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Expert System Diagnosing Diseases in Aglaonema Plants Using the Dempster Shafer Method

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ABSTRACT

Aglaonema is an ornamental plant called Sri Fortune or Chinese Evergreen. This plant grows well in the tropics. One of the common problems in aglaonema plants is the emergence of diseases that cause plant damage. So we need an expert system that can help the community to diagnose the disease as an initial treatment in disease control. The expert system was built using the Dempster Shafer method by entering disease data and symptoms which aims to determine the disease experienced by the Aglaonema plant without having to manually diagnose. The results showed how the process of calculating the initial combination rule to the last combination rule was based on the selected symptoms, so it could be concluded that the highest density value was Bacterial Stem Rot disease with a density value of 0.8881 or 88.81%.

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1. INTRODUCTION

At the beginning of the development of computer technology, computers were only used as a means of calculating or processing existing data to extract information in decision making. Over time, the role and use of computers continues to grow, and dominates human life to this day. One method of making computers that can process knowledge is called artificial intelligence technology. One area of artificial intelligence technology is expert systems. Agriculture is also in dire need of technology, including information on AgIaonema plant diseases.

Aglaonema is an ornamental plant called Sri Fortune or Chinese Evergreen. This plant grows well in the tropics. This plant is increasingly popular because of its relatively easy care and beautiful appearance. One of the common problems in agIaonema plants is the onset of disease. Several diseases that often attack Aglaonema plants are stem or root rot bacteria and Fusarium stem rot. This disease attacks tens of millions of rupiah indiscriminately, by default and specifically targets Aglaonema.

An expert system is an information system that contains expert knowledge and can be used for consultation. An expert system is also a computer program that contains knowledge from 1 (one) or more human experts from a particular field. Expert systems consist of various methods, including confidence factors, naive Bayes methods, and so on. In this research, the writer chose the Dempster Shafer method. Dempster Shafer is an expert system method that uses mathematical theory

to find evidence that is based on a function of reasonable beliefs and reasons. Used to combine individual information (evidence) and calculate the probability of an event. The advantages of the Dempster Shafer method are that it can distinguish between uncertainty and ignorance, and has attributes that are in accordance with the methods of thinking of experts.

2. RESEARCH METHOD

To assist in the preparation of this research, it is necessary to have a clear research framework structure in stages. The framework in this research can be depicted in the following figure:

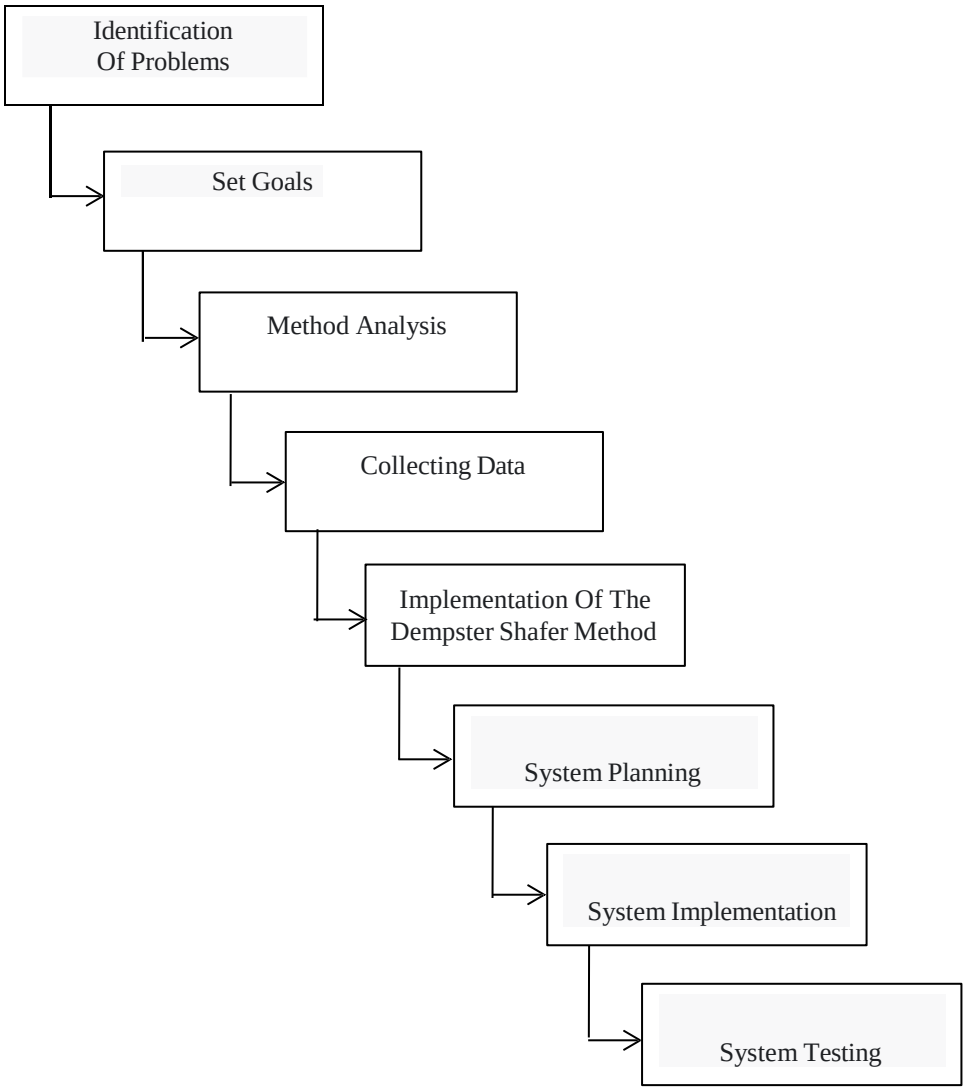

Figure 1. Research Framework

The description of the framework in Figure 1 is as follows:

1. Identification Of Problems

The research question determines the quality of the research and whether the activity can become research. An urgent problem is the absence of a system that can diagnose aglaonema and UB. Basa Flower has limited information about the symptoms and types of glaucoma. Flower language. The author has a system

2. Set Goals

At this stage it will be determined what goals to be achieved from this research. The goal to be achieved is to build an application that can diagnose aglaonema plant disease in UB. Flower base quickly and precisely.

3. Method Analysis

The analysis was carried out on the method used in this step. Therefore, it is hoped that researchers can find the right way to overcome problems that arise in research and early management or early treatment of aglaonema plant disease so that researchers can find solutions to these problems.

4. Collecting Data

At this stage, the data collection process was carried out using the interview method to observe and analyze knowledge about the types of Aglaonema plant diseases so as to obtain the data and information needed such as physical data on symptoms and solutions for Aglaonema plant diseases experienced by plants. These data were obtained from ornamental plant experts who have decades of experience in dealing with diseases of aglaonema plants. Data collection techniques used in this study are:

a. Interview

This study uses structured questions for questions and is interviewed by the owner of UB. Basa Flower as an investigative expert.

b. Documentation

Documentation is a method of collecting data by analyzing or reviewing documents made by experts.

Documentation is achieved by collecting data from existing documents so that researchers can take notes or

photos, etc.

c. Literature review

Literature study is a method of collecting information and data through library activities related to research

ongoing activities, such as journals, books, and previous research.

5. Implementation of the Dempster Shafer Method

At this stage, the analysis method is carried out using the Dempster Shafer method. Thus, it is hoped that researchers can find solutions to problems by calculating according to the formula along with the values obtained from experts.

6. System Planning

At this stage, the system model design was analyzed using the Schaeffer Starch Star method to develop the Aguronema expert system for the diagnosis of plant diseases. The purpose of using UML diagrams for system design is to use numbers that are used to describe or model applications. Use case diagrams, action diagrams, class diagrams and sequence diagrams. This step includes a description of the database design used. Its purpose is to group data related to database design. In addition, interfaces and menus are created during the user interface planning phase and then available for use by the program.

7. System Implementation

The author carries out activities in the form of system implementation after building the system. This is done using the Visual Basic 2010 programming language using a database in the form of Microsoft Access 2010

8. System Testing

After the system is implemented, the author conducts tests to ensure that the system meets the results of the analysis and design, and provides an opinion on whether the system meets expectations..

3. RESULTS AND DISCUSSION

Types of diseases that often occur in aglaonema plant diseases can be seen from table 4.1 which has been made based on observational data from UB. Flower Language.

Table 1. Types of Aglaonema Plant Diseases

Disease Code	Disease Name	Treatment Solution
P01	Bacterial Stem Rot	To overcome this disease, the diseased leaves are trimmed and discarded or can be sprayed with Vinegar Solution at the recommended dose.

P02	Rotten Root	To deal with this disease, the plant is uprooted, damaged roots are removed. The roots are washed. Plants in pots in clean pots. Plantation media used is new plantation media. Do not use old growing media because it has been contaminated with Pythium. You can also spray the plant with a fungicide such as Aliette.
P03	Fusarium Stem Rot	Remove the plant from the pot, then remove the diseased part. Plants are then replanted with a new planting medium.

The types of symptoms that often occur in aglaonema plant diseases can be seen from the table made based on data from UB. Flower Language.

