

SYSTEMIC LUPUS ERITHEMATOSUS DISEASE DETECTION EXPERT SYSTEM IN IMMUNOLOGY USING WEB-BASED DEMPSTER-SHAFER METHOD

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ABSTRACT

Autoimmune is a disease caused by healthy cells or human immune system being attacked. Thus, the body must be able to distinguish between its own antigens and foreign antigens. There are also several types of autoimmune diseases, one of which is lupus. Lots of people underestimate their health, and because of the lack of information about the disease, an application in the form of an expert system is needed to diagnose symptoms and provide information about Lupus. In this study, the Dempster-shafer method is used because it is believed to be able to combine separate pieces of information to be able to calculate the likelihood of an event. And the results of this study indicate that the system that works to diagnose Lupus has a level of accuracy of; 80% with the system testing of 15 data conducted by direct experts.

Keywords: immunology; expert system; systemic lupus erythematosus;



dempster-shafer; web based;

1. INTRODUCTION

The rapid development of technology, to make the process of detecting diseases in Immunology (Lupus Erythematosus Systemic) can be facilitated by the ability of computers, where the system can process information and knowledge, it is no doubt that this can be seen with the increasing number of emerging programs intelligent who is able to solve problems, in diagnosing various diseases [1]. And if the main function of the immune system is disturbed, it can cause an imbalance that can manifest until it becomes a recurrent infection, of malignancy and also autoimmunity in the body. It can be concluded that autoimmune disease is a disease caused by the immune system that attacks healthy cells in the human body so the body must be able to distinguish between its own antigens and foreign antigens. If there is a failure in distinguishing the substance itself or foreign substances, it will result in the formation of antibodies in the body's own parts (autoantibodies). As for several types of diseases from autoimmune itself, namely: Hepatitis, HIV, Systemic Lupus Erythematosus [2].

In this study, the Dempster-shafer method is used because it has been believed to be able to accommodate uncertainty or combine separate pieces of information, to calculate the likelihood of an event being experienced. In addition to also being able to assist humans in obtaining information about symptoms of the disease, this expert system was also made for some of the requirements of the final project entitled "Implementation of Immunological Disease Detection Application Systems using the Web-Based Dempster-Shafer Method in Systemic Lupus Erythematosus Disease ". In the pattern of student behavior search using a new method from the AHC that is ALG takes a dataset of 1523 student posts that produce the highest value of 0.9925 [3]. In research aimed at assisting teachers in determining direction to be more effective and efficient, the k-nearest neighbor algorithm is used, in which this study obtains data from students directly, and then analyzed with manual calculations, then applied to determine applications. And it has results that is, in determining majors can be done directly so that it is faster [4].

And recently introduced a new algorithm called Average Linkage Dissimilarity, where this algorithm combines the inequality technique of cluster isolation and cumulative techniques. And the algorithm test results using Average Linkage Dissimilarity show that ALG outperforms the LSS-GCSS algorithm (Local Standards Score-Global Cumulative Score Standards) in previous studies [5]. Until, in research that discusses Hepatitis in which Hepatitis is a disease of liver disorders. And in this study, the method used is the Dempster-shafer method. Based on the results of testing the accuracy of the system, it shows that the system is good enough and can also be used to diagnose hepatitis [6]. In subsequent studies that discuss the transmission of HIV / AIDS, it is explained that HIV is a disease that attacks the body's immunity, which until now also has not found a drug that can cure.

In this study using the Dempster-shafer method and the test results obtained, that the system can be used in early detection in patients with HIV / AIDS [7]. In the next discussion about the Endocrine System or known as the glandular system which is a glandular system that is able to work on the human body and the results of its secretions which are commonly referred to as hormones, the Dempster-shafer method is used as an algoritma. And based on the test results, from 35 cases, the accuracy level of the test was 91,428% which showed that the method was able to function properly [8]. In research that discusses that gastric disease is heartburn. Ulcer disease can be caused by stomach acid, so that the wound arises. The method used is Dempster-shafer and based on the results of system testing, it was concluded that, the expert system in gastric disease has a match or suitability of 70% [9]. In research that explains that tropical diseases are common diseases that occur in tropical regions. Usually a person can get symptoms due to frequent neglect, so that the disease suffered is getting worse. In this study, the authors used the Dempster-shafer method. Thus, it can be concluded that, the success rate of system testing using 104 medical record sample data results is 94.23% [10].

In research that discusses that, the trust structure of the Dempster-shafer has a two-step process, namely the selection of one focus element and the selection of objects from the chosen focus element. Generalizing this model, allows for more general types of uncertainty to model the fundamental uncertainties associated with the selection of focus elements [11]. In research that discusses the generalization of the Dempster-shafer theory along with the function of belief that explains that the evidence from the Dempster-shafer theory has been widely used in various fields of application, because of its flexibility and effectiveness in modeling uncertainty without prior information [12]. In research that discusses the expert system of diagnosing Tuberculosis. Tuberculosis is a lung disease which is a dangerous disease caused by micro-bacteria. The results of consultation with the system can show that the system is able to determine the disease based on symptoms entered by the user of the system (people with Tuberculosis) using the Dempster-shafer method [13]. In research that discusses the classification at the stage of sleep using the Dempster-shafer theory for the fusion classifier. The Dempster-shafer method is used to combine output derived from the classification of two EEG channels. Then the classification accuracy results increased by 88.23% from only 71.93% [14].

In research that discusses skin diseases found in humans, explains that skin diseases are common diseases that transmit humans of all ages. And experience several factors in the form of climate, environment, residence, unhealthy living habits, allergies and others. And from the results of the study there is an automatic system that can resemble experts or experts in helping to overcome the problem of disease and can diagnose skin diseases accurately by using the Dempster-shafer method [15]. In research that discusses nutritional disorders in thin body can affect productivity. Based on the results of research applying the Dempster-shafer method that this expert system will greatly assist users in obtaining information on symptoms, as well as consistent treatment [16]. In research that discusses the disruption of the digestive system in humans is a dangerous disease, due to lack of awareness of public health is still low. In this study using the Dempster-shafer method which has the highest value with a confidence level of 85% compared to the certainty factor method with a value of 60% [17]. In further research on diseases of the human face where the skin is a sensitive body part and has an important role, and one of its functions is to eliminate waste substances. And the results of this study explain that the Dempster-shafer method can help in detecting skin diseases before and after overcoming them [18].

In this study, about Personality Disorders that personality disorders are ways of thinking and ways of behaving someone that makes that person different from others. In this study the authors compared the Dempster-shafer method with the Certainty Factor method. Which obtained the test results that the Dempster-shafer method has an accuracy in diagnosing the disease up to 90%, while the Certainty Factor is only 85% [19]. In this study, about lung disease, that the lungs are one of the most vulnerable respiratory organs. The Dempster-shafer method calculates several possibilities of lung disease based on the density of the probability values held by each symptom. And this study uses 65 data obtained from PT. Tegowanu Grobogan District Health Center. Based on the results of this study it can be concluded that the diagnosis using the Dempster-shafer method has an accuracy of 83.08% [20].

2. RESEARCH METHOD

In this study the authors describe several explanations or understandings of the Expert System, the method used, and the research flowchart. In order that this research is easy to understand, the following explanation;

A. Expert system

Expert system or known as artificial intelligence is one of the first applications in the field of computer science, which emerged from preliminary research, using computer efficiency that can behave intelligently like humans in the field of artificial intelligence, explanation of reasoning, expert system is one of the applications based on knowledge of a kind of special reasoning that with relatively and directly as imitated human activities [21].

B. Method Dempster-shafer

In this study, the authors used the Dempster-shafer method which was first introduced by Dempster, who had experimented with an uncertainty model with a range of probabilities as a single probability. In general, Dempster-shafer theory is written in an interval: [Belief, Plausibility] Belief (bell) which means a measure of strength in supporting a set of propositions.

If it is 0, it indicates no evidence, and if it is 1, it indicates there is certainty. According to Giarratano and Riley, the belief function can be formulated as follows:

$$Bel(X) = \sum m(Y) \quad Y \subseteq X \quad (2.1)$$

While, Plausibility (Pls) denoted as equation 2.2.

$$Pls(X) = 1 - Bel(X') = 1 - \sum m(Y) \quad Y \subseteq X' \quad (2.2)$$

Explanation:

Bel(X) = Belief (X) Pls(X) = Plausibility (X) m(X) = mass function dari (X) m(Y) = mass function dari (Y)

Plausibility also valued from 0 to 1, if you believe in X', then you can say Belief (X') = 1 so that from the formula above the value of Pls (X) = 0.

