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Diagnosis of Kidney Disease Using Fuzzy Logic Method

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Abstract: Kidney disease is a condition in which the kidneys cannot function properly. Kidney disease is one of the diseases that can cause death and disability. Ignorance and lack of information about kidney disease causes the death rate of people with kidney disease to increase every year. Limited special kidney facilities in Indonesia are one of the factors slowing treatment. To distinguish what type of kidney disease sufferers of symptoms need to bring in an expert or specialist in internal medicine for a consultation. However, there are some problems with an expert such as an expert who is not always in place, the cost of consulting an expert is quite expensive, and still limited. Unhealthy lifestyle is also a factor in the increase in kidney disease sufferers. With these problems it can be concluded that it is necessary to create a system that can diagnose diseases without having to consult an expert with an expert system. An expert system is a system that can store expert information in a computer. In the Fuzzy Logic method, the existing data will be inferred by creating a rule in the form of IF_THEN and using the AND operation, then the minimum value (MIN) of several existing variables will be selected. From the results of trials conducted in this study it was found that based on the symptoms that occur the patient suffers from Acute Renal Failure.

Keywords : Fuzzy Logic, Kidney Failure, Expert System.

1. Introduction

Kidney disease is a condition in which the kidneys cannot function properly. Kidney disease is one of the diseases that can cause death and disability in several countries around the world. Every year the number of deaths caused by kidney disease is increasing. The problem that occurs is people's ignorance of the early symptoms of kidney disease and difficulty distinguishing one kidney disease from another, and special kidney facilities in Indonesia are still very limited.

From the results of observations that have been carried out at Dr.RMDjoelham binjai

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Hospital, 50 people will suffer from kidney disease in 2021 to 2022. Of the 50 patients suffering from kidney disease were grouped into 3 parts, namely: kidney stones, acute kidney failure and chronic kidney failure. There were 26 patients with kidney stone disease, 18 patients with acute kidney failure, and 6 patients with chronic kidney failure.

To distinguish what type of kidney disease sufferers of symptoms need to bring in an expert or specialist in internal medicine for a consultation. However, there are a number of expert problems, namely experts who are not available, the cost to consult with experts is quite expensive, and is still limited. With these problems it can be concluded that it is necessary to create a system that can diagnose diseases without having to consult an expert with an expert system.

Expert systems began to be used to help an expert or experts in diagnosing kidney disease. With the current advances in information technology in the field of health or medicine, detecting a disease with a computer will make it easier for medical personnel and the general public to determine what disease they are suffering from. The increase in the number of people with kidney disease is generally influenced by people's lives which have an impact on unhealthy lifestyles such as eating instant food, unhealthy drinks such as soda or alcohol, smoking, and lack of activities such as sports. Therefore, we need a system that can be used to determine whether a person has kidney disease or not by using the fuzzy logic method. People who have kidney disease generally do not realize that they have kidney disease, because basically the characteristics of kidney disease are not easy to know with certainty.

The advantage of the Tsukamoto method is that it has tolerance for inaccurate data and is easy to understand. there is the tsukamoto method, each rule is represented using fuzzy sets, with a monotone membership function. To determine the exact output value, we look for it by changing the input into a number in the domain of the fuzzy set.

This research was conducted by (Gunawan and Yanti 2021) with the title: expert system for diagnosing ARI (acute respiratory infection) using the fuzzy logic method with a mobile web-based method. decision making. Based on these problems, the researchers want to discuss and find solutions in building this expert system through research with the title "ARI Diagnostic Expert System (Acute Respiratory Infection) Using Web-Based Fuzzy Logic Method With PHP", it is hoped that this system will make it easier for researchers to patients in diagnosing acute respiratory infections through the web system.

In the Fuzzy Logic method, the existing data will be inferred by creating a rule in the form of IF_THEN and using the AND operation, then the minimum value (MIN) of several existing variables will be selected. After finding the results, then calculating the weighted average (z) to convert the linguistic variable values to numerical values. Furthermore, a final evaluation will be carried out which is intended to provide an overview of what type of kidney disease the patient is suffering from.