Table 2. Types of Disease Symptoms

Code Symptom	Code
G01	The leaves or stems are damaged and slimy
G02	Crushed leaves and stems
G03	There are smaller plant shoots
G04	Leaf bones turn brown
G05	There are white spots on the plant roots
G06	The stems and roots of the plant dry up
G07	There are white spots on the trunk
G08	The edge of the stem is reddish purple
G09	There is a small bright red circle under the stem
G10	Leaves rotting at the ends
G11	There is a hole in the leaf
G12	There are yellow spots on the leaves

The rules that begin with if-and-then for each type of aglaonema plant disease are explained as follows:

Table 3. Rules of Symptoms and Disease

No. Rules	Symptoms and Disease Rules
R01	If (broken and slimy leaves or stalks) And (destroyed leaves and stalks) And (There are smaller plant shoots) And (leaves turn brown) Then Bacterial Stem Rot Disease
R02	If (There are white spots on the roots of the plant) And (The stems and roots of the plant dry up) And (There are white spots on the stems) Then Root Rot Disease
R03	If (the rim of the stem is reddish purple) And (There is a small bright red circle under the stem) And (the leaf rots at the tip) And (There is a hole in the leaf) And (There is a yellow spot on the leaf) Then Fusarium Stem Rot Disease

From the known symptoms of aglaonema plant disease, it can be concluded that the rule base is the relationship between symptoms and aglaonema plant disease.

Table 4. Rule Base

Code	Symptom	P01	P02	P03
G01	The leaves or stems are damaged and slimy	√		
G02	Crushed leaves and stems	√		
G03	There are smaller plant shoots	√		
G04	Leaf bones turn brown	√		
G05	There are white spots on the plant roots		√	
G06	The stems and roots of the plant dry up		√	

G07	There are white spots on the trunk	√	
G08	The edge of the stem is purple Redness		√
G09	There is a small red circle bright under the stem		√
G10	Leaves rotting at the ends		√
G11	There is a hole in the leaf		√
G12	There are yellow spots on the leaves		√

After the rule base has been defined using the table above, the next step is to use a table inference engine and use the Dempster Shafer method to perform the calculation process.

In the implementation of the Dempster Shafer method, a density value is needed. Where this value is obtained from an expert on plant disease aglaonema. The following are basic rules or information about the symptoms of aglaonema plant disease along with the density value for each disease symptom.

Table 5. Symptom Density Values

Disease Code	Type Of Disease	Symptom Code	Weight
P01	*Bacterial Stem Rot*	G01	0,4
		G02	0,6
		G03	0,8
		G04	0,6
P02	Busuk Akar	G05	0,4
		G06	0,6
		G07	0,6
		G08	0,8
		G09	0,6
P03	*Fusarium Stem Rot*	G010	0,8
		G11	0,4
		G12	0,6

In the calculation of the Dempster Shafer method, the formula used to diagnose the plant disease Aglaonema is as follows:

$$m_3(\mathrm{Z}) = \frac{\sum X \cap Y = Z^{m1(X).m2(Y)}}{1 - \sum X \cap Y = \theta^{m1(X).m2(Y)}}$$

Information :
m1 = Density for the first symptom
m2 = Second symptom density
m3 = The combination of the two densities above
θ = Universe of talks from a set of hypotheses (X' and Y')
x dan y = Subset of Z

Examples of cases, for example, the symptoms of the disease that appear on the Aglaonema plant are 4 symptoms, namely the leaves or stems are damaged and slimy (G1), There are smaller plant shoots (G3), the leaf bones turn brown (G4) and There are white spots on the trunk (G7) . Based on the symptoms of the disease, it is as follows:

Symptoms 1: Damaged and slimy leaves or stalks (G1)
Symptom 2: There are smaller plant shoots (G3)
Symptoms 3: Leaf bones turn brown (G4)
Symptoms 4: There are white spots on the trunk (G7)
Then determine the initial density value (m) consisting of the following belief and plausibility.

Symptom 1 : Damaged and slimy leaves or stalks (G1)

Based on table 3.5 the relationship between symptoms and disease and the value of symptom density to diagnose disease, it is obtained:

m1{ P01 } = 0,4

m1 { θ } = 1 – 0,4 = 0,6

Symptom 2: There are reduced plant shoots (G3)

Based on table 4.4 the relationship between symptoms and disease and the value of symptom density to diagnose disease, it is obtained:

m2 { P01 } = 0,8

m2 { θ } = 1 – 0,8 = 0,2

Table 6. Combination Rules for M_3

density 2 (m2) \ density 1 (m1)	{ P01 } { 0.4 }	{ θ } { 0.6 }
{ P01 } { 0,8 }	{ P01 } { 0.32 }	{ P01 } { 0.48 }
{ θ } { 0,2 }	{ P01 } { 0.08 }	{ θ } { 0,12 }

