Journal of Electrical Engineering and Computer (JEECOM)
Vol. 7, No. 1 (2025), DOI: 10.33650/jeecom.v4i2
p-ISSN: 2715-0410; e-ISSN: 2715-6427

Expert System for Skin Disease Diagnosis Using the Best First Search Method and Fuzzy Tsukamoto

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Article Info

Article history:

Received March 21, 2025
Revised March 28, 2025
Accepted March 14, 2025

Keywords:

Best First Search
Fuzzy Tsukamoto
Expert System
Skin Disease

ABSTRACT

The skin is the largest organ and is vulnerable to various diseases, which can spread through direct contact or the environment. Skin disease diagnosis requires expertise, yet access to dermatologists is limited. An AI-based expert system improves accuracy, standardizes assessments, and supports early treatment. Skin diseases are among the ten most common conditions in outpatient care in Indonesia, often caused by poor hygiene and environmental exposure. The limited number of dermatologists makes diagnosing and treating skin diseases more challenging. This study develops an expert system for diagnosing skin diseases using the Best First Search method and Fuzzy Tsukamoto as an alternative or complement to medical diagnosis. Best First Search efficiently navigates a predefined rule-based system to prioritize the most relevant diagnoses, improving accuracy and speed. Meanwhile, Fuzzy Tsukamoto handles uncertainty in symptom severity by applying fuzzy logic, allowing for a more flexible and precise assessment of disease progression. Testing shows that the system achieves an accuracy of 83.3%, outperforming some conventional rule-based methods. While not yet meeting clinical dermatology standards, this accuracy highlights its potential as a supportive tool for early diagnosis, assisting patients and medical professionals in improving diagnostic efficiency and healthcare quality for skin diseases.

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1. INTRODUCTION

The skin plays a crucial role in human life, including its function as the sense of touch. As the body's outermost layer, it is directly exposed to external stimuli such as touch and pain, making it susceptible to various diseases [1]. Skin diseases are among the most common health problems worldwide, affecting millions of people each year. According to data from the Central Statistics Agency of Indonesia (BPS) in 2020, environmental hygiene significantly influences the prevalence of skin diseases, with the number of people living in poverty increasing to 26.42 million from 26.07 million in 2019 [2]. Skin is also an essential medium for human interaction; however, certain diseases spread through direct skin-to-skin contact, such as handshakes, or indirectly through shared items like towels, jackets, and handkerchiefs used by individuals with contagious skin conditions [3]. Several external factors contribute to skin diseases, including poor environmental hygiene, extreme climate changes, and allergies [4]. Consulting a qualified medical professional is essential, as improper treatment can exacerbate skin diseases. Furthermore, limited knowledge about skin conditions may contribute to their rising incidence [5]. This highlights the need for a reliable and accessible

diagnostic tool to assist in identifying skin diseases accurately. **Therefore, it is crucial to develop a system that can replicate expert knowledge to aid in solving problems related to skin health** [6].

An expert system is a computer-based system that utilizes expert knowledge, facts, and reasoning techniques to solve problems in specific fields that cannot be addressed by non-experts [7], [8]. In the context of skin disease diagnosis, an expert system can provide initial assessments based on symptoms reported by users, reducing dependency on direct consultations with medical professionals. The Best First Search method follows a graph traversal process based on priority order using a priority queue [9]. It selects the node with the lowest priority to efficiently find the optimal solution [10]. Compared to other search methods such as Depth First Search or A Search, Best First Search is chosen due to its heuristic approach that efficiently guides the search towards the most promising solution, reducing unnecessary computations [11]. This method allows expert systems to generate output from the analysis of previously processed variables [11]. The Fuzzy Tsukamoto method is a scientific algorithm in intelligent systems used to calculate degrees of truth, offering high flexibility [12]. In this method, every IF-Then rule must be represented using fuzzy sets, where the membership functions are invariant or monotonic [13]. Fuzzy Tsukamoto is selected over other fuzzy logic approaches, such as Sugeno and Mamdani, due to its ability to handle uncertainty in medical diagnosis with a continuous output representation, making it suitable for skin disease classification [12]

A study [14] implemented the Best First Search algorithm in a tourism information system, chosen for its ability to evaluate nodes based on heuristic functions, enabling efficient pathfinding. Another study [15] utilized the Fuzzy Tsukamoto method for early detection of gadget addiction in children, achieving an accuracy of 87.83%. Research [16] applied Fuzzy Tsukamoto in an expert system for leukemia diagnosis, obtaining an accuracy of 90%. Another study [17] used the method for diagnosing depression levels in university students, achieving 76% accuracy. Meanwhile, research [18] employed Fuzzy Tsukamoto for heart disease risk diagnosis, resulting in an accuracy of 83% based on a comparison between system and expert diagnoses.

