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Expert System on Soybean Disease Using Knowledge Representation Method

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Abstract

Soybean (Glycine mx L.) is one of the important strategic commodity in Indonesia which is cultivated widely. Soybean demand continues to rise with the increasing demand for soy as food industry ingredients such as tofu, tempeh, soy milk soy tauco and snack. However, efforts to increase the production and development of soybean agribusiness has some constraints that may reduce production by 50% due to certain diseases. The situation is of course very detrimental to soybeans in particular and the public in general. But the farmers have very low knowledge about the technical maintenance of the soybean crop. These circumstances resulted in a high dependence of farmers on crop pest controllers are limited. To overcome these problems was made based application based mobile operating system Android. However, mobile devices have limitations in computing resources ranging from the ability of the processor to the memory capacity. To optimize computing resources on mobile devices, we need a method of knowledge representation that consists of a frame-based and rule-based representation with the rules or rule that is used to determine whether the peanut plants infected with certain diseases, in which the types of diseases that can be detected on do this thesis includes diseases of bacterial pustules, antarchnose disease, mosaic virus disease, damping, rust disease and blight. then analyzed knowledge representation which is the most optimal. This can be done by comparing the scenario some knowledge of the representation of the level of validity and cases symptoms can be resolved.

Keywords*: expert system soybean disease, android, knowledge representatio*n

1. Introduction

Soybean demand in Indonesia each year is always increasing along with population growth and per capita income improvement. Therefore, the necessary supply of soybean addition be imported because domestic production can not meet these needs

However, efforts to increase the production and development of soybean agribusiness still has some obstacles such as plant pests (OPT), especially diseases Damping (Rhizoctonia solani), Antrachnose, pustules bacteria, rust, blight, and Mosaic Virus which can cause the plant to die. That situation must be pay attention especially soybean farmers and the public at large. One of the most important parts in the soybean plant health treatment is to make observations on soybean plants that unexpected illness. But unfortunately, the farmers have very low knowledge about the technical maintenance of soybean crops such as the type of disease in the suffering of soybean plants. These circumstances resulted in farmers high dependence on controlling pests (IPM). By using the knowledge representation of the knowledge base that already exists, the information can be manipulated in accordance with the facts. Knowledge representation makes it possible to reduce the data storage capacity on a storage medium (database) with a wide range of knowledge representation. In this thesis will be implemented some knowledge representation that consists of a frame-based representation and rule-based representation for knowledge representation later in the analysis where the most optimal. This can be done by comparing the scenario some knowledge of the representation of the level of validity and cases symptoms can be resolved.

This study aims to help soybean farmers by designing an expert system to detect diseases on soybean plants; Implementing the method of frame-based representation and the rule base representation to detect the disease on soybeans.

2. Research Method

The first step in developing an expert system is to identify the problem to be studied, in this case is to identify the problems that will be made in advance, as for the issues that will be taken in the construction of an expert system to diagnose the disease on soybean plants as well as how to handle.

Table 1. Data of Soybean Disease

ID Disease	Disease
P1	Karat
P2	Hawar
P3	Rebah
P4	Virus Mozaik
P5	Antarchnose
P6	Pustul bakteri

Table 2. Symstoms of Soybean Disease

No	ID Symtoms	Symtoms
1	G1	There is spore in surface of the laeves
2	G2	There is abscess which colour is light brown
3	G3	Seed appears purple spot
4	G4	Leaves contains red purple spot in the corner
5	G5	There is rotten at the root of the soybeans
6	G6	Leaves suddenly go pale and witheres
7	G7	Leaves ,stem and pod became rotten at the direct cross
8	G8	There is Miselium that makes leaves sticky each other
9	G9	There is spot in the surface of seed
10	G10	Plants becomes stunded
11	G11	There is mozaic pattern that colour dark green at the leaves
12	G12	Leaves and pod contanis many spots which black
13	G13	The lower leaves becomes drop
14	G14	The young pong attack pest and becomes empty
15	G15	Old pod bceomes stunded
16	G16	There is small spot green at the surface of the leaves
17	G17	Leaves becomes all drop

After We identified Soybean Disease and Symstoms of Soybean Disease, We have to make crosscheck betweet symtoms with disease as shown in table 3. This is used to create a rule

Table 3. Crosscheck between symstoms with disease

ID Symstoms	Disease					
	P1	P2	P3	P4	P5	P6
G1	√	√				√
G2	√					
G3		√				
G4		√				
G5		√				

G6		√	√			
G7			√			
G8			√			
G9				√		
G10				√		
G11			√	√		
G12					√	
G13					√	
G14					√	
G15					√	
G16	√			√		√
G17	√				√	√

Rule of production is usually written in the form if it (IF-THEN). The rule can be considered as two parts of the relationship implications premise (if) and the conclusion section (then). If the premise part fulfilled, the conclusion section will also be true. A rule consists of clauses a similar clause of a sentence subject, verb and object that expresses a fakta.thereis clause premises and conclusion in a rule. A rule can also consist of several premises and more than one conclusion. Rules of the premise and the conclusion may be associated with "OR" or "AND". Following the rules of combination in identifying the disease each of soybean disease,you can see in table 4.

Table 4. Rule Combination

Rules	**Combination**
Rule 1	IF G1 AND G2 AND G16 AND G17 THEN P1
Rule 2	IF G1 AND G3 AND G4 AND G5 AND G6 THEN P2
Rule 3	IF G6 AND G7 AND G8 AND G11 THEN P3
Rule 4	IF G9 AND G10 AND G11 AND G16 THEN P4
Rule 5	IF G12 AND G13 AND G14 AND G15 AND G16 THEN P5
Rule 6	IF G 1AND G 16 AND G17 THEN P6

The method used in this research is the certainty factor.Certainty factor expressed confidence in an incident (facts or hypotheses) based on evidence or expert judgment.[10]

$$CF(H,E) = MB(H,E) - MD(H,E)$$

Where:
CF(H,E)= *certainty factor* ofhypothesis H influenced the fact E
MB(H,E) = *Measure of increased belief*of hypothesis H that affect the fact E
MD(H,E) = *Measure of increased disbelief*) of hypothesis H that affect the fact E

Implementation of certainty factor calculation performed after a diagnosis completed and belief of value produced by the formula:

$$CFcombine\ CF(H,E)_{1,2} = CF(H,E)_1 + CF(H,E)_2 * [1 - CF(H,E)_1]$$
$$CFcombine\ CF(H,E)_{=1\wedge 2,3} = CF(H,E)_{1\wedge 2} + CF(H,E)_3 * [1 - CF(H,E)_{1\wedge 2}]$$

Information :

CF(H,E) : *certainty factor*of hypothesis H that affect the fact E
CFcombine CF(H,$E)_{1,2}$: *certainty factor*of hypothesis H that affect the fact E with rules 1 and rules 2
CFcombine CF(H,$E)_{=1\wedge2,3}$: *certainty factor*of hypothesis H that affect the fact E with rules 1,2 and 3

From the results of interviews with Mr. Candra Supriadi as the expert of Soybean plant ,it can be obtained trust value of soybean plant disease symptom. Belief and disbelief values are obtained based on symptoms whether they are related to soybean plant disease types,you can see in the table 2.5. Each symptom has a percentage in determining plant diseases.

