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Designing an Expert System for Diagnosing Otitis Disease Using Forward Chaining and Certainty Factor Methods

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Abstract

The ear is the five senses and is the external organ that most often interacts with external objects, the most common disturbance in the ear organs is an infection in the ear called otitis, otitis is an inflammation that causes an infection in the ear. Otitis itself has many types such as external, media, internal and others. with research using an Expert System, utilizing the Forward Chaining and Certainty Factor methods, it is hoped that it can help patients to be able to consult the system, as appropriate to consult an ENT-KL specialist, with an accuracy of up to 94% .

Keywords: *Detection, Expert System, Forward Chaining, Certainty Factor, infection in the ear called otitis*

1. Introduction

Errors that occur when diagnosing the disease can cause delays in treatment which can lead to death. Development of an expert system to diagnose broiler chicken disease using *forward chaining* and *certainty factor* and a combination of weight values. The results of testing the accuracy level of diagnosis of broiler chicken disease is 100% [1] . The cause of skin cancer is due to *ultraviolet radiation* which causes damaged skin cells. Skin cancer can be prevented if detected early before it spreads. This study aims to design an expert system for diagnosing skin cancer using the *forward chaining method* and *certainty factor* . The results of cancer diagnosis using this expert system show an accuracy rate of 100% [2] . The expert system is a system that has been widely used in the health sector because this system is considered to have the knowledge of an expert which is implemented into the system. So that the results of the diagnosis are in the form of intelligent reasoning. Research on the diagnosis of dental and oral diseases using the *certainty factor method* shows a diagnosis accuracy rate of 99% [3] .

Uncertainty Information from the diagnosis of the disease can lead to errors in the diagnosis. To prevent uncertainty, the *certainty factor* method is used . *Certainty factor* prevents uncertainty based on the *rule.* This study uses the *certainty factor method* in an expert system to diagnose seahorse disease. The results of testing the data show a high level of accuracy using *the certainty factor* [4] . One of the diseases that are dangerous for children is respiratory disease. The lack of specialist doctors causes delays in handling respiratory tract infections. This study aims to design an expert system for detecting respiratory tract diseases using *certainty factor* and *forward chaining* . The results of the diagnosis of respiratory tract infections with an accuracy rate of 90% [5] . The expert system for diagnosing rheumatic diseases uses *forward chaining* and *certainty factor methods.* Some of the rheumatic diseases diagnosed are *Rheumatoid Arthritis, Gout Arthritis,* and *Osteoarthritis.* The result of testing the diagnostic accuracy level of this expert system is 80% [6] . Otitis disease is often overlooked even though this disease can be dangerously contagious and deadly. This study designed an expert system for diagnosing otitis disease using the *forward chaining method* and *certainty factor.* The results of the Otitis diagnosis test showed an accuracy rate of 100% [7] .

The risk of choosing the wrong method of contraception can have an impact on the body of the user. It takes knowledge about the advantages and disadvantages of contraception. This study aims to choose contraceptives using the *forward chaining method* and *certainty factor* . The test results of this expert system show an accuracy rate of 75% [8] , making it difficult for consumers to choose a DSLR (Digital Single Lens Reflex) camera with good quality. The purpose of this study is to design an expert system that can recommend the selection of good quality DSLR cameras using the *forward chaining method* and *certainty factor* . The results of testing this expert system can recommend the selection of a DSLR camera that is relevant to the MOS values of 3.5 and 4 [9] . The structure of the expert system can be seen in Figure 1 [10] .

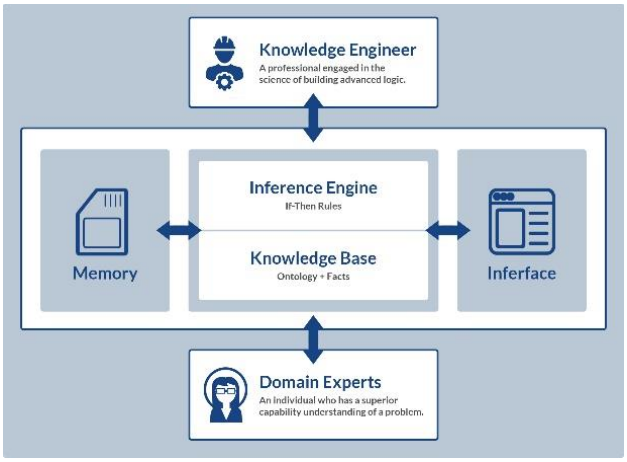

Figure 1. Architecture System Expert

2. Research Methodology

This framework is the stage carried out in this research to solve the problem. The framework can be seen as in Figure 2.