Building on previous studies, this research aims to develop an expert system for skin disease diagnosis by integrating the Best First Search and Fuzzy Tsukamoto methods. Unlike existing studies, this research combines these two approaches to enhance diagnostic accuracy and efficiency in dermatological assessments. The objective of this study is to design an optimal diagnostic system that assists medical professionals and individuals in identifying skin diseases more accurately, thereby improving healthcare services in dermatology. By integrating Best First Search and Fuzzy Tsukamoto, this system is expected to provide accurate and efficient diagnoses, ultimately supporting clinical decision-making in skin disease management.

2. RESEARCH METHOD

2.1. Data Collection

At this stage, data collection is conducted through direct interviews with experts in the relevant field and information gathered from various relevant scientific articles. Interviews provide a deeper and more contextual understanding, while scientific articles serve as references to strengthen the validity of the collected data. The combination of these sources is expected to provide a strong and comprehensive foundation for supporting the research process.

2.2. Method Implementation

Best First Search is a search method that utilizes knowledge about a problem to guide the search toward the node where the solution is located. This approach is also known as heuristic search. It focuses on finding the best solution based on available knowledge, allowing the search to be directed efficiently, determining the starting point, and applying the best process to reach the solution [19].

In the context of an expert system for skin disease diagnosis, Best First Search plays a crucial role in optimizing the selection of symptoms that lead to the most accurate diagnosis. The system represents skin diseases as nodes in a search space, where each symptom acts as a branching factor. By utilizing a heuristic function, the algorithm prioritizes the most relevant symptoms based on predefined medical knowledge, reducing unnecessary evaluations and improving efficiency in reaching the correct disease classification. This approach enhances the system's ability to provide accurate and timely diagnostic results.

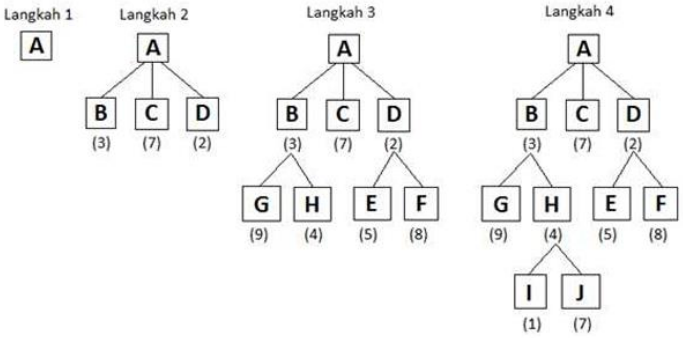

Figure 1. Best First Search Algorithm

According to [8], Fuzzy Tsukamoto is a technique in fuzzy inference systems where each consequent part of an IF-THEN rule is expressed as a fuzzy set with a uniform membership function. The Fuzzy Tsukamoto model is structured as follows :

IF (X IS A) and (Y IS B) Then (Z IS C)

where A, B, and C are fuzzy sets. The Tsukamoto method consists of the following stages:

- Fuzzification: Input values (e.g., symptom severity) are transformed into fuzzy values.
- Rule Formation: Expert knowledge is structured as IF-THEN rules.
- Inference Process: The MIN function determines the degree of rule activation (α-predicate) for each rule.
- Defuzzification: A crisp output (Z*), representing the diagnosis confidence level, is obtained using the formula:

$$Z^* = \frac{\sum a_i z_i}{\sum a_i}$$

where Z^* is the output, a_i is the rule activation level, and z_i is the rule's inferred value.

In a skin disease expert system, Fuzzy Tsukamoto is used to determine disease severity based on symptom intensity. For example:

- Rule 1: IF (Redness is High) AND (Itching is Severe) THEN (Disease Severity is High)
- Rule 2: IF (Redness is Medium) AND (Itching is Moderate) THEN (Disease Severity is Medium)

The system processes patient symptoms, assigns fuzzy values, applies inference rules, and finally defuzzifies the output to produce a numerical severity score, assisting medical professionals in determining treatment urgency.

