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HUMAN FACIAL DISEASE DIAGNOSIS SYSTEM USING DEMPSTER SHAFER METHOD

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ABSTRACT

Skin is a very important and sensitive part of the human body. It is directly related to the outside world. In everyday life, the skin plays an important role. One of its functions is to remove waste substances. The lack of knowledge and limited sources of information causes low public awareness of skin health as well as not seeing a doctor. Regular skin checks can overcome the beginning of skin diseases that might trigger other more dangerous diseases. The system in this study is designed to detect and to know the symptoms of facial skin diseases that are felt. This knowledge-based system design was developed to diagnose human facial skin disease using the dempster shafer method. The results can help detecting earlier facial skin diseases and overcoming them.

Key words : diagnosis system, facial skin disease, *dempster-shafer*.

1. INTRODUCTION

The skin is a sense of touch and as a support for appearance in humans. Therefore, it is of much importance to maintain health or existence. The skin can experience various types of diseases, ranging from minor illnesses such as itching or more severe ones that can result in death. Sometimes, the skin is used as a form of interaction between humans. While some diseases can be transmitted only through touch, or the interaction of the skin with other skin. The use of towels, clothes, jackets, handkerchiefs of others who are affected will properly transmit the skin diseases.

A study, [1] has been conducted using of a knowledge-based system to diagnose human facial skin disease via the dempster shafer method. This knowledge-based system arises because of problems in a specific or special field. Users need a computerized solution to these problems like expert ways to solve problems. Including the field of facial skin medicine. One method that can diagnose facial skin disorder is the Dempster-Shafer method with a fairly good degree of accuracy [2].

Calculation of system uncertainty can be done by several methods. One method that can be used is the Demspter Shafer method. This method is expected to produce a more accurate diagnosis and have better certainty without changes or additions to knowledge.

2. RELATED WORKS

Dempster Shafer Theory is a Bayesian generalization of the theory of subjective probability. The trust function is based on the degree of trust in a problem with probability for a related problem. The degree of trust has mathematical probability properties; how much the difference depends on how closely the two problems are related [3].

The Dempster Shafer method is introduced [4], which experiments with uncertainty models with range probabilities as a single probability. Then [5] performs evidence based on belief functions and plausible reasoning. A separate combination of information to calculate the probability of an event. In general, the Dempster Shafer theory is written in an interval: [Belief, Plausibility].

Belief (Bel) is a measure of evidence strength in supporting a set of propositions. If it is worth 0 (zero) then it indicates that there is no evidence, and if it is worth 1, it indicates certainty [6].

The Belief function can be denoted as follows:

$$Bel(X) = \sum_{Y \subseteq X} m(Y) \quad \textbf{(1)}$$

Plausibility (Pl) is denoted as:

$$Pl(X) = 1 - Bel(X') = 1 - \sum_{Y \subseteq X'} m(X') \quad \textbf{(2)}$$

whare :
Bel(X) = *Belief* (X)
Pl(X) = *Plausibility* (X)
m(X) = *mass function* dari (X)
m(Y) = *mass function* dari (X)

Plausibility is also worth 0 to 1, if it is believed to be X 'then it can be said Belief (X') = 1 so that from the equation above the value Pl (X) = 0. In the Dempster-Shafer theory there is also a frame of discernment denoted by Θ. This FOD is a universe of discussion of a set of hypotheses so that it is often called an environment.

$$\ominus = \{\theta 1, \theta 2, \ldots\ldots, \theta n\} \quad \textbf{(3)}$$

where :
Θ = FOD or *Environment*
θ1,..,θn = element / element part in the Environment

In the Dempster-Shafer theory, disbelief in the environment is denoted m (θ). While mass function (m) in the Dempster-Shafer theory is the level of confidence of an evidence (symptom), called the evidence measure so it is denoted by (m).

The expert system has a number of evidence that will be used as a factor in uncertainty in taking. To overcome this amount of evidence, the Dempster-Shafer theory uses the Dempster's Rule of Combination rule..

$$m3(Z) = \frac{\sum_{X \cap Y = Z} m1(X).m2(Y)}{1 - k} \quad \textbf{(4)}$$

where :
m1 (X) = mass function of evidence (X) obtained from the value of belief and plausibility (X).
m2 (Y) = mass function of evidence (Y) obtained from the value of belief or belief and plausibility (Y).
m3 (Z) = mass function of the evidence (Z) result or the trust value of the calculation process using equation (4).
k = Amount of evidential conflict or empty set of process slices.