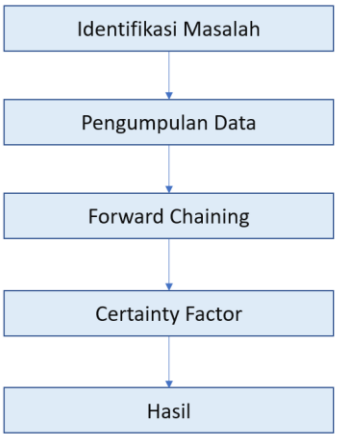

Figure 2. Framework

Identification of the problem of this study aims to direct this research to achieve the expected goals. The purpose of this study is to design an expert system for diagnosing otitis disease using *forward chaining* and *certainty factor methods*. *Forward Chaining* is a fact finding technique where the facts are known, then the facts are matched to the IF part of the If-THEN rule. If there are facts that match the IF part, then the rule is executed. Furthermore, when the rule is executed, a new fact (the THEN part) will be stored in the

database [11] . The *certainty factor* method is a method that can overcome uncertainty. *Certainty factor* shows a certainty value to a fact. *Certainty factor* has a maximum value of +1.0 (*Definitely*), while the minimum value is -1.0 (*Definitely not*). The positive value is the value of the degree of confidence and the negative value is the value of the degree of uncertainty [12] . The *Certainty Factor method* can be carried out as in formula 1 [13] .

$$\text{CF (} Rule \text{) = MB(H,E) * MD(H,E)} \quad (1)$$

$$MB(H,E) = \{\frac{MAX[P(H|E),P(H)]-P(H)}{MAX[1,0]-P[H]}, P(H) = 1 \quad (2)$$

$$MD(H,E) = \{\frac{MIN[P(H|E),P(H)]-P(H)}{MIN[1,0]-P[H]}, P(H) = 0 \quad (3)$$

Information:
CF (*Rule*) = *Certainty factor*.
MB(H,E) = a measure of confidence in hypothesis H, if given *evidence* E (between 0 and 1).
MD(H,E) = a measure of distrust of *evidence* H, if given evidence E (between 0 and 1).
P(H) = the probability of the truth of the hypothesis H.
P(H|E) = probability that H is true because of the fact E.

Collecting data related to anosmia in the form of medical records at RSUD M Djamil and conducting interviews with ENT specialist doctors. The sample data used are 7 types of anosmia disease that most often suffer as shown in Table 1.

Table 1. Disease Data

No	*Disease Code*	*Disease Name*
1	P01	Otitis Externa
2	P02	Otitis Media
3	P03	Otitis Interna
4	P04	Barotrauma
5	P05	Tinnitus
6	P06	Cholesteatoma
7	P07	Otosclerosis

In the Anosmia Disease Expert System, there are 7 types of diseases with codes P01-P07. Otitis disease has several symptoms that usually mark the type of disease that is infected, in this study of infectious otitis disease 37 symptoms were found that accompany the 7 diseases, as shown in table 2

Table 2. Symptom Data

No	Code	Symptom Name
1	G1	Itchy Ears
2	G2	Pain, especially when the ear is touched or pulled
3	G3	Ears look red and swollen
4	G4	Fluid coming out of the ear
5	G5	Ears feel full or clogged
6	G6	Fever
7	G7	A lump appears in the neck or around the ear due to swollen lymph nodes
8	G8	Headache
9	G9	Loss of appetite
10	G10	Difficulty sleeping at night
11	G11	Loss of balance

No	Code	Symptom Name
12	G12	Fluid coming out of the ear
13	G13	Smelly ears
14	G14	Vertigo
15	G15	Ears ringing
16	G16	Acute ear pain
17	G17	Difficult to focus on eyes
18	G18	Hearing loss in the high frequency area of one ear
19	G19	Ears feel uncomfortable
20	G20	Foreign object in ear
21	G21	The habit of picking the ear too deeply using certain objects, such as cotton buds or toothpicks
22	G22	A very loud sound, like an explosion
23	G23	Impact or injury to the head or ear
24	G24	Barotrauma or sudden changes in air pressure, for example when in an airplane or diving
25	G25	Disorders of nerve cells in the ear
26	G26	aging
27	G27	The habit of hearing voices at a loud volume, either for a short period of time or for a long time
28	G28	Earwax blockage
29	G29	Hardened ear bones
30	G30	Painful
31	G31	Ears smell bad
32	G32	Ears feel full or clogged
33	G33	Weakening of facial muscles on the side of the ear affected by cholesteatoma
34	G34	Difficult to hear low voices and whispers
35	G35	Tend to speak in a low voice, because one's own voice sounds louder
36	G36	Tend to be easier to hear when the atmosphere around is noisy
37	G37	Hearing loss that gets worse over time

Table 2 describes the symptoms used in this study as many as 37 data with coding from G01-G37

