International Journal of Information System & Technology
Akreditasi No. 158/E/KPT/2021 | Vol. 6, No. 2, (2022), pp. 186-195

Analysis and Design of Anosmia Disease Diagnosis Expert System Using Forward Chaining and Certainty Factor Methods

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Abstract

The nose is an important organ for the body as the five human senses, disorders often occur in the nasal organs, one of which is anosmia disease, ansomia is a disorder that occurs in the nasal organs that can eliminate the sufferer's ability to feel smells, basically anosmia is common, but in the midst of a serious pandemic. With research on Expert Systems using the Forward Chaining and Certainty Factor methods so that users can consult the system like consulting an ENT-KL specialist doctor with an accuracy of 96%..

Keywords: *Anosmia, Certainty Factor, Forward Chaining, Expert System*

1. Introduction

The development of information technology is very fast over time. One of the branches of science is artificial intelligence. Artificial intelligence has several related sciences, namely the sac system, artificial neural network, computer vision, etc. This study will discuss the design of an expert system using the forward chaining method and the certaity factor[1]. These technological advances are very helpful for humans in all fields including the world of health, this research aims to help diagnose infectious skin diseases by utilizing the Forward Chaining and Certainty Factor methods with an accuracy rate of up to 100% [2]. Frequent errors in diagnosing the type of disease can lead to mishandling which can lead to death. This study aims to develop an expert system for diagnosing disease in broiler chickens using the forward chaining method and certainty factor as well as a combination of symptom weight values. The results of the diagnostic test of broiler chicken disease show a validation accuracy rate of 100%[3].

Disease diagnostic information allows the results to be a statement of uncertainty. So to prevent the results of uncertainty in the expert system, the certainty factor method is used. This method can overcome uncertainty based on the rule set. In this study, the certainty factor method is applied to diagnose seahorse disease in an expert system. The test results show the certaity factor method can overcome uncertainty in the expert system with a high level of accuracy[4]. This study aims to develop an expert system for diagnosing rheumatic diseases using the forward chaining method and certainty factor. The types of rheumatic diseases diagnosed were Gout Arthritis, Rheumatoid Arthritis, and Osteoarthritis. The results of testing the data using the forward chaining method and certainty factor show a high level of accuracy, which is 80%[5].

Respiratory tract disease in children is a disease that is quite dangerous for children. It takes a doctor who is an expert in handling respiratory tract infections. Lack of expert doctors causes slow treatment of respiratory tract infections. This study designed an expert system for detecting respiratory tract infections using the forward chaining method and certainty factor. The results of the disease diagnosis test show an accuracy rate of 90%[6]. The choice of contraception is not an easy thing because the risks or effects have an impact on the body that has never used it. Not all contraceptives are always suitable for the body of the user. So it takes knowledge to know the advantages and disadvantages of each contraceptive. To choose the contraceptive method, the forward chaining method is

ISSN : 2580-7250

used and combined with the certaity factor method. The results of the combined test of the two methods produce an accuracy rate of 75%[7].

Technological advances in the digital era allow the availability of various Digital Single Lens Reflex (DSLR) camera products. This condition makes it difficult to choose a DSLR camera that suits consumers. This study aims to design an expert system to help recommend DSLR cameras using the forward chaining method and certainty factor. The recommendation results are then represented in the Mean Opinion Score (MOS) value. The evaluation resulted in an MOS score of 3.5 out of 4, proving that the expert system can make relevant recommendations[8].

Expert systems are widely used in the health sector because expert systems are seen as knowledge of an expert that is implemented into a system. So that the resulting decision is in the form of intelligent reasoning. In this study, the certainty factor method is applied to diagnose dental and oral diseases. The test results for the diagnosis of dental disease and smooth showed an accuracy rate of 99%. Skin cancer is the abnormal growth of skin cells that cannot be controlled. Skin cancer arises because the [9]DNA of skin cells is damaged by ultraviolet radiation. This skin cancer can be prevented if detected early before it spreads. But most people are indifferent and do not want to check or consult a doctor so that the condition worsens without realizing it. This study designed an expert system for skin cancer detection using forward chaining and certainty factor methods. The results of the skin cancer diagnosis test show an accuracy rate of 100%[10]. The structure of the Expert System has 2 main parts, namely the development environment which is the part that is used to enter knowledge from experts into the Expert System, and the consulting environment is the part that is used by non-expert users to gain knowledge. The structure of the Expert System can be seen in Figure 1[11].

