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Expert System of Early Detection of Arthritis with Web-Based Certainty Factor Method

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ABSTRACT

Rheumatoid disease is one type of disease that attacks the joints in humans. Patients with this disease if it does not know the type of type of arthritis can cause paralysis. Expert systems in this study is expected to be one of the solutions for the early detection of arthritis in the joints of man. The method used is Certainty Factor, this method can cope with uncertainty in decision-making based on perceived symptoms that have been fed by the user. The purpose of this research is done by means of a comparison between the method of certainty factor with Dempster Shafer, so as to approach the best accuracy value. This expert system is created using the programming language PHP and MySQL database, Created by a web-based system which is expected to facilitate the user in getting information about Arthritis disease. The test results from this journal by comparing the certainty factor method with Dempster Shafer method. The result is the method of Dempster Shafer gain accuracy value of 96% of 50 test data, and the certainty factor method gain accuracy rate of 98% of 50 test data.

1. Introduction

*arthritis*is one of a variety of chronic diseases are common problems. "Today, arthritis affects more than one in four adults" [1]. The high frequency of occurrence of arthritis in the community due to the health and behavior of society such as stress, wrong diet, lack of physical activity and healthy lifestyle.

Some diseases such as Rheumatoid Arthritis Rheumatoid arthritis is the most severe type and can cause paralysis, if not treated quickly and appropriately be fatal. To help people with rheumatoid arthritis to know the types in the suffering, then we need a system that can do early detection of arthritis. The expert system may provide information about arthritis disease should an expert skilled in the field of arthritis. Early detection is given based on the symptoms that have been learned and based on the experience of experts Orthopedic Specialist.

Some journals are used for reference, the authors take 15 benchmark for comparison. In the first reference journals, which can be authors conclude that the problems in the capture is a tropical disease and the methods used in this study cerainty factor method. The results of the present study was calculated based on the results of testing the system with the test results of medical records, the results obtained by 86.65% [2]. Subsequent research problems taken that diagnosis ENT diseases, methods adopted are methods certainty factor. The results obtained in this study do not explain medical data and test data system [3]. The next reference journals that have problems in the capture that diagnose diseases of bones, joints, and muscles in humans, the methods used certainty factor. The results of this study do not take data from an expert, but from a user application that attempts, the result is the system meets user needs, information and diagnosis system is quite good, safe and easy to use [4]. Problems taken at the next reference journal that is disease pregnant women, using certainty factor. The test results obtained by the results of 100% of its system functionality and accuracy of the system is also 100%, the samples used were 13 samples of data [5]. The next reference journals have problems of the eye disease, using the same

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Jurnal Mantik
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method. Results of this analysis, the system can diagnose the disease with 75% accuracy rate of 15 experts of data, and the 52 symptoms in the diagnosis process [6]. the result is a system meets user needs, information and diagnosis system is quite good, safe and easy to use [4]. Problems taken at the next reference journal that is disease pregnant women, using certainty factor. The test results obtained by the results of 100% of its system functionality and accuracy of the system is also 100%, the samples used were 13 samples of data [5]. The next reference journals have problems of the eye disease, using the same method. Results of this analysis, the system can diagnose the disease with 75% accuracy rate of 15 experts of data, and the 52 symptoms in the diagnosis process [6]. the result is a system meets user needs, information and diagnosis system is quite good, safe and easy to use [4]. Problems taken at the next reference journal that is disease pregnant women, using certainty factor. The test results obtained by the results of 100% of its system functionality and accuracy of the system is also 100%, the samples used were 13 samples of data [5]. The next reference journals have problems of the eye disease, using the same method. Results of this analysis, the system can diagnose the disease with 75% accuracy rate of 15 experts of data, and the 52 symptoms in the diagnosis process [6]. using certainty factor. The test results obtained by the results of 100% of its system functionality and accuracy of the system is also 100%, the samples used were 13 samples of data [5]. The next reference journals have problems of the eye disease, using the same method. Results of this analysis, the system can diagnose the disease with 75% accuracy rate of 15 experts of data, and the 52 symptoms in the diagnosis process [6]. using certainty factor. The test results obtained by the results of 100% of its system functionality and accuracy of the system is also 100%, the samples used were 13 samples of data [5]. The next reference journals have problems of the eye disease, using the same method. Results of this analysis, the system can diagnose the disease with 75% accuracy rate of 15 experts of data, and the 52 symptoms in the diagnosis process [6].

