETOOTH BLUETOOTH

Table description: K is the damage code and 1 is the sequence of damage, so K1 means damage in the first order.

2) Symptom Table

Below will be in the form of a table regarding Symptoms by providing a code for each symptom of damage.

Table 4
Identification of symptoms of damage

SYMPTOM CODE	SYMPTOM NAME
G1	Totally dead
G2	Blinking on the display unit
G3	A loud sound
G4	There is no beep sound
G5	No display appears on the display unit
G6	Black lines appear on the display unit
G7	Black dots appear on the display unit
G8	Product cannot pair
G9	Bluetooth is not detected

Table description: G is the symptom code and 1 is the sequence of symptoms starting from the smallest value, namely 1, so G1 means the symptom in the first order.

3) Damage and Symptom Matrix

From the table data between the damage and symptoms table, a matrix table can be made to determine the similarity of symptoms experienced, which is presented in the table 5.

Table 5
Damage and symptoms matrix

FAULT CODE	SYMPTOM CODE				
	K1	K2	K3	K4	K5
G1	√	√			
G2		√			
G3			√		
G4			√		
G5	√				
G6				√	
G7				√	
G8					√
G9					√

From the data matrix above, it can be seen that to look for cases of the same symptoms, there are damage cases with code K1 with a total of 2 cases, K2 with a total of 2 cases, K4 with a total of 3 cases. From the symptom and damage data, it can be used as a new case or can be symbolized by X (X is a new symptom or new case).

3.2. Usecase Diagram

Use Case Diagrams describe the expected functionality of a system. What is emphasized is "what" the system does, and not "how". Use Case diagrams also describe the pattern of system behavior, the sequence of transactions that are related and carried out by one actor[11]. Figure 2 is a Usecase Diagram for consultation handling damage diagnosis.

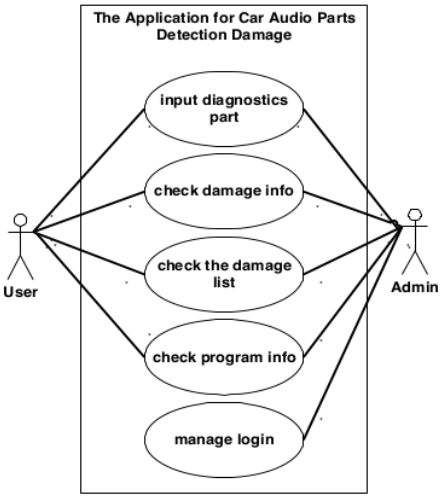

Fig 2. Usecase diagram

3.3. Database Design

In designing a database on this system[12], there are several tables that will be stored in a database. The tables are tabel, tmp_gejala, gejala, tmp_analisa, relasi, login, tmp_kerusakan, kerusakan, analisa_hasil.

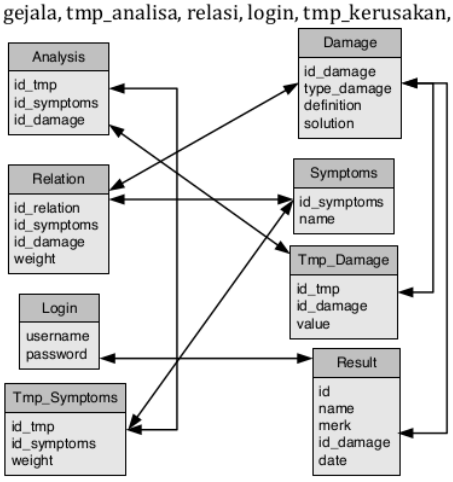

Fig. 3. Database Design

3. Result

4.1. Retrieve Process

Retrieve process is a process of finding the similarities between new and old cases. The search for similarities between new and old cases is done by matching the symptoms entered by the user with the symptoms in the knowledge base[13].The detection process is carried out by entering new cases (target cases) which contain signs of damage to be detected into the system, then the indexing system processes using the backpropagation method to obtain the index of the new cases. After the index is obtained, the system then calculates the value of the equation between the new case and the base case before it.

