# Expert System for Detecting Ear Diseases Using Case-Based Reasoning (CBR) Method

**Arridha Zikra Syah[1], Rolly Yesputra[2], Jhonson Efendi Hutagalung[2]**

[1] Faculty of Computer Science, Information Systems Study Program, Royal University, Kisaran, Indonesia

[2]Faculty of Computer Science, Computer Systems Study Program, Royal University, Kisaran, Indonesia

E-mail: [1*]azsyra@gmail.com, [2]rollyyp1@gmail.com,[3]jhonefendi12@yahoo.co.id

## ABSTRACT

The presence of innovation in the health sector generally experiences rapid changes and updates in various parts of human life. Data innovation is used to handle information in various ways to produce quality data, which is used for welfare purposes and is key data for direction. Earache is a disease of the inner or middle ear which generally causes different side effects on the ear. This ear infection generally attacks adults, adolescents, and children, causing high clinical costs. Therefore, we really need a tool or framework that can look like an expert in diagnosing a disease. The master framework is not used to replace expert capacity but is only used as an inseparable framework. An expert system is a structure that can imitate the thinking of a PC master and can handle problems that specialists generally solve. The procedure used in this master framework is the Case-Based Reasoning (CBR) strategy because this technique provides a comparability value for a case by remembering similar events that have occurred when using the data or information to overcome new or eventual problems. This issue can be resolved by applying the newly used settings. The best number of similarities between the third case shows that this new case practically has the same or equivalent side effects as the case with a higher score, especially the third old case, with a specific of 0.56, where the precision value of the similarity data for the current state is 4 %. This causes the data to be close between old cases and new cases.

***Keywords:*** *Expert System, Ear Disease, Case Based Reasoning (CBR)*

## INTRODUCTION

The presence of technology in the health sector always experiences rapid changes and updates in various parts of human life. Technology is available and continues to be improved as a positive form of convenience for society. Currently, without realizing it, society depends on the technology produced in advanced life, where media develops into new types of media. The characteristics of new media and one of the important materials in technological change are digital, where all information is in the form of numbers, which are then converted into text, photo illustrations, and so on [Aandanu et al., 2022]. Information technology is a technology used to handle information, including handling, obtaining, collecting, storing, and controlling information in various ways to produce quality data, especially relevant, precise, and precise data, which is used for individuals, businesses, and various things. Purposes. Government and is key data for independent direction[Ahmadiham et al., 2020]. Expert systems are part of the software engineering discipline in relation to computerised logic (Artificial Intelligence) that transfers human information to PCS so that PCS can solve problems as professionals usually do [Cholik & Cecep A. 2021]. This expert system is designed to recognize ear disease, namely an infection in the back or middle ear that lasts quite a long time and is characterized by discharge from the ear or a loud, painful buzzing sound that has become a disease. The problem of society is that the number of victims of ear disease is quite high due to the lack of medical personnel who are able to conduct examinations and provide diagnoses of infections suffered by the local community [Dedek Cahyati Panjaitan et al., 2021].

The ear is a very important organ for humans. This is because the ear is connected to the human hearing system. The ear is connected through the Eustachian tube, which causes disorders in one ear organ that will affect each other. Ear disease can attack individuals of all ages, and they only consider it a common disease that can be cured without the help of others [Dona et al., 2021].

The discovery of ear disease is usually done physically by visiting an emergency center or clinic. It is handled by a specialist or doctor, either a general professional or a specialist. Conclusions about the infection are made by a specialist considering the side effects experienced by the patient. Currently, PC innovation has penetrated all fields, including medicine. The expertise of this specialist will be communicated in PC innovation. Human skills in this PC are then known as (Specialist Framework) [Ikhsan et al., 2020].

The increasing incidence of ear disease and the lack of specialist doctors researching patients believed to have ear disease make the most common way to identify ear disease more difficult because each infection has many similar diseases and similar side effects. In general, the patient search system actually requires direct doctor involvement and physical investigations. The current situation certainly provides obstacles, especially the limited working hours for specialist patients who are really queuing for examination, as well as the limited time for patients to complete interview interactions. For this reason, a specialist framework is needed

as a means of simple access to obtain correct data obtained from specialists or individuals who are experts in certain fields [Imamah, Imamah & Akhmad Siddiqi, 2019].

Case-based reasoning (CBR) is one of the techniques that will be used to overcome existing problems. According to Francisca (2010), Case-Based Reasoning (CBR) is a technique for solving problems by remembering very/comparative events that have occurred before and after, utilizing this information/data to solve new problems, or ultimately solving problems by adjusting the settings that have been used previously [Indrasmara Cahaya, 2023].