2.3. Accuracy Testing

Before this expert system can be used by users, it must first undergo a testing phase. This testing is conducted to ensure that the system achieves a high level of accuracy. The accuracy of the applied method is determined through accuracy calculations. The formula used for this calculation is as follows:

$$Accuracy = \frac{Correct\ Amount}{Total\ respondents} \times 100\%$$

3. RESULT AND DISCUSSION

3.1. Data Collection

This study requires two types of data: disease data and symptom data. The collected data consists of 10 types of skin diseases and 45 types of symptoms. Disease data is labeled with the code “P,” while symptom data is labeled with the code “G.” These data sets are used to create a decision table that links diseases and symptoms. The dataset used in this study is derived from previous research published in journals related to expert systems for skin disease diagnosis.

Table 1. Disease Data

Code	Disease Name
P1	Dermatitis
P2	Abscess

P3	Tinea Versicolor
P4	Varicella
P5	Scabies
P6	Impetigo
P7	Ringworm
P8	Herpes Zoster
P9	Tinea Pedis
P10	Morbus Hansen

3.2. Knowledge Modeling

Based on the ten identified types of skin diseases, various symptoms can be recognized as key indicators for detecting each disease. These symptoms serve as a fundamental basis for classification and aid in making a more accurate and targeted diagnosis. Table 2 presents the symptoms related to skin conditions, while Table 3 below outlines the diagnostic rules for each skin disease.

Before being used in the system, data is collected in the form of a decision table, mapping the relationship between symptoms and diseases based on severity levels assessed by experts or derived from literature. Instead of explicitly converting the decision table into a decision tree, the system applies IF-THEN fuzzy inference rules, which are then evaluated using Best First Search.

Tabel 2. Symptom Data

Code	Symptom Name	Code	Symptom Name	Code	Symptom Name
G1	Itch	G16	More noticeable if sunbathing	G31	A reddish circular skin rash appears
G2	Alergy	G17	Slight fever, runny nose, fatigue, lethargy and weakness	G32	Limp body
G3	Skin blistering	G18	High fever	G33	Headache
G4	Inflamed skin	G19	Headache, joint pain and dizziness	G34	Bubbles (vesicles) appear in clusters
G5	Stinging	G20	A watery rash appears all over the body	G35	Attacks one side of the body only
G6	Pus discharge	G21	Itching after spots break out	G36	Sores between fingers or fingernails
G7	Redness appears on the face, knees, hands and feet	G22	Red pimples/spots	G37	An unpleasant odor appears
G8	Small reddish bumps appear	G23	Heat on the inflamed skin area	G38	Spotting between the fingers
G9	Pain when pressed	G24	Pain in the skin	G39	Frequent exposure to moist skin areas
G10	Swelling	G25	Blistering with reddish-yellow fluid	G40	Frequent attacks between the fingers
G11	Fever	G26	Fluid blisters form scabs (erusta)	G41	There are white or reddish patches that are numb
G12	Mild itch	G27	Swollen lymph nodes around the wound	G42	Numbness in both hands and feet
G13	Dry and flaky skin	G28	If it breaks, it will spread around	G43	Eyebrow thinning
G14	Thickened skin	G29	Scaly and inflamed skin	G44	Eye muscle paralysis
G15	The color of the skin becomes lighter or darker (stripes)	G30	Moist and watery	G45	Thickening of the ear lobes

Table 3. Diagnose Rule

Disease Code	Rule
P1	IF G1 AND G2 AND G3 AND G4 AND G5 AND G6 AND G7 THEN P1
P2	IF G1 AND G4 AND G8 AND G9 AND G10 AND G11 THEN P2
P3	IF G12 AND G13 AND G14 AND G15 AND G16 THEN P3
P4	IF G17 AND G18 AND G19 AND G20 AND G21 THEN P4
P5	IF G1 AND G22 AND G4 AND G23 AND G5 AND G6 THEN P5
P6	IF G1 AND G24 AND G25 AND G26 AND G27 AND G28 THEN P6
P7	IF G1 AND G14 AND G29 AND G30 AND G31 THEN P7
P8	IF G11 AND G32 AND G33 AND G34 AND G35 THEN P8
P9	IF G1 AND G36 AND G37 AND G38 AND G39 AND G40 THEN P9
P10	IF G41 AND G42 AND G43 AND G44 AND G45 THEN P10

3.3. Method Implementation

The search technique used in this system is Best First Search, which prioritizes the most promising path toward a solution based on available knowledge or heuristics. The severity value entered by the patient serves as the heuristic value for symptoms, ranging from 1 to 100. The diagnosis process using Fuzzy Tsukamoto begins with identifying detected skin disease symptoms. Each diagnostic rule is then processed using a membership function, where the consequences of each rule are represented as fuzzy sets with a monotonic membership function. The severity of each symptom is fuzzified into a degree of membership, which is then used to determine the likelihood of a disease. Best First Search is utilized to determine the optimal diagnosis by prioritizing the search path with the highest probability based on fuzzified symptom weights, ensuring that the most probable disease diagnosis aligns with patient data.