C. Data collection

In this research, the author uses two (2) techniques in collecting data as follows;

1. Study literature

Which, literature study is done by collecting reading sources, from the internet media in the form of journals, e-books, and books from various kinds of research in accordance with the problem taken.

2. Interview

The interview technique, in which the authors interviewed directly to experts to get more information, related to the symptoms of this systemic Lupus Erythematosus disease.

3. Research flowchart

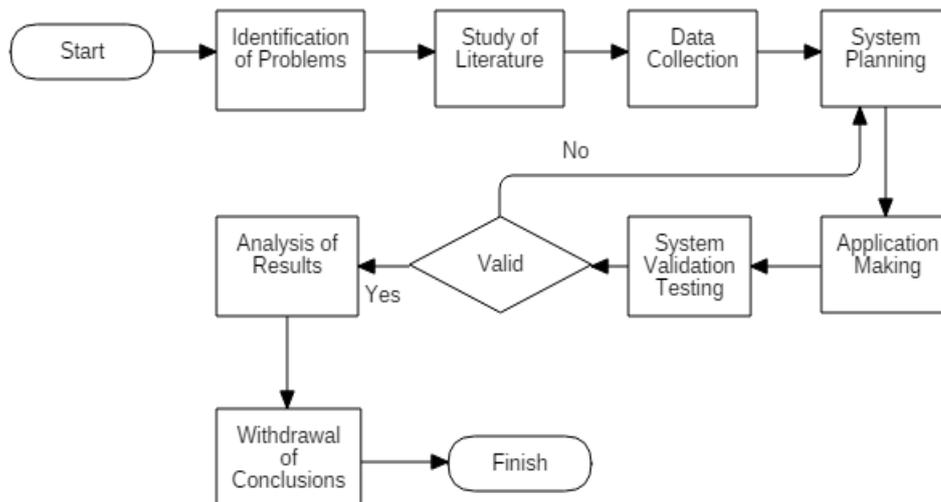


Figure. 1 Research method

In Figure 1, it explains that there is a research flowchart where the first process is to identify problems in diseases that are included in immunology, and in the second stage the process of doing a literature study becomes one of the reference references in obtaining various related information. Then in the third stage, the process of

data collection, where the writer must determine the technique of data collection by interviewing a specialist in internal medicine, or observing directly in patients with Lupus itself. Then in the fourth stage there is a system design process, this is one of the design drawings in the making of the application and also the process of implementing the system to be built, and then in the fourth stage which is valid or whether an information has been inputted, if invalid, then the system will return to the design of the system, and if valid, then the system will enter the next stage. Then in the fifth stage, Results analysis is the process of elaborating results that are already valid. Then at the last stage in the conclusion stage is the result of research that has been analysed.

