Implementation of Expert System for Detection Periodontitis Disease Using Fuzzy Logic

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Article Info	ABSTRACT
	The wellbeing area is one region that requires innovation in technology. Wellbeing is for sure a costly thing for people. In this manner it takes individual affectability to care for it. One of the solid organs that people frequently disregard is teeth and mouth. Periodontitis is a dental and oral illness that is frequently grumbled of by numerous individuals. In any case, as of recently, periodontitis has not been a critical worry of Indonesian individuals. It is important to give data and comprehension about periodontitis side effects to dynamic smokers by making an expert system. A system is expected to distinguish the underlying indications and straightforwardly beat these side effects. The expert system is a part of Computer Science that fills in as a spot to move information from specialists so computers can have the aptitude to tackle issues utilizing these specialists' information. The technique utilized in this examination is the Fuzzy Logic strategy. This present investigation's eventual outcomes are analytic outcomes from the fluffy rationale technique, where the exactness of the Fuzzy Logic strategy is 93.33%.

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1. INTRODUCTION

At this time, the use of computer technology can be seen in various areas of life. One of them is in the field of Health in the problem of diagnosing diseases. One of the diseases diagnosed using computer technology is disease periodontitis. Periodontitis is a disease mostly caused by cigarettes. Cigarettes contain chemicals such as Nicotine, Tar, Arsenic, Carbon Monoxide, BenzeneI, etc. The largest group is nitrogen compounds, which are 24%, as well as 15% hydrocarbons. The main component is carbon monoxide (CO), namely 5-23 mg/cigarette, nitric acid: 0.1-1.6 mg/cigarette, acealdehyde: 0.2-1.3 mg/cigarette, acid format: 0.1-1.1 mg/cigarette, methyl chloride 0.1-0.8 mg/cigarette, cyanide acid: 0.03 - 0.7 mg/cigarette, as well as 50 other carcinogen compounds (Sumerti,2016,) (Mellawati, J., & Chichester, D. 1996). The substances contained in tobacco identified a number of 2500 components that have been identified chemical components. (Tirtosastro, S, et al., 2009). An active smoker has a six times higher risk of contracting periodontitis than non-smokers. However, most people tend to rarely check the condition of teeth and mouth so that awareness and knowledge about periodontitis disease is minimal in addition to economic factors that are one of the problems people are reluctant to consult and examine their teeth and mouth. For this reason, an expert system is needed that can help the general public in consulting with dentists and oral experts and free of charge. By implementing fuzzy logic method

in this expert system is expected to produce high accuracy value in producing diagnosis. Fuzzy logic method is generally applied to problems that contain elements of uncertainty, inaccuracy (imprecise), noisy, and so on. Fuzzy logic bridges precision machine language with human language that emphasizes significance so that it can help generate certainty for diagnose results in periodontitis.

2. RESEARCH METHODE

Expert system is a system that aims to transfer knowledge from an expert into a system. Implementation of the expert system can be added with various methods to improve the value of system accuracy in providing out-of-product results or diagnoses. Various researches on expert systems in various fields including in the field of Health. The expert system is divided into several parts, namely the Rule-Based Expert System, the Frame-Based Expert System, the Fuzzy Logic-Based Expert System and the Expert System Based on Neural Network. In this research the expert system used is fuzzy logic based expert system. Based on various expert system implementations that use fuzzy logic method that the advantages or advantages of using fuzzy logic method can imitate the ability of an expert with a high level of durability and can do reasoning heuristically and tentatively. (Tan, 2017) (Zadeh, 1965) (Soltania, et all, 2017).

Various implementations using fuzzy method have been conducted as an example of research conducted on health problems related to dental and oral health conducted in various studies (Simanjuntak et all, 2018) (Krisnawan et all, 2014)(Rochana et all,2014) (Tuslaela, P, 2018) (Hardi, et all, 2020). Cigarettes contain addictive substances that are very dangerous for human health. Addictive substances are substances that if consumed by humans will cause addiction or addiction and can cause a variety of diseases such as heart disease, blood vessels, stroke, chronic obstructive pulmonary disease, lung cancer, can also cause the onset of pathological conditions in the oral cavity. Active smokers have higher levels of plaque compared to non-smokers, in other words smokers have worse oral hygiene compared to non-smokers(Asiking, 2016). Poor oral hygiene conditions can lead to periodontal disease for longer. (Sumerti, 2016),(Yosadi,2013)

In this research, the implementation of expert system was built using fuzzy logic method. There are a few phases that should be finished by doing issue investigation, specifically by distinguishing or assessing different issues and hindrances that will emerge in the system so that later should be possible countermeasures, enhancements or likewise improvement. After the analysis of the problem and then done analysis of fuzzy logic method used in this research. Here is the stage of research conducted in this study that begins with the collection of symptom data and examples of cases that occur in periodontitis. Symptom data obtained from interviews with experts. Here is the symptom data along with symptom weight that can be seen in table 1 below.