It is believed that using a specialist system can accelerate the identification of ear disease so that the type of infection can be easily recognized. From the description above, the creator is interested in studying the "Expert System for Detecting Ear Diseases Using the Case-Based Reasoning (Cbr) Method" as an elective answer to the problems experienced by the local area [Julyana et al., 2023].

## LITERATURE REVIEW

### Decision Support System

#### Definition of Expert System

Expert systems are part of the software engineering discipline in relation to computerized logic (Artificial Intelligence) that transfers human information to a PC so that the PC can solve problems, as professionals usually do [Cholik & Cecep A. 2021]..

Benefits of Expert System. The advantages of the Specialist Framework are:

1) No cost when not in use, while human experts require daily costs.
2) Able to provide training for novice users who work with expert systems will become more experienced.
3) Can be duplicated (multiplied) as needed with minimal time and little cost.
4) Able to take and preserve the expertise of experts (especially those that include rare expertise).
5) Able to operate in hazardous environments.

#### Definition of Ear Disease

Ear and hearing disease problems are still a problem throughout the world. Ear diseases, including cerumen and middle ear disease / inner ear, are also common cases. In addition, one of the ear diseases is hearing loss, which can be caused by many factors and affects people of all ages, from birth to old age. The ear is one part of the human body that has an essential function and is an extraordinary organ that can function as a hearing and balance system. Ear disease is an important medical condition that often occurs, such as hearing loss, ringing, pulsation, and others. The most common causes of disorders in these organs are disease and responsiveness [Labolo et al., 2022].

**Definition of Case Base Reasoning (CBR)**

Case-based reasoning (CBR) is a case-based thinking that plans to handle other problems by adjusting the settings of past cases to be similar to new cases. New cases are coordinated with existing cases for the data set hoarding situation (case base), and at least one comparable case is found. The settings suggested through case matching are then reused for comparable cases. Assuming there are no new case pairs for the hoarding situation data set, CBR will store the new case (Hold) in the information data set. CBR execution can be used in various fields, especially clinical brain research, medicine, and others.

Four cycles occur in the CBR strategy in dealing with problems, namely:

1) Retrieve. In this cycle, the framework distinguishes suitable boundaries that can be used as a source of perspective and then looks for old cases that are similar to new cases.
2) Reuse. In this cycle, the system will reuse data from past cases or make adjustments first to overcome problems in the long term.
3) Revise. In this cycle, the framework will audit the settings obtained from old cases.
4) Retain. In this cycle, if by chance another setting is found that is superior to the existing setting, then the new setting will be ordered and set aside for later use in similar cases from now on [M Fachroni Azmi et al., 2020].

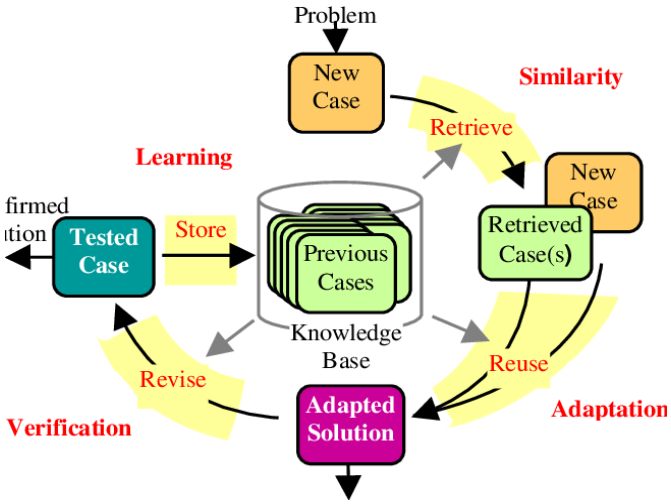


**Figure 1. Case-Based Reasoning Method Cycle**

**System Definition**

In this system, clients need to know the condition of their ears but also the obstacles to diagnosing and recognizing ear disease. From this problem, clients will be helped in determining the ear disease suffered by the surrounding environment [Marpaung et al., 2021].