1) Calculation of cases in retrieving process

The first step in calculating the case in the retrieving process is as follows:

a) Determine the weight value

In handling the problem of damage to the car audio part, it is necessary to determine the identification of symptoms in each problem or problem encountered, there are several levels of problems encountered in each case, the first is severe symptoms, namely the problem level is high, the second is moderate symptoms, namely the level of problems in the case. experience is relatively high, and the third is the usual symptom, namely the level of problem in the case experienced is low. For the determination of the weight value, it is determined based on the level of importance or urgency of handling on a scale of 1 to 5 (1 = ordinary, 5 = weight). so that a relative scale is found that is 3 which is then called (moderate). So it can be concluded in table form regarding the parameter weight assessment (w) as follows:

Table 6
Parameter weight

Parameter Weight	Symptom Level (w)
Severe Symptoms	5
Moderate Symptoms	3
Usual Symptoms	1

b) Score the weight for each symptom

The weight value for each symptom describes the weight value of each symptom, where the value is obtained from a direct interview with Maintenance[14]. The following is a table of the weighting values for each symptom.

Table 7
Weight values for each symptom

Symptom Code	Symptom Name	Weight Value
G1	Totally dead	5
G2	Blinking on the display unit	1
G3	A loud sound	3
G4	There is no beep sound	1
G5	No display appears on the display unit	5
G6	Black lines appear on the display unit	1
G7	Black dots appear on the display unit	1
G8	Product cannot pair	3
G9	Bluetooth is not detected	3

c) Determine the value of Similarity (s)

To determine the similarity value, it is determined based on the level of similarity in the previous case, the higher the similarity case, the higher the value and the lower the similarity value, the smaller the similarity value[15], in the case of diagnosing damage to the car audio part, the similarity value is 0 and 1 (0). = There is no similarity to the previous case, 1 = there is similarity or the previous case experienced by the next case.

Table 8
Similarity Of Symptom Attribute Values

SYMPTOM	SYMPTOM	SIMILARITY
Totally dead	Totally dead	1
Blinking on the display unit	Blinking on the display unit	1
No display appears on the display unit	No display appears on the display unit	1
Blinking on the display unit	Totally dead	0
Blinking on the display unit	No display appears on the display unit	0
No display appears on the display unit	Totally dead	0
No display appears on the display unit	Blinking on the display unit	0

d) Identification of problems regarding IC Power

Below is presented in the form of an old case identification table, namely the damage to the Power IC with a new case.

Table 9
Power IC case identification with new case (X)

No	Old Case and New Case		Value of Similarity (s)	Weight Parameter (w)
	K1	X		
1	Totally dead (G1)	Totally dead (G1)	1	5
2	No display appears on the display unit(G5)	Totally dead (G1)	0	5

From the table above, similarity can be found using the CBR calculation, which is as follows:
You know: S1 = 1, S2 = 0, W1 = 5, W2 = 5
Where:
Code S shows the similarity or similarity and Code W shows the weight of the parameter while column No shows the sequence of case names, from the description, it is obtained:

(1) S1 = the value in column S number one which has a value of 1 because the G1 symptoms experienced in the old case (K1) were also experienced by case X.
(2) S2 = the value in column S the second number which has a value of 0 because the G05 symptoms experienced in the old case (K1) have no resemblance to case X
(3) W1 = parameter weight value in column w number one which has a value of 5 because the G01 symptom is a severe symptom category.
(4) W2 = the parameter weight value in column w number two which has a value of 5 because the G05 symptom is a severe symptom category.

Then it can be entered into the formula (1). The similarity value between the old case Similarity (K1) and the new case X is 0.5

e) Identification of problems regarding IC Flash Programing

Below is presented in the form of an identification table of old cases, namely damage to the IC Flash Programming with new cases.