Table 1. Symptoms of Periodontitis and Weight of Symptoms

No	Sympthomps	Weights
S1	Buildup of plaque and tartar on teeth	0.8
S2	The mouth feels bad and the breath becomes smelly	0.9
S3	Shrinkage of the gums, so that the size of the teeth looks higher than usual.	0.9
S4	Discharge of pus in the part that limits the teeth and gums	0.6
S5	The distance between one tooth and the other feels stretchy.	0.8
S6	Pain when chewing.	0.1
S7	Gums are swollen and are red or punglish.	0.4
S8	Rocking Teeth	0.6
S9	Gums feel soft to the touch	0.6
S10	The presence of stains on the teeth	0.4
S11	Sensitive teeth	0.1
S12	Cavities	0.4

After the collection of symptom data, fuzzy rule is made that is useful to determine the final result of the process of determining the conclusion of the identified result. Here is tabel fuzzy logic rule that can be seen in table 2 below.

Table 2. Fuzzy logic rules

No	Rules
1	if G1,G2,G3 is Yes then Periodontitis
2	if G1,G2,G4 is Yes then Periodontitis

3	if G1,G2,G5 is Yes then Periodontitis
4	if G1,G3,G4 is Yes then Periodontitis
5	if G1,G3,G5 is Yes then Periodontitis
6	if G1,G4,G5 is Yes then Periodontitis
7	if G2,G3,G4 is Yes then Periodontitis
8	if G2,G3,G5 is Yes then Periodontitis
9	if G2,G4,G5 is Yes then Periodontitis
10	if G3,G4,G5 is Yes then Periodontitis
11	if G1,G2,G6,G7,G8,G9 is Yes then Periodontitis
12	if G1,G2,G6,G7,G8,G10 is Yes then Periodontitis
13	if G1,G2,G6,G7,G8,G11 is Yes then Periodontitis
14	if G1,G2,G6,G7,G8,G12 is Yes then Periodontitis
15	if G1,G2,G6,G7,G9,G10 is Yes then Periodontitis
16	if G1,G2,G6,G7,G9,G11 is Yes then Periodontitis
17	if G1,G2,G6,G7,G9,G12 is Yes then Periodontitis
18	if G1,G2,G6,G7,G10,G11 is Yes then Periodontitis
19	if G1,G2,G6,G7,G10,G12 is Yes then Periodontitis
20	if G1,G2,G6,G7,G11,G12 is Yes then Periodontitis
21	if G1,G2,G6,G8,G9,G10 is Yes then Periodontitis
22	if G1,G2,G6,G8,G9,G11 is Yes then Periodontitis
23	if G1,G2,G6,G8,G9,G12 is Yes then Periodontitis
24	if G1,G2,G6,G8,G10,G11 is Yes then Periodontitis
25	if G1,G2,G6,G8,G10,G12 is Yes then Periodontitis
26	if G1,G2,G6,G8,G11,G12 is Yes then Periodontitis
27	if G1,G2,G6,G9,G10,G11 is Yes then Periodontitis
28	if G1,G2,G6,G9,G10,G12 is Yes then Periodontitis
29	if G1,G2,G6,G9,G11,G12 is Yes then Periodontitis
30	if G1,G2,G6,G10,G11,G12 is Yes then Periodontitis

After the fuzzy logic rule is determined, it uses sample data obtained from the hospital to be tested using fuzzy logic method. The sample data can be seen in table 3 below.

Table 3. Patient sample data obtained from dental and oral hospitals

Patient	S1	S2	S3	S4	S5	S6	S7	S8	S9	S0	S1	S2	Result
Patient 1	T	T	F	F	T	F	T	F	F	T	T	T	P
Patient 2	F	F	F	T	F	T	T	F	F	T	T	F	FP
Patient 3	T	T	F	F	T	F	F	T	F	F	F	F	P
Patient 4	F	F	F	T	F	F	T	T	T	T	T	F	FP
Patient 5	F	F	F	F	T	F	T	F	F	F	F	F	FP
Patient 6	T	F	F	T	F	F	T	F	F	F	F	F	FP
Patient 7	F	T	T	F	F	F	F	T	F	F	T	T	FP
Patient 8	F	F	F	F	F	F	F	F	T	T	T	F	FP
Patient 9	F	F	T	F	F	T	F	T	F	T	T	F	FP
Patient 10	T	T	T	F	T	F	F	T	F	T	F	F	P
Patient 11	F	T	T	T	F	F	F	T	F	T	F	T	P
Patient 12	F	F	F	F	F	F	F	F	T	T	F	F	FP
Patient 13	F	F	F	T	F	T	T	T	T	F	T	F	FP
Patient 14	F	F	F	F	T	F	F	F	T	F	F	F	FP
Patient 15	F	F	T	F	T	F	T	T	F	F	F	T	FP