Furthermore, researchers took 10 international reference journals from various sources. The first reference journals can be concluded that the journal is taking the problem of oral health in humans, the method used is the method of certainty factor. The test results from this journal can diagnose the system health of the teeth and mouth in humans have 94 627% accuracy rate of 14 test data [7]. The next international journal that the results of tests the diagnosis of stroke, the method of settlement of this journal using a comparison between the method of certainty factor with Dempster Shafer. The result is superior method than the certainty factor with Dempster Shafer method of the accuracy of concluding a disease of the symptoms that have been given [8]. Next journal that discusses the cirrhosis is a chronic liver disease, the method used certainty factor. The results of the research, it can be concluded that the accuracy of the application is to reach 100% [9]. Journal of the fourth on the issue of the use of borax in food that cause disease. Results from this study are pretty accurate with a high percentage [10]. Journal further discusses the problems in insomnia patients that suffer from the lack of sleep. Accuracy rate in this study reached 93.33% [11]. The next journals that discuss dermatitis disease in which patients have abnormalities in the skin. The results of this research have reached 90% accuracy rate of 10 data of patients [12]. Journal seventh discuss diseases of rice plants, the disease or pest in rice plants. The results of these journals around 60% of farmers agree that the system has benefits and 78% features an interesting system [13]. Next journal which discusses red pepper, red chili has a fairly complex diseases so that farmers are difficult to handle, forward chaining method used to diagnose the disease and calculate the probability with certainty factor method. The results of these journals have a high level of accuracy of the system [14]. Next journal that has the problem of disease in animals. The results from this journal that has reached 90% accuracy rate, and six of 25 symptoms of disease in chickens [15]. Last journal that problems exist in a good contraceptive choice and safe to use. The method used a combination of forward chaining method with certainty factor method. System accuracy rate reached 75% [16].

In this study the authors will design expert system for early detection of rheumatoid disease with a web-based using certainty factor (CF). CF method will obtain the results of early detection of disease based on the highest possible results obtained from the calculation of the symptoms selected by the user. These results are expected to help people know about the disease and get treatment immediately so as not to be dangerous.

Arthritis disease itself is a disease in the joint area, there are more than 100 kinds of diseases that affect the area around the joint. Thus the authors just take a couple of arthritis include Osteoarthritis, Rheumatoid Arthritis (arthritis), ankylosing spondylitis, Fibromyalgia, Juvenile Rheumatoid Arthritis, Gout Arthritis (gout). As well as the types of symptoms and problem resolution of an expert. A limitation of the method adopted is the method where the certainty factor that this method is applied to get one final

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Jurnal Mantik
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https://iocscience.org/ejournal/index.php/mantik/index

result of early detection of arthritis. The use of the programming language PHP, Javascript and MYSQL database

The purpose of this research is done by means of a comparison between the method of certainty factor with Dempster Shafer, so as to approach the best accuracy value. And another goal to produce an expert system that can detect the disease early arthritis by using a web-based certainty factor.