The combination {P01} in column 2 row 2 is obtained fro the intersection between {P01} and {P01}. The value of 0.32 is obtaine d from the product of 0.8 x 0.4. Similarly, {P01} in row 3 of the second column. Image is a slice of and {θ} in the third row c the third column the value 0.12 is the product of 0.2 x 0.6

Refer to the dempster shafer formul a $m_1 X . m_2 Y$ does not exi st, then the value is 0, so the M3 value can be calculated as follows:

m_3(P01) = $\frac{0,32+0,48+0,08}{1-0}$ = 0,88

m_3(θ) = $\frac{0,12}{1-0}$ = 0,12

Then the dempster shafer calculation is continued on the next selected symptom, namely:

Symptom 3: Leaf bones turn brown (G4)

Based on table 4.4 the relationship between symptoms and disease and the value of symptom density to diagnose disease, it is obtained:

m4 { P01 } = 0,6

m4 { θ } = 1 – 0,6 = 0,4

Table 7. Combination Rules for M_5

density 4 (m4) \ density 3 (m3)	{ P01 } { 0.88 }	{ θ } { 0.12 }
{ P01 } { 0,6 }	{ P01 } { 0.528}	{ P01 } { 0.48 }
{ θ } { 0,4 }	{ P01 } { 0.352}	{ θ } { 0,048 }

The combination {P01} in column 2 row 2 is obtained fro the intersection between {P01}

and {P01}. The value of 0.528 is obtained from the product of 0.6 x 0.88. Similarly, {P01} in row 3 of the second column. The figure is the intersection of and {θ} in the third row of the third column, the value of 0.048 is the product of 0.4 x 0.12.

Refer to the dhemspter shaper formula $m_1\ X.\ m_2Y$ does not exist, then the value is 0, so the M_5 value can be calculated as follows:

$m_5(\text{P01}) = \frac{0{,}528+0{,}072+0{,}352}{1-0} = 0{,}952$

$m_5(\theta) = \frac{0{,}048}{1-0} = 0{,}048$

Symptom 4: There are white spots on the trunk (G7)

Based on table 4.4 the relationship between symptoms and disease and the value of symptom density to diagnose disease, it is obtained:

$M_6\ \{\ P02\ \} = 0{,}6$

Then refer to the formula so that the plausibility value is obtained.

$M_6\ \{\ \theta\ \} = 1 - 0{,}6 = 0{,}4$

Table 8. Combination Rules For M_7

density 6 (m6) \ density 5 (m5)	{ P01 } { 0.952}	{ θ } { 0.048 }
{ P02 } { 0,6 }	Ø { 0.5712}	{ P02 } { 0.0288}
{ θ } { 0,4 }	{ P01 } { 0.3808}	{ θ } { 0,0192 }

Refer to the dhemspter shaper formula $m_1\ X.\ m_2Y$ already exists, the value is 0.5712 so that the M_7 value can be calculated as follows:

$m_7(\text{P01}) = \frac{0{,}3808}{1-0{,}5712} = \frac{0{,}3808}{0{,}4288} = 0{,}8881$

$m_7(\text{P02}) = \frac{0{,}0288}{1-0{,}5712} = \frac{0{,}0288}{0{,}4288} = 0{,}0672$

$m_7(\theta) = \frac{0{,}0192}{1-0{,}5712} = \frac{0{,}0192}{0{,}4288} = 0{,}0448$

From the calculation using the Dempster Shafer method above, it can be obtained that the diagnosis result is Bacterial Stem Rot (P01) with a confidence value of 0.8881 or 88.81%. To overcome this disease, the diseased leaves are trimmed and discarded or can be sprayed with Vinegar Solution at the recommended dose.

4. CONCLUSION

After carrying out various stages, the following conclusions are obtained By using an expert system to diagnose aglaonema plant diseases with the Dempster Shafer method, users can quickly and correctly display the results of aglaonema plant disease diagnosis according to the Dempster Shafer method calculations. From the symptoms that have been selected by the user, it can be concluded that the Aglaonema plant has Bacterial Stem Rot disease with a percentage value of 88.81%. With the implementation of an expert system for diagnosing aglaonema plant diseases with the dempster shafer method built using Microsoft Visual Basic 2010 and Microsoft Access 2010 databases, it can make it easier for users to collect data and select disease symptoms and produce output in the form of print outs can be done quickly and without cost. By using an expert system to diagnose aglaonema plant diseases, which are designed to solve problems faced by many users, namely the problem of ignorance of the disease experienced by their Aglaonema plants. With the implementation of this system, it is hoped that all obstacles regarding ignorance related to aglaonema plant diseases can be overcome effectively and efficiently.

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