Table 3. Rules for determining the type of disease using *Forward Chaining*

No	Mechanism
1	IF G1 is true AND G2 is true AND G3 is true AND G4 is true AND G5 is true AND G6 is true AND G7 is true AND THEN P1
2	IF G8 is true AND G9 is true AND G10 is true AND G11 is true AND G12 is true AND G13 is true AND THEN P2
3	IF G14 is true AND G15 is true AND G16 is true AND G6 is true AND G17 is true AND G18 is true AND G19 is true AND THEN P3
4	IF G20 is true AND G21 is true AND G22 is true AND G23 is true AND G24 is true AND THEN P4
5	IF G25 is true AND G26 is true AND G27 is true AND G28 is true AND G29 is true AND THEN P5
6	IF G30 is true AND G31 is true AND G12 is true AND G32 is true AND G33 is true THEN P6
7	IF G34 is true AND G35 is true AND G36 is true AND G37 is true AND G17 is true THEN P7

Table 3 shows the relationship that symptoms with codes G1, G2, G3, G4, G5 and G6 are P1 disease. The weighting of MB and MD values that have been agreed upon by researchers and experts can be seen in Table 4 as follows:

Table 4 . Assurance Value

Interpretation	Score
Definitely not	-1.0
Almost certainly not	-0.8
Most likely not	-0.6
Probably not	-0.4
Don't know	-0.2-0.2
maybe	0.4
Most likely	0.6
Almost sure	0.8
Certain	1.0

Certainty Factor algorithm will be used to find the confidence value from the results of the *rule search* obtained from *Forward Chaining* . The MB and MD values obtained from the experts in rule 2 are as follows; *IF* G1 *is true AND* G2 *is true AND* G3 *is true AND* G4 *is true AND* G5 *is true AND* G6 *is true AND THEN* P1.

MB Nilai Value	MD Nilai value
$CF_{Mbcombine1}(CF_{MBG01}, CF_{MBG02})$ $= CF_{MBG01} + CF_{MBG02} \times (1 - CF_{MBG01})$ = 0.6 + 1 * (1 – 0.6) = 0.6 + 1 * 0.4 = 0.6 + 0.4 = 1	$CF_{Mdcombine1}(CF_{MDG01}, CF_{MDG02})$ $= CF_{MDG01} + CF_{MDG02} \times (1 - CF_{MDG01})$ = 0.2 + (-0.2 * (1– 0.2) = 0.2 + (-0.2 * 0.8) = 0.2 – 0.16 = 0.04
$CF_{Mbcombin2}(CF_{Mbcombine1}, CF_{MBG03})$ = 1.0 + 0.6 * (1 – 1.0) = 1.0 + 0.6 * 0 = 1.0 + 0 = 1	$CF_{MDcombin2}(CF_{Mbcombine1}, CF_{MDG03})$ = 0.04 + 0.1 *(1 – 0.04) = 0.04 + 0.1 * 0.96 = 0.04 + 0.96 = 1
$CF_{Mbcombin3}(CF_{Mbcombine2}, CF_{MBG04})$ = 1.0 + 0.8 *(1 – 1.0) = 1.0 + 0.8 * 0 = 1.0 + 0 = 1	$CF_{Mdcombin3}(CF_{Mbcombine2}, CF_{MDG04})$ = 1.0 + 0.1*(1-1) = 0.136
$CF_{Mbcombin4}(CF_{Mbcombine3}, CF_{MBG05})$ = 1.0 + 1.0 * (1 – 1.0) = 1.0 + 1.0 * 0 = 1.0 + 0 = 1	$CF_{Mdcombin4}(CF_{Mbcombine3}, CF_{MDG05})$ = 0.136 + -0.1 * (1 – 0.136) = 0.0496
$CF_{Mbcombin5}(CF_{Mbcombine4}, CF_{MBG06})$ = 1.0 + 1.0 * (1 – 1.0) = 1.0 + 1.0 * 0 = 1.0 + 0 = 1	$CF_{Mdcombin5}(CF_{Mbcombine3}, CF_{MDG06})$ = 0.0496+ 0.2 * (1 – 0.496) = 0.23968

$$CF(Rule2)=MB(H, E)-MD(H, E) \quad (4)$$
$$= CF_{MBbcombin5} - CF_{MDcombin5}$$
$$= 1 – 0.23968$$
$$= 0.76032$$

CF diagnosis of otitis externa. Based on the results of these calculations, the CF of ear disease (Otitit Eksterna) is 0.76032 or 76.32%.