Table 10
Identification Of Ic Flash Programming Cases With New Cases (X)

No	Old Case and New Case		Value of Similarity (s)	Weight Parameter (w)
	K1	X		
1	Totally dead (G1)	Totally dead (G1)	1	5
2	Blinking on the display unit	Totally dead (G1)	0	1

From the table above, similarity can be found using the CBR calculation, which is as follows:
You know: S1 = 1, S2 = 0, W1 = 5, W2 = 1
Where:

Code S shows the similarity or similarity and Code W shows the weight of the parameter while column No shows the sequence of case names, from the description, it is obtained:

1) S1 = the value in column S number one which has a value of 1 because the G01 symptom experienced in the old case (K2) is also experienced by case X.
2) S2 = the value in the second number S column which has a value of 0 because the G02 symptoms experienced in the old case (K2) have no resemblance to case X.
3) W1 = parameter weight value in column w number one which has a value of 5 because the G01 symptom is a severe symptom category.
4) W2 = the parameter weight value in column w number two which has a value of 1 because the G02 symptom is a moderate symptom category.

The similarity value between the old case Similarity (K2) and the new case X is 0.833

f) Test Case Results

From the test results in each case, it can be seen the level of similarity of the tested cases, which is presented in the table 11.

Table 11
Results of Test Cases

Case	Code of Damage	Symtoms Case	Value Damage	Diagnosis Case	Solution
1	K1	Totally dead No display appears on the display unit	0.5	IC Power	Repair (manual soldering, replace part)
2	K2	Totally dead Blinking on the display unit	0.833	IC Flash Programing	Repair (manual soldering, replace part)

g) Similarity Value

From the table of test results, it can be seen which case has the lowest similarity value and the highest similarity value[16], from this data, the similarity value is close to the case, namely the K2 case or IC Flash Programming with a similarity level of 0.833 in the table below.

Conclusion From the calculation of all cases that have the highest similarity weight is the IC Flash Programming (K2) case, which is equal to 0.833, So, the IC Flas Programing case solution is recommended to users (because it has the greatest similarity weight value).

4.2. Testing Application

The following is a picture of a web-based application, the user will be asked to select the symptoms experienced by the part[17]. On this page the system will display the results of the symptoms inputted in the diagnostic process, this page displays the results of the similarity value and calculation of the case based reasoning method.

System testing aims to test pre-designed system components and to ensure that every element of the system functions as expected. Blackbox testing has been carried out by 4 people in the maintenance section of the car audio section of PT. Denso Ten Manufacturing Indonesia and 1 application admin, where all functions of the application such as logging in, adding damage types, adding rules, adding symptoms, and symptom reports are functioning and working properly.In the application test shown in Figure 4, 10 cases of damage types and symptoms were tested. The results obtained conformity with 100% accuracy.

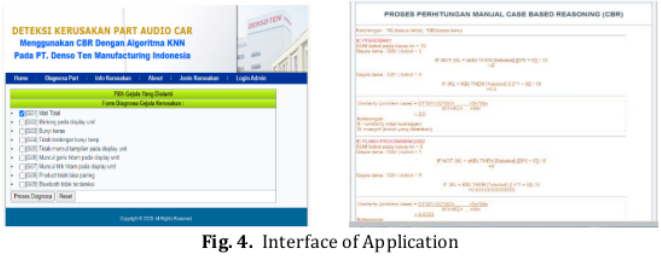

Fig. 4. Interface of Application

4. Conclusion

Based on the results of the discussion and testing, it can be concluded that the application can run and be used by users properly according to their needs and the results have 100% accuracy. The nearest neighbor algorithm is able to classify the problem of symptoms and car audio damage while CBR is able to solve problems that have been classified by the nearest neighbor algorithm. CBR is a method that works well in case-based reasoning, where the results of cases that have been analyzed are obtained from cases that have happened before.

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In the manufacturing process, Denso Ten prioritizes quality from the machine to the raw materials used. This part is what Denso uses as raw material. Ten means imported products from various countries. In the process of supplying raw materials, Denso Ten received them in a damaged state. This can be caused by shocks during the trip or mistakes made by the sender. Damaged parts are collected and repaired by maintenance manually before being used again in the production area.

