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Mobile Expert System Using Forward Chaining for Diagnosing Teak Tree Disease

Mobile Expert System Using Forward Chaining for Diagnosing Teak Tree Disease

Imamah[1], Wahyudi Agustiono[2], Eka Malasari Rochman[3], Nuris Firdaus[4]

[1,2,3,4] Engineering Faculty,University of Trunojoyo Madura Bangkalan, Indonesia

i2m@trunojoyo.ac.id

Abstract. The teak trees is a high-quality wood that grows in Indonesia. Teak trees are susceptible to pests and diseases within the first to 12 months of life. The limited number of agricultural agents in each sub-district becomes a reason why we proposed a mobile expert system to detect pests and diseases in teak trees. The method used in this study is forward chaining. The results of this study showed that 9 of disease were successfully detected by a human expert. Whereas by using the mobile expert system only 7 diseases were successfully detected. From this comparison, the accuracy of the mobile expert system using forward chaining method is 77%.

1. Introduction

Teak tree (Tectona grandis sp) are producing high-quality wood, it has a straight trunk and can reach a height of 30-40 meters. Teak wood is in great demand because of its high durability, natural durability and aesthetic qualities[1]. Even though, teak is more resistant to pests, farmers still have to anticipate pests or diseases which can damage teak plants at any time and also damage the price[2].

The proper treatment at range of age 0 to 12 months will contribute greatly to the quality of wood that will be produced by the teak tree. The proper treatment depends on how The Farmers solving issue causing by disease and pest. Some pests and diseases that often attack teak trees are leaf spot disease and root rot. But the limited number of agricultural consultants in each sub-district involve the farmers difficult to obtain information on how to properly manage pests and disease. When farmers detect disease and pest in teak trees, they only ask other farmers to determine how to control or treat it. In fact, each disease has different control and treat methods [3] .

Based on this matter, we proposed the mobile expert system which ability to diagnose disease and pest in teak trees. This application will help the farmers to early detect diseases that attack teak trees without having to ask an agricultural consultant. this application will transfer the expertise of agricultural consultant into a mobile expert system using the forward chaining method. Forward chaining is chosen because of it a simple and effective method for the expert system, and the reception of new data can trigger new inferences, which makes the engine better suited to dynamic situations in which conditions are likely to change[4][5][6][7][8].

2. Related Work

This section provides a review of articles mainly studying application of expert system and Forward Chaining. In 2017, Al Rekhawi proposed an expert system for rickets diagnosis, which provides the patients with the diagnosis, recommendation and treatment[9]. Nurdiyanto was developed a system

using forward chaining to determine the levels of sugar-content [10]. Suharjito was developed an expert system that provides a means of consultation imitating the reasoning process of an expert in solving complex problems concerning the health of cows reproduction using fuzzy tsukamoto [11]. Ariawan using CIPP model that is combined with Forward Chaining Method to evaluate the implementation of Practice Teaching Program for prospective teachers at Undiksha[12]. Aristoteles proposed an expert system that can diagnose the chili plants disease using forward chaining method[3]. Research that conducted by Nurlaeli present implementation of the forward chaining method in the diagnosis diseases and pests of corn crop [13].
Widya Lelisa was proposed expert system to diagnosing patients based on the facts experienced using forward chaining method compile with certainty factor (CF). The accuracy of this research is 85% [14]. Muhammad also proposed forward chaining to diagnose cattle disease with accuracy 100% [15].

3. Methods

In this study, mobile expert system developed using the forward chaining method. Data about disease and symptoms of teak tree were obtained from interviews with agricultural experts and literature studies. Knowledge base was developed based on information and knowledge obtained from agricultural experts and literature studies.

3.1. Forward Chaining

Forward chaining is a popular implementation strategy for expert systems, business and production rule systems [16]. Forward Chaining is a search technique that starts with facts Known, then match the facts with the IF part of the rule IF - THEN . If there are facts that match the IF section, then rule is executed [17] [18]. When a rule is executed, then a new fact (part THEN) Add to database Steps in creating an expert system by using the forward chaining method, namely:

- The definition of the problem starts with the selection of the problem domain and knowledge acquisition.
- Input the definition data to start inference because it is needed by forward chaining system.
- Defining data control structures to help controlling the activation of a rule.
- Writing the initial code in the knowledge domain.
- System testing in order to know the extent of the system running.
- Designing the interface with a knowledge base.
- System development.
- System evaluation.

3.2. Proposed Solution for Teak Disease and Pest

The Forward Chaining algorithm of applies to programs of arbitrary cardinality [19]. So to draw conclusions from the facts the decision tree is used. Decision tree is a knowledge representation tool generated from the questions that asked to get a solution. Decision trees use several criteria to choose which branches to go through so that later only one branch will be chosen to make a decision result [20]. The conclusions from the symptoms was found is used the Best First Search method, which is this search method relies on two existing search methods, namely the Breadth First and the Depth First Search method. Diseases and pests as a conclusion of the search and tracking process shown in Table 1.