3.4. Accuracy Testing

Accuracy testing is conducted to ensure that the system achieves a high level of accuracy. Experts must validate the test results to verify the correctness of the diagnoses generated by the developed application. The results of the testing are presented in Table 4.

Table 4. Accuracy Testing

No	**Symptom**	**Symptom severity (0-100)**	**Diagnosis result**	
			System	**Expert**
1	Fever, runny nose, fatigue, lethargy and weakness (G17)	80	Varicella 82.5 %	Varicella
	High fever (G18)	85		
	Itching (G1)	80		
2	Thick skin G14	70	Ringworm 76.6 %	Moths of the body
	Scaly and inflamed skin G29	80		
	Moist and juicy G30	80		
3	Spots between fingers (G38)	80	Tinea Pedis 80 %	-
	Numbness in both hands and feet (G42)	90		
	Paralysis of eye muscles (G44)	70		
4	Pain when pressed (G9)	90	Abscess 73.3 %	Abscess
	Inflamed skin (G4)	70		
	Fever (G11)	60		
5	Mild itching (G12)	70	Tinea Versicolor 78.3%	Tinea Versicolor
	The color of the skin becomes lighter or darker (mottled) (G15)	85		
	More visible when sunbathing (G16)	80		
	Allergies (G2)	50		

6	Itching after spots break out (G21)	89	Varicella 83.5 %	Varicella
	Watery rash appears all over the body (G20)	78		
	If it breaks it will spread around (G28)	70		
7	Pain (G5)	85	Dermatitis 85 %	Dermatitis
	Redness appears on the face, knees and feet (G7)	85		
	Allergies (G2)	85		
	Swelling (G10)	80		
8	Thickened skin (G14)	60	Tinea Versicolor 60 %	-
	Pus discharge (G6)	50		
	Limp body (G32)	60		
9	There is headache (G33)	60	Herpes Zoster 53.3%	-
	Fever (G11)	40		
	Pain in the skin (G24)	40		
10	Itching (G1)	80	Tinea Pedis 83.3%	Ringworm
	There are wounds between the fingers or nails (G36)	90		
	Often strikes between the fingers (G40)	80		
11	Swollen lymph nodes around the wound (G27)	70	Impetigo 82.5 %	Impetigo
	If it breaks it will spread around (G28)	95		
	Moist and juicy (30)	80		
12	There are white or reddish spots that are numb (G41)	80	Morbus Hansen 80 %	Hansen's disease
	Eyebrow thinning (G43)	80		
	Ear lobe thickening (G45)	80		
13	Itching (G1)	85	Ringworm 88.3%	Moths of the body
	Thickened skin (G14)	85		
	A reddish circular skin rash appears (G31)	95		
14	Mild itching (G12)	70	Tinea Versicolor 76.6%	Tinea Versicolor
	Thickened skin (G14)	75		
	More visible when sunbathing (G16)	85		
	Limp body (G32)	65		
15	Groups of bubbles (vescules) appear (G34)	75	Herpes Zoster 77.5 %	Herpes Zoster
	Attacks one side of the body only (G35)	80		
16	Headache, joint pain and dizziness (G19)	80	Varicella 80 %	Varicella
	A watery rash appears all over the body (G20)	80		
	Itching after spots break out (G21)	90		
	High fever (G18)	70		
17	Unpleasant odor appears (G37)	75	Tinea Pedis 80 %	Ringworm
	Often attacks between the fingers (G40)	85		
	Often located on moist skin areas (G39)	80		
18	High fever (G12)	80	Varicella 75 %	Varicella
	Allergies (G2)	70		