The maintenance division of PT Denso Ten said that the maintenance operators, which are only 5 people, often face difficulties in parts damage due to lack of adequate systems. The checking process until data processing is done manually. In fact, this situation is complicated by the frequent maintenance of the maintenance department changing new maintenance operators because the rate of employee resignation at PT Denso Ten is almost 75% each year. So that the maintenance team has to do training for new operators every time it changes.

Based on previous research conducted by Khumaidi (2016) to determine the location of the franchise using the Combination of Nearest Neighbor Algorithm and Case Based Reasoning (CBR) which produces an accuracy rate of up to 95% [1] and Salamun's research (2017) on an expert system on sexual behavior deviations using Nearest Neighbor and CBR can help psychologists find and analyze existing cases and provide advice [2]. Adib's research (2020) uses CBR and Nearest Neighbor to diagnose ginger plant diseases [3]. These studies with CBR and Nearest Neighbor have been good at solving problems. However, this research will try to take a different approach by entering new cases containing signs of damage to be detected into the system, then the indexing system is processed using the backpropagation method to obtain a new case index[4] [5]. After the index is obtained, the system then calculates the equation value between the new case and the previous base case. Where the Nearest Neighbor algorithm serves to classify existing problems and CBR serves as a tool to solve problems that have been classified with the Nearest Neighbor algorithm.

2. Research Method

3.1. Data

The research was conducted using data from PT Denso Ten Mfg Indonesia Summary Part NG in 2019 with a total of 1,620 data in building a system database. The data displays the Part Name, Part Number, the damage that occurred, the name of the maintenance that handled it, and so on. The following is a summary of the sample data on 7/1/2019 as a reference for research material and the system development process can be seen in table 1.

Table 1
Summary Damage Form

Date	P/No	P/Name	Damage Name	Damage Qty	Maintenance Name	Damage Variance
7/1/19	225834-0360A700	Heatsink	Equipment Problem	4	Roni S	Scratch
7/1/19	225834-0380A700	IC Power	Equipment Problem	5	Ahmad F	Broken
7/1/19	225834-0380A700	IC Flash Programing	Equipment Problem	2	Yunas A	Broken
7/1/19	225834-0390A700	Display Unit	Equipment Problem	1	Dedi I	Solder Bold
7/1/19	225834-04000700	Bluetooth	Equipment Problem	2	Roni S	Bending
7/1/19	225834-03000700	IC Audio	Equipment Problem	1	Akhmad F	Bending

Following an explanation of the description in choosing symptoms of damage, the authors classify the types of damage to the car audio section based on the symptoms experienced. Based on data obtained from direct interviews with 4 people in the maintenance section of the car audio section of PT. Denso Ten Manufacturing Indonesia in April 2020.

Table 2
Faults, Symptoms, and Solution

No	Damage	Symptom	Solution
1	IC Power	- totally dead - The display does not appear	Repair (Manual soldering, replace part)
2	IC Flash Programing	- totally dead - Blinking on display unit	Repair (Manual soldering, replace part)
3	Audio IC	- Loud beep - No beep sound appears	Repair (Manual soldering, replace part)
4	Display Unit	- Black dots appear on the display - A black line appears on the display unit	Repair (Manual soldering, replace part)

No	Damage	Symptom	Solution
5	Bloetooth	- Product cannot be paired - Bluetooth not detected	Repair (Manual soldering, replace part)

From the table 2 will be in the form of 3 tables, namely a table of symptoms and a table of cases in order to make it easier to analyze the problem of damage to car audio parts. The following table will be created:

1) Table of Damage

Below will be in the form of a table regarding damage by providing a code for each fault.

Table 3
Damage identification

Damage Code	Damage Name
K1	IC POWER
K2	IC FLASH PROGRAMING
K3	AUDIO IC
K4	DISPLAY UNIT
K5	BLUETOOTH BLUETOOTH

Table description: K is the damage code and 1 is the sequence of damage, so K1 means damage in the first order.