Table 1. Disease and Pest in Teak Tree

Code	P1	P2	P3	P4	P5	P6	P7	P8	P9
Disease	Leaf spots	Curly leaves	Soot dew	Dew of flour	Leaf pox	Root rot	Rotten heart	Caterpillar	Rat

Table 2 shows the rule-based diseases and symptoms. Based on this rule, diseases and pests in teak trees are diagnosed.

Table 2. Rule Based of Disease and Sympthon

Symphon Codes (G)		Disease Codes (P)								
		1	2	3	4	5	6	7	8	9
1	Spots on leaves	x	x	x	x	x				
2	Yellow-brown patches	x								
3	Black spots			x						
4	Bright yellow patches					x				
5	Round / oval / irregular patches	x								
6	White patches like flour / cotton				x					
7	Hollow leaves								x	
8	Perforated leaves leave leaf bones								x	
9	The leaves turn yellow and wither				x		x	x		
10	Notched leaves					x				
11	Hard textured leaves					x				
12	The leaves are bulging / curly		x							
13	Young stems are green-kning			x						
14	Brown root						x			
15	Leaves fall out				x					
16	The protrusion is dark brown on the leaves					x				
17	Broken branch and wound							x		
18	Soft / filamentous wood structure							x		
19	Branches peel off									x
20	Branches are covered with white mushrooms						x			
21	Roots are covered with white mushrooms						x			
22	Brown root rot						x			
23	The teak tree dries and dies									x

The process of diagnosing the disease starts with examining the symptoms that most appear in teak disease and pests, as shown in the Table 2 which is G1.

There are five types of diseases that have symptoms of G1, namely diseases P1, P2, P3, P4 and P5. If the symptom of G1 is true then the probability of disease is P1, P2, P3, P4 and P5. then the system checks the second symptom, if G2 is true then the probability of the disease is P1. in this iteration, if G5 is also true then P1 disease is detected. repetitive iterations until one fact is found to be true, but if there are facts that have not been set on rule based and are equally true or equally false, the system cannot detect or undefined.

4. Result and Discussion

This research has success in develop an mobile expert system that can detect diseases and pests in teak trees based on information from human expert. The interface of mobile expert system is shown in Figure 1. There are several features provided, the user interface for input symptoms of the disease that found by the user, then the diagnosis results and suggestions for handling diseases and pests detected is provide in another screen of application as show in figure 1.

Fig. 1. Display menu on mobile expert system.

In this system, the user should choose a diagnosis menu, then the system will ask questions according to the symptoms in table 2. if user set true for the first symptoms question as show in table 2, then system will lead the user to the next question. If the user set not true for the second symptoms question then system will be directed to the other question until the system finds a result or prove symptoms adjusted to rule based. The final results of the diagnosis will be displayed as in figure 1.

4.1. Accuracy Testing

In order to be used, this expert system must go through a due diligence process. due diligence is done by comparing the results of diagnosis by a mobile expert system with the results by human experts. The comparison results are shown in Table 3.

Table 3. Comparison Result Expert System and Human Expert

Symptoms	Human Expert	Mobile Expert
Spots on leaves, Yellow-brown patches, Round / oval / irregular patches.	Leaf spots	Leaf spots
Spots on leaves, The leaves are bulging / curly	Curly leaves	Curly leaves
Spots on leaves, Black spots, Young stems are green-kning	Soot dew	Not Detected
Spots on leaves, White patches like flour / cotton, The leaves turn yellow and wither, Leaves fall out.	Dew of flour	Dew of flour
Spots on leaves, Bright yellow patches, Notched leaves, Hard textured leaves, dark brown on the leaves.	Leaf pox	Leaf pox
The leaves turn yellow and wither, Brown root, Branch branches are covered with white mushrooms, Roots are covered with white mushrooms, Brown root rot.	Root rot	Not Detected
The leaves turn yellow and wither, Broken branch and wound, Soft / filamentous wood structure	Rotten heart	Rotten heart
Hollow leaves, Perforated leaves leave leaf bones,	Caterpillar	caterpillar
Branch branches peel off, The teak tree dries and dies.	Rat	Rat

Table 3 show that 9 diseases were identified by human expert, and only 7 diseases were identified by the mobile expert. The mobile expert failed to detect soot dew and root rot diseases. Based on this result, accuracy results are calculated as follows:

Accuracy = (Mobile expert Result/ Human expert Result) * 100% …..(1)

Accuracy = (7/ 9) * 100% = 77 %

Based on this test, the accuracy of mobile expert system using forward chaining is 77%.

5. Conclusion

This study using forward chaining to diagnose disease and pest in teak tree. There are 23 symptoms used in determining 9 disease and pest in teak tree. In this research, we have compared a result of diagnosis by MES and by HE. Based on this research, an accuracy of MES using forward chaining is 77%. The MES failed to detect soot dew and root rot. in future research we can combine forward chaining with certainly factor to increase accuracy MES for diagnose disease and pest in teak tree.

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