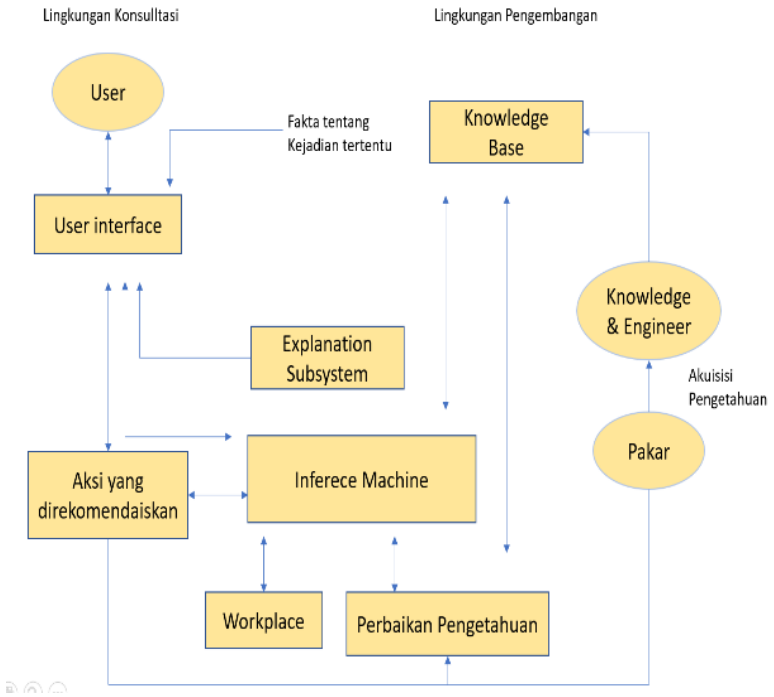

Figure 1. Expert System Architecture.

2. Research Methodology

This framework is a step-by-step process to solve the problems in this research. The framework can be seen as in Figure 2.

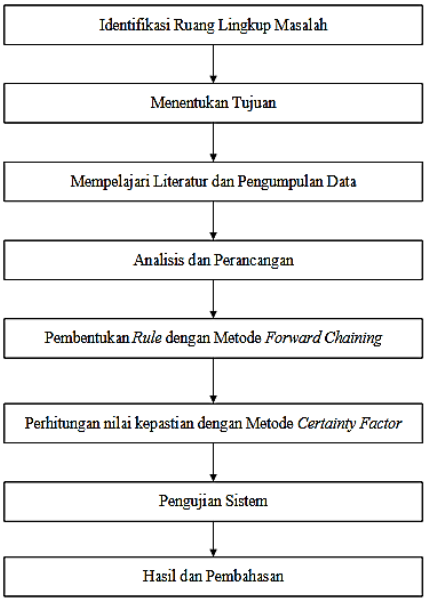

Figure 2. Research Framework

2.1. Identification of Problems

The identification phase of the problem scope of this research aims to direct the achievement of the expected research objectives. The purpose of this study is to design an expert system to detect anosmia disease early on by using the Forward Chaining and Certainty Factor methods.

2.2. Data Collection

Collect literature and study it so that it can be used as a reference for research. Collecting data related to anosmia in the form of medical records at M Djamil Hospital and conducting interviews with ENT specialist doctors. The sample data used are the 6 most common types of anosmia, as shown in Table 1.

Table 1. Data on Anosmia Disease

No	Disease Code	Disease Name
1	P01	Sinus Infection
2	P02	Have a cold
3	P03	Flu
4	P04	Allergic Rhinitis
5	P05	Allergic Non-Rhinitis
6	P06	Covid-19

Anosmia disease has several symptoms that usually mark the type of disease that is infected, in the study anosmia disease has 33 symptoms that accompany the 6 diseases, as shown in Table 2.