2) Symptom Table

Below will be in the form of a table regarding Symptoms by providing a code for each symptom of damage.

Table 4
Identification of symptoms of damage

SYMPTOM CODE	SYMPTOM NAME
G1	Totally dead
G2	Blinking on the display unit
G3	A loud sound
G4	There is no beep sound
G5	No display appears on the display unit
G6	Black lines appear on the display unit
G7	Black dots appear on the display unit
G8	Product cannot pair
G9	Bluetooth is not detected

Table description: G is the symptom code and 1 is the sequence of symptoms starting from the smallest value, namely 1, so G1 means the symptom in the first order.

3) Damage and Symptom Matrix

From the table data between the damage and symptoms table, a matrix table can be made to determine the similarity of symptoms experienced, which is presented in the table 5.

Table 5
Damage and symptoms matrix

FAULT CODE	SYMPTOM CODE				
	K1	K2	K3	K4	K5
G1	√	√			
G2		√			
G3			√		
G4			√		
G5	√				
G6				√	
G7				√	
G8					√
G9					√

From the data matrix above, it can be seen that to look for cases of the same symptoms, there are damage cases with code K1 with a total of 2 cases, K2 with a total of 2 cases, K4 with a total of 3 cases. From the symptom and damage data, it can be used as a new case or can be symbolized by X (X is a new symptom or new case).

3.2. Usecase Diagram

Use Case Diagrams describe the expected functionality of a system. What is emphasized is "what" the system does, and not "how". Use Case diagrams also describe the pattern of system behavior, the sequence of transactions that are related and carried out by one actor[11]. Figure 2 is a Usecase Diagram for consultation handling damage diagnosis.

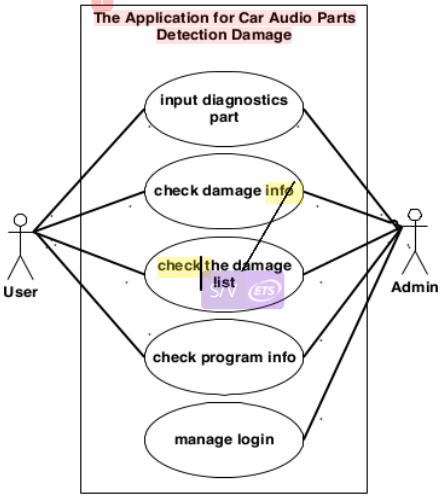

Fig 2. Usecase diagram

3.3. Database Design

In designing a database on this system[12], there are several tables that will be stored in a database. The tables are tabel, tmp_gejala, gejala, tmp_analisa, relasi, login, tmp_kerusakan, kerusakan, analisa_hasil.

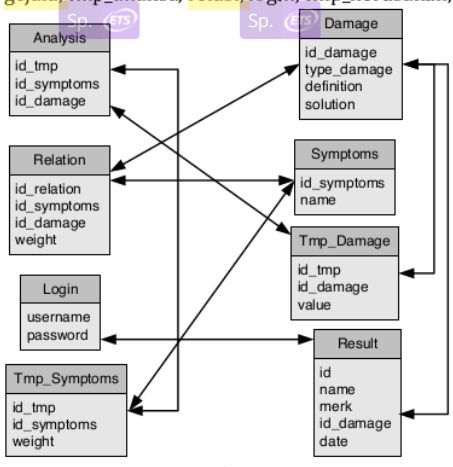

Fig. 3. Database Design

3. Result

4.1. Retrieve Process

Retrieve process is a process of finding the similarities between new and old cases. The search for similarities between new and old cases is done by matching the symptoms entered by the user with the symptoms in the knowledge base[13].The detection process is carried out by entering new cases (target cases) which contain signs of damage to be detected into the system, then the indexing system processes using the backpropagation method to obtain the index of the new cases. After the index is obtained, the system then calculates the value of the equation between the new case and the base case before it.