Patient 16	F	T	T	T	F	T	T	T	T	T	F	T	P
Patient 17	F	F	F	T	F	T	F	T	T	T	T	T	FP
Patient 18	F	F	T	T	T	T	F	F	F	T	F	F	P
Patient 19	F	F	T	F	F	F	T	T	F	F	T	F	FP
Patient 20	T	F	T	T	T	T	T	T	T	T	F	F	P
Patient 21	F	F	F	F	F	F	T	F	F	F	T	T	FP
Patient 22	F	T	F	T	F	F	T	F	T	F	F	F	FP
Patient 23	F	T	F	F	T	T	T	F	F	F	T	F	FP
Patient 24	T	F	F	F	F	T	T	T	F	F	F	F	FP
Patient 25	T	F	F	T	F	T	T	F	F	F	T	T	P
Patient 26	F	T	F	F	T	T	T	T	T	F	T	F	FP
Patient 27	T	T	F	T	T	T	T	F	T	F	F	T	P
Patient 28	F	F	F	F	F	T	T	F	F	T	T	F	FP
Patient 29	T	T	F	T	T	T	T	T	T	F	F	F	P
Patient 30	F	T	F	F	F	T	T	F	T	T	T	T	FP

Description:

T : Yes
F : No
P : Periodontitis
FP : Non Periodontitis

Calculates the probability of symptoms periodontitis and non periodontitis disease based on sample data.
 P (Periodontitis) = 11/30 = 0,366666667 x 100% = 36,667%
 P (Non Periodontitis) = 19/30 = 0,633333333 x100% = 63,333%
The following is the probability of symptoms indicated periodontitis disease that can be seen in the table below.

3.   RESULT AND ANALYSIS

Testing is done by doing manual calculation using fuzzy logic method to find out the suitability of the results obtained by fuzzy method by following the stages in the fuzzy logic method in the form of fuzzification, system inference and fuzification process. Here are the stages of the fuzzy method:

A. Fuzzification Fuzzification is the process by which an   input is changed from crips form (firm)to fuzzy(linguistic variable).

$$\mu[x, a, b, c] = \begin{cases} \frac{(x-a)}{(b-a)}; a \leq x \leq b \\ \frac{(c-x)}{(c-b)}; b \leq x \leq c \end{cases}$$

Description :
X : value weight of the expert
a : minimum value limit on each symptom
b : The middle value of the minimum and maximum limits
c : Maximum value limit on each symptom

Calculate the value b (the middle value of the minimum limit) of each interval category with the formula:

$$b = \frac{\sum a\, sampai\, b}{n}$$

a. Range ringan interval $(0,0 \leq a \leq 0,4)$

$$b = \frac{0,0 + 0,1 + 0,2 + 0,3 + 0,4}{5} = \frac{1}{5} = 0,2$$

So the middle value at light intervals is 0.2
b. Medium interval $(0.3 \leq a \leq 0.7)$

$$b = \frac{0,3 + 0,4 + 0,5 + 0,6 + 0,7}{5} = \frac{2,5}{5} = 0,5$$

So the middle value at medium intervals is 0.5.

c. Severe interval $0.6 \leq a \leq 1.0$

$$b = \frac{0,6 + 0,7 + 0,8 + 0,9 + 1,0}{5} = \frac{4}{5} = 0,8$$

So the middle value at severe intervals is 0.8.

b. Calculates the fuzzification values of S1, S10, S11, S12 .
User selects symptoms of S1, S10, S11, S12 where the weight and interval values are listed in the table
Formula

$$F = \frac{(x - a)}{(b - a)}$$

a. Calculating Fuzzification S1

$$F = \frac{0,8 - 0,6}{0,8 - 0,6} = 1$$

b. Calculating S10 Fuzzification

$$F = \frac{0,4 - 0,0}{0,2 - 0,0} = 2$$

c. Calculating Fuzzification S11

$$F = \frac{0,1 - 0,0}{0,2 - 0,0} = 0,5$$

d. Calculating Fuzzification S12

$$F = \frac{0,4 - 0,0}{0,2 - 0,0} = 2$$

B. Defuzzification Process
   Defuzzification is the last process of the fuzzy process with the aim of the result of fuzzification being converted and expressed into a fuzzy set to a real number. Here is the Defuzzification Formula in Fuzzy Sugeno method.