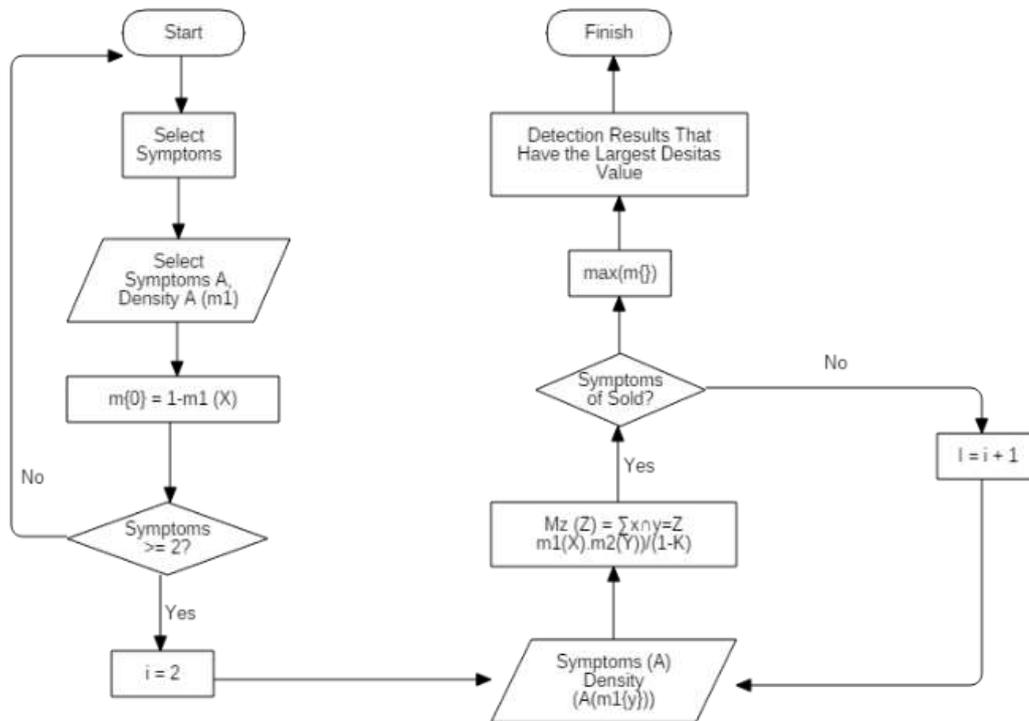


Figure. 2 Flowchart method

Explanation:

I = indicator (evidence)

m = density / trust value

x = output/result

4. System flowchart

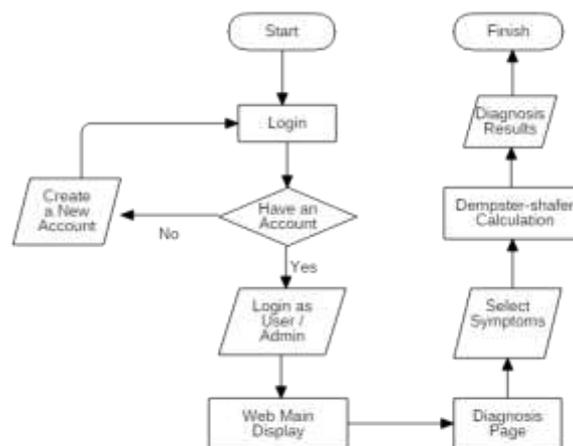


Figure. 3. System flowchart

Flowchart system is a flow, where the expert system asks the user to log in if they already have an account, and if the user does not have an account, the system asks the user to create an account first. When you have successfully logged in as a user, the system displays the main view on the web, then goes to the diagnosis page and the user selects the symptoms, then the system will do the calculation using the Dempster-Shafer algorithm, to output the diagnostic results of the symptoms selected by the user.

3. RESULTS AND DISCUSSION

3.1 Knowledge base

Table 1 is about indicator of Lupus.

Table. 1 Indicator of lupus

Code	Indication	Bel
G1.	Headache	0.5
G2.	Easily Tired	0.4
G3.	Muscle and Joint Pain	0.7
G4.	Migraine	0.5
G5.	Migraine	0.5
G6.	Swollen Joints (Arthritis)	0.7
G7.	Chest pain	0.4
G8.	Hair loss	0.5
G9.	Dry eye	0.5
G10.	Depression	0.5
G11.	Memory loss	0.7
G12.	Shortness of breath	0.6
G13.	Swelling of The Ankle	0.7
G14.	Finger whitening / blue when exposed to cold	0.8
G15.	Convulsions	0.6
G16.	Bloody Urine (Proteinuria)	0.7
G17.	Kidney Problems	0.8
G18.	Mental disorders	0.6
G19.	Weight Loss Suddenly	0.6
G20.	Extreme fatigue	0.5
G21.	Skin is Easy to Burn if Exposed to the Sun.	0.8
G22.	Scaly Skin, Red but Not Itchy	0.8
G23.	Inflammation of the Lungs / Heart	0.8
G24.	Butterfly-like rash	0.9
G25.	Difficulty Differentiating Reality / Imagination	0.7
G26.	Hallucinations	0.5
G27.	Fever	0.5
G28.	Mouth / Nose Ulcer	0.8

Table 2 is about indicators for lupus.

