**APPLICATION EXPERT SYSTEM FOR DIAGNOSIS OF UTERINE DISEASE FUZZY LOGIC**

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**Abstract:** Uterine disease is one of the major threats to society, especially women, because the high mortality rate currently occurs in women due to suffering from one of the diseases that attacks the uterus of women. This disease attacks a woman's important organ, namely the uterus, although not all diseases that attack the uterus of women are able to kill them, but many other impacts will affect women's health such as not being able to have children or other bad effects. The main discussion in this study is to diagnose uterine disease by implementing an Expert System. The development of this expert system uses the Fuzzy Logic method, which is a methodology of facts or knowledge to draw a conclusion. The way this method works is done by searching through the application of data and information entered first and will lead to a conclusion. Testing uses fuzzy logic. The results of the study were that the patient had Endometriosis with a confidence value of 0.63 or 63% to carry out diagnostic testing based on the same symptoms as the manual calculation in providing recommendations between the symptoms that arise with the uterine disease experienced by the patient.

**Keywords:** expert system; fuzzy logic; uterine disease*;*

**Abstrak:** Penyakit rahim merupakan salah satu ancaman besar bagi masyarakat khususnya wanita, karena tingkat kematian yang tinggi saat ini terjadi pada wanita akibat menderita salah satu penyakit yang menyerang rahim wanita ini. Penyakit ini menyerang organ penting wanita yaitu rahim, meskipun tidak semua penyakit yang menyerang rahim wanita ini mampu membunuh mereka namun banyak dampak lainnya yang akan mempengaruhi kesehatan wanita seperti tidak dapat memiliki keturunan ataupun akibat buruk lainnya. Pembahasan utama dalam penelitian ini adalah mendiagnosa penyakit rahim dengan menerapkan Sistem Pakar. Adapun pengembangan sistem pakar ini menggunakan metode Fuzzy Logic, yang mana metodologi dari fakta atau pengetahuan untuk menarik suatu kesimpulan. Cara kerja metode ini dilakukan dengan pencarian yang melalui penerapan data-data dan informasi masukkan dahulu dan akan menuju suatu kesimpulan. Pengujian menggunakan logika fuzzy. Hasil dari penelitian adalah bahwa pasien mengalami penyakit Endometriosis dengan nilai kepercayaan 0.63 atau 63% untuk dilakukan pengujian diagnosa berdasarkan gejala yang sama dengan perhitungan manualnyadalam memberikan rekomendasi anatar gejala yang timbul dengan penyakit rahim yang dialami pasien.

**Kata kunci:** fuzzy logic; penyakit rahim; sistem pakar;

**INTRODUCTION**

The increasing development of technological progress makes human life easier in carrying out activities. The development of technology that continues to grow rapidly from time to time, all forms of activities carried out by humans cannot be separated from the use of technology [1]. Computers in the current era of globalization have become a primary need to support human work. The role of computers is currently expanding, not only as a tool for calculating but also as a tool for solving problems faced by humans. One part of computer science that allows computers to do work as well as humans is artificial intelligence which is part of an expert system. Technological advances allow easier access to information and facilitate the process of identification and medical care, namely for users of expert systems that can facilitate the identification of diseases. In this case, the author will raise the diagnosis of uterine disease.

Expert systems are a field of computer science that utilizes computers so that they can behave intelligently like humans. This system attempts to adopt human knowledge into computers, so that computers can solve problems as experts usually do. Expert systems can also draw conclusions in a consistent time, and in some cases can even produce conclusions faster than experts [2]. Expert systems can also draw conclusions in a consistent time, and in some cases can even produce conclusions faster than experts [3].

Uterine disease is one of the major threats to society, especially women, because the high mortality rate currently occurs in women due to suffering from one of the diseases that attacks the woman's uterus. Uterine disease is the number one killer for women not only in Indonesia but also in the world. This disease attacks a woman's important organ, namely the uterus, although not all diseases that attack a woman's uterus are able to kill them, but there are many other impacts that will affect women's health such as not being able to have children or other bad consequences [4]. This disease is not contagious, but the disease arises due to abnormal physical conditions and unhealthy lifestyles. One of the uterine diseases that exist is Ca cervix, cysts, Myoma a uteri, ca ovaries [5]. Common symptoms of uterine disease include abnormal vaginal bleeding, such as menstrual cycles or after menopause, abnormal vaginal discharge, such as pink or brown containing blood or having a foul odor, pain in the lower abdomen or pelvis, fever, swelling in the abdomen, pain when urinating, recurrent bladder infections, bleeding outside the menstrual cycle and in the form of clots and other symptoms [6]. Most people today ignore or do not respond well to disorders that occur in uterine disease because of the lack of knowledge about the symptoms. However, uterine disease is very important for women, because if even the slightest symptom or disorder arises that is ignored, it can have serious consequences such as disrupting many functions in the body. If not treated immediately, this condition can trigger worsening symptoms and can even cause the risk of not having children.

Manan Simatupang is a health service institution that organizes individual health services that provide inpatient, outpatient and emergency services. The process of diagnosing diseases in patients at the H. Abdul Manan Simatupang Regional General Hospital is still carried out conventionally where patients must come to the hospital for consultation and disease checks. Furthermore, the doctor will examine the patient and write the results of the consultation on the patient's medical record card. Cyst disease has increased systematically which occurred in 2024 Of course this is one type of disease that needs special attention. This cyst itself is a disease that can cause various symptoms that can interfere with the quality of life of women, such as menstrual disorders and can cause serious complications, if there is no quick and appropriate treatment. Therefore, further research on the causative factors, health impacts, and methods of handling and preventing this disease is very important to increase public awareness about cysts.

In addition to the increasing cases of cyst disease, there are several obstacles in the practice of doctors that are often found in the medical consultation process, including the limited hours and working time of doctors, in addition, the relatively high consultation fees are often an obstacle for the community. Thus, both the community as users of health services and doctors as experts really need a system that can facilitate the process of diagnosing and consulting diseases quickly, efficiently, and affordably. The presence of a system that is able to support the process of consultation and diagnosis remotely is expected to help the community get early information regarding their health conditions, so that preventive measures and treatment can be carried out earlier. For this reason, the community needs an expert who can facilitate the process of early diagnosis and treatment of uterine disease, as well as provide education regarding prevention and proper treatment. This expert can help explain the symptoms that may be experienced by the patient, recommend beneficial lifestyle changes, and offer treatment options that are appropriate to the patient's condition so that treatment can be carried out earlier.

Due to this, the need for the use of information technology is an appropriate solution in dealing with recognizing early symptoms in online medical consultations. With the help of this technology, patients can access health services without being tied to time and place, making it easier for them to consult a doctor about the symptoms of the cyst. A computerized expert system to help the process of diagnosing early symptoms of the disease suffered by patients [7].

The expert system method used in this study is Fuzzy Logic. Fuzzy Logic is a calculation algorithm from word variables, to replace calculations through numbers. The series of words used in fuzzy logic are not as accurate as numbers, but the use of words is much closer to human instincts where humans can directly encounter the values ​​of word variables that have been used every day[8].

Research entitled Risk Factors for the Incidence of Myoma a Uteri in Outpatients at Undata Hospital, Central Sulawesi Province. Concludes that the variables of obesity and the use of hormonal contraception are not risk factors for the occurrence of Myoma a Uteri, while the variable definition of Vitamin D is a risk factor in outpatients at Undata Hospital, Central Sulawesi Province [9]. Next, with the title Expert System for Diagnosing Nasal Polyps Using Fuzzy Logic Method. It can help diagnose nasal polyps earlier, besides that it also makes it easier for patients to find out the diagnosis of nasal polyps so that patients with symptoms of nasal polyps no longer need to consult a specialist doctor and this will also reduce time and costs [10].

The use of fuzzy logic allows the system to handle physical symptoms from patient history, this method is an ideal method for use in expert system applications because of its ability to process ambiguous data and provide diagnostic results that are close to how doctors work in making decisions. This will certainly help medical personnel in providing faster and more precise treatment to patients, as well as simplifying the consultation process between patients and doctors.

**METHOD**

This expert system uses the Fuzzy Logic method in diagnosing uterine disease at the Abdul Manan Simatupang Kis-aran Regional General Hospital. Fuzzy logic is used as a way to map problems from input to expected output [11]. Based on facts, knowledge, or reasoning that can help solve a problem. The Fuzzy Logic method is one of the components that form soft computing. In many cases, fuzzy logic is used as a way to map problems from input to expected output [12]. Fuzzy is a computational framework based on fuzzy set theory, fuzzy rules are in the form of IF-THEN [13]. Fuzzy Logic is applied to calculate the severity of the disease based on the symptoms entered by the user is able to answer questions that have uncertain *answers* [14]. The data on uterine disease patients at the Abdul Manan Simatupang Kisaran Regional General Hospital are in Table 1.

Table 1. Data on the Number of Uterine Disease Patients in 2024

|  |  |
| --- | --- |
| Types of Disease | Month |
| Jan | Feb | Mar | Apr | May | Jun | Jul | Agts | Sept | Okt | Nov | Dec |
| Ca cervix | 24 | 1 | 3 | 0 | 0 | 0 | 1 | 2 | 1 | 1 | 2 | 0 |
| Kista | 38 | 0 | 2 | 0 | 2 | 2 | 5 | 5 | 0 | 1 | 2 | 0 |
| Mioma Uteri | 10 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Ca Ovarium | 6 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

 Before performing fuzzy inference, researchers must first know how fuzzy logic works in Figure 1 [10].



Figure 1. How Fuzzy Logic Works

 The following is an explanation of the fuzzy inference structure. A fuzzy knowledge base is a collection of fuzzy

rules in the form of IF.THEN statements. Fuzzyfication is the process of converting system input that has a definite value into

a linguistic variable using membership functions stored in the fuzzy knowledge

base.

𝜇(𝑥) = $\left\{\begin{array}{c}0\\\overline{\left(X-a\right)}\\\left(b-a\right)\end{array}\right.\begin{matrix}jika X \leq a\\jika a \leq χ \leq b\\jika χ \geq b\end{matrix}$

The inference engine is a process to change fuzzy input into fuzzy output by following the rules (IF-THEN Rules) that have been set in the fuzzy knowledge base.

Defuzzification is a fuzzy output obtained from the inference engine into a firm value using the appropriate membership function when fuzzification is carried out from$ =\frac{μ \left(z\right) . dari d-z}{μ (z\_{}d-z}$

**RESULTS AND DISCUSSION**

In conducting the research, the author used an expert system with the fuzzy logic method through the knowledge data used was uterine disease and its symptoms obtained from the results of interviews with obstetricians and gynecologists at the Abdul Manan Simatupang Kisaran Regional General Hospital. The uterine disease and its symptoms are shown in Table 2 and Table 3.

Table 2. Uterine Disease

|  |  |
| --- | --- |
| Code | Disease Name |
| P1 | Endometriosis Disease |
| P2 | Ovarian Cyst Disease |
| P3 | Uterine Myoma Disease |
| P4 | Uterine Infections |
| P5 | Adenomyosis disease |

Table 3. Symptoms of Uterine Disease

|  |  |
| --- | --- |
| Code | Disease Symptoms |
| G1 | Lower abdominal cramps or pelvic pain |
| G2 | Menstruation is irregular, abnormal, and close to the period |
| G3 | Pain or pressure when urinating |
| G4 | Pain, spotting of blood from the vagina |
| G5 | Bloating, swelling, pressure on the stomach |
| G6 | Post menopause bleeding |
| G7 | Post menopause bleeding |
| G8 | Headache and frequent fatigue |
| G9 | Pathogenic vaginal discharge |
| G10 | Pain in the vaginal area |
| G11 | Vaginal bleeding during/after intercourse |
| G12 | Swelling in the legs |
| G13 | Bleeding during menstruation or outside menstruation |
| G14 | Pain in the bladder or other pelvic organs |
| G15 | In the lower part of the uterus the abdomen feels elastic |
| G16 | Pain in the pelvic area |

From the results of the knowledge of data acquisition in the first stage, it will be modeled in the form of a decision table. The decision table is used to group symptoms for each disease as shown in Table 4.

Table 4. Uterine Disease Diagnosis Decision Table

|  |  |
| --- | --- |
| Symptom Code | Disease Code |
| P1 | P2 | P3 | P4 | P5 |
| G1 | √ | √ |  |  |  |
| G2 | √ | √ |  |  |  |
| G3 | √ |  | √ |  | √ |
| G4 | √ |  |  |  |  |
| G5 |  | √ |  |  |  |
| G6 |  | √ |  |  |  |
| G7 |  | √ | √ |  |  |
| G8 |  |  | √ |  |  |
| G9 |  |  | √ |  |  |
| G10 |  |  | √ |  |  |
| G11 |  |  | √ | √ | √ |
| G12 |  |  | √ | √ |  |
| G13 |  |  |  | √ |  |
| G14 |  |  |  | √ |  |
| G15 |  |  |  | √ |  |
| G16 |  |  |  |  | √ |

The process of diagnosing uterine disease begins with the input of symptoms experienced by the user (patient). Some of the symptoms entered will be calculated using the fuzzy logic method based on their respective weights. The results of the diagnosis of the type of uterine disease experienced by the patient are based on the largest density value. For example, a test case for the diagnosis process based on identification with symptoms as shown in Table 5.

Tabel 5. Test Cases

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Symptom Code | Symptom | Disease Code | Disease Name | Weight |
| G1 | Lower abdominal cramps or pelvic pain | P1 | Endometriosis | 0.63 |
| G2 | Menstruation is irregular, abnormal, and close to the period | P2 | Ovarian Cyst | 0.5 |
| G3 | Pain or pressure when urinating | P3 | Uterine Myoma | 0.5 |
| G4 | Pain, spotting of blood from the vagina | P4 | Uterine Infection | 0.5 |
| G11 | In the lower part of the uterus the abdomen feels elastic | P5 | Adenomyosis | 0.5 |
| G16 | Pain in the pelvic area | P1 | Endometriosis | 0.5 |

Here are some examples of rules that are taken from all the existing rules. From the rules above, the membership value of each rule's chances is obtained, namely:

R1: α1 = IF G1(tall) (0)) and G2(tall) (0)) and G3(tall) (0)) and G4 (tall) (0)) THEN P1 (tall)(0)).

R2 : α2 = IF G1(currently (0)) and G2(currently (0)) and G3(currently

(0)) and G4 (currently (0)) THEN P1 (currently(0)).

R3: α3 = IF G1 (low (2/3)) and G2(low (1/3)) and G3(currently (1/2)) and G4 (currently (1/2)) THEN P1 (low(1/3)).

R4: α4 = IF G1(low (2/3)) and G2(low (1/3)) and G3(low (0)) and G4 (tall) (0)) THEN P1 (low(0)).

R5 : α5 = IF G3(tall) (0)) and G7(tall) (0)) and G9(tall) (0) THEN P5 (tall)(0)).

R6 : α6 = IF G3 (currently (1/2)) and G7(currently (1/2)) and G9(currently (1/2)) THEN P5 (tall)(1/2)).

R7 : α7 = IF G3 (currently (1/2)) and G7(low (0)) and G9(low (0)) THEN P5 (low(0)).

Then look for the value Z:

Formula for finding value Z :

µOpportunity Tall [x]

= $\frac{x-0,1}{(\left(0,9\right)-\left(0,1\right)}= - \frac{0,1}{0,8}= ∝$

$$ x=\left(0,8\right)\left(x\right)+(0,1)$$

µOpportunity low [x]

= $\frac{\left(0,9\right)-(x)}{(\left(0,9\right)-\left(0,1\right)}= - \frac{\left(0,9\right)-(x)}{0,8}= ∝$

 $x=\left(0,9\right)-\left(0,8\right)\left(α\right)$

$$α1=0 =z1=\left(0\right)\left(0,8\right)+\left(0,1\right)=0,1$$

$$α2=0 =z2=\left(0\right)\left(0,8\right)+\left(0,1\right)=0,1$$

$$α3=0 =z3=\left(0,9\right)-\left(0,8\right)\left(\frac{1}{3}\right)= 0,633$$

$$α4=0 =z4=\left(0,9\right)-(0,8)(0)=0,9$$

$$α5=0 =z5=\left(0,8\right)\left(0\right)+\left(0,1\right)=0,1$$

$$α6=0 =z6=\left(0,8\right)(\frac{1}{2})+\left(0,1\right)=0,5$$

$$α7=0 =z7=\left(0,9\right)-(0,8)(0)=0,9 $$

Then the defuzzification process is carried out:

$$z(P1)= \frac{∝pred1\*z1+ ∝pred2\*z2+…∝pred4\*z4}{∝pred1+ ∝pred2+…+ ∝pred4}$$

$$z(P1)= \frac{\left(0\right)\left(0,1\right)+\left(0\right)\left(0,1\right)+\left(\frac{1}{3}\right)\left(0,633\right)+(0)(0,9)}{0+0+\left(\frac{1}{3}\right)+0}$$

$=(\frac{1}{3})(0.633)/(\frac{1}{3}$ )

= 0,633

$$z(P5)= \frac{∝pred5\*z5+ ∝pred6\*z6 ∝pred7\*z7}{∝pred5+ ∝pred6+ ∝pred7}$$

$$z(P1)= \frac{\left(0\right)\left(0,1\right)+\left(1/2\right)\left(0,5\right)+\frac{\left(0\right)\left(0,9\right)}{0}+\left(0\right)\left(\frac{1}{2}\right)+0}{0+(\frac{1}{2})+0}$$

$=\left(0\right)\left(0,1\right)+\left(\frac{1}{2}\right)\left(0.5\right)+\frac{\left(0\right)\left(09\right)}{0}+(\frac{1}{2}$ )+0

$=(\frac{1}{2})(0.5)/(\frac{1}{2})$ )

= 0,5

So the probability of the disease and its percentage is:

P1 = 0,633

P5 = 0,5

Based on the results of manual calculations, it can be concluded that Patient 1 has Endometriosis with a confidence value of 0.63 or 63%. As for using a system developed using PHP and MySQL programming languages ​​to conduct diagnostic testing based on the same symptoms as the manual calculations.

Based on the validation of the results of the diagnosis of uterine disease with symptoms G2, G3, G4, G11, and G16 with manual calculations and using the system have the same diagnosis results, namely endometriosis with a confidence level of 63%.

**CONCLUSION**

This expert system application is able to diagnose uterine disease experienced by patients at the H. Abdul Manan Simatupang Kisaran Regional General Hospital using the fuzzy logic method. This system is made dynamic so that if there are changes or additions to uterine disease or symptoms, it can be done easily. Helping the community in terms of economy, simply by using a cellphone and a stable internet network. Testing using fuzzy logic. The results of the study are that the patient has Endometriosis with a confidence value of 0.63 or 63% to carry out diagnostic testing based on the same symptoms as the manual calculation in providing recommendations between the symptoms that arise with the uterine disease experienced by the patient..

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