Expert System Diagnosis of Cataract Eyes Using Fuzzy Mamdani Method

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Abstract. Cataracts are eye diseases characterized by cloudy or opacity of the lens of the eye by changing the colour of black into grey-white which slowly continues to grow and develop without feeling pain and pain that can cause blindness in human vision. Therefore, researchers make an expert system of cataract eye disease diagnosis by using Fuzzy Mamdani and how to care. The fuzzy method can convert the crisp value to linguistic value by fuzzification and includes in the rule. So this system produces an application program that can help the public in knowing cataract eye disease and how to care based on the symptoms suffered. From the results of the design implementation and testing of expert system applications to diagnose eye disease cataracts, it can be concluded that from a trial of 50 cases of data, obtained test results accuracy between system predictions with expert predictions obtained a value of 78% truth.

1. Introduction

The eye is one of the organs of the body that serves as a means of the five senses that are very important to humans so as to see all the beauty in life. If the eyes are disturbed will cause difficult for humans in vision and can experience blindness so must be careful in maintaining the health of organs every day from various diseases that attack one of them is eye disease cataracts[1].

Cataract is an eye disease that can cause blindness in humans. In this disease can be marked by the cloudy and opacity of the lens of the eye that affects the decrease of human vision, will appear like a white stain that will constantly cover the lens of the eye so that the black will be a white color. These eyes will result in normal aging that becomes blurred and murky on the human senses that are almost reaching above 40 years are usually called senile cataracts[2].

Cataract eye disease usually grows slowly so it will continue to add and grow without causing pain and pain. There are several factors that cause humans suffering from cataracts that continue to increase every year is the lack of public knowledge. Cataracts often attack both eyes in different conditions at once and will continue to develop for years without feeling pain. Therefore, there is a system that is used as a tool for diagnosis in cataract eye disease in order to avoid error handling in a case that is Expert System.

Expert System is a computer program that has the ability like an experienced human and knowledge in experts in a particular field. Basically there are some components contained in it, namely Knowledge Base (KB), Inference Machine (IE), Control Strategy (CS)[3]. Knowledge is a practical understanding of a particular object or domain. The knowledge used in this expert system is a series of symptoms-diagnosis, cause-effect, action-reaction, on the object. An expert system in the
health world is an application used to take a diagnostic decision or predict medical or health problems[4].

Several previous studies Ivana Herliana W. Jayawardanu and Seng Hansun made Design of Expert System for Early Cataract Detection Using C4.5 Algorithm [5]. This application is used to detect cataract early disease to calculate accuracy value. Based on the results of experiments conducted using 10-fold cross so that the accuracy of output system type is 80%, and the accuracy value of result output system is 93.2%. Yudi and Yessi Nofrima make the Design of Expert System Diagnosis of Cataract Eye Disease in Human-Based Web [2]. This application uses Inference Forward Chaining method is able to identify by requiring a lot of data for more accurate test results. Galih Hendro Martono, M.Eng and Siti Agrippina Alodia Yusuf perform Diagnosis of Senile Cataract Disease Using a Web Based Case Based Reasoning (CBR) Method [6]. This app is used to solve problems that look for the similarities of previous cases with new cases that yield 70% value. Dwi Marta Sukandi, Agung Trionko Basuki and Shinta Puspasari made the Application of Fuzzy Mamdani Method To Predict Total Palm Oil Production Based on Inventory Data and Demand Amount [7]. The application of this system using Fuzzy Mamdani method to meet the demand with the percentage value of 86.67% and the average difference between production and prediction is 16.23333. Fariz Aziz Khaerulah and Aripin made the Diagnosis Expert System for Dental Caries Disease Using Fuzzy Mamdani Method [8]. This application uses Fuzzy Mamdani Method knowing with the accuracy rate of 90% and has a fairly small error of about 10%.

Characteristics this system is a processing that does not require answers to what has been inputted from each question, for example there are how many symptoms of each type in cataract eye disease. Because the system will diagnose the new one next. In this system research that handles cataract eye disease by applying a Fuzzy Mamdani Logic method. Where fuzzy logic was first discovered by Lotfi A. Zahed, a professor of the University of California in 1965. Fuzzy Logic is a method that has a value between true or false and has a membership weight. Fuzzy logic is used to translate a scale by using language (linguistic) and can cultivate uncertainty so that it quickly decides a human reason [9]. Fuzzy logic techniques include several methods, namely: Tsukamoto method, mamdani method and Sugeno method. In this system will use Mamdani method. Where, Fuzzy Mamdani method is also called Max - Min method and can know a fuzzy rule condition with "If ... Then". In this fuzzy mamdani method has advantages and disadvantages that is: intuitive, easy to understand, flexible, and can work together. To get an output (output) it requires several stages, namely: Fuzzyfikasi, Fuzzy knowledge base formation, Fuzzy Set, Defuzzyfikasi using Centroid method[7].

This system will facilitate a doctor's job in examining the patient to find out the results of the diagnosis of the illness suffered by the patient based on the symptoms experienced by the patient using the Fuzzy Mamdani method. Because of this in recent years, the methodology in a computer vision has been widely applied to systems in health informatics and telemedicine to diagnose illness, in which there is a diagnostic error in physicians with new knowledge[10]. Application in solving such expert system can be generated through input and output. In this system inputannya form of symptoms of cataract eye disease, and its output is the result of the type of cataract eye disease.

2. Methodology

The set of variables on fuzzy mamdani contained in expert system of cataract eye disease diagnosis are as follows:
1. Variable 1, This variable 1 is the value taken from the consultation at the time of the interview with the physician. This variable has 3 set criteria. Low criteria range between 0 to 40, Medium between 20 to 80, and Height between 60 to 100.
2. Variable 2, This variable 2 is the value taken from the consultation at the time of the interview with the physician. This variable has 3 set criteria. Low criteria range between 0 to 40, Medium between 20 to 80, and Height between 60 to 100.
3. Variable 3, This variable 3 is the value taken from the consultation at the interview with the physician. This variable has 3 set criteria. Criteria Seemed to range between 0 to 60, Medium between 40 to 90, and Height between 80 to 100.

4. Variable 4, This variable 4 is the value taken from the consultation at the time of the interview with the physician. This variable has 3 set criteria. Low criteria range between 0 to 40, Medium between 20 to 80, and Height between 60 to 100.

5. Limiting Variables, This limiting variable is the value taken from the consultation at the time of the interview with the physician. This variable has 3 set criteria. Immature criteria range from 0 to 40, Matur between 20 to 80, and Hypermatur between 60 to 100.

In building a system requires a design to analyze and results so as to achieve maximum results. There are several design systems that will be built namely interface design, flowchart, use case diagram and other design models. Flowchart is a section with certain symbols that describe the process sequence in detail and the relationship between a process (instruction) with other processes in a program. In the expert system of cataract eye disease diagnosis with fuzzy mamdani method there is a system flowchart and flowchart method that will build the system. Below is a system flowchart where, this flowchart describes the flow of the system as a whole.

Flowchart method Fuzzy Mamdani describes the steps or sequence of problem solving process with Fuzzy Mamdani method in Expert System Diagnosis Cataract eye disease. The process begins with the input of symptoms of cataract eye disease, arrange the symptoms in the form of questions, the calculation process with the method Fuzzy Mamdani, and the last is the percentage of suffering from cataract eye disease.

Diagnosis process will be done by using fuzzy mamdani method that there are several stages to know the diagnosis result of patient's disease that is First Stage of Rule Formation. Formation of rules on diagnostic questions there are 3 criteria rules, namely: Low, Medium, and High. With a total of 81 rules.

Second Phase Application Function Implications. If the rule has been established, then the next to calculate predicate rules by entering the variables or set fuzzy into rules that have been made. There is a patient case with the following data:

Consultation as follows:
- Question 1: opacities begin to affect the lens (25)
- Question 2: Normal lens stadium (50)
- Question 3: The forerunner and the eyepiece become narrower (70)
- Question 4: Deeply discharges the lens fluid (80)

Application function implicasinya as below:

\[
[R67] \text{If Question 1 is Low AND Question 2 is Medium AND Question 3 is Appear AND Question 4 is High THEN Matur.}
\]

Referring to the membership function of each group then obtained the data as follows:

\[
-predicate \ 1 = \mu \text{ question1 Low } \land \mu \text{ questions2 Medium } \land \mu \text{ question3 Looks } \land \mu \text{ question4 Height}
\]

\[
= \min (\mu \text{ question1 Low }[25], \mu \text{ question2 Medium }[50], \mu \text{ question3 Looks }[70], \mu \text{ question4 Height}[80])
\]