Table. 2 Output of indications for lupus

No	Code	Name
1.	01	Indicated attacked with lupus disease
2.	02	Not indicated in lupus diseases

Table 3 contains the rules as follows:

Table. 3 Table rules

Code	Name	Rule
01.	Indicated attacked with lupus disease	G3,G6,G11,G12,G13,G14,G15, G16,G17,G21,G22,G23,G24,G25,G28
02.	Not indicated in lupus diseases	G1,G2,G4,G5,G7,G8,G9,G10,G18 ,G19,G20,G26,G27

3.2 Method analysis

By testing the system, the user selects three symptom indicators as follows;

1. Headache
2. Easily Tired
3. Ulcer (Mouth and nose sores)

a) Indicator 1

Headache(G1)

G1 : (Not indicated) O2

$$M1 \{O2\} = 0.5$$

$$M1 \{\theta\} = 0.5$$

b) Indicator 2

Easily Tired (G2)

G2 : (Not indicated) O2

$$M2 \{O2\} = 0.4$$

$$M2 \{\theta\} = 0.6$$

	m2 {O2} 0.4	m2{\theta} 0.6
m1 {O2} 0.5	{O2} 0.2	{O2} 0.3
m1 {\theta} 0.5	{O2} 0.2	{\theta} 0.3

$$m3 \{O2\} = \frac{0.2+0.2+0.3}{1-0} = 0.7$$

$$m3 \{\theta\} = 1 - 0.7 = 0.3$$

c) Indicator 3

Ulcer (Mouth and nose sores)

G28 : (Indicated) O1

$$M3 \{O1\} = 0.8$$

$$M3 \{\theta\} = 0.2$$

	m4 {O1} 0.8	m4{\theta} 0.2
m3 {O2} 0.7	{\theta} 0.56	{O2} 0.14
m3 {\theta} 0.3	{O1} 0.024	{\theta} 0.06

$$m5 \{O1\} = \frac{0.24}{1-0.56} = 0.545$$

$$m5 \{O2\} = \frac{0.14}{1-0.56} = 0.318$$

$$m5 \{\theta\} = 1 - (0.545+0.318) = 0.137$$

The greatest value of confidence found in {O2} is not indicated to have a problem in mental health with a value of 0.545 x 100% = 54.5%.

3.3 Interface system

Figure 1-3 show the different displays of the expert system for immune disease along with some of the explanations.



Figure. 1 Home page



Figure. 2 Consultation

On the consultation page there is the display of all indicators of symptoms of lupus that can be selected by the user.



Figure. 3 Diagnosis results

On the diagnosis results page is a display of the symptoms that have been selected by the user who issued the diagnosis results.

3.4 Testing accuracy

Based on system testing conducted by experts, 15 times, it produces the following output:

Table. 4 Accuracy testing results

No	Indicator	Diagnosis Expert	Diagnosis System	Result
1	1, 9, 10, 16	Not indicated	Not indicated	Corresponding
2	2, 3, 7	Not indicated	Indicated	Not Corresponding
3	1, 4, 9, 17, 22	Indicated	Indicated	Corresponding
4	4, 5	Not indicated	Not indicated	Corresponding
5	2,8,9,13,20,21	Indicated	Indicated	Corresponding
6	1,2,3,4,5,9,13,16	Indicated	Not indicated	Not Corresponding
7	9, 10, 15, 20, 23	Indicated	Indicated	Corresponding
8	25, 28	Indicated	Indicated	Corresponding
9	11, 12, 19, 27	Indicated	Indicated	Corresponding
10	1, 5, 13, 16	Indicated	Indicated	Corresponding
11	1, 4, 8	Not indicated	Not indicated	Corresponding
12	4, 5, 10, 11	Not indicated	Not indicated	Corresponding
13	2, 7, 22, 23	Indicated	Indicated	Corresponding
14	6, 16, 17	Indicated	Indicated	Corresponding
15	1, 2, 20, 26, 27	Indicated	Not indicated	Not Corresponding

Based on the results of the accuracy test results;

$$\frac{\text{Lots of data to match}}{\text{Lots of sample data}} \times 100\%$$

$$\frac{12}{15} \times 100\% = 80\%$$

Then it can be concluded the results of the percentage calculation on the system test above, have a success rate of 80%

4. CONCLUSION

In the immune system diagnosis of Lupus using the Dempster-shafer method, it can be used as a tool or a way to diagnose Lupus. The system can be used in a way, the user selects the symptoms of the Lupus disease. By using the Dempster-shafer method, the calculation process will produce the highest trust value which is the decision of a direct expert, so that the system can combine or calculate the likelihood of any event that is experienced over a period of 30 days. Based on the results of testing the system, which uses 15 cases shows an accuracy of 80% and with these results indicate that the application system of early detection of immune disease in Lupus is suitable for use in diagnosing the disease.

ACKNOWLEDGEMENT

This research is an outcome of the internal competitive grant scheme of the Universitas Nasional.

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