3. Result and Disscusion

Implementation of the system design that has been made using the PHP programming language with MySQL *database* as storage media. Based on manual and system calculations, it can be found the similarity of certainty values for each Otitis disease which can be seen in Table 5 as follows:

Table 5. Achieved CF values

No	Disease Name	CF value
1	Otitis Externa	0.7527168
2	Otitis Media	0.940896
3	Otitis Interna	0.8211456
4	Barotrauma	0.76032
5	Thinitus	0.85536
6	Cholesteatoma	0.8554
7	Otosclerosis	0.78408

3.1. Database Implementation

The database designed consists of five tables, which consist of an admin table for admin access rights as input data processing on the system, a diagnostic table used in storing anosmia disease data along with disease codes, a symptom table containing data from each anosmia disease symptom, a consultation table that used to store user consultation history and relation table which is a connecting table for *rule formation* and weighting of each symptom.

3.2. Interface Implementation

Mozilla or google chrome) in its use. Users can choose a menu from several menu forms consisting of:

Figure 4. Application Start Menu

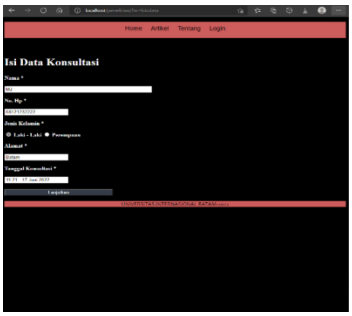

Figure 6. Consultation Start Menu

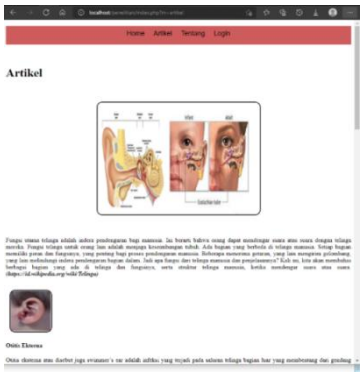

Figure 5. Article Menu

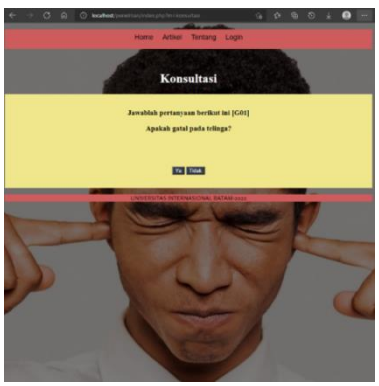

Figure 7. Consultation Menu

User consultation activity on the system by asking questions related to symptoms and the *user* answers by clicking the 'Yes' and 'No' buttons.

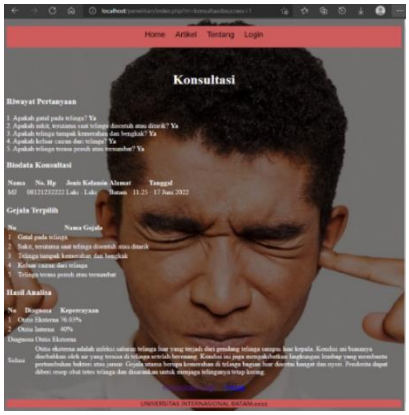

Figure 8. Consultation Results Menu

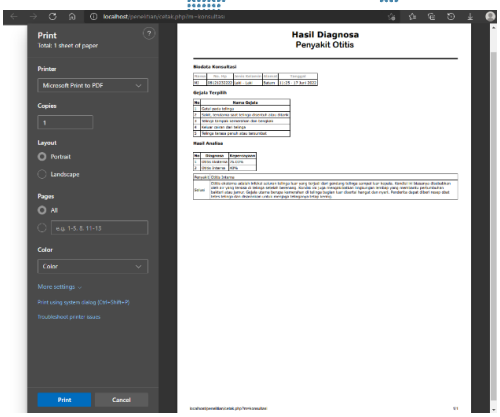

Figure 9. Consultation Result Report

User consultation on the system with selected symptoms G1, G2, G3, G4 and G5 as the result of Otitis External disease with a confidence level of 76.03%. In this study, a trial of the Expert System application was carried out to detect Inflammatory Ear Disease or Otitis to 15 *users* , the results obtained from these tests and compared with the opinions of ENT specialists-KL, the accuracy of the system is 100% from the data from RSUD M Djamil.

4. Conclusion

From the results of the description of the research that has been carried out above, several conclusions are the design of the Expert System Application to detect Otitis Disease can determine the type of inflammatory ear disease or otitis according to the symptoms felt by system users with the *Forward Chaining* and *Certainty Factor methods* so as to help the wider community in detecting the type of disease and determine the first step in treating the disease using an application in the form of Otitis Disease Expert System website . By using the *Forward Chaining* and *Certainty Factor methods* as tools , the system is able to determine the type of inflammatory ear disease or otitis in accordance with the specialist's expertise and provides a certainty value for system users suffering from a diagnosed disease in the percentage value of confidence. With a system testing accuracy rate of 100%.

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