**Case Similarity Measurement**

Finding cases that are similar to new cases means that each old case will be contrasted with other cases, considering the side effects experienced. The Similarity Methodology is a systemic strategy that can determine the severity of the closeness of a case so that if the case

is considered close enough, the case will be a response to the client's interests. Comparability carries out a weighted assessment check for each case that is its response, while the CBR computation recipe is as follows [Muh Jasmin et al., 2023].

$$Similitary\ (problem, case) = \frac{S1\ x\ W1 + S2\ x\ W2 + \ldots\ldots\ldots + Sn\ x\ Wn}{W1 + W2 + \ldots\ldots\ldots\ldots + Wn} \quad (1)$$

Description:

S: Similarity (Similarity Value), which is 1 (same) and 0 (different)

W: Weight (weight)

**Accuracy Value**

By looking for the precision value in testing, a proportion of data that matches what will be tried is needed. This also requires the number of existing cases that will assess accuracy at an early stage. The calculation recipe is as follows [Prasetyo et al, 2021].

$$\text{Nilai Keakuratan} = \frac{\text{Jumlah yang sesuai}}{\text{Jumlah Kasus}}\ x100\% \quad (2)$$

## METHODS

### Research Framework

The inspection system helps scientists in coordinating the investigation because it will act as an assistant in directing the investigation, so the discussion of each stage of the investigation can be described in the attached [Rosmini et al., 2025].:

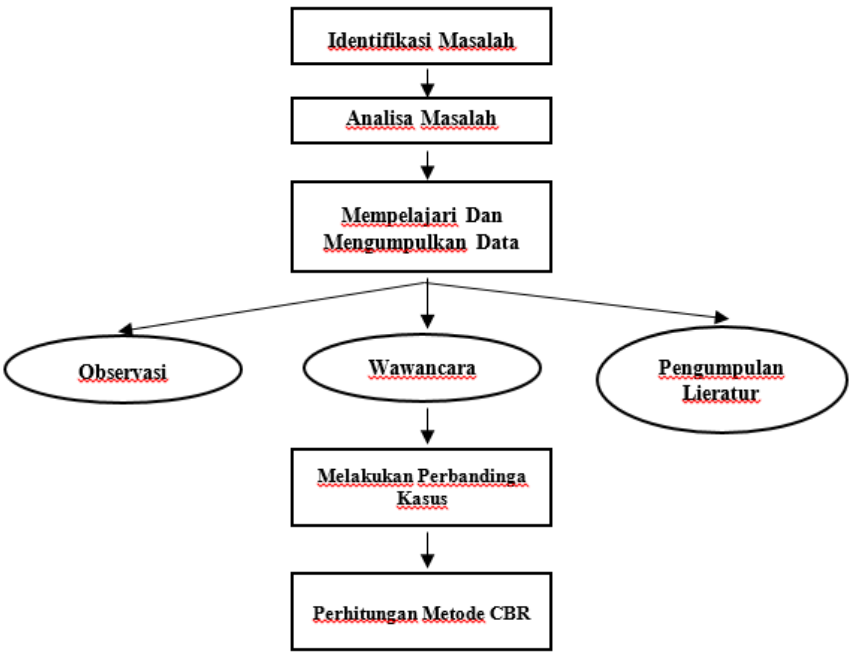


**Figure 2. Research Framework**

1) Identifying Problems. At this stage, determine the center of the problem in the exploration

so that you can find out the problems in the examination. The cycle and consequences of recognizing problems or inventorying problems.

2) Analyzing Problems. Problems that differentiate the interaction of evidence will give rise to a problem that will then be studied. The most common way to describe a research problem is through the stages of understanding a problem that has not been determined with certainty. By investigating unresolved problems, these problems can be understood and analyzed properly.
3) Studying and Collecting Data. This exploration is carried out to build jargon rules, ideas, and speculations that help complete the exam. This exploration is realized through books of understanding and daily notes that are connected to the examination carried out. The diversity of information, both basic information and supporting information, is very useful in helping to complete this exam. Methods that involve collecting information related to hypotheses, implementation, and testing using a special framework that has been collected will be arranged based on standards related to research. Collecting these rules will help improve the process of collecting exploratory information. After collecting information, the next stage is checking the information. The information and data collected will be used to help research; this information can be obtained through direct meetings with specialist doctors and internal medicine experts who can understand the most common ways to treat ear infections experienced by patients.
4) Data Collection Techniques.
    - Observation. Observation is a method of collecting information that collects information directly or different tiered reviews for the field or test location. By utilizing understanding, supervisors can see and target the situation directly and collect data that can be obtained through interviews.
    - Interviews. Through this collection framework, scientists collect several questions regarding problems related to ear contamination and direct questions and answers to ear specialists to obtain more data information.
    - Literature Collection. Collect important data from various sources, including books, journal articles, research reports, and various sources that may reveal knowledge about the subject being studied. These sources are obtained from libraries, online information bases, logical diaries, and others.
5) Conducting Case Comparison. After collecting a lot of information, the researcher can compare old cases with new cases to see if there are similarities [Siti Nurhayati et al., 2022].
6) CBR Method Calculation. After all the information has been collected and a correlation has been made between old cases and new cases, the researcher can start working on the CBR method calculation to get a bigger answer [Sitorus, Arfian Jumintar et al., 20225].