1) Calculation of cases in retrieving process

The first step in calculating the case in the retrieving process is as follows:

a) Determine the weight value

In handling the problem of damage to the car audio part, it is necessary to determine the identification of symptoms in each problem or problem encountered, there are several levels of problems encountered in each case, the first is severe symptoms, namely the problem level is high, the second is moderate symptoms, namely the level of problems in the case experience is relatively high, and the third is the usual symptom, namely the level of problem in the case experienced is low. For the determination of the weight value, it is determined based on the level of importance or urgency of handling on a scale of 1 to 5 (1 = ordinary, 5 = weight). so that a relative scale is found that is 3 which is then called (moderate). So it can be concluded in table form regarding the parameter weight assessment (w) as follows:

Table 6
Parameter weight

Parameter Weight	Symptom Level (w)
Severe Symptoms	5
Moderate Symptoms	3
Usual Symptoms	1

b) Score the weight for each symptom

The weight value for each symptom describes the weight value of each symptom, where the value is obtained from a direct interview with Maintenance[14]. The following is a table of the weighting values for each symptom.

Table 7
Weight values for each symptom

Symptom Code	Symptom Name	Weight Value
G1	Totally dead	5
G2	Blinking on the display unit	1
G3	A loud sound	3
G4	There is no beep sound	1
G5	No display appears on the display unit	5
G6	Black lines appear on the display unit	1
G7	Black dots appear on the display unit	1
G8	Product cannot pair	3
G9	Bluetooth is not detected	3

c) Determine the value of Similarity (s)

To determine the similarity value, it is determined based on the level of similarity in the previous case, the higher the similarity case, the higher the value and the lower the similarity value, the smaller the similarity value[15], in the case of diagnosing damage to the car audio part, the similarity value is 0 and 1 (0). = There is no similarity to the previous case, 1 = there is similarity or the previous case experienced by the next case.

Table 8
Similarity Of Symptom Attribute Values

SYMPTOM	SYMPTOM	SIMILARITY
Totally dead	Totally dead	1
Blinking on the display unit	Blinking on the display unit	1
No display appears on the display unit	No display appears on the display unit	1
Blinking on the display unit	Totally dead	0
Blinking on the display unit	No display appears on the display unit	0
No display appears on the display unit	Totally dead	0
No display appears on the display unit	Blinking on the display unit	0

d) Identification of problems regarding IC Power

Below is presented in the form of an old case identification table, namely the damage to the Power IC with a new case.

Table 9
Power IC case identification with new case (X)

No	Old Case and New Case		Value of Similarity (s)	Weight Parameter (w)
	K1	X		
1	Totally dead (G1)	Totally dead (G1)	1	5
2	No display appears on the display unit(G5)	Totally dead (G1)	0	5

From the table above, similarity can be found using the CBR calculation, which is as follows:
You know: S1 = 1, S2 = 0, W1 = 5, W2 = 5
Where:
Code S shows the similarity or similarity and Code W shows the weight of the parameter while column No shows the sequence of case names, from the description, it is obtained:

(1) S1 = the value in column S number one which has a value of 1 because the G1 symptoms experienced in the old case (K1) were also experienced by case X.
(2) S2 = the value in column S the second number which has a value of 0 because the G05 symptoms experienced in the old case (K1) have no resemblance to case X
(3) W1 = parameter weight value in column w number one which has a value of 5 because the G01 symptom is a severe symptom category.
(4) W2 = the parameter weight value in column w number two which has a value of 5 because the G05 symptom is a severe symptom category.

Then it can be entered into the formula (1). The similarity value between the old case Similarity (K1) and the new case X is 0.5

e) Identification of problems regarding IC Flash Programing

Below is presented in the form of an identification table of old cases, namely damage to the IC Flash Programming with new cases.