Table 2. Symptom Data

No	Code	Symptom Name
1	G1	Headache
2	G2	Sore throat
3	G3	Feels a lot of pressure on the face
4	G4	The nose continues to run with a thick green liquid.
5	G5	Smelly breath
6	G6	Tooth pain
7	G7	Sneeze.
8	G8	difficulty breathing or shortness of breath

No	Code	Symptom Name
9	G9	dry cough
10	G10	The body feels tired.
11	G11	Nasal congestion
12	G12	Body aches
13	G13	Fever 1-3 days
14	G14	Cough (with breath accompanied by wheezing (breath sounds wheezing))
15	G15	shivering body
16	G16	stuffy or runny nose
17	G17	Coughs.
18	G18	Eyes itchy or watery.
19	G19	Swollen eyes and dark lower eyelids (panda eyes).
20	G20	Itching of the mouth and throat.
21	G21	A rash appears on the skin.
22	G22	Weak.
23	G23	Irritants in the surrounding environment, such as perfume, cigarette smoke, and air pollution fumes
24	G24	mucus (phlegm) in the throat (postnasal drip)
25	G25	drug use
26	G26	high fever 3.8 degrees and above
27	G27	easy to get tired
28	G28	body aches and pains
29	G29	diarrhea
30	G30	chest pain
31	G31	red or irritated eyes
32	G32	difficulty speaking or moving, or being confused
33	G33	rash on the skin, or discoloration of the fingers or toes

Analysis of the requirements needed for the system to be designed, namely the display design to the file design of the system. So that patients who will consult with the expert system can easily conduct consultations.

2.3. Forward Chaining

Formation of Rule With Forward Chaining Methodis a known fact-finding technique. Then the facts are matched against the IF part of the IF-THEN rules. If there are facts that match the IF part, then the rules are executed. After the facts are executed, the THEN part is stored in the database[12]. The following are the stages of the Forward Chaining algorithm [13]:

a) Defining the Problem.
b) Data to be processed.
c) Determine the rule based on the data.
d) The result of rule identification.

2.4. Certainty Factor

Calculation of the certainty value with the Certainty Factor method.*Certainty Factor*the method used to overcome uncertainty. *Certainty Factor*measure the certainty value of an expert. The maximum value of CF is 1.0 (definitely true), while the minimum value of CF is -1.0 (definitely false) [14]. Processing of the CF method can be carried out as in formula 1[15].

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

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

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

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.

3. Result and Discussion

AnalysisAnosmia disease relation can be seen inTable 3 rules for determining the type of disease using Forward Chaining.

Table 3. Rule 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 THEN P1
2	*IF*G2 is true AND G7 is true AND G8 is true AND G9 is true AND G10 is true AND G11 is true AND THEN P2
3	*IF*G2 is true AND G1 is true AND G12 is true AND G13 is true AND G14 is true AND G15 is true AND G16 is true AND THEN P3
4	*IF*G7 is true AND G11 is true AND G17 is true AND G18 is true AND G19 is true AND G20 is true AND G21 is true AND G22 is true AND THEN P4
5	*IF*G11 is true AND G17 is true AND G23 is true AND G24 is true AND G25 is true AND THEN P5
6	*IF*G1 is true AND G2 is true AND G8 is true AND G26 is true AND G27 is true AND G28 is true AND G29 is true AND G30 is true AND G31 is true AND G32 is true AND G33 is true AND THEN P6

In Table 3. Shows the relationship that symptoms with codes G1, G2, G3, G4, G5 and G6 are P1 disease. Calculation of Certainty Value with Certainty Factor usingThe weighting of MB and MD values that have been agreed upon by researchers and experts can be seen in Table 4.

Table 4. Weights of Certainty Values

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

In this stage, a 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 Value
CFMbcombine1 (CFMBG01, CFMBG02)
= CFMBG01 + CFMBG02 x (1 - CFMBG01)
= 0.6 + 1 * (1 – 0.6)

= 0.6 + 1 * 0.4
= 0.6 + 0.4
= 1
CFMbcombin2 (CF Mbcombine1, CFMBG03)
= 1.0 + 0.6 * (1 – 1.0)
= 1.0 + 0.6 * 0
= 1.0 + 0
= 1
CFMbcombin3 (CF Mbcombine2, CFMBG04)
= 1.0 + 0.8 *(1 – 1.0)
= 1.0 + 0.8 * 0
= 1.0 + 0
= 1
CFMbcombin4 (CF Mbcombine3, CFMBG05)
= 1.0 + 1.0 * (1 – 1.0)
= 1.0 + 1.0 * 0
= 1.0 + 0
= 1
CFMbcombin5 (CF Mbcombine4, CFMBG06)
= 1.0 + 1.0 * (1 – 1.0)
= 1.0 + 1.0 * 0
= 1.0 + 0
= 1