	Itching after spots break out (G21)	70		
19	Itching (G1)	75	Scabies 77.5 %	Scabies
	Red bumps/spots (G32)	80		
	Blisters with reddish yellow liquid (G25)	65		
20	A reddish lump filled with pus appears (G8)	87	Abscess 81 %	Abscess
	Swelling (G10)	75		
21	Numbness in both hands and feet (G42)	75	Morbus Hansen 77.5 %	Hansen's disease
	Itching (G1)	60		
	There are white or reddish spots that are numb (G41)	80		
	Paralysis of eye muscles (G44)	75		
	Ear lobe thickening (G45)	80		
22	Scaly and inflamed skin (G29)	80	Ringworm 83.3 %	Moths of the body
	Itching (G1)	80		
	A reddish circular skin rash appears (G31)	90		
23	Blistered skin (G3)	85	Dermatitis 83.3%	Dermatitis
	Redness appears on the face, knees, hands, and feet (G7)	85		
	Inflamed skin (G4)	80		
24	Mild itching (G12)	80	Tinea Versicolor 80 %	Tinea Versicolor
	The color of the skin becomes lighter or darker (mottled) (G15)	85		
	Dry and scaly skin (G13)	75		
25	Itching (G1)	80	Dermatitis 80 %	-
	Heat in inflamed area of skin (G23)	85		
	Red bumps/spots (G22)	75		
26	Limp body (G32)	75	Herpes Zoster 78.3	Herpes Zoster
	There is pain in the head (G33)	80		
	Attacks one side of the body only (G35)	80		
27	Pain (G5)	65	Dermatitis 80 %	Dermatitis
	Pus discharge (G6)	95		
	Itching (G1)	80		
28	Slight fever, runny nose, fatigue, lethargy and weakness (G17)	60	Varicella 58.3%	Varicella
	A watery rash appears all over the body (G20)	65		
	Itching after spots break out (G21)	50		
29	Itching (G1)	90	Dermatitis 90 %	-
	High fever (G18)	70		
	Pain when pressed (G9)	70		
30	Blister fluid forms scabs (erusta) (G26)	60	Impetigo 78.75 %	Impetigo
	If it breaks, it will spread around (G28)	90		
	Pain in the skin (G24)	90		
	Blisters with reddish-yellow liquid (G25)	75		

Based on Table 4, the accuracy test results indicate that the system can diagnose skin diseases effectively, aligning with expert diagnoses. The percentage values are calculated using the Fuzzy Tsukamoto method, where users input severity levels for each symptom on a scale of 0-100. A correct diagnosis is defined

as a case where the system's output matches the expert's diagnosis for the same patient, meaning the predicted disease and severity level fall within an acceptable range of the expert's assessment. Cases are not counted as correct diagnoses if the predicted disease differs from the expert's assessment, the severity level deviates significantly (e.g., Tinea Pedis vs. Ringworm), or the system produces an inconclusive result due to insufficient input data. The system produced 25 diagnoses that matched expert evaluations. The system's accuracy can be determined through the calculation below.

$$Accuracy = \frac{Number\ of\ correct}{Total\ respondent} \times 100\%$$

$$Accuracy = \frac{25}{30} \times 100\%$$

$$Accuracy = \ 83{,}3\%$$

4. CONCLUSION

This expert system integrates Best First Search to efficiently select the most relevant diagnoses based on patient symptoms, while Fuzzy Tsukamoto refines the diagnosis by assessing disease severity using fuzzy logic and membership functions. Accuracy testing with 30 test data points resulted in an accuracy rate of 83.3%, surpassing several conventional rule-based systems. However, experts suggest that for clinical applications, further improvements are needed to enhance reliability, such as utilizing a larger dataset and incorporating additional medical parameters. These findings align with previous studies, which demonstrated that Fuzzy Tsukamoto-based systems provide accurate diagnoses consistent with expert manual calculations. Therefore, integrating both methods enhances the system's reliability in delivering more precise diagnoses.

REFERENCES

[1] T. S. Waruwu, M. D. S. Lubis, and N. G. Silaen, "Sistem Pakar Pemeriksaan Penyakit Kulit Memanfatkan Metode Certainty Faktor," *Jurnal Widya*, vol. 3, no. 2, 2022.

[2] M. A. Hanin, R. Patmasari, and R. Y. Nur, "Sistem Klasifikasi Penyakit Kulit Menggunakan Convolutional Neural Network (CNN)," vol. 8, no. 1, pp. 273–281, 2021.

[3] F. Bimantoro, "Sistem Pakar Diagnosa Penyakit Kulit pada Manusia dengan Metode Dempster Shafer," vol. 4, no. 2, pp. 129–138, 2020.

[4] R. Meri, "Aplikasi Sistem Pakar Dalam Mendiagnosis Penyakit Kulit Pada Manusia Berbasis Visual," *Jurnal Ilmiah Informatika*, vol. 9, no. 02, pp. 110–115, 2021, doi: 10.33884/jif.v9i02.4439.

