BETTA FISH DISEASE DIAGNOSIS USING FUZZY LOGIC SUGENO AND FORWARD CHAINING METHOD

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ABSTRACT

Betta fish are very popular with people of all ages who make betta fish as small and medium businesses who consider betta fish as a business, but betta fish maintenance is quite the opposite. The ease of breeding betta fish and ignorance in caring for good fish can cause death in betta fish caused by various diseases. Therefore, an expert system for diagnosing disease in betta fish was created. In this study the Forward Chaining method was used to diagnose fish disease, while the Fuzzy Sugeno method determined the severity of the disease. The accuracy generated by the system based on tests carried out using 100 data was 93%.

1. Introduction

Betta fish are very popular with people of all ages who make betta fish a small and medium business. Many consider betta fish as a business, but betta fish keeping is quite the opposite. The problem that often occurs in betta fish is a common thing faced by betta fish farmers and entrepreneurs. This has a major impact on increasing the number of ornamental fish lovers, considering that ornamental fish has become one of the leading commodities in the country, and Indonesia has succeeded in becoming an exporter of ornamental fish. fifth largest in the world, leading the national ornamental fish market.

Diseases of betta fish are very common on the cultivation scale, because it is difficult for novice breeders to diagnose the various diseases of betta fish and also few experts know the ins and outs of betta fish disease, therefore an expert system is needed that will help and make cultivators familiar. in caring for their betta fish so that farmers can find out what disease they are suffering from and how to treat the disease [1].

2. Literature Study

a. Expert system

An expert system is a system that tries to imitate or manipulate the knowledge and skills of an expert in a certain area in the form of a computer program. So that ordinary people can solve a complicated problem which can only be done by an expert. Expert System Structure In general, it consists of 3 main components, namely: knowledge base, working memory, and inference engine [2].

The first one is knowledge base is part of an expert system that contains/stores information. The knowledge base contained in expert systems varies depending on the subject matter of the system to be configured. For example, a medical expert system has knowledge of a medical topic. Knowledge base in various forms, one of which is in the form of a ruled-based system.

The second one is working memory contains/stores the facts found in the consultation process with the expert system. The user consultation process includes the necessary facts. The system then looks for matches between these facts and the data in the database to create these new facts. The system stores this new fact in working memory. Therefore, working memory stores information about facts entered by the user or new facts based on the conclusions of the system.

And the last is inference engine is tasked with finding matches between facts in working memory and facts about a particular knowledge domain in the knowledge base, then the inference engine will draw conclusions about the problems posed to the system.

b. Forward Chaining

The Forward Chaining method is a method that is often used in expert system decision making. In this method, the search process is carried out by tracing facts from left to right, starting from the premises and ending with the final conclusion. The Forward Chaining method is often also referred to as a data-based approach, where the search for decisions is controlled by available data.

This system is based on the cycle of knowledge in action. The system first searches all rules whose conditions exist in the knowledge base, after that it looks for probability values for each disease. Finding the probability value of a disease diagnosis can use the equation below [3].

$$P = \frac{n(A)}{n} x\, 100 \qquad (1)$$

Information:

A : Symptoms

P : Probability of the disease appearing

n : Total number of symptoms

n(A) : Number of symptoms

c. Fuzzy Logic

Fuzzy logic is an appropriate way to map the input space into an output space. There are several ways to map the input to output space, including fuzzy systems, linear systems, expert systems, neural networks, differential equations, multidimensional interpolation tables. Logic generally only consists of 2 truth values, namely true (worth 1) and false (worth 0) but sometimes information or data is less precise to be declared true or false so that logic is developed that is not only true and false but uses logic that has an interval value between 0 and 1 which can be called fuzzy logic [4].

Fuzzy set theory is the basis of fuzzy logic. The degree of membership plays a role in ensuring that the existence of elements in a set is very meaningful. Membership value or degree of membership is the main characteristic of reasoning with fuzzy logic [5].

d. Fuzzy Sugeno

Sugeno fuzzy method is a systematic approach to fuzzy rule generation from a given set of input data. In this method, there are 4 stages to obtain results, namely: Set formation, determining the degree of the set, calculating the predicate of the rule, Defuzzification.

The steps of completion in the Sugeno method are as below:

1. Fuzzy set formation.

   At this stage, determining the variables that will be used in the system both input variables and output variables.

2. Determining the degree of membership of the fuzzy set (μ)

   At this stage, each variable in the fuzzy set will have its membership degree determined. The membership degree becomes a value in the fuzzy set. One way to get the degree of membership is by means of a Linear and Triangular curve representation function approach.

3. Calculating the rule predicate (α)

   Variables that have been included in the fuzzy set formed by the rules obtained will be calculated the predicate value of the rules by the implication process.

4. Defuzzification

   The last step of the fuzzy inference process is to convert the fuzzy value version resulting from the rule aggregation into a crisp number. The input of the defuzzification process is a fuzzy set obtained from the composition of fuzzy rules, while the resulting output is a number in the domain of the fuzzy set. So if given a fuzzy set in a certain range [1].

One way that can be used is the weighted average method. This defuzzification method is most often used in applications that use fuzzy logic algorithms because it is efficient in terms of computing. For the formula to measure the weighted average method, namely:

$$WA = \frac{(\mu Z1 * Z1) + (\mu Z2 * Z2) + (\mu Z3 * Z3) \ldots . + (\mu Zn * Zn)}{Z1 + Z2 + Z3 \ldots . + Zn} \quad (2)$$

Information:

WA : Average Value

μZ : Predicate value of n rule

Z : index value of n

a. Accuracy

The level of testing accuracy will be used in the testing phase of this research. Here, the accuracy calculation is carried out, namely the number of correctly classified data divided by the total data. For the formula to measure accuracy [6], namely:

$$Accuracy = \frac{Number\ of\ appropriate\ diagnosis\ result\ data}{Total\ medical\ record\ data} \times 100\% \quad (3)$$

b. Related Research

In other studies that have been conducted with the title Expert System for Diagnosing Lung Disease Using Forward Chaining in this study, the probability value of system accuracy is 84.21% and system inaccuracy is 15.79% [7]. In another study with the title Expert System to Detect Heart Disease Risk Levels Using Fuzzy Inference (Sugeno) in this study the results of system testing from 82 test data resulted in 24% moderate risk levels, 13% moderate risk and 62% high risk. For system work based on the results of expert (doctor) and system validation, a percentage of 89.02% of the test data is obtained, and 10.98% of the test data is not suitable.

In previous research, research has been conducted entitled Expert System for Diagnosing Schistosomiasis Disease Using a Combination of Forward Chaining and Fuzzy Logic Takagi Sugeno Kang. Where Forward Chaining works as a method for tracing every symptom that occurs in a knowledge base that is built based on information obtained from experts. Fuzzy Logic Takagi Sugeno Kang works as a determinant of the percentage level of patients adopting schistosomiasis disease based on the search results carried out by the Forward Chaining Search method [8].

5. Methodology

a. Data Collection

The data is obtained from betta fish farmers through interviews conducted verbally through experts consisting of disease data, symptoms, disease Rule, and the value of the severity of each symptom, as well as 100 data that will be used. In table 1, data on diseases and symptoms are given for each disease along with the value of the severity of a symptom for the disease. Table 2 provides data on disease names and codes for each disease. While the symptom names and codes for each symptom are available in table 3. And table 4 provides rules for each disease.