Table 10
Identification Of Ic Flash Programming Cases With New Cases (X)

No	Old Case and New Case		Value of Similarity (s)	Weight Parameter (w)
	K1	X		
1	Totally dead (G1)	Totally dead (G1)	1	5
2	Blinking on the display unit	Totally dead (G1)	0	1

From the table above, similarity can be found using the CBR calculation, which is as follows:
You know: S1 = 1, S2 = 0, W1 = 5, W2 = 1
Where:

Code S shows the similarity or similarity and Code W shows the weight of the parameter while column No shows the sequence of case names, from the description, it is obtained:

1) S1 = the value in column S number one which has a value of 1 because the G01 symptom experienced in the old case (K2) is also experienced by case X.
2) S2 = the value in the second number S column which has a value of 0 because the G02 symptoms experienced in the old case (K2) have no resemblance to case X.
3) W1 = parameter weight value in column w number one which has a value of 5 because the G01 symptom is a severe symptom category.
4) W2 = the parameter weight value in column w number two which has a value of 1 because the G02 symptom is a moderate symptom category.

The similarity value between the old case Similarity (K2) and the new case X is 0.833

f) Test Case Results

From the test results in each case, it can be seen the level of similarity of the tested cases, which is presented in the table 11.

Table 11
Results of Test Cases

CASE	CODE OF DAMAGE	SYMPTOMS CASE	VALUE DAMAGE	DIAGNOSIS CASE	SOLUTION
1	K1	TOTALLY DEAD NO DISPLAY APPEARS ON THE DISPLAY UNIT	0.5	IC POWER	REPAIR (MANUAL SOLDERING, REPLACE PART)
2	K2	TOTALLY DEAD BLINKING ON THE DISPLAY UNIT	0.833	IC FLASH PROGRAMING	REPAIR (MANUAL SOLDERING, REPLACE PART)

g) Similarity Value

From the table of test results, it can be seen which case has the lowest similarity value and the highest similarity value[16], from this data, the similarity value is close to the case, namely the K2 case or IC Flash Programming with a similarity level of 0.833 in the table below.

Conclusion From the calculation of all cases that have the highest similarity weight is the IC Flash Programming (K2) case, which is equal to 0.833, So, the IC Flas Programing case solution is recommended to users (because it has the greatest similarity weight value).

4.2. Testing Application

The following is a picture of a web-based application, the user will be asked to select the symptoms experienced by the part[17]. On this page the system will display the results of the symptoms inputted in the diagnostic process, this page displays the results of the similarity value and calculation of the case based reasoning method.

System testing aims to test pre-designed system components and to ensure that every element of the system functions as expected. Blackbox testing has been carried out by 4 people in the maintenance section of the car audio section of PT. Denso Ten Manufacturing Indonesia and 1 application admin, where all functions of the application such as logging in, adding damage types, adding rules, adding symptoms, and symptom reports are functioning and working properly.In the application test shown in Figure 4, 10 cases of damage types and symptoms were tested. The results obtained conformity with 100% accuracy.

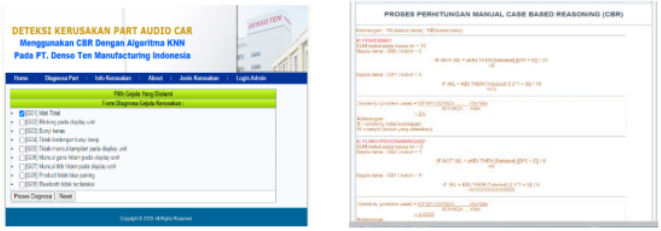

Fig. 4. Interface of Application

4. Conclusion

Based on the results of the discussion and testing, it can be concluded that the application can run and be used by users properly according to their needs and the results have 100% accuracy. The nearest neighbor algorithm is able to classify the problem of symptoms and car audio damage while CBR is able to solve problems that have been classified by the nearest neighbor algorithm. CBR is a method that works well in case-based reasoning, where the results of cases that have been analyzed are obtained from cases that have happened before.

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P/V You have used the passive voice in this sentence. You may want to revise it using the active voice.