MD value
CFMdcombine1 (CFMDG01, CFMDG02)
= CFMDG01 + CFMDG02 x (1 - CFMDG01)
= -0.1 + (-0.2 * (1– -0.1)
= -0.1 + (-0.2 * 0.8)
= -0.1 – 0.22
= -0.32
CFMDcombin2 (CF Mbcombine1, CFMDG03)
= -0.32+ 0.1 *(1 – -0.32)
= -0.32+ 0.1 * 0.64
= -0.32+ 0.64
= -0.19
CFMdcombin3 (CF Mbcombine2, CFMDG04)
= -0.19+ (-0.1 * -0.19)
= -0.307
CFMdcombin4 (CF Mbcombine3, CFMDG05)
= -0.307+ 0.1 * (1 – -0.307)
= -0.0454
CFMdcombin5 (CF Mbcombine3, CFMDG06)
= -0.0454+ 0.1 * (1 – -0.0454)
= 0.163648

CF(Rule2)=MB(H, E)-MD(H, E)
= CFMBbcombin5 - CFMDcombin5
= 1 – 0.163648
= 0.836352

Based on the results of these calculations, the CF of sinus infection is 0.836352 or 83.63%. 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 anosmia disease which can be seen in Table 5.

Table 5. Achieved CF values

No	Disease Name	CF value
1	Sinus Infection	0.836352
2	Have a cold	0.940896
3	Flu	0.8211456
4	Allergic Rhinitis	0.8279885
5	Non-allergic rhinitis	0.92928
6	Covid 19	0.8743558

The database implementation designed consists of five tables, which consist of an admin table for admin access rights as input data processing on the system, a diagnosis table used in storing anosmia disease data along with disease codes, a symptom table containing data from each anosmia disease symptom, a consultation table which is used to store user consultation history and relation table which is a connecting table for rule formation and weighting of each symptom. The implementation of this research uses the PHP programming language using a web browser (mozilla or google chrome) in its use as shown in Figure 3.

Figure 3. Application Start Menu

Figure 4 is a user consultation activity on the system by asking questions related to symptoms and the user answers by clicking the 'Yes' and 'No' buttons.

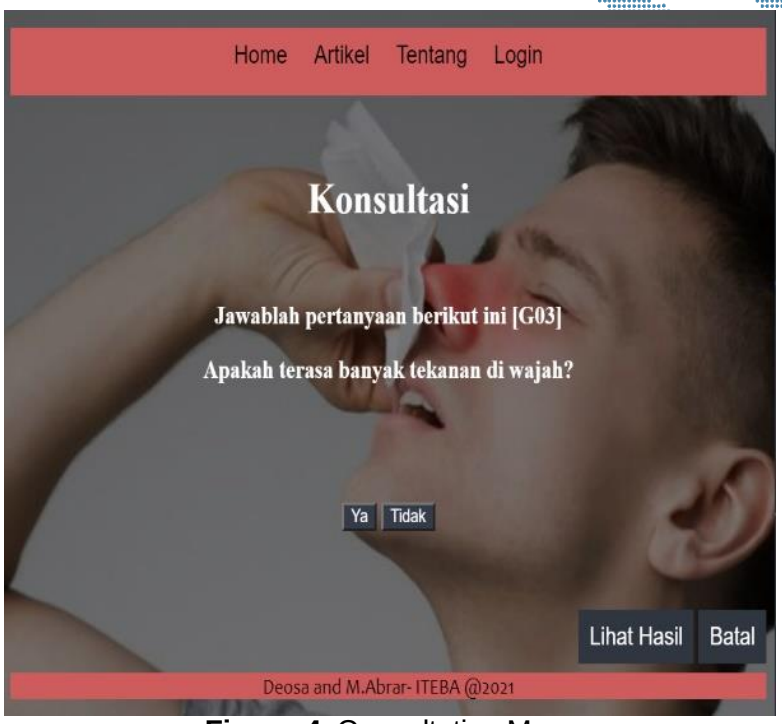

Figure 4. Consultation Menu

The results of the consultation with an expert system for diagnosing anosmia can be seen in Figure 5.

Figure 5. Consultation Results

4. Conclusion

From the exposure of the research above, the results obtained in the form of a design of an expert system application to detect anosmia disease that can be used by sufferers as an online consultation medium, by utilizing a combined method of Forward Chaining and Certainty Factor. The results of the consultation of patients who become users in the system are appropriate and able to determine the type of disease suffered by the user

according to the expertise of a specialist in Ear Nose Throat and Head Neck Disease (ENT-KL) with a system accuracy rate of 96%.

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