$$WA = \frac{F1B1 + F2B2 + F3B3 + \cdots + FnBn}{F1 + F2 + F3 + \cdots + Fn} = 2$$

Description:
WA : Weighted Avarage
Fn : Value of rule To-n
Bn : Input value of index To n

$$WA = \frac{F.S1 \text{ x Weight.} S1 + F.S10 \text{ x weight.} S10 + F.S11 \text{ x weight.} S11 + F.S12 \text{ x weight.} S12}{F.S1 + F.S10 + F.S11 + F.S12} = 2$$

$$WA = \frac{(1x0,8) + (2x0,4) + (0,5x0,1) + (2x0,4)}{1 + 2 + 0,5 + 2} = \frac{2,45}{5,5} = 0,445$$

From the result of defuzzification produced 0.445 x100% = 44.5%. So it can be concluded that the user does not have periodontitis.
Conducted testing of expert system using 30 sample data. Here is a table of sample data along with the results and the results of diagnose expert system testing using fuzzy logic method.

Table 5. Expert system program test results

Patient	S1	S2	S3	S4	S5	S6	S7	S8	S9	S0	S1	S2	Result	Fuzzy Logic
PatieFt 1	T	T	F	F	T	F	T	F	F	T	T	T	P	P
Patient 2	F	F	F	T	F	T	T	F	F	T	T	F	FP	FP
Patient 3	T	T	F	F	T	F	F	T	F	F	F	F	P	FP
Patient 4	F	F	F	T	F	F	T	T	T	T	T	F	FP	FP
Patient 5	F	F	F	F	T	F	T	F	F	F	F	F	FP	FP

Patient 6	T	F	F	T	F	F	T	F	F	F	F	F	FP	FP
Patient 7	F	T	T	F	F	F	F	T	F	F	T	T	FP	FP
Patient 8	F	F	F	F	F	F	F	F	T	T	T	F	FP	FP
Patient 9	F	F	T	F	F	T	F	T	F	T	T	F	FP	FP
Patient 10	T	T	T	F	T	F	F	T	F	T	F	F	P	P
Patient 11	F	T	T	T	F	F	F	T	F	T	F	T	P	P
Patient 12	F	F	F	F	F	F	F	F	T	T	F	F	FP	FP
Patient 13	F	F	F	T	F	T	T	T	T	F	T	F	FP	FP
Patient 14	F	F	F	F	T	F	F	F	T	F	F	F	FP	FP
Patient 15	F	F	T	F	T	F	T	T	F	F	F	T	FP	FP
Patient 16	F	T	T	T	F	T	T	T	T	T	F	T	P	P
Patient 17	F	F	F	T	F	T	F	T	T	T	T	T	FP	FP
Patient 18	F	F	T	T	T	T	F	F	F	T	F	F	P	FP
Patient 19	F	F	T	F	F	F	T	T	F	F	T	F	FP	FP
Patient 20	T	F	T	T	T	T	T	T	T	T	F	F	P	P
Patient 21	F	F	F	F	F	F	T	F	F	F	T	T	FP	FP
Patient 22	F	T	F	T	F	F	T	F	T	F	F	F	FP	FP
Patient 23	F	T	F	F	T	T	T	F	F	F	T	F	FP	FP
PatieFt 24	T	F	F	F	F	T	T	T	F	F	F	F	FP	FP
Patient 25	T	F	F	T	F	T	T	F	F	F	T	T	P	P
Patient 26	F	T	F	F	T	T	T	T	T	F	F	F	FP	FP
Patient 27	T	T	F	T	T	T	T	F	T	F	F	T	P	P
Patient 28	F	F	F	F	F	T	T	F	F	T	T	F	FP	FP
Patient 29	T	T	F	T	T	T	T	T	T	F	F	F	P	P
Patient 30	F	T	F	F	F	T	T	F	T	T	T	T	FP	FP

Based on the test table of expert system program above obtained that the test results using 30 samples obtained 28 samples diagonis results using sample data in accordance with the test results by using system test data using fuzzy logic method, so that it can be concluded that the percentage of accuracy of testing using fuzzy method is $28/30 \ x 100\% = 93{,}33\%$

4. CONCLUSIOON

Based on the results of system testing, it was obtained that to improved the accuracy of Fuzzy Logic method in diagnosing periodontitis disease by 93.33% based on sample data as much as 30 data obtained that 28 sample data in accordance with system testing using fuzzy logic method. This expert system only diagnoses the initial symptoms experienced by the user and does not replace the functional of a doctor, so it is recommended to consult a dentist for further treatment.

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