Table 5. Value of Believe disbelieve of Soybeans symtoms

	Soybean Disease											
	Karat		Hawar		Rebah		VM		Antrachnose		Pustul B	
	MB	MD	MB	MD	MB	MD	MB	MD	MB	MD	MB	MD
G1	0,8	0,2	0,75	0,25	0,2	0,8	0,2	0,8	0,2	0,8	0,75	0,25
G2	1,0	0,2	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8
G3	0,2	0,8	0,75	0,2	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8
G4	0,2	0,8	0,75	0,2	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8
G5	0,2	0,8	0,75	0,2	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8
G6	0,2	0,8	0,8	0,2	0.6	0,4	0,2	0,8	0,2	0,8	0,2	0,8
G7	0,2	0,8	0,2	0,8	0,8	0,2	0,2	0,8	0,2	0,8	0,2	0,8
G8	0,2	0,8	0,2	0,8	0,8	0,2	0,2	0,8	0,2	0,8	0,2	0,8
G9	0,2	0,8	0,2	0,8	0,2	0,8	0,8	0,2	0,2	0,8	0,2	0,8
G10	0,2	0,8	0,2	0,8	0,2	0,8	0,8	0,2	0,2	0,8	0,2	0,8
G11	0,2	0,8	0,2	0,8	0,6	0,2	0,8	0,2	0,2	0,8	0,2	0,8
G12	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,8	0,2	0,2	0,8
G13	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,8	0,2	0,2	0,8
G14	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,8	0,2	0,2	0,8
G15	0,2	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,8	0,2	0,2	0,8
G16	0,8	0,2	0,2	0,8	0,2	0,8	0,5	0,5	0,2	0,8	0,6	0,4
G17	0,8	0,2	0,2	0,8	0,2	0,8	0,2	0,8	0,8	0,2	0,75	0,2

Sample case:

A soybean farm suffered some form of Soybean Plant diseases are unknown. Symptoms experienced are:
- There is a spot on the skin Seeds
- Plant Being a Little
- There are dark green mosaic on leaves
- Small patches of pale green

The symptoms that have been described,system will carry out the process in accordance with the method of Certainty Factorafter the calculation process is completed, the system will show the type of soybean plant diseases produced.We Simulate symstoms by variable
A: There is a spot on the skin Seeds
B: Being a Little
C: There are dark green mosaic on leaves
D: Small patches of pale green

Then We Calculate the symstom with Certainty Factor:

Karat Disease:

MB (*Measure of increased belief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,2+0,2*(1-0,2)	0,0396
2	A ∩ B ∩ C	=	0,0396+ 0,2*(1-0,0396)	0,0588
3	A ∩ B ∩ C ∩ D	=	0,0588 +0,8*(1-0,0588)	0,8124

MD(*Measure of increased disbelief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,8+ 0,8*(1-0,8)	0,96
2	A ∩ B ∩ C	=	0,96+ 0,8*(1-0,96)	0,992
3	A ∩ B ∩ C ∩ D	=	0,992 +0,2*(1-0,992)	0,99216

CF(H,E)= MB(H,E) – MD(H,E)= 0,8124 - 0,99216= **-0,179**

Hawar Disease:

MB (*Measure of increased belief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,2+ 0,2*(1-0,2)	0,0396
2	A ∩ B ∩ C	=	0,0396+ 0,2*(1-0,0396)	0,0588
3	A ∩ B ∩ C ∩ D	=	0,0588 +0,2*(1-0,0588)	0,0776

MD(*Measure of increased disbelief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,8+ 0,8*(1-0,8)	0,96
2	A ∩ B ∩ C	=	0,96+ 0,8*(1-0,96)	0,992
3	A ∩ B ∩ C ∩ D	=	0,992 +0,8*(1-0,992)	0,9984

CF(H,E)= MB(H,E) – MD(H,E)= 0,0776- 0,9984= **-0,9208**

Rebah Disease:

MB(*Measure of increased belief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,2+ 0,2*(1-0,2)	0,0396

2	A ∩ B ∩ C	=	0,0396+ 0,8*(1-0,0396)	0,807
3	A ∩ B ∩ C ∩ D	=	0,807 +0,2*(1-0,807)	0,8108

MD(*Measure of increased disbelief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,8+ 0,8*(1-0,8)	0,96
2	A ∩ B ∩ C	=	0,96+ 0,2*(1-0,96)	0,9608
3	A ∩ B ∩ C ∩ D	=	0,9608 +0,8*(1-0,9608)	0,99216