Table 1. Betta Fish Disease Data

No	Symptoms	Value of Severity	Diagnosis
1	G1	35	*Fin rot*
	G2	10	
	G3	65	
2	G4	45	*White Spot*
	G16	10	
	G17	65	
3	G5	25	*White Spot*
	G1	24	
	G4	4	
	G16	65	
	G17	20	*Columnaris*
4	G5	10	
	G1	1	
	G12	20	
5	G13	20	
	G1	12	*White Spot*
	G4	3	
	G16	50	
	G17	25	
6	G5	20	*White Spot*
	G1	12	
	G4	3	
	G16	30	
7	G17	80	*Fin rot*
	G1	50	
	G1	70	
8	G2	2	*Pop Eye*
	G5	30	
	G1	80	
	G7	40	
9	G5	40	*White Spot*
	G17	24	
	G4	2	
	G16	80	
	G17	100	
10	G5	90	*Columnaris*
..	G1	..	..
100	G12	30	*White Spot*

Table 2. Disease Data

Disease Code	Disease Name
P1	*Fin rot*
P2	*White Spot*
P3	*Velvet*
P4	*Pop Eye*
P5	*Dropsy*
P6	*Swim Bladder Disorder*
P7	*Inflamed Gills*
P8	*Columnaris*

Table 3. Symptom Data

Symptom Code	Symptom Name
G1	Pale Fish Color
G2	Whole Fish Fins
G3	Red or black marks appear on the body and fins of the hippopotamus
G4	White spots on the body of the fish
G5	Snapping Fins
G6	The body of the fish is sprinkled with shiny dust
G7	Swollen fish eyes
G8	Swollen fish belly
G9	Raised scales like pineapple scales
G10	Red gills
G11	Gill flaps are tightly closed
G12	There are boils or lesions on the fish body
G13	White spots in the mouth
H1	Lying on its side
H2	Unable to pass feces
H3	Lack of appetite
H4	Does not move swiftly

Table 4. Disease Rule

Rule Code	Rule	Disease
R1	If G1 OR G2 OR G3 OR G5 Then P1	*Fin rot*
R2	If G4 OR H3 OR H4 OR G1 OR G5 Then P2	*White Spot*
R3	If H1 OR G1 OR G6 OR Then P3	*Velvet*
R4	If H4 OR G1 OR G5 OR G7 Then P4	*Pop Eye*
R5	If G1 OR G8 OR G9 OR H2 Then P5	*Dropsy*
R6	If G8 OR H1 OR H2 OR H3 Then P6	*Swim Bladder Disorder*
R7	If H4 OR G10 OR G11 Then P7	*Inflamed Gills*
R8	If G12 OR G13 OR G14 Then P8	*Columnaris*

b. Framework

In this study to produce the appropriate output. The first stage is the process to determine the diagnosis of the disease using tracing the rule set using the Forward Chainig method. Calculation of the percentage using the probability formula which will take the highest value of the presentation to be the diagnostic result. The second stage will calculate the severity of the disease using Fuzzy Sugeno with the first step is to determine the limit of the range value of each set of input variables determined with the expert, thus producing a membership curve for each input variable. After the system is given input in the form of disease symptoms which will be processed with a membership function into a fuzzy value with the Fuzzyification process. Then the value is processed in the inference engine based on the appropriate rule base. After getting a fuzzy value from the inference process, the fuzzy value is converted into an output which is a crisp value that shows the results of the severity of the disease with the defuzzification process.