[5] M. D. A. Putra, A. D. Baihaqie, and A. Irawan, "Sistem Pakar Diagnosa Penyakit Kulit pada Manusia dengan Menerapkan Metode Forward Chaining," *Jurnal Riset dan Aplikasi Mahasiswa Informatika (JRAMI)*, vol. 5, no. 2, pp. 325–332, 2024, doi: 10.30998/jrami.v5i2.9191.

[6] S. Wahyuni, "Sistem Pakar Diagnosa Penyakit Kulit Pada Manusia Menggunakan Metode Hybrid," *Jurnal Sains Informatika Terapan*, vol. 2, no. 1, pp. 25–30, 2023, doi: 10.62357/jsit.v2i1.177.

[7] M. Elan and K. Handoko, "Sistem Pakar Mendiagnosa Penyakit Pada Ikan Arwana Menggunakan Metode Forward Chaining Dan Depth First Search Berbasis Web," *Jurnal Comasie*, vol. 3, 2022.

[8] S. S. Thiansin P. Hasan and A. F. Maulana, "Sistem Pakar Diagnosa Penyakit Kulit Manusia Menggunakan Metode Backward Chaining Berbasis Website," *Jurnal Teknik Informatika dan Sistem Informasi*, vol. 11, no. 4, pp. 449–462, 2024.

[9] N. Hasan G. J. Yanris and E. R. Hasibuan, "A Mobile-based Expert System for Disease Diagnosis Child using Best-First Search Algorithm," *Sinkron*, vol. 7, no. 2, pp. 701–707, 2022, doi: 10.33395/sinkron.v7i2.11426.

[10] D. A. Ahmad and R. Rachman, "Implementasi Sistem Pakar Diagnosis Penyakit Tifus dengan Metode Breadth-First Search dan Best-First Search," *Jurnal Informatika dan Teknik Elektro Terapan*, vol. 11, no. 3s1, 2023, doi: 10.23960/jitet.v11i3s1.3457.

[11] Y. Afero, "Algoritma Best First Search Menentukan Lintasan Jalur," vol. 5, no. 2, pp. 138–145, 2021.

[12] I. U. W. Mulyono, Y. Kusumawati, A. Susanto, and D. I. I. Ulumuddin, "E-Sistem Pakar Diagnosa Dini Penyakit Diabetes Menggunakan Metode Fuzzy Tsukamoto," *Prosiding Seminar Nasional Lppm Ump*, vol. 0, no. 0, pp. 515–522, 2021.

[13] S. N. Rizki, Y. Yenni, and N. Jarti, "Perancangan Aplikasi Sistem Informasi Wisata Menggunakan Metode Algoritma Best First Search," *Bit-Tech (Binary Digital - Technology)*, vol. 7, no. 2, 2024, doi: 10.32877/bt.v7i2.1845.

[14] F. B. Andika and A. S. Purnomo, "Sistem Pakar Deteksi Dini Tingkat Kecanduan Gadget pada Anak Menggunakan Fuzzy Tsukamoto," *Jurnal Informatika dan Rekayasa Perangkat Lunak*, vol. 5, no. 2, p. 135, 2023, doi: 10.36499/jinrpl.v5i2.8750.

[15] S. Levianto and A. A. Soebroto, "Sistem Pakar Diagnosis Penyakit Leukimia dengan Metode Fuzzy Tsukamoto," *Jurnal Pengembangan Teknologi Informasi dan Komputer*, vol. 5, no. 12, pp. 5329–5338, 2021.

[16] Yuliana, M. Arhami, and Hendrawaty, "Sistem Pakar Diagnosa Tingkat Depresi pada Mahasiswa Menggunakan Metode Fuzzy Tsukamoto Berbasis Web," *Jurnal Teknologi Rekayasa Informasi dan Komputer*, vol. 6, no. 2, pp. 68–76, 2023.

[17] U. A. et al., "Diagnosa Resiko Penyakit Jantung Menggunakan Logika Fuzzy Metode Tsukamoto," *Infokes*, vol. 11, no. 1, pp. 31–40, 2021.

[18] K. Mahfudh, A. Azizi, M. Rafi, and H. Fazlullah, "Penerapan Algoritma Best First Search Pa," vol. 2, pp. 0–4, 2020.

[19] S. Maryam, E. Bu, and E. Hatmi, "Penerapan Metode Fuzzy Mamdani dan Fuzzy Tsukamoto Dalam Menentukan Harga Mobil Bekas," *Journal of Informatics, Electrical and Electronics Engineering*, vol. 1, no. 1, pp. 10–14, 2021.