CF(H,E)= MB(H,E) – MD(H,E)= **-0,9208**- 0,99216= **-1,9108**

Virus Mozaik Disease:

MB(*Measure of increased belief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,8+0,8*(1-0,8)	0,96
2	A ∩ B ∩ C	=	0,96+0,8*(1-0,96)	0,992
3	A ∩ B ∩ C ∩ D	=	0,992+0,8*(1-0,992)	0,9984

MD(*Measure of increased disbelief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,2+ 0,2*(1-0,2)	0,0396
2	A ∩ B ∩ C	=	0,0396+ 0,2*(1-0,0396)	0,0588
3	A ∩ B ∩ C ∩ D	=	0,0588 +0,2*(1-0,0588)	0,0776

CF(H,E)= MB(H,E) – MD(H,E)= 0,9984- 0,0776= **0,9208**

Antrachnose Disease:

MB(*Measure of increased belief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,2+ 0,2*(1-0,2)	0,0396
2	A ∩ B ∩ C	=	0,0396+ 0,2*(1-0,0396)	0,0588
3	A ∩ B ∩ C ∩ D	=	0,0588 +0,2*(1-0,0588)	0,0776

MD(*Measure of increased disbelief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,8+ 0,8*(1-0,8)	0,96

2	A ∩ B ∩ C	=	0,96+ 0,8*(1-0,96)	0,992
3	A ∩ B ∩ C ∩ D	=	0,992 +0,8*(1-0,992)	0,9984

CF(H,E)= MB(H,E) – MD(H,E)= 0,0776- 0,9984= **-0,9208**

Pustul Bakteri Disease:
MB**(***Measure of increased belief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,2+ 0,2*(1-0,2)	0,0396
2	A ∩ B ∩ C	=	0,0396+ 0,2*(1-0,0396)	0,0588
3	A ∩ B ∩ C ∩ D	=	0,0588 +0,8*(1-0,0588)	0,8124

MD(*Measure of increased disbelief)*

	Symtoms		Calculate	Result
1	A ∩ B	=	0,8+ 0,8*(1-0,8)	0,96
2	A ∩ B ∩ C	=	0,96+ 0,8*(1-0,96)	0,992
3	A ∩ B ∩ C ∩ D	=	0,992 +0,2*(1-0,992)	0,99216

CF(H,E)= MB(H,E) – MD(H,E)= 0,8124 - 0,99216= **-0,179**

Based on calculations Certainty Factor, then the highest value at Virus Mozaic disease with a value of **0.9208**. From the results obtained, the system diagnose that the plant disease Mosaic Virus.

3. Results and Analysis

Implementation of expert system software diseases on soybean plants include diagnosing Disease of Karat, RebahDisease, Hawar Disease, pustules bacteriaDisease, viruses MozaikDisease and AntrachnoseDiseasebased on inputs (input) the symptoms of the patient by the user who operates the application. The final result of the process is the possibility of the name of disease diagnosis and treatment recommended soybeans.

3.1. Display Instalation

Installation screen is the display when the program is run, there will be a request to install the display as shown in the following figure 1.

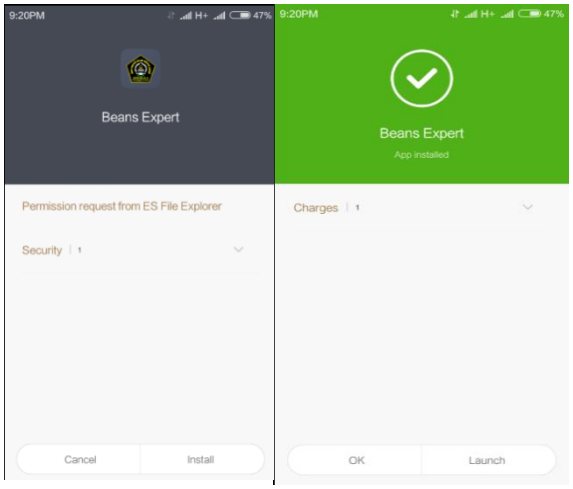

Figure 1. Instalation

3.2. Home Screen

Home Display is a display that is useful to the process of selecting the method to be used and instructions for use of aplication.Home screen can be seen in figure 2.