Based on the calculation of rule-rule above, then mengronasilkan decision Is Matur. The next stage is the third stage of the rule composition. The result of the rule predicate calculation on each rule / rule is used MAX method to do the composition between all rules. From the implication of the rules on diagnostic questions then obtained the value of MAX and MIN and Boundaries Area 1 and 2 as follows:

\[
a1 = (ba-bb) \times \max + bb \quad (1)
\]

\[
a2 = (ba-bb) \times \min + bb \quad (2)
\]
Fourth Stage is Affirmation / Defuzzyfication. The Confirmation Method (Defuzzyfication) used is the centroid method. With the formula to find the value of \( z \) * (center point) based on the equation found on the theoretical basis. After the defuzzy process is complete it will result in the calculation of the value or diagnosis score of the patient's illness. The first thing to do in the defuzzy stage is to look for moments 1, 2 and 3.

\[
M_1 = \text{min} / 2 \times a_{12} \tag{3}
\]

\[
M_2 = (1 / (ba-bb) / 2 \times a_{23}) - (bb / (ba-bb) / 2 \times a_{22}) \times ((1 / (bb) / 3 \times a_{13}) - (bb / (ba-bb) / 2 \times a_{12})) \tag{4}
\]

\[
M_3 = (\text{Max} \times ba_2 / 2) - (\text{Max} \times (ba-bb) / 2 \times (ba-bb)) \tag{5}
\]

Next look for Area Area A1, A2 and A3.

\[
A_1 = a_1 \times \text{Min} \tag{6}
\]

\[
A_2 = (\text{Min} + \text{Max}) \times (a_{2-a_{1}}) / 2 \tag{7}
\]

\[
A_3 = (ba- (ba-bb)) \times \text{Max} \tag{8}
\]

Searching for the Center.

\[
\text{Central point} = (M_1 + M_2 + M_3) / (A_1 + A_2 + A_3) \tag{9}
\]
Table 1. The Decision Level

| Decision Level | Decision    |
|----------------|------------|
| 1              | Imatur     |
| 2              | Matur      |
| 3              | Hypermatur |

3. Results and Discussion

Analysis of the accuracy of this system is to know the purpose of the system in providing the results of the correct output and in accordance with the medical record data obtained from experts. To test the accuracy of this application is to compare between system prediction with experts. In the trial accuracy using 50 patient data with symptoms input experienced by the patient.

From the table 1 of data accuracy test, obtained a comparison between the prediction of the system with expert predictions derived from the calculation of fuzzy logic method mamdani with expert predictions from medical record data. Of the 50 patient data, the results obtained 39 correct data checks and 11 incorrect data. To calculate the percentage of data corresponding to an expert or accuracy, calculated using the formula:

\[
\text{% Accuracy} = \frac{\text{True Data}}{\text{Amount of test data}} \times 100\% \quad (10)
\]

From the test results all data can be obtained as follows:

\[
\text{% Accuracy} = \frac{39}{50} \times 100\% = 78\% \quad (11)
\]

Table 2. Data Test Accuracy

| No | Name       | System Test | Expert Data | Result |
|----|------------|-------------|-------------|--------|
| 1  | Ny.Hatijah | Kat.Imatur  | Kat.Imatur  | True   |
| 2  | Tn.Aris    | Kat.Imatur  | Kat.Imatur  | True   |
| 3  | Ny.Misnaya | Kat.Imatur  | Kat.Imatur  | True   |
| 4  | Tn.Sumarwi | Kat.Matur   | Kat.Matur   | True   |
| 5  | Tn.Sunaryo | Kat.Imatur  | Kat.Imatur  | True   |
| 6  | Ny.Pusahya | Kat.Imatur  | Kat.Imatur  | True   |
| 7  | Ny.Latifatun | Kat.Matur  | Kat.Imatur  | True   |
| 8  | Tn.Taha    | Kat.Imatur  | Kat.Imatur  | True   |
| ...| ...        | ...         | ...         | ...    |
| 46 | Tn.Rasyid  | Kat.Imatur  | Kat.Imatur  | True   |
| 47 | Tn.Saliye  | Kat.Imatur  | Kat.Imatur  | True   |
| 48 | Ny.Ruhani  | Kat.Imatur  | Kat.Imatur  | True   |
| 49 | Ny.andriyani | Kat.Imatur | Kat.Imatur  | True   |
| 50 | Tn.maskut  | Kat.Imatur  | Kat.Imatur  | True   |
From the above calculation, expert system for diagnosis of cataract eye disease with fuzzy mamdani Logic method has the value of accuracy test percentage of 78%.

4. Conclusion

From the results of the design of the implementation and testing of expert system applications to diagnose eye disease cataracts, it can be concluded that from a trial of 50 cases of data, obtained test results accuracy between system predictions with expert predictions obtained value of 78% correctness. From the test results of this expert system application, it is expected that the improvement by conducting the development of expert system application further by using other methods so that the bias compared from the results obtained. then by testing on another case to find a high degree of accuracy.

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