**RESULTS**

From the results of the review and examination of this expert system, this problem uses a case-based reasoning (CBR) strategy, which is used to facilitate the equivalence of existing cases with past cases, so it is very good as a justification in carrying out follow-up activities. A choice is that ear disease must be watched out for by considering the secondary effects experienced. By considering the meeting with experts to conclude the truth of each effect, then in general, will know about the seriousness of the secondary effects, with the following details:

The parameter weights (w) given are:

Important Symptoms: 5

Moderate Symptoms: 3

Common Symptoms: 1

Here, the examiner only takes 3 past cases to determine the assessment of cases with early side effects and cases with new secondary effects that occur in patients. The following is an outline of the symptoms of ear infection:

**Table 1. Old Case Symptoms List 1**

| *Kode* | *Gejala* | *Bobot* |
|---|---|---|
| $P_1$ | Pendengaran Hilang | 5 |
| $P_2$ | Telinga Keluar Nanah | 5 |
| $P_3$ | Telinga Berair | 1 |
| $P_4$ | Pendengaran Menurun | 3 |
| $P_5$ | Telinga Berdenging | 1 |
| $P_6$ | Telinga Tersumbat | 3 |

**Table 2. Old Case Symptoms List 2**

| *Kode* | *Gejala* | *Bobot* |
|---|---|---|
| $P_7$ | Daya Tahan Tubuh Pasien Rendah | 1 |
| $P_8$ | Telinga Nyeri | 5 |
| $P_9$ | Nyeri Kepala | 5 |
| $P_6$ | Telinga Tersumbat | 3 |
| $P_{10}$ | Pembengkakan Telinga | 5 |
| $P_4$ | Pendengaran Menurun | 3 |
| $P_5$ | Telinga Berdenging | 1 |
| $P_{11}$ | Kemerahan dan Gatal | 1 |

**Table 3. Old Case Symptoms List 3**

| Kode | Gejala | Bobot |
|---|---|---|
| $P_7$ | Daya Tahan Tubuh Pasien Rendah | 1 |
| $P_3$ | Telinga Berair | 1 |
| $P_4$ | Pendengaran Menurun | 3 |
| $P_8$ | Telinga Nyeri | 5 |
| $P_5$ | Telinga Berdenging | 1 |
| $P_{12}$ | Telinga Berdarah | 5 |
| $P_9$ | Nyeri Kepala | 5 |
| $P_6$ | Telinga Tersumbat | 3 |
| $P_{10}$ | Pembengkakan Telinga | 5 |

| | | |
|---|---|---|
| $P_1$ | Pendengaran Hilang | 5 |
| $P_2$ | Telinga Keluar Nanah | 5 |

**Table 4. List of New Case Symptoms**

| Kode | Gejala | Bobot |
|---|---|---|
| $P_{13}$ | Demam | 5 |
| $P_1$ | Pendengaran Hilang | 5 |
| $P_2$ | Telinga Keluar Nanah | 5 |
| $P_3$ | Telinga Berair | 1 |
| $P_4$ | Pendengaran Menurun | 3 |
| $P_5$ | Telinga Berdenging | 1 |
| $P_6$ | Telinga Tersumbat | 3 |
| $P_{11}$ | Kemerahan dan Gatal | 1 |
| $P_{14}$ | Adanya Tonjolan Dibagian Daun Telinga | 5 |
| $P_{10}$ | Pembengkakan Telinga | 5 |
| $P_{12}$ | Telinga Berdarah | 5 |

After the researcher has information on old cases with new cases, the next step is to correlate by matching information from both cases:

Same/existing values = 1

Non-existing values = 0

**Table 5. Comparison of Old Cases with New Cases**

| *Gejala Kasus Lama* | | | *Gejala Kasus Baru* | *Similarity* | | | *Bobot* |
|---|---|---|---|---|---|---|---|
| *1* | 2 | 3 | | 1 | 2 | 3 | |
| - | - | - | $P_{13}$ | 0 | 0 | 0 | 5 |
| $P_1$ | - | $P_1$ | $P_1$ | 1 | 0 | 1 | 5 |
| $P_2$ | - | $P_2$ | $P_2$ | 1 | 0 | 1 | 5 |
| $P_3$ | - | $P_3$ | $P_3$ | 1 | 0 | 1 | 1 |
| $P_4$ | $P_4$ | $P_4$ | $P_4$ | 1 | 1 | 1 | 3 |
| $P_5$ | $P_5$ | $P_5$ | $P_5$ | 1 | 1 | 1 | 1 |
| $P_6$ | $P_6$ | $P_6$ | $P_6$ | 1 | 1 | 1 | 3 |
| - | $P_{11}$ | - | $P_{11}$ | 0 | 1 | 0 | 1 |
| - | - | - | $P_{14}$ | 0 | 0 | 0 | 5 |
| - | $P_{10}$ | $P_{10}$ | $P_{10}$ | 0 | 1 | 1 | 5 |
| - | - | $P_{12}$ | $P_{12}$ | 0 | 0 | 1 | 5 |
| | $P_7$ | $P_7$ | - | - | 0 | 0 | 1 |
| | $P_8$ | $P_8$ | - | - | 0 | 0 | 5 |
| | $P_9$ | $P_9$ | - | - | 0 | 0 | 5 |

Then, to find out the closeness of the old case with the new case is formed by calculating the similarity value, which is as follows:

**Calculation on Old Case 1:**

$$Similitary\ (problem, case) = \frac{\text{S1 x W1 + S2 x W2 + ..... + Sn x Wn}}{\text{W1 + W2 + .....+ Wn}}$$

$$\text{S} = \frac{(0x5) + (1x5) + (1x5) + (1x1) + (1x3) + (1x1) + (1x3) + (0x1) + (0x5) + (0x5) + (0x5)}{5 + 5 + 5 + 1 + 3 + 1 + 3 + 1 + 5 + 5 + 5}$$

$$S = \frac{0+5+5+1+3+1+3+0+0+0+0}{39}$$

$$S = \frac{18}{39} = 0{,}461538$$

**Calculation on Old Case 2:**

$$Similitary\ (problem, case) = \frac{S1 \text{ x } W1 + S2 \text{ x } W2 + \ldots\ldots\ldots + Sn \text{ x } Wn}{W1 + W2 + \ldots\ldots\ldots\ldots + Wn}$$

$$S = \frac{(0x5)+(0x5)+(0x5)+(0x1)+(1x3)+(1x1)+(1x3)+(1x1)+(0x5)+(1x5)+(0x5)+(0x1)+(0x5)+(0x5)}{5+5+5+1+3+1+3+1+5+5+5+1+5+5}$$

$$S = \frac{0+0+0+0+3+1+3+1+0+5+0+0+0+0}{50}$$

$$S = \frac{13}{50} = 0{,}26$$

**Calculation on Old Case 3:**

$$Similitary\ (problem, case) = \frac{S1 \text{ x } W1 + S2 \text{ x } W2 + \ldots\ldots\ldots + Sn \text{ x } Wn}{W1 + W2 + \ldots\ldots\ldots\ldots + Wn}$$

$$S = \frac{(0x5)+(1x5)+(1x5)+(1x1)+(1x3)+(1x1)+(1x3)+(0x1)+(0x5)+(1x5)+(1x5)+(0x1)+(0x5)+(0x5)}{5+5+5+1+3+1+3+1+5+5+5+1+5+5}$$

$$S = \frac{5+5+5+1+3+1+3+1+5+5+5+1+5+5}{50}$$

$$S = \frac{28}{50} = 0{,}56$$

**Calculation of Data Accuracy in Case**

$$\text{Nilai Keakuratan} = \frac{\text{Jumlah yang sesuai}}{\text{Jumlah Kasus}}\ x100\%$$

$$K = \frac{0{,}56}{14}\ x100\%$$
$$K = 0{,}04\ x\ 100\% = 4\%$$

Therefore, similar data exist between past cases and new cases, and the best number of similarities between the three cases indicates that this new case has very similar or comparable side effects to the higher-value case. The accuracy value of the similarity information for the current situation is 4%, especially for the third old case, which is 0.56.

## CONCLUSION

As for the search that has been completed while thinking about the equation in the title "Expert System for Detecting Ear Diseases Using the Case-Based Reasoning (CBR) Method," it can be accepted that this expert structure can be used to accelerate the search and receipt of data for the entire population or community who need information about ear diseases. In addition, this application can also be used as a guide for the general public to complete early treatment

for common secondary effects that arise.

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