2. Literature

In this study, several references were taken from the literature from previous studies which were useful as a comparison of reference materials in completing this research.

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The first study was conducted by (Waruwu 2021) entitled "Expert System Using the Tsukamoto Method for Diagnosing Diverticulitis" concluded that in diagnosing diverticulitis, an expert system was designed based on the symptoms experienced. Based on the results of the diagnosis of diverticulitis, the patient's body accuracy level is 128 > 55 = experiencing diverticulitis with a high level referring to the Fuzzification value.

The second research is a study conducted by (Ananta Dama Putra, Adi Purnawan, and Purnami Singgih Putri 2018) entitled "Expert System for Diagnosing Eye Diseases with Fuzzy Logic and Naïve Bayes" concluded that the implementation of Naïve Bayes in the application is to help produce answers with value definite from the uncertain value derived from the patient. The implementation of Naïve Bayes in the application is to calculate the probability of disease suffered by the patient based on the compatibility of the symptoms entered by the patient and the symptoms in the system. The expert system for diagnosing eye diseases has been tested by an expert and can provide a level of similarity between an expert's diagnosis and system 81%.

The third study was a study conducted by (Hafizh and Putra 2018) entitled "Implementation of the Dempster Shafer Method in a Web-Based Kidney Disease Diagnosis Expert System Using PHP and MySQL" which in this study contained that the researcher concluded that the expert system was proven to be capable of tracing of the existing symptoms, thus providing information about the disease and its solution based on the search results for the questions given by the system. With the Dempster Shafer method, you can determine the percentage of impaired symptoms based on the number of symptoms that are input. In addition, this system can help relieve the work of specialists in internal medicine.

The fourth research is a study conducted by (Khoironi, Abdul Rosyid, and Muhammad Azmi 2021) entitled "Expert System for Diagnosing Kidney Disease Using the Bayes Algorithm". The researcher concludes that the expert system that has been successfully built can be used to diagnose kidney disease, which includes the process of identifying the disease and managing the knowledge base so that the results obtained are as expected, namely diagnosing kidney disease using the Bayes algorithm. This expert system application uses the Bayes method which carries out a diagnostic process with known symptoms to obtain a decision. This expert system application can display detailed probability calculations for the system that has been designed.

The last research was conducted by (Kusumaningtyas, Hasbi, and Wijayanto 2019) entitled "Expert System for Diagnosing Respiratory Diseases Using the Fuzzy Tsukamoto Method". suffered by patients because the results of the system being developed are not much different from the running system. Second, based on the results of disease diagnosis in an expert system with a manual system, the accuracy of the system is 80%.

3. Methods

3.1. Fuzzy Logic Rules

The fuzzy rules that can be used as follows:

1. if (nausea is nausea) and (blood_in_urine is red_light) and (skin_feels_itchy is yes) and (pain_in_waist is severe) and (pain_when_urinary is very_painful) and

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(change_color_urine is cloudy) then (kidney stone output)

2. if (pain_urinary_urinary_is very_painful) and (change_color_urine is cloudy) and (loss_lust_eating is loss_appetite_eat) and (leaving_stones/sand_urine_urine_is cloudy) and (pain_in_waist is severe) and (skin_feels_itchy is yes) then (output kidney stones)
3. if (nausea is nausea) and (vomiting is vomiting) and (easy_tired is very_tired) and (pain_in_waist is severe) and (shortness of breath is tightness) and (swelling_legs is swelling) then (output acute kidney failure)
4. if (fever is moderate) and (nausea is nausea) and (vomiting is vomiting) and (blood_in_urine is reddish) and (easy_tired is tired) and (skin_feels_itchy is yes) then (output acute kidney failure)
5. if (blood_in_urine is brown) and (loss_of_appetite_eat is loss_of_appetite_eat) and (blood_pressure is high) and (shortness of breath is shortness of breath) and (swelling_in_legs is swelling) and (easy_tired is tired) then (output chronic renal failure)
6. if (nausea is nausea) and (vomiting is very_vomiting) and (blood_in_urine is red_brown) and (blood_pressure is high) and (skin_feels_itchy is yes) and (swelling_on_legs is swelling) then (output chronic renal failure)

From the disease rules above, it can be seen that if one of the symptoms is absent or not seen in the patient, then the rule can still conclude the disease, that's because all the rules depend on the doctor's decision, for example, there are only 6 symptoms found out of 15 symptoms of a disease that can already be found. define a disease.

3.2. Completion of Fuzzy Logic Cases

If a person experiences symptoms of fever 39.5 degrees, nausea 6 days, vomiting 4 days, chest pain 4 days, leg swelling 50.8 mm, fatigue 6 days, shortness of breath feels tight, accompanied by blood in the urine 55%.

Resolution:

- Fever = 39.5 degrees
- Nausea = 6 days
- Vomiting = 4 days
- Chest Pain = 4 days
- Leg Swelling = 50.8
- Easy Fatigue = 6 days
- Shortness of breath feels shortness = 6
- Blood In Urine = 55%

Then look for the value of the membership function for each symptom (μ):

1. Calculate the value of μFever

   $\mu\text{Fever\_High}(x) = (x - a)/(b - a)$

   $\mu\text{Fever\_High}(39{,}5) = (39{,}5 - 38)/(40 - 38)$

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$$= \frac{1,5}{2} = 0,75$$

2. Calculate the value of µNausea
   $\mu\text{nausea}(x) = (b - x)/(c - b)$
   $\mu\text{nausea}(6) = (5 - 6)/(7 - 5)$
   $$= \frac{1}{2} = 0,5$$

3. Calculate the value of µvomit
   $\mu\text{vomit}(x) = (x - a)/(b - a)$
   $\mu\text{vomit}(4) = (4 - 3)/(5 - 3)$
   $$= \frac{1}{2} = 0,5$$
4. Calculate the value of µChest Pain
   $\mu\text{Chest\_Pain}(x) = (x - a)/(b - a)$
   $\mu\text{Chest\_Pain}(4) = (4 - 3)/(5 - 3)$
   $$= \frac{1}{2} = 0,5$$
5. Calculate the value for µSwelling of the Feet
   $\mu\text{Swelling}(x) = (x - a)/(b - a)$
   $\mu\text{Swelling}(50,8) = (50,8 - 40)/(60 - 40)$
   $$= \frac{10,8}{20} = 0,54$$
6. Calculate the value of µEasy to Fatigue
   $\mu\text{Very\_Tired}(x) = (b - x)/(c - b)$
   $\mu\text{Very\_Tired}(6) = (5 - 6)/(7 - 5)$
   $$= \frac{1}{2} = 0,5$$
7. Calculate the value of µSuffocation
   $\mu\text{Suffocating}(x) = (b - x)/(c - b)$
   $\mu\text{Suffocating}(6) = (5 - 6)/(7 - 5)$
   $$= \frac{1}{2} = 0,5$$
8. Calculate the value of µBlood in Urine
   $\mu\text{Red\_Brown}(x) = (x - a)/(b - a)$
   $\mu\text{Red\_Brown}(55) = (55 - 40)/(60 - 40)$

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$$= \frac{15}{20} = 0{,}75$$

4. Results And Discussion

Finding the z value for each rule using the MIN function:

[R1] if (nausea is nausea) and (blood_in_urine is red_young) and (skin_feels_itchy is yes) and (pain_in_waist is severe) and (pain_when_urine is very_painful) and (change_color_urine is cloudy) then (kidney stone output)

$\alpha - predikat_1 = \min(0{,}5; 0; 0{,}4; 0{,}33; 0; 0)$
$= 0$
$z_1 = 0{,}3 - 0(0{,}3 - 0)$
$= 0{,}3 * 0{,}3$
$= 0{,}09$

[$R2$]if (pain_urinary_urinary_is very_painful) and (change_color_urine is cloudy) and (loss_lust_eating is loss_appetite_eat) and (leaving_stones/sand_urine_urine_is cloudy) and (pain_in_waist is severe) and (skin_feels_itchy is yes) then (output kidney stones)

$\alpha - predikat_2 = \min(0; 0; 0{,}5; 0{,}8; 0{,}33; 0{,}4)$
$= 0$
$z_2 = 0{,}3 - 0(0{,}3 - 0)$
$= 0{,}3 * 0{,}3$
$= 0{,}09$

[$R3$]if (nausea is nausea) and (vomiting is vomiting) and (easy_tired is very_tired) and (pain_in_waist is severe) and (shortness of breath is tightness) and (swelling_legs is swelling) then (output acute kidney failure)

$\alpha - predikat_3 = \min(0{,}5; 0{,}5; 0{,}5; 0{,}33; 0{,}5; 0{,}5)$
$= 0.33$
$z_3 = 0{,}33(0{,}6 * 0{,}3) + 0{,}3$
$= 0{,}33 * 0{,}3 + 0{,}3$
$= 0{,}399$

[$R4$]if (fever is moderate) and (nausea is nausea) and (vomiting is vomiting) and (blood_in_urine is redness) and (easy_tired is tired) and (skin_feels_itchy is yes) then (output acute kidney failure)

$\alpha - predikat_4 = \min(0; 0{,}5; 0{,}5; 0; 0{,}5; 0{,}4)$
$= 0$
$z_4 = 0(0{,}6 - 0{,}3) + 0{,}3$
$= 0 * 0{,}3 + 0{,}3$
$= 0{,}3$

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[$R5$]if (blood_in_urine is brown) and (loss_of_appetite_eat is loss_of_appetite_eat) and (blood_pressure is high) and (shortness of breath is shortness of breath) and (swelling_in_legs is swelling) and (easy_tired is tired) then (output chronic renal failure)

$$\alpha - predikat_5 = \min(0{,}25; 0{,}5; 0{,}8; 0{,}5; 0{,}5; 0{,}5)$$
$$= 0.25$$
$$z_5 = 0{,}25(1 - 0{,}6) + 0{,}6$$
$$= 0{,}25 * 0{,}4 + 0{,}6$$
$$= 0{,}7$$

[$R6$]if (nausea is nausea) and (vomiting is very_vomiting) and (blood_in_urine is red_brown) and (blood_pressure is high) and (skin_feels_itchy is yes) and (swelling_on_legs is swelling) then (output chronic renal failure)

$$\alpha - predikat_6 = \min(0{,}5; 0; 0{,}75; 0{,}8; 0{,}4; 0{,}5)$$
$$= 0$$
$$z_6 = 0(1 - 0{,}6) + 0{,}6$$
$$= 0 * 0{,}4 + 0{,}6$$
$$= 0{,}6$$

$$(defuzzifikasi)$$
$$= \frac{(0 * 0{,}09) + (0 * 0{,}09) + (0{,}33 * 0{,}399) + (0 * 0{,}3) + (0{,}25 * 0{,}7) + (0 * 0{,}6)}{0 + 0 + 0{,}33 + 0 + 0{,}25 + 0}$$
$$= \frac{0{,}30667}{0{,}58} = 0{,}5287$$

Then the results of fuzzy logic calculations using the Tsukamoto method are acute kidney failure.

5. Conclusion

in this research, with an expert system for diagnosing kidney disease using the Fuzzy Logic method, it can help diagnose kidney disease based on the symptoms or criteria that the patient has. With this system, it can help the Binjai Hospital in diagnosing kidney disease patients so that the treatment process can be carried out faster. Minimizing time and patient ignorance in dealing with this kidney disease. Based on the trials conducted, it was confirmed that the patient was diagnosed with Acute Renal Failure.

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