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Soybean Variety Identification System Using Fuzzy Tsukamoto and Case Based Reasoning

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Abstract. This study identified various soybean varieties using the Fuzzy Tsukamoto method and Case Based Reasoning to determine the differences between soybean varieties. This research method uses the rules of the Expert System Developments Live Cycle which consists of several stages, namely defining problems, planning, system analysis, knowledge acquisition, knowledge base creation, knowledge validation, implementation and testing. The purpose of this research is to identify soybean varieties using Fuzy Tsukamoto and Case Based Reