
Expert System For Diagnosis Of Vitiligo Disease Using The Fuzzy Mamdani Method Based On Web-Based

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Abstract

Vitiligo is a disease that causes the skin color to fade. Besides being able to attack any area of the skin on the body, this fading color can also occur on the inside of the mouth, eyes, and hair. In this study, an expert system for diagnosing vitiligo has been built, in order to make it easier for patients to find out the level of vitiligo they are suffering from. The problem of this research is how to build an expert system to diagnose vitiligo by implementing Fuzzy Logic using the Mamdani Method, Fuzzy logic is one approach that uses certain stages. The system was built using a structured approach with Use Case, Sequence, and Activity Diagrams as a system design tool

Keywords: *Vitiligo, Expert System, Mamdani Method, Fuzzy Logic*

1. Introduction

An expert system is a computer program containing knowledge of one or more human experts about a specific field. Expert systems can solve problems in accordance with the knowledge of an expert who is entered into the system. Expert systems are generally used to carry out activities to diagnose a problem that can only be solved by an expert.

Good accuracy is obtained from the activity of diagnosing a disease using a computerized expert system so that it is greatly affected by the expert system method used. expert system methods generally consist of several methods, one of which is the fuzzy mamdani method, which is a method that is able to model human thought processes into a system to diagnose a disease, especially vitiligo.

Vitiligo is a skin disease that can cause skin color to fade, besides being able to attack the skin area, vitiligo disease can also occur in any skin area such as eyes and hair. For the general public, usually to find out the diagnosis of vitiligo, they must consult an expert who is an expert in the field of diagnosing this disease. However, the problem that often occurs is the use of time that is less efficient for experts to serve many patients for consultation so that it is difficult to handle patient problems with efficient, effective time and accurate diagnostic results.

2. Method

The research framework used is the waterfall model.

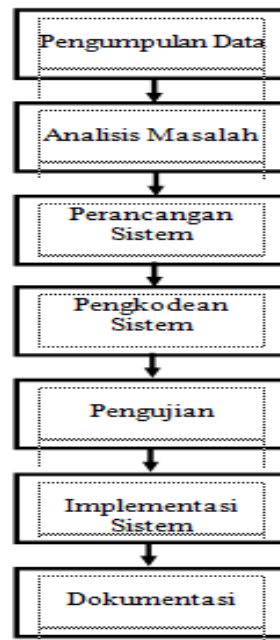


Figure 4. Research framework

1. Data collection

Data collection is done in two ways, namely:

- a. Observation (Observation)
namely direct observation to the research site to collect data related to the diagnosis of vitiligo.
- b. Interview
Conduct interviews with related parties regarding the current system for the process diagnosis of Vitiligo at the study site.

2. Problem analysis

Analyzing the data obtained from the research site that has been carried out at the data collection stage to identify problems that occur in the study of vitiligo diagnosis.

3. System planning

The system design is divided into two parts, namely the system logic design and the interface design design.

4. System Coding

Implementing the program code into the Vitiligo disease diagnosis expert system which has been designed so that the Vitiligo disease diagnosis expert system can be used to solve the Vitiligo disease diagnosis problem in this study.

5. System Test

Test Vitiligo disease diagnosis expert system in order to find out the shortcomings of the system that has been built in this study.

6. System Implementation

System implementation is as a tangible manifestation of the data system that has been built to solve problems in the process of diagnosing Vitiligo in real terms.

7. Documentation

Prepare research reports according to the research topics that have been carried out.

Analysis is a problem solving technique by breaking down a system into its components with the aim of learning how these components work and interact to

accomplish their goals. System design is a complement of system analysis into a complete system with the aim of getting a better system.

2.1. Data analysis

Data analysis is an effort or way to process data into information so that the characteristics of the data can be understood and useful for problem solving, especially problems related to research.

Table 1.
Patient data

No	Patient Code	Patient's name
1	P01	Rio Wirawan
2	P02	Great Inspiration
3	P03	Holy Shinta

Table 2.
Symptoms of Vitiligo Penyakit

No	Symptom	Variable
1	Family history of vitiligo or autoimmune disease	C1
2	Skin like sunburn	C2
3	Skin cancer	C3
4	Disorders of the eye	C4
5	Hearing loss	C5
6	Side effects of therapy, such as dry and itchy skin	C6
7	Vitiligo Risk	C7

Table 3.
Patient Outcome Data

No	Patient's name	C1	C2	C3	C4	C5	C6
1	Rio Wirawan	40	28	34	38	35	17
2	Great Inspiration	5	10	8	15	20	15
3	Holy Shinta	22	27	19	30	28	19

2.2. Analysis Method

Method analysis is the step taken to carry out the process of solving the problem of vitiligo diagnosis experienced by patients by applying the Mamdani fuzzy method which has been chosen in this study as a problem solving method.

1. Fuzzy Set Formation

Table 4.
Fuzzy Set

Function	Symptom	set	Universe	Domain
Input	C1	Low	[0 – 40]	[0 1020]

Input	C2	Currently	[0 – 40]	[102030]
		Tall	[0 – 40]	[203040]
		Low	[0 – 40]	[0 1020]
	C3	Currently	[0 – 40]	[102030]
		Tall	[0 – 40]	[203040]
		Low	[0 – 40]	[0 1020]
	C4	Currently	[0 – 40]	[102030]
		Tall	[0 – 40]	[203040]
		Low	[0 – 40]	[0 1020]
	C10	Currently	[0 – 40]	[102030]
		Tall	[0 – 40]	[203040]
		Low	[0 – 40]	[0 1020]
C6	Currently	[0 – 40]	[102030]	
	Tall	[0 – 40]	[203040]	
	Low	[0 – 40]	[0 1020]	
Output	C7	Currently	[0 – 40]	[102030]
		Tall	[0 – 40]	[203040]
		Low	[0 – 40]	[0 1020]

based on the symptoms and domains of the set that have been determined, the next step is to determine the membership function of each variable and calculate the value or degree of membership based on the membership function that has been determined.

a. Fuzzy Set of Variables C1 (History of Vitiligo or autoimmune disease in the family)

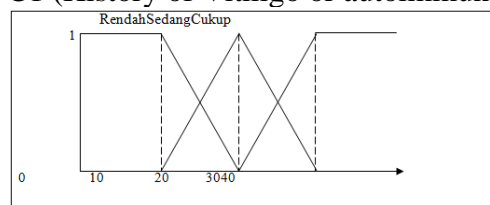


Figure 5. Triangle Curve Membership Function Degree Variable C1

The membership functions are:

1. Low

$$\mu_{(C1)}Rendah = \begin{cases} 1; & x \leq 10 \\ \frac{20 - x}{20 - 10}; & 10 \leq x \leq 20 \\ 0; & x \geq 20 \end{cases}$$

2. Currently

$$\mu_{(C1)}Sedang = \begin{cases} 0; & x \leq 10 \text{ atau } x \geq 20 \\ \frac{x - 10}{20 - 10}; & 10 \leq x \leq 20 \\ \frac{30 - x}{30 - 20}; & 20 \leq x \leq 30 \end{cases}$$

3. Tall

$$\mu_{(C1)}Tinggi = \begin{cases} 0; & x \leq 20 \\ \frac{x - 30}{30 - 20}; & 20 \leq x \leq 30 \\ 1; & 30 \leq x \leq 40 \end{cases}$$

b. C2 Variable Fuzzy Set (Skin Like Sunburn)

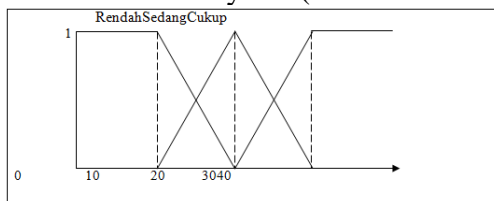


Figure 6. Triangle Curve Membership Function Degree Variable C2

The membership functions are:

1. Low

$$\mu_{(C1)}Rendah = \begin{cases} 1; & x \leq 10 \\ \frac{20 - x}{20 - 10}; & 10 \leq x \leq 20 \\ 0; & x \geq 20 \end{cases}$$

2. Currently

$$\mu_{(C1)}Sedang = \begin{cases} 0; & x \leq 10 \text{ atau } x \geq 20 \\ \frac{x - 10}{20 - 10}; & 10 \leq x \leq 20 \\ \frac{30 - x}{30 - 20}; & 20 \leq x \leq 30 \end{cases}$$

3. Tall

$$\mu_{(C1)}Tinggi = \begin{cases} 0; & x \leq 20 \\ \frac{x - 30}{30 - 20}; & 20 \leq x \leq 30 \\ 1; & 30 \leq x \leq 40 \end{cases}$$

c. Fuzzy Set of Variables C3 (Skin Cancer)

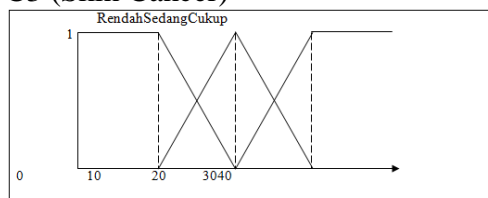


Figure 7. Triangle Curve Membership Function Degree Variable C3

The membership functions are:

1. Low

$$\mu_{(C1)Rendah} = \begin{cases} 1; & x \leq 10 \\ \frac{20 - x}{20 - 10}; & 10 \leq x \leq 20 \\ 0; & x \geq 20 \end{cases}$$

2. Currently

$$\mu_{(C1)Sedang} = \begin{cases} 0; & x \leq 10 \text{ atau } x \geq 20 \\ \frac{x - 10}{20 - 10}; & 10 \leq x \leq 20 \\ \frac{30 - x}{30 - 20}; & 20 \leq x \leq 30 \end{cases}$$

3. Tall

$$\mu_{(C1)Tinggi} = \begin{cases} 0; & x \leq 20 \\ \frac{x - 30}{30 - 20}; & 20 \leq x \leq 30 \\ 1; & 30 \leq x \leq 40 \end{cases}$$

d. Fuzzy Set of Variables C4 (Eye Disorders)

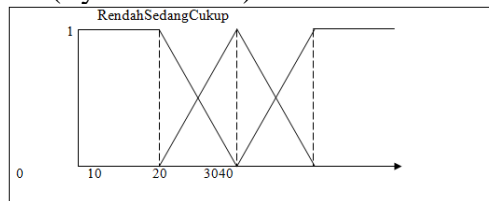


Figure 8. Triangle Curve Membership Function Degree Variable C4

The membership functions are:

1. Low

$$\mu_{(C1)Rendah} = \begin{cases} 1; & x \leq 10 \\ \frac{20 - x}{20 - 10}; & 10 \leq x \leq 20 \\ 0; & x \geq 20 \end{cases}$$

2. Currently

$$\mu_{(C1)Sedang} = \begin{cases} 0; & x \leq 10 \text{ atau } x \geq 20 \\ \frac{x - 10}{20 - 10}; & 10 \leq x \leq 20 \\ \frac{30 - x}{30 - 20}; & 20 \leq x \leq 30 \end{cases}$$

3. Tall

$$\mu_{(C1)Tinggi} = \begin{cases} 0; & x \leq 20 \\ \frac{x - 30}{30 - 20}; & 20 \leq x \leq 30 \\ 1; & 30 \leq x \leq 40 \end{cases}$$

e. Fuzzy Set of Variables C5 (Hearing Impairment)

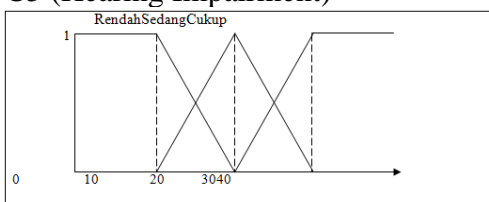


Figure 9. Triangle Curve Membership Function Degree Variable C5

The membership functions are:

1. Low

$$\mu_{(C1)}Rendah = \begin{cases} 1; & x \leq 10 \\ \frac{20 - x}{20 - 10}; & 10 \leq x \leq 20 \\ 0; & x \geq 20 \end{cases}$$

2. Currently

$$\mu_{(C1)}Sedang = \begin{cases} 0; & x \leq 10 \text{ atau } x \geq 20 \\ \frac{x - 10}{20 - 10}; & 10 \leq x \leq 20 \\ \frac{30 - x}{30 - 20}; & 20 \leq x \leq 30 \end{cases}$$

3. Tall

$$\mu_{(C1)}Tinggi = \begin{cases} 0; & x \leq 20 \\ \frac{x - 30}{30 - 20}; & 20 \leq x \leq 30 \\ 1; & 30 \leq x \leq 40 \end{cases}$$

f. Fuzzy Set of Variables C6 (Therapeutic Side Effects, Such as Dry and Itchy Skin)

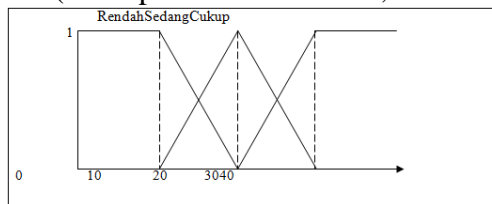


Figure 10. Triangle Curve Membership Function Degree Variable C6

The membership functions are:

1. Low

$$\mu_{(C1)}Rendah = \begin{cases} 1; & x \leq 10 \\ \frac{20 - x}{20 - 10}; & 10 \leq x \leq 20 \\ 0; & x \geq 20 \end{cases}$$

2. Currently

$$\mu_{(C1)}Sedang = \begin{cases} 0; & x \leq 10 \text{ atau } x \geq 20 \\ \frac{x - 10}{20 - 10}; & 10 \leq x \leq 20 \\ \frac{30 - x}{30 - 20}; & 20 \leq x \leq 30 \end{cases}$$

3. Tall

$$\mu_{(C1)}Tinggi = \begin{cases} 0; & x \leq 20 \\ \frac{x - 30}{30 - 20}; & 20 \leq x \leq 30 \\ 1; & 30 \leq x \leq 40 \end{cases}$$

g. Fuzzy Set of Variables C7 (Vitiligo Risk)

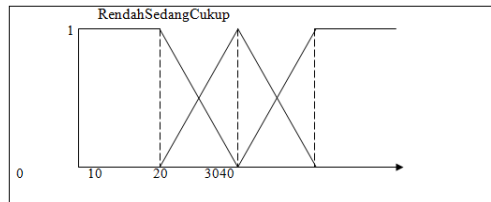


Figure 11. Triangle Curve Membership Function Degree Variable C7

The membership functions are:

1. Low

$$\mu_{(C1)Rendah} = \begin{cases} 1; & x \leq 10 \\ \frac{20 - x}{20 - 10}; & 10 \leq x \leq 20 \\ 0; & x \geq 20 \end{cases}$$

2. Currently

$$\mu_{(C1)Sedang} = \begin{cases} 0; & x \leq 10 \text{ atau } x \geq 20 \\ \frac{x - 10}{20 - 10}; & 10 \leq x \leq 20 \\ \frac{30 - x}{30 - 20}; & 20 \leq x \leq 30 \end{cases}$$

3. Tall

$$\mu_{(C1)Tinggi} = \begin{cases} 0; & x \leq 20 \\ \frac{x - 20}{30 - 20}; & 20 \leq x \leq 30 \\ 1; & 30 \leq x \leq 40 \end{cases}$$

2. Formation of Rules

The following are the rules for diagnosing Vitiligo which are the provisions in this study.

- a. R1 :IF History of vitiligo or autoimmune disease in the family = High AND Sunburnt skin = Moderate AND Skin cancer = High AND Eye problems = Moderate AND Hearing loss = High AND Side effects of therapy, such as dry and itchy skin = Moderate THEN Risk Vitiligo=Tall
- b. R2 :IF History of vitiligo or autoimmune disease in the family = Moderate AND Sunburnt skin = High AND Skin cancer = Moderate AND Eye disorders = High AND Hearing loss = Moderate AND Side effects of therapy, such as dry and itchy skin = High THEN Risk Vitiligo=Tall
- c. R3 : IF History of vitiligo or autoimmune disease in the family = High AND Sunburnt skin = High AND Skin cancer = Moderate AND Eye disorders = Moderate AND Hearing loss = High AND Side effects of therapy, such as dry and itchy skin = High THEN Risk Vitiligo=Tall
- d. R4: IF History of vitiligo or autoimmune disease in the family = Moderate AND Sunburnt skin = High AND Skin cancer = Moderate AND Eye disorders = High AND Hearing loss = High AND Side effects of therapy, such as dry and itchy skin = High THEN Risk Vitiligo=Tall
- e. R5 : IF History of vitiligo or autoimmune disease in the family = Moderate AND Skin like sunburn = Moderate AND Skin cancer = High AND Eye problems = Moderate AND Hearing loss = Moderate AND Side effects of therapy, such as dry and itchy skin = High THEN Risk Vitiligo=Medium

- f. R6 : IF History of vitiligo or autoimmune disease in the family = Moderate AND Skin like sunburn = Moderate AND Skin cancer = Moderate AND Eye disorders = Moderate AND Hearing loss = Moderate AND Side effects of therapy, such as dry and itchy skin = Moderate THEN Risk Vitiligo=Medium
- g. R7 : IF History of vitiligo or autoimmune disease in the family = Moderate AND Skin like sunburn = Moderate AND Skin cancer = Moderate AND Eye disorders = High AND Hearing loss = High AND Side effects of therapy, such as dry and itchy skin = Moderate THEN Risk Vitiligo=Medium
- h. R8 : IF History of vitiligo or autoimmune disease in the family = Moderate AND Sunburnt skin = Low AND Skin cancer = Low AND Eye problems = High AND Hearing loss = Moderate AND Side effects of therapy, such as dry and itchy skin = Moderate THEN Risk Vitiligo=Medium
- i. R9 : IF History of vitiligo or autoimmune disease in the family = Low AND Skin like sunburn = Low AND Skin cancer = Moderate AND Eye disorders = Moderate AND Hearing loss = Moderate AND Side effects of therapy, such as dry and itchy skin = Moderate THEN Risk Vitiligo=Low
- j. R10 : IF History of vitiligo or autoimmune disease in the family=Low AND Sunburnt skin=Low AND Skin cancer=Low AND Eye problems=Low AND Hearing loss=Moderate AND Side effects of therapy, such as dry and itchy skin=Medium THEN Risk Vitiligo=Low
- k. R11 : IF History of vitiligo or autoimmune disease in the family = Low AND Sunburnt skin = Moderate AND Skin cancer = Moderate AND Eye disorders = Low AND Hearing loss = Low AND Side effects of therapy, such as dry and itchy skin = Low THEN Risk Vitiligo=Low
- l. R12 : IF History of vitiligo or autoimmune disease in the family = Low AND Sunburnt skin = Low AND Skin cancer = Moderate AND Eye disorders = Low AND Hearing loss = High AND Side effects of therapy, such as dry and itchy skin = Low THEN Risk Vitiligo=Low.

3. Fuzzy Value

a. Fuzzy Value for C1 . Symptoms

Table 5.

Patient's name	Symptoms of C1		
	Family history of vitiligo or autoimmune disease		
	Currently	Low	Tall
Rio Wirawan	0	0	1
Great Inspiration	1	0	0
Holy Shinta	0	0.8	0.2

b. Fuzzy Value for C2 . Symptoms

Table 6.

Patient's name	Symptoms of C2		
	Skin Like Sunburn		
	Currently	Low	Tall
Rio Wirawan	0	0.2	0.8
Great Inspiration	1	0	0
Holy Shinta	0	0.3	0.7

c. Fuzzy Value for C3 . Symptoms

Table 7.
Symptoms of C3

Patient's name	Skin cancer		
	Currently	Low	Tall
Rio Wirawan	0	0	1
Great Inspiration	1	0	0
Holy Shinta	0.1	0.9	0

d. Fuzzy Value for C4 . Symptoms

Table 8.
Symptoms of C4

Patient's name	Eye Disorders		
	Currently	Low	Tall
Rio Wirawan	0	0	1
Great Inspiration	0.5	0.5	0
Holy Shinta	0	0	1

e. Fuzzy Value for C5 . Symptoms

Table 9.
Symptoms of C5

Patient's name	Hearing Loss		
	Currently	Low	Tall
Rio Wirawan	0	0	1
Great Inspiration	0	1	0
Holy Shinta	0	0.2	0.8

f. Fuzzy Value for C6 . Symptoms

Table 10.
Symptoms of C6

Patient's name	Therapeutic side effects, such as dry and itchy skin		
	Currently	Low	Tall
Rio Wirawan	0.3	0.7	1
Great Inspiration	0.5	0.5	0
Holy Shinta	0.1	0.9	0

4. Affirmation (Defuzzification)

The overall conclusion by taking the maximum membership level of each consequent application of the implication function and combining all the conclusions of each rule, so that the ranking results are obtained as follows:

Table 11.
Nationalization (Defuzzification)

Patient's name	Results	
	Total	Vitiligo Risk (C7)

Rio Wirawan	30	Tall
Great Inspiration	20	Currently
Holy Shinta	7.5	Low

Based on the analysis of patients using the Mamdani method based on symptoms, the results showed that Rio Wirawan's patient was declared to have vitiligo with a total of 30, which means he had a high risk of vitiligo, while Ilham Akbar's patient had a moderate risk of vitiligo with a value of 20, and Shinta Suci had a low risk of vitiligo with value 7.5.

5. Conclusion

From the results of the thesis of the Expert System for Diagnosing Vitiligo Disease Using the Fuzzy Mamdani method, several conclusions can be drawn, including:

- This research has produced a Web-Based Vitiligo Diagnosis Expert System using the Fuzzy Mamdani method using 7 variables, 6 variables for symptoms and 1 for output in the form of the level of vitiligo experienced by the patient.
- The expert system used can help users to determine the level of vitiligo experienced by the symptoms, and the rules that have been determined by experts.

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