2. Research methods

2.1 Design Flow Research.

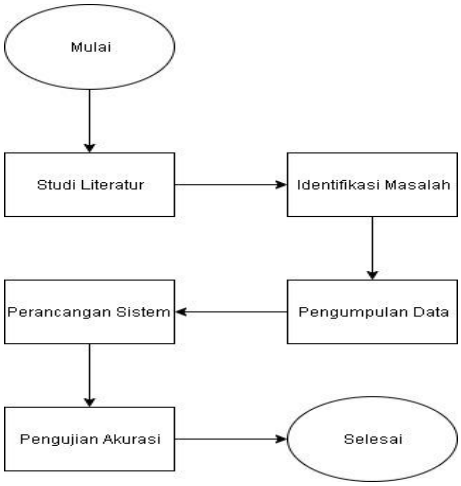

Image 1, Flow Research

Based on the image above that explained the flow of research that begins with a literature study phase, where at this stage the authors obtain the information from scientific journals, books, resources associated with this research. The next stage is the identification of the problems that exist in the study, the authors identify the object of this research problem is arthritis. The third phase of data collection, data collection comes from observation, interview, and literature study after getting the data associated with the system the authors analyze the data which will be taken to continue a subject of research. The next stage of the system design and system testing, system design is a process of making the complete system of design and coding, And the latter is testing accuracy.

2.2 Data collection

Data collected through the 2 ways interviews, and literature:

a. Interview
   Interviews were conducted with experts who have experience in the field of arthritis. The expert is an Orthopedic Specialist. Orthopedic physician who is experienced in dealing with patients suffering from arthritis.
b. Literature review
   Library Studies done by taking the theories of books, journals, and related to the problem so that it has a theoretical basis and foundation that can be justified.

2.3 *certainty Factor*

*certainty Factor*or the so-called Certainty Factor Shortliffe introduced by Buchanan in the manufacture MYCIN (kind of expert systems in the field of disease diagnosis) in 1975. The certainty factor is trust in an incident, facts and hypotheses based on the evidence of an expert assessment experts [17]. Here is the concept of the basic formulation of certainty factors:

Here are some combination formula of certainty factor in a variety of conditions

a. *certainty Factor* the premise Single

   CF [Symptoms] = CF (User) * CF [Expert]

b. *certainty Factor* the combination of the same premise

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Jurnal Mantik
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CFCombine = CF1 + CF2 * (1-CF1)

c. Calculating the percentage of CF Combine

Percentage value CF = CFCombine x 100

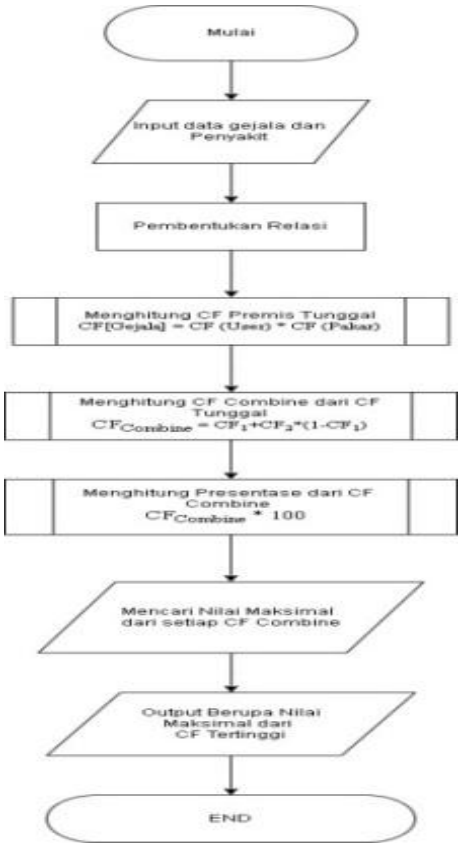

Figure 2. Flowchart Certainty Factor

In figure 2 above describes the flow of the certainty factor calculation starts from the inputting of symptoms and diseases, after the establishment of relations that included the establishment of relations, namely building relationships in every symptom and disease and the provision of value cf of experts. Next calculate a single premise, namely cf cf of any symptoms and their relationships, then combine with other single premise cf. After getting the results then converted to the form of percent. One final output of this calculation and display symptoms cf the value of the highest combination.

2.4 flowchart System

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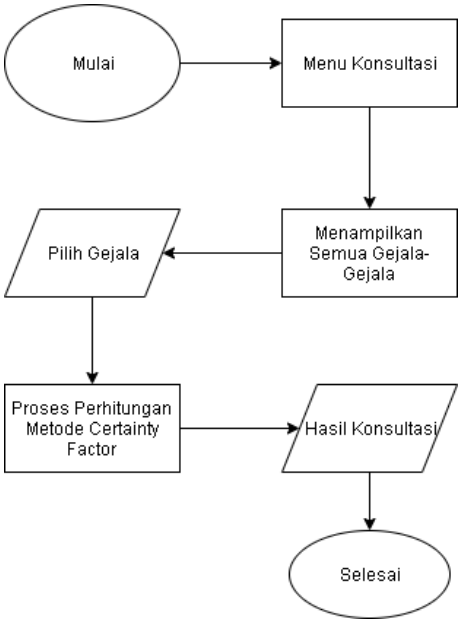

Picture 3. Flowchart System

System process flow in Figure 3 explains that the new system starts and is displayed to the menu page after the consultations were forwarded to display all the symptoms were there and fed by the user after that will start the process of calculation using the last CF.Dan will appear in the form of consultation results user information data, and disease-related information and information about the disease.

2.5 Use Case Diagram

Use case diagrams in this study is an overview flow occurs between user and the system.

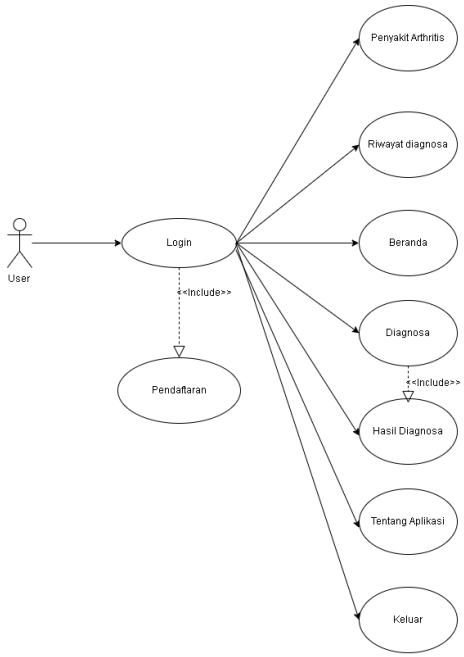

Figure 4, Use Case Diagram

In Figure 4 is a picture of the flow of the process in this study. Users will find the first page is a login page, then enter the homepage, the user can select the diagnosis, history of diagnosis, of arthritis, of applications and out of the system.

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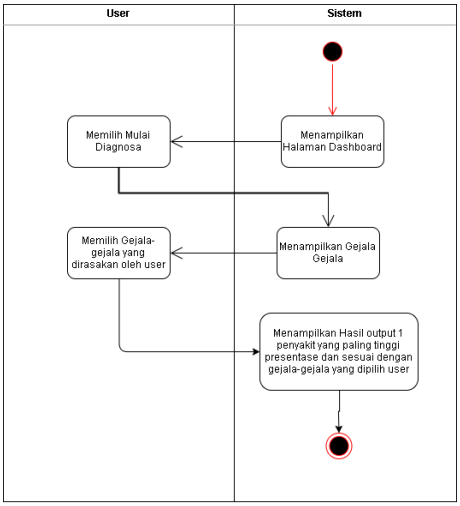

Picture 5. Activity Diagram

Figure 5 illustrates a relationship between the system with the user, The system will choose according to the needs of the user, *user* can choose symptoms are felt. The output of the program are prevention, description and value of the highest percentage of the value of CF.

3. Results and Discussion

3.1 Process Certainty Factor

The process of method certainty factor to determine the type of arthritis of the symptoms that are based on the knowledge and experience of experts gained from interviews showed 6 types of arthritis are osteoarthritis, rheumatoid arthritis, Juvenile rheumatoid arthritis, fibromyalgia, ankylosing spondylitis, and arthritis gout or also called uric acid.

table 1,
Data Disease Symptoms

Symptoms code	Symptoms name
G1	Heavy workers were using a joint continuously
G2	The movement of the joints to become limited
G3	Joint sounds when actuated
G4	Swelling of the joints that Feels Pain
G5	Feel stiff in the morning
G6	Changes while walking
G7	Rigidity occurs less than 30 minutes
G8	Rigidity occurs more than one hour in the morning
G9	Changes toe shape
G10	Joint pain from small to large joints
G11	Pain and stiffness in the night or early morning
G12	Joint pain began to subside when physical activity starts
G13	Often attacks the spine or pelvis
G14	Posture starts to bend
G15	Experiencing Shortness of Breath
G16	Fatigue experienced severe
G17	Pain widespread and strike spread throughout the body
G18	The body is very sensitive to pain even gentle touch also cause pain
G19	Rigid body when in the same position for a long time
G20	Headaches caused by a stiff neck or shoulder
G21	irritable bowel causing diarrhea
G22	cognitive Disorders

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Jurnal Mantik
Volume 3 Number 4, February 2020, pp. 400-411 E-ISSN 2685-4236
https://iocscience.org/ejournal/index.php/mantik/index

G23	Children
G24	There is a rash on the arms or legs
G25	Pain in the neck or hip
G26	Pain in the wrist or knee
G27	Joint pain suddenly attacked at midnight
G28	Red or purple rash on areas that are painful
G29	Warm in the diseased joints
G30	A history of gout from family
G31	The affected area is the foot, thumb, ankle, or knee
G32	Air often consume beverage alcohol

Table 1 is a data table arthritis symptoms derived from Orthopedic Specialist doctors at the General Hospital Zahirah, The table above displays 32 symptoms.

Table 2.
Arthritis Disease Data

Diseases code	Disease name
P1	osteoarthritis
P2	Rheumatoid Arthritis (Arthritis)
P3	ankylosing Spondylitis
P4	fibromyalgia
P5	Juvenile Rheumatoid Arthritis
P6	Gout Arthritis (Gout)

Table 2 is a disease of arthritis. The author chooses six types of arthritis are obtained from interviews with doctors experienced in their field.

Table 3.
CF Rules (Expert)

Diseases code	Disease name	Symptoms code
P1	osteoarthritis	G1 (0.6), G2 (0.6), G3 (1), G4 (0.6), G5 (0.8), G6 (0.8), G7 (0.6).
P2	rheumatoid arthritis	G4 (0.4) G8 (0.8), G9 (1), G10 (0.6), G28 (0.4)
P3	ankylosing Spondylitis	G11 (0.8), G12 (0.6), G13 (1) G14 (1), G15 (0.4)
P4	fibromyalgia	G5 (0.8), G16 (0.6), G17 (0.8), G18 (0.4), G19 (0.4), G20 (0.6), G21 (0.4), G22 (0.4)
P5	Juvenile Rheumatoid Arthritis	G6 (0.8), G23 (1), G24 (0.4), G25 (0.8), G26 (0.6)
P6	Gout arthritis	G4 (0.6), G27 (0.8), G28 (0.8), G29 (0.6), G30 (1), G31 (0.8), G32 (0.6)

Table 3 explains the rules of the symptoms of the disease according to the class-based orthopedic specialist.

Example calculations using certainty factor method can be applied to a case that is experiencing the following symptoms:

Table 4.
The case of the user who experience symptoms

Symptoms code	Symptoms name	conviction
G4	Swelling in the joints painful	sure enough
G8	Rigidity occurs more than one hour in the morning	Sure
G11	Pain and stiffness in the night or early morning	CukupYakin
G13	Often attacks the spine or pelvis	slightly sure
G27	Joint pain suddenly attacked at midnight	Sure
G28	Red or purple rash on areas that are painful	Sure

By using certainty factor will be known the possibility of involvement of the disease suffered by the user. Here is the application of probability calculations with certainty factor method based on the case in Table 4 are:

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Jurnal Mantik
Volume 3 Number 4, February 2020, pp. 400-411 E-ISSN 2685-4236
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a. Determining the Value of Certainty Factor

Determining the value of CF from experts and determine the weight value will be used as the user CF rule [18].

Table 5.
Weight Value CF Expert

No.	Information	Weight Value
1	Very sure	1
2	Sure	0.8
3	sure enough	0.6
4	slightly sure	0.4
5	Do not know	0.2
6	No	0

Table 6.
Rule CF User

No.	Information	Weight Value
1	Sure	0.8
2	sure enough	0.6
3	slightly sure	0.4

b. CF calculation of any relationship between the symptoms of the disease.

Calculations using formula CF CF Every single premise, namely

CF (expert) * CF (user)

a) Rheumatoid Arthritis Disease

Table 7.
CF Rheumatoid Arthritis

Symptoms code	Weights CF Expert	Weight Value CF User	value CF
G4	0.4	0.6	0:24
G8	0.8	0.8	0.64
G28	0.4	0.8	0:32

b) Ankylosing Disease Spondilytis

Table 8.
CF Ankylosing Spondylitis

Symptoms code	Weights CF Expert	Weight Value CF User	value CF
G11	0.8	0.6	0:48
G13	1	0.4	0.4

c) Gout Arthritis Disease

Table 9.
CF Gout Arthritis (gout)

Symptoms code	Weights CF Expert	Weight Value CF User	value CF
G4	0.6	0.6	0:36
G27	0.8	0.8	0.64
G28	0.8	0.8	0..64

c. Calculation CF CF combination of the above. Followed by calculating cf combination.

a) Rheumatoid Arthritis Disease

From Table 4 symptoms included in the symptom of rheumatic diseases, namely G4, G8, G28. Following his calculations:

CF (A) = CF (G4) + CF (G8) * (1-CF (G4)
= 0:24+ 0.64 * (1-0.24)
= .7264
CF (B) = CF (A) + CF (G28) * (1-CF (A))
= 0.7264 + 0:32* (1-0.7264)

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Jurnal Mantik
Volume 3 Number 4, February 2020, pp. 400-411 E-ISSN 2685-4236
https://iocscience.org/ejournal/index.php/mantik/index

=0.813952

Then CF of symptoms felt by the user for rheumatoid arthritis by 0928

b) Ankylosing spondylitis disease

From Table 4 symptoms included in the symptom of rheumatic diseases, namely G11, G13 following its calculations:

CF (A) = CF (G11) + CF (G13) * 1- (CF (G11))
= 0:48 + 0.4* (1-0.48)
= 0712

Then CF of symptoms felt by the user for rheumatoid arthritis by 0856

c) Gout Arthritis Disease

From Table 4 symptoms included in the symptom of rheumatic diseases, namely G4, G27, G28. Following his calculations:

CF (A) = CF (G4) + CF (G27) * 1- (CF (G4))
= 0.36 + 0.64 * (1-0.36)
= 0.7696

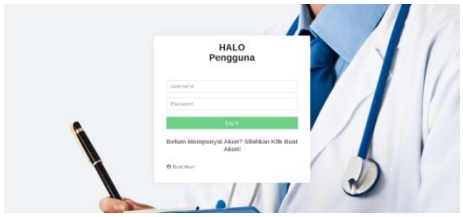
CF (B)= CF (A) + CF (G28) * (1-CF (A))
= 0.7696 + 0.64 * (1-0.7696)
= 0.917056

After getting the results of the search for the maximum value of the calculation and multiplied by 100 to get the results in terms of percent. Of the three diseases that are a maximum of Gout Arthritis is a disease that obtain the highest value combination cf ie 91.7056%

3.2 display Interface

Figure 6. Main page

Figure 6 is the first page that appears when you open the website, which is contained in this page is going to the menu for the user consultation.



Picture 7. Page Login

Figure 7 above displays the login page for users to be able to proceed to consultation menu. On this page there is also a menu to create a new account for the user to register.

Picture 8. Pages Consultancy

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Jurnal Mantik
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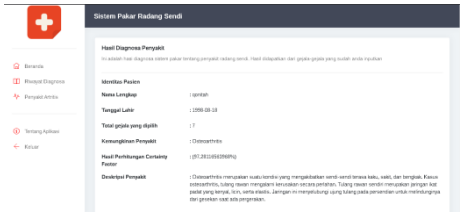
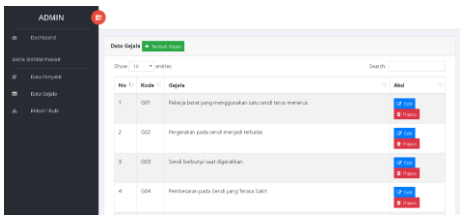
On this page the user input symptoms of what has been perceived and press up to forward to the results page to see the results of the diagnosis.



Picture 9. Consultation Results Page

On this page displays the results of the possibility of illness, the user's full name, date of birth. And on this page there is also a recognition of related diseases and their prevention.



Picture 10. Input Page Symptoms

On this page admin can input the corresponding symptoms of the approval of relevant experts, other menus that edit, delete and add symptom data contained in this page.

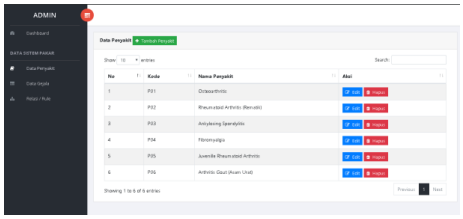
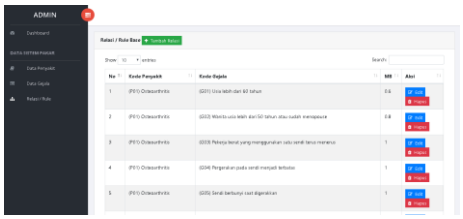


Figure 11, Pages Input Disease

On this page admin can input a disease approved by experts and can edit, delete, and add of input pages diseases.



Picture 12. Page Input Relation

On this page there are the rules of the system is the relationship between his illness and symptoms, as well as the input value admin cf experts who have been approved by the expert.

3.3 testing Accuracy

Calculation of accuracy in this study the authors compared the results of the output of the expert system with a certainty factor method Dempster Shafer method. the accuracy of the comparison test was performed using 50 data and calculated the accuracy of the method and Dempster Shafer certainty factor. Here is a test of the accuracy of an expert system with a certainty factor method:

Table 10.
Accuracy Testing Method Expert systems Certainty Factor

No.	Symptoms name	diagnosis Expert	output System	Ket
1	Sounds when actuated joints, enlargement of the joints that Feels Pain, feels stiff in the morning, Changes in walking.	osteoarthritis	Osteoarthritis (98.34112%)	Corresp onding

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2	Enlargement of the joints Feels Sick, posture began to bow, often attacks the spine or pelvis.	ankylosing Spondylitis	Ankylosing Spondylitis (88%)	Corresponding
3	Feel stiff in the morning, Headaches caused or buhu stiff neck, irritable bowel causing diarrhea.	fibromyalgia	Fibromyalgia (84.3328%)	Corresponding
4	Changes while running, stiffness occurs in less than 30 minutes, are rash on the arms or legs.	osteoarthritis	Osteoarthritis (76.96%)	Corresponding
5	The movement in the joints becomes limited, kids, pain in the neck or hips, red or purple rash Incidence	Juvenile Rheumatoid Arthritis	Juvenile Rheumatoid Arthritis (100%)	Corresponding
6	Red or purple rash, feels warm on the sore joint, swelling On Joints affected.	Gout Arthritis (Gout)	Gout Arthritis (Gout) (88.0192%)	Corresponding
7	Rigidity occurs more than one hour in the morning, Swelling In Joints affected, joint pain from small to large joints.	Rheumatoid Arthritis (Arthritis)	Rheumatoid Arthritis (Arthritis) (84.3328%)	Corresponding
8	Stiffness and pain felt during the morning, experiencing shortness of breath, body rigid when in the same position for a long time.	osteoarthritis	Fibromyalgia (69.76%)	It is not in accordance with
9	Heavy workers were using a joint continuously, feels stiff in the morning, pain is widespread and strike spread throughout the body.	osteoarthritis	Osteoarthritis (81.28%)	Corresponding
10	Changes while walking, small to large joint pain, swelling On Joints affected.	osteoarthritis	Osteoarthritis (66.72%)	Corresponding

The results of testing the accuracy of the system with the diagnosis of experts involving 50 data testing is as follows:

$$\text{accuracy} = = 98\%\frac{49}{50}X100$$

Next is the calculation accuracy of expert systems Dempster Shafer method:

table 11,
Accuracy Testing Method Expert System Dempster Shafer

No.	Symptoms name	diagnosis Expert	output System	Ket
1	Sounds when actuated joints, enlargement of the joints that Feels Pain, feels stiff in the morning, Changes in walking.	osteoarthritis	Osteoarthritis (96.64%)	Corresponding
2	Enlargement of the joints Feels Sick, posture began to bow, often attacks the spine or pelvis.	ankylosing Spondylitis	Ankylosing Spondylitis (100%)	Corresponding
3	Feel stiff in the morning, Headaches caused or buhu stiff neck, irritable bowel causing diarrhea.	fibromyalgia	Fibromyalgia (76%)	Corresponding
4	Changes while running, stiffness occurs in less than 30 minutes, are rash on the arms or legs.	osteoarthritis	Osteoarthritis (47.37%)	Corresponding
5	The movement in the joints becomes limited, kids, pain in the neck or hips, red or purple rash Incidence	Juvenile Rheumatoid Arthritis	Juvenile Rheumatoid Arthritis (100%)	Corresponding
6	Red or purple rash, feels warm on the sore joint, swelling On Joints affected.	Gout Arthritis (Gout)	Gout Arthritis (Gout) (60%)	Corresponding
7	Rigidity occurs more than one hour in the morning, Swelling In Joints affected, joint pain from small to large joints.	Rheumatoid Arthritis (Arthritis)	Rheumatoid Arthritis (Arthritis) 92%	Corresponding
8	Stiffness and pain felt during the morning, experiencing shortness of breath, body rigid when in the same position for a long time.	osteoarthritis	Fibromyalgia 44.44%	It is not in accordance with
9	Heavy workers were using a joint continuously, feels stiff in the morning, pain is widespread and strike spread throughout the body.	osteoarthritis	Fibromyalgia 61.54%	It is not in accordance with
10	Changes while walking, small to large joint pain, swelling On Joints affected.	osteoarthritis	Osteoarthritis 36.92%	Corresponding

The results of testing the accuracy of the system with the diagnosis of experts involving 50 data testing is as follows:

$$\text{accuracy} = = 96\%\frac{48}{50}X100$$

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Table 12.
Comparison of the accuracy

Accuracy	CF	DS
	98%	96%

According to the table 12 level of accuracy in comparison with the certainty factor method Dempster Shafer method. certainty factor method has the advantage to as much as 98% accuracy rate.

4. Conclusion

Based on the results of the discussion on the application of expert systems for early detection of arthritis by applying the certainty factor then the conclusions that can be taken include:

a. Based on the accuracy of testing that has been done by comparing the system with certainty factor method with Dempster Shafer method, getting the level of accuracy of the method Dempster Shafer of 96% of 50 test data. While the best results obtained from the expert system with certainty factor methods that get results accuracy by 98% of 50 test data.
b. The system can produce a form of information and early detection of arthritis using certainty factor.

5. Conclusion

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