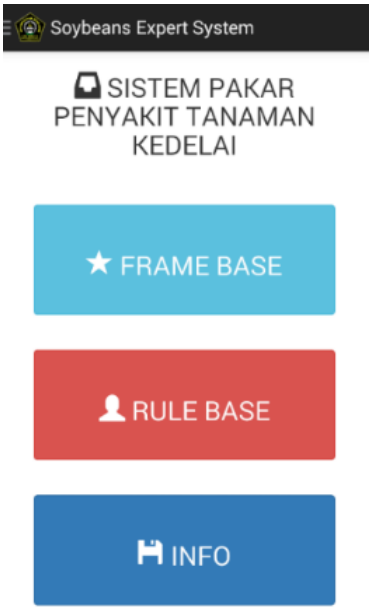

Figure 2. Home Screen

3.3. Frame Based Screen

Frame Base Screen contains the base frame selection method. Frame base is a method that uses the grouping system of each disease and the constituent parts of soybean plants, you can see in the figure 3.

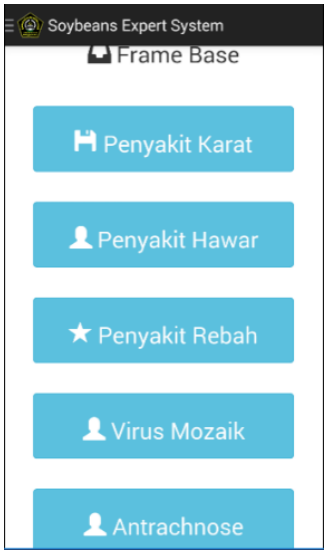

Figure 3. Frame Base Screen

3.4. Rule Base Screen

Rule-based Input Display is a display that works to find solutions to the symptoms. Views rule base as shown in the picture below, you can see in the figure 3.

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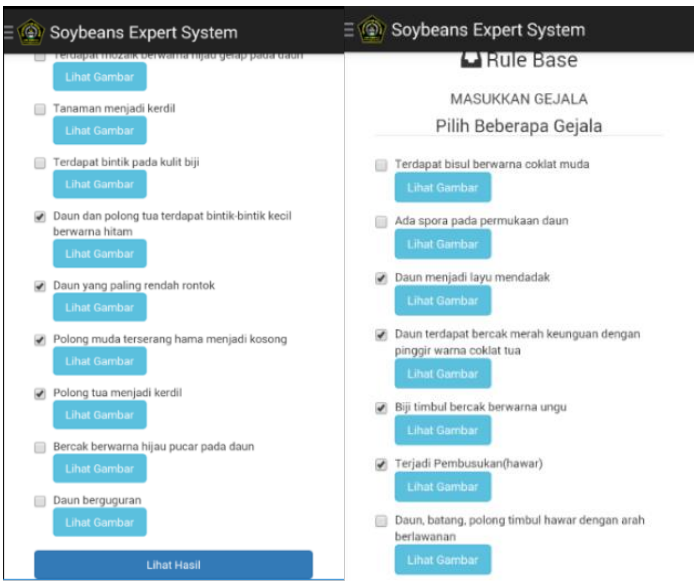

Figure 4. Rule Base Screen

3.5. Experiment Result

Testing of expert system application is done with some trial data scenario which is a collection of symptoms that appear on soybean crop, the data of the symptoms are tested by Rule based and Frame based method. The results shown by the application either use a method of diagnosis is done significantly by calculating the accuracy of the symptoms entered by the user with the weight obtained from interviews with an expert. After the experiment 120 times that is 60 times the experiment Frame base and 60 times the rule base then obtained the accuracy of the method Frame base and rule based,you can see on the table 6 as experiment of frame base and table 7 as experiment as rule base.

Table 6. Experiment of Frame Base

	Hasil Diagnosa *Frame base*					
	P1	*P2*	*P3*	*P4*	*P5*	*P6*
P1	***8***	-	-	*1*	*2*	*1*
P2	-	***7***	-	-	-	-
P3	-	-	***8***	-	*2*	*1*
P4	-	-	*1*	***8***	-	-
P5	*1*	*2*	-	*1*	***6***	-
P6	*1*	*1*	*1*	-	-	*7*
					Success Rate	*44*

Table 7. Experiment of Rule Base

	Hasil Diagnosa *Rule Base*						
	P 1	*P2*	*P3*	*P4*	*P5*	*P6*	*Tidak Ada Indikasi Penyakit*
P1	***4***	*1*	-	-	-	*1*	*4*
P2	-	***5***	*1*	-	-	-	*4*
P3	-	*1*	***4***	*1*	-	-	*4*
P4	*1*	-	*1*	***4***	-	*1*	*3*
P5	*1*	-	-	-	***5***	*1*	*3*
P6	*1*	*1*	-	*1*	*1*	***3***	*3*
						Success Rate	*25*

4. Conclusion

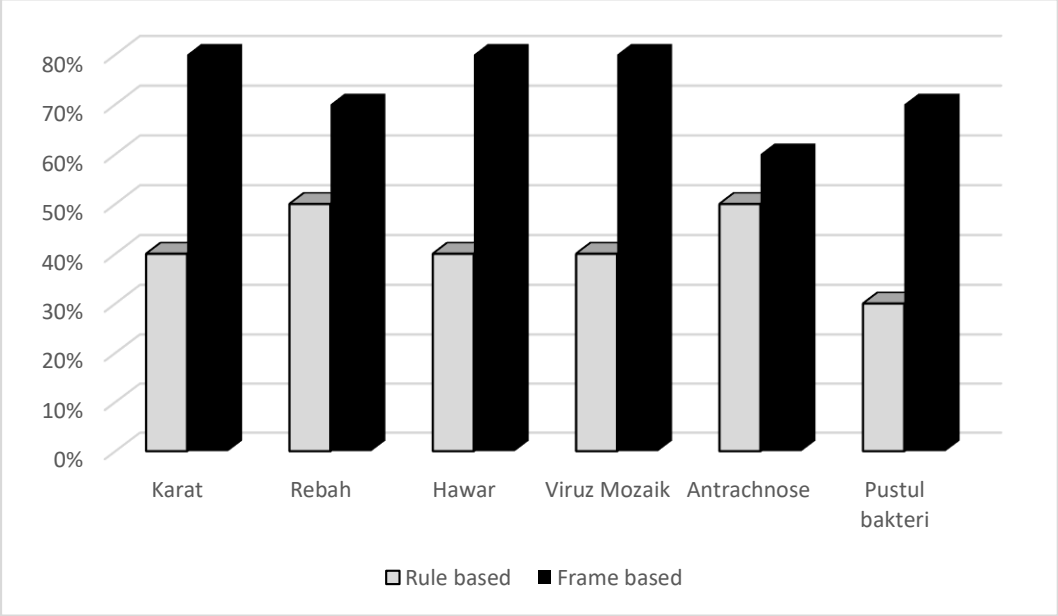

Figure 5 Experiment Result between Rule Based and Frame Based

From figure 5 as experiment between rule base and frame,frame base method has better result than rule base because the basis of knowledge representation for the soybean crop disease this conclusion is based frame then produced a program that has been in accordance with the goal to produce a solution that fits with the symptoms fed. While the rule-based there is a possibility of failure in finding a solution to the disease on soybean plants.

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