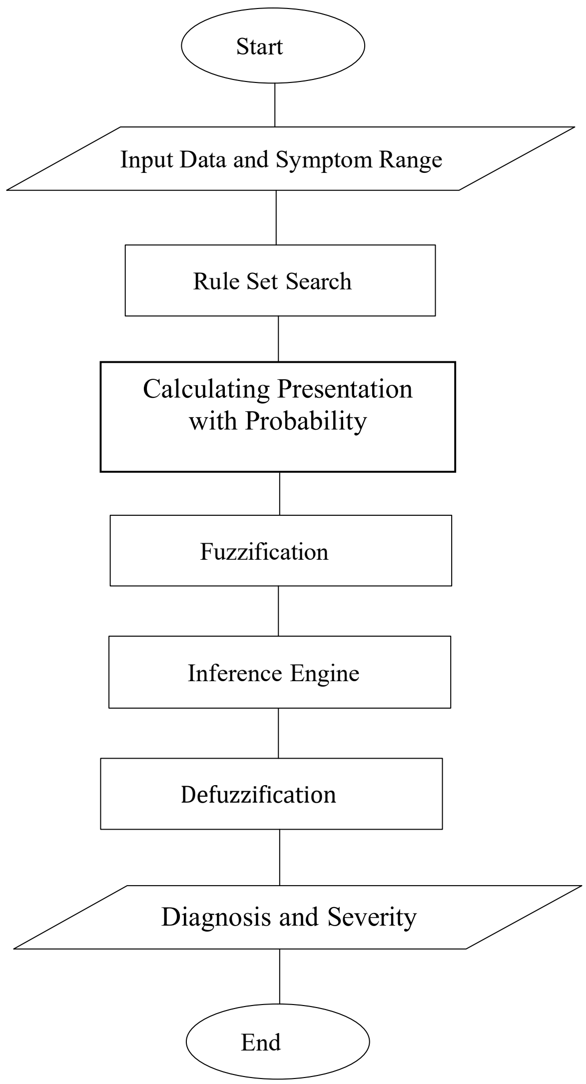

Fig 1. Research Framework

6. Result and Discussion

In this test, expert diagnosis data on cupang fish that has been obtained from experts is used as input data. After that, the diagnosis results from the system will be compared with the diagnosis results from the expert. Table 5 shows a comparison of the system results and expert diagnoses along with the severity of each disease based on the system output.

Table 5. System Accuracy Test Result

No	symptoms	Value	Expert Diagnosis	System Diagnosis	Severity
1	G1	35	Fin rot	Fin rot	91%
	G2	10			
	G3	65			
2	G4	65	White Spot	White Spot	50%
	G16	38			
	G17	2			
	G5	75			
	G1	90			
3	G4	25	White Spot	White Spot	84%
	G16	24			
	G17	4			
	G5	65			
	G1	20			
4	G12	10	Columnaris	Columnaris	100%
	G13	1			
	G1	20			
5	G4	20	White Spot	White Spot	70%
	G16	12			
	G17	3			
	G5	50			
	G1	25			
6	G4	20	White Spot	White Spot	70%
	G16	12			
	G17	3			
	G1	30			
7	G1	80	Fin rot	Fin rot	100%
	G2	50			
	G5	70			
8	G1	30	Pop Eye	Pop Eye	50%
	G7	80			
	G5	40			
	G17	2			
9	G4	40	White Spot	White Spot	50%
	G16	24			
	G17	2			
	G5	80			

	G1	100			
10	G12	90	Kolumnaris	Kolumnaris	100%
...	...	...	...	...	...
100	G4	30	White Spot	White Spot	83%
	G16	12			
	G17	4			

The results of the evaluation of the system concluded that the expert system for diagnosing cupang fish diseases using forward chaining and fuzzy sugeno methods has an accuracy rate of 93% based on the results of system tests with 100 expert diagnosis data with the results of the system diagnosis. There are 7 test data that produce different diagnoses with expert diagnoses. This is because in the diagnosis process there are diseases with the same probability, therefore the system chooses the disease with the first order as the diagnosis result. Meanwhile, there are rules that have 2 symptoms in the same disease, this causes the prediction results to be more dominant towards one disease. Nevertheless, the results of this test provide a conclusion that the use of forward chaining and fuzzy sugeno methods can be successfully used in diagnosing diseases in cupang fish.

7. Conclusion

Based on the explanation in the previous chapter, namely implementation, it can be conclude that:

1. The use of the forward chaining method involves matching user symptoms with existing disease rules. Then, the probability formula is used to calculate the probability value of each rule. After that, the highest probability value is determined as the diagnosis result. Sugeno fuzzy method is used to calculate the severity based on the type of disease diagnosed through the Forward Chaining method.
2. The system achieved 93% accuracy based on testing using 100 data. However, there were 7 test data that produced different diagnoses from the expert's diagnosis. This difference was caused by the presence of diseases with the same probability, so the system chose the top disease as the diagnosis result. In addition, there are rules that have 2 symptoms in the same disease, so the prediction tends to be more dominant to one disease.

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