The amount of evidential conflict (k) can be formulated by:

$$k = \sum_{X \cap Y = \emptyset} m1(X).m2(Y) \quad \textbf{(5)}$$

Then from the above equation can be substituted with and become:

$$m3(Z) = \frac{\sum_{X \cap Y = Z} m1(X).m2(Y)}{1 - \sum_{X \cap Y = \emptyset} m1(X).m2(Y)} \quad \textbf{(6)}$$

The steps of the dempster shafer algorithm are as follows:

1. Determine the evidence or symptoms chosen, at least two.
2. Perform calculations, the first set is evidence or first symptom, the second set contains evidence or the second symptom.
3. Determine the first and second set of slices. The trust value for this slice is the belief or belief value of the evidence or the first symptom multiplied by the second trust value.
4. The slice of the first universe set with the second set is denoted by Θ. The trust value for this set is (1 minus the trust value of the first set) multiplied by the second trust value.
5. Look for the set of slices between the first set and the second set of universes. The trust value for this slice is the first trust value multiplied by (1 minus the second set of trust values).
6. Look for the set of slices between the first universe set and the second universe. The trust value for this slice is (1 minus the trust value of the first set) multiplied by (1 minus the trust value of the second set).
7. The sum of all trust values from the blank set of slice results above if there is, using equation (5). If there is no empty set, k is 0.
8. Record new data for each slice that forms a trust value. Each slice is an existing value divided by (1 minus the number of blank sets of trust values) using equation (6).
9. Repeat steps 2 through 8 with new data as a result of step 8. Evidence or subsequent symptoms when choosing more than 2 symptoms. Repeat this step until the new data calculation results are followed by the last evidence or symptom data selected.
10. Look for the highest or maximum trust value from the last process as a result or final decision of the Shafer-dster process.

3. RESEARCH METHOD

3.1. System Analysis

The system in this study is a calculation to diagnose human facial skin disease. In this study, the stages used are as follows:

1. Data on human facial skin disease obtained from a dermatologist.
2. Enter the symptoms experienced by the patient into the system to get the diagnosis.
3. Diagnosis of disease using the Dempster Shafer Method based on the symptoms experienced by the patient.

3.2. System Flow Designing

The design of a facial skin disease diagnosis system using the Dempster Shafer method uses several stages such as system process flow design which can be seen in Figure 1.

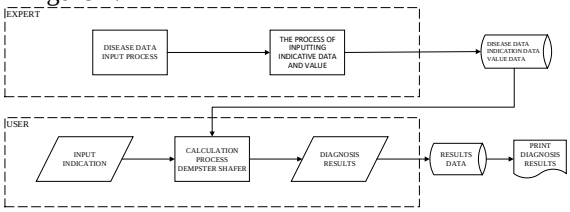

Figure 1. Flow of System Processes

3.3. Structure of Knowledge Based System

The structure of a knowledge-based system has two main parts, namely: the development environment or the facial dermatologist and the consultation environment. This structure can be seen in Figure 2..

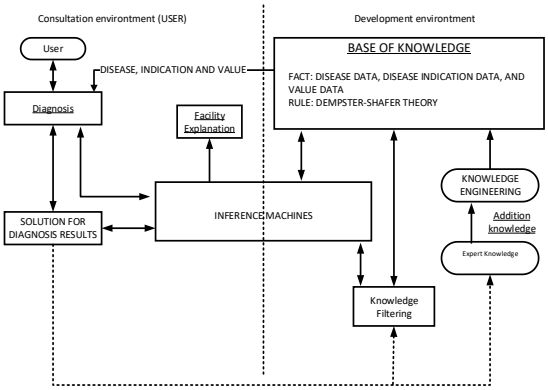

Figure 2. System Structure

3.4. Context Diagram

Context diagram in this system consists of two external entities, namely doctors and users. Patients with facial skin disease as users enter data. User data and symptoms felt. Admin input physician account data and article data. Doctors enter data on illness, symptoms, and weights for symptoms of the disease. The context diagram can be seen in Figure 3.

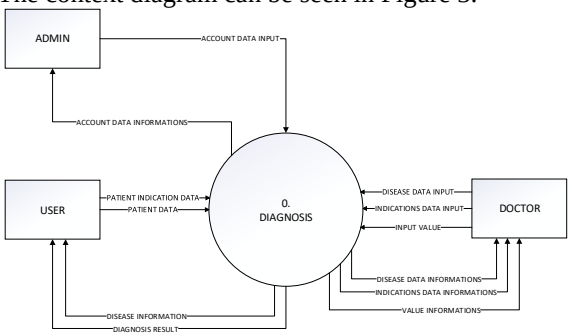

Figure 3. Context Diagram

4. RESULTS AND DISCUSSION

4.1. Requirement analysis

Requirement analysis is an important stage in system development. The analysis is carried out according to user requirements, namely :

a. Input

Data needed in the form of data on diseases, symptoms, and knowledge. Weight in the form of belief or belief value and plausibility. Disease data as the core of knowledge is used for diagnosis. Symptom data is chosen by the user. Knowledge or weight becomes the knowledge base of the system. Knowledge includes Belief (Bel) and Plausibility values obtained from doctors.

1. Disease Data

List of diseases in the system can be shown in Table 1.

Table 1. disease table.

Code of Disease	Disease
P01	Acne Vulgaris
P02	Rosacea
P03	Tinea Barbae
P04	Allergic Contact Dermatitis
P05	Atopic dermatitis
P06	Perioral dermatitis
P07	Seborrheic dermatitis
P08	Melasma
P09	Seborrheic Keratosis
P10	Squamous Cell Carcinoma
P11	Bowen disease
P12	Angioedema

2. Symptom Data

A list of symptoms that are indicative of disease can be seen in Table 2.

Tabel 2. Symptoms Table

Symptom Code	Symptom
G01	Blackheads
G02	Itching and pain
G03	Oily skin
G04	Swelling and redness
G05	Lumps (swelling), and large pimples accompanied by pus
G06	Lumps that are reddened in pain
G07	Lumps accompanied by redness that contains yellowish liquid
G08	Furious, yellowish liquid comes out
G09	Around the hair there is a fungus, the hair is easily pulled out
G10	Itching on facial skin
G11	Dry facial skin accompanied by lumps
G12	Swelling due to scratching, can extend to other parts (forehead, scalp)
G13	Itching that peaks at night
G14	Dry and itchy facial skin
G15	Redness appears on the skin of the upper lip to the mouth
G16	Smooth yellow scaly skin
G17	Itching that triggers a burning sensation
G18	Dry, reddish facial skin and an itchy sensation on the skin of the face
G19	Facial skin turns gray
G20	Found on the face like a black to brownish mole
G21	Spots appear on the face of the part (cheeks, forehead, trunk and chin)
G22	There is brown plaque on the face
G23	Lumps appear in groups on the face
G24	Lumps on the face are denser with rotting wounds
G25	Red meat (warts) appear, rough structure
G26	The meat grows on the surface of the skin
G27	Reddened facial skin due to sunlight
G28	Swelling in the throat
G29	Shortness of breath, hoarseness
G30	Nausea (vomiting and diarrhea)

3. Knowledge Base

The knowledge base contains the weight of the value of belief. The value is given by the doctor based on belief and plausibility. As shown in Table 3.

Table 3 Knowledge Base

Clinical Symptoms	P											
	1	2	3	4	5	6	7	8	9	10	11	12
G01	*											
G02	*		*								*	
G03	*						*					
G04		*										*
G05		*										
G06		*										
G07			*									
G08			*									
G09				*								
G10				*	*							
G11				*								
G12					*							
G13					*							
G14						*						
G15						*						
G16						*						
G17							*					
G18							*					
G19								*				
G20								*				
G21								*				
G22									*			
G23									*			
G24										*		
G25										*		
G26											*	
G27											*	
G28												*
G29												*
G30												*

b. Process Requirements

Data is processed into diagnostic results obtained when the user chooses the symptoms that are felt. Data is processed in the system using the dempster shafer method to find out the diseases suffered by patients. This method calculates the belief and plausibility value of the selected symptoms. The results of calculations with the highest percentage are the results

of diagnosis. These results are in the form of a disease that the patient may suffer.

Sample case:
If the user chooses G1, G2, G17 for the patient's symptoms, the process is:
1. G1 = Blackheads
2. G2 = Itching and pain
3. G17 = Itching that triggers a burning sensation

Table 4. **Selected symptoms**

No.	Symptoms	Disease	*Belief (Bel)*	*Plausibility (1-Bel)*
1.	G1	P1	0.8	0.2
2.	G2	P1,P3,P11	0.7	0.3
3.	G17	P7,P11	0.8	0.2

Calculation of G1 and G2 :
m1{ P1} = 0.8
m1{Θ} = 0.2
m2{P1,P3,P11} = 0.7
m2{ Θ } = 0.3
where:
m1 {P1} = mass function of evidence 1, which is obtained from the belief value or belief symptom 1.
m1 {Θ} = disbelief in the environment obtained from symptom plausibility 1.
m2 {P1, P3, P11} = mass function of evidence 2, which is obtained from the belief value or belief symptom 2.
m2 {Θ} = disbelief in environment 2 obtained from symptom plausibility 2.

1. {P1,P3,P11} ∩ {P1} = {P1} and 0.8 X 0.7 = 0.56
2. { P1,P3,P11} ∩ {Θ} = { P1,P3,P11} and 0.7 X 0.2 = 0.14
3. {Θ} ∩ {P1} = {P2} and 0.3 X 0.8 = 0.24
4. {Θ} ∩ {Θ} = {Θ} and 0.2 X 0.3 = 0.06

Table 5. The calculation results of m1 and m2

	{P1,P3,P11} (0.7)	{Θ} (0.3)
{ P1} (0.8)	{P1} (0.56)	{P1} (0.24)
{Θ} (0.2)	{P1,P3,P11} (0.14)	{Θ} (0.06)

$k = 0$ Because all sets have intersection, a new density of calculations G01 and G02 is generated using equation (6) as below:

$$m3\{P2\} = \frac{0.56 + 0.14}{1 - 0} = \frac{0.7}{1} = 0.7$$

$$m3\{P1, P2, P3, P5, P7, P10\} = \frac{0.24}{1 - 0} = \frac{0.24}{1} = 0.24$$

$$m3\{\theta\} = \frac{0.06}{1 - 0} = \frac{0.06}{1} = 0.06$$

Calculation of results from G01 and G02 with G17, where m3 is the result of G01 and G02, while m4 is data from G17.

m3{P1} = 0.7
m3{P1,P3,P11} = 0.24
m3{Θ} = 0.06
m4{P7,P11} = 0.8
m4{Θ} = 0.2

Table 6. The calculation of m3 and m4.

	{P7,P11} (0.8)	{Θ} (0.2)
{P1} (0.8)	(1)	(2)
{ P1,P3,P11} (0.14)	(3)	(4)
{Θ} (0.06)	(5)	(6)

1. {P1} ∩ {P7,P11} = {k} dan 0.8 X 0.8 = 0.64
2. {P1} ∩ {Θ} = {P1} dan 0.8 X 0.2 = 0.16
3. {P1,P3,P11 } ∩ {P7,P11} = { P11} dan 0.14 X 0.8 = 0.112
4. {P1,P3,P11} ∩ {Θ} = {P1,P3,P11} dan 0.14 X 0.2 = 0.028
5. {Θ} ∩ {P7,P11} = {P7,P11} dan 0.06 X 0.8 = 0.048
6. {Θ} ∩ {Θ} = {Θ} dan 0.06 X 0.2 = 0.012

Tabel 7 The calculation results of m3 and m4.

	{P7,P11} (0.8)	{Θ} (0.2)
{P1} (0.8)	{k} (0.64)	{P2} (0.07)
{P1,P3,P11} (0.14)	{P11} (0.112)	{ P1,P3,P11} (0.028)
{Θ} (0.06)	{P7,P11} (0.048)	{Θ} (0.012)

$k = 0.64$ is the number of empty set values from the results of intersections m3 and m4 obtained from equation (5).

New density is obtained from the calculations of G1 and G5 with G19 using equation (6). Results as follows:

$$m5\{P1\} = \frac{0.16}{1 - 0.64} = 0.4444 \rightarrow 0.4444\ x\ 100\% = 44.44\%$$

$$m5\{P11\} = \frac{0.112}{1 - 0.64} = 0.3111 \rightarrow 0.3111\ x\ 100\% = 31.11\%$$

$$m5\{P1, P3, P11\} = \frac{0.028}{1 - 0.64} = 0.0777 \rightarrow 0.0777\ x\ 100\% = 7.7\%$$

$$m5\{P7, P11\} = \frac{0.048}{1 - 0.64} = 0.1333 \rightarrow 0.1333\ x\ 100\% = 13.3\%$$

$$m5\{\theta\} = \frac{0.012}{1 - 0.64} = 0.0333 \rightarrow 0.0333x\ 100\% = 3.3\%$$

So it can be said, patients with symptoms of G1, G2, and G17 as a result of diagnosis are P7, while the confidence level is 44.44%

4.2. Implementation of Diagnosis Page

Diagnostic page is used to input data, then choose the symptoms suffered by the patient. This page contains process, reset, and print results. Reset to delete the symptoms that were suffered. The process for carrying out the calculation of disease diagnosis. Print to produce a diagnosis. As shown in figure 4.

Figure 4. Consultation page.

The calculation results in figure 4, then printed to get a recommendation. As shown in Figure 5

Figure 5 Printout recommendations.

4.3. Implementation of Disease Data Page

This page is only accessed by experts (doctors). This page details the disease data that is in the system. As shown in figure 6.

Figure 6. Disease data page.

4.4. Implementation of Symptom Data Pages

This symptom data page is accessed by experts (doctors). This page details the symptom data that is in the system. Can be seen in Figure 7.

Figure 7. Page of disease symptoms data.

5. CONCLUSIONS

Based on the results of research on the system of diagnosing human facial diseases using the dempster shafer method, the conclusions are as follows:

a. The system is able to diagnose the disease and display possible outcomes based on input symptoms.
b. After getting the results of the calculation, then every possible disease gets a score or value. The highest score as a result of diagnosis of the disease suffered.
c. Furthermore, research can be developed with different methods or compare with several other methods with the possibility of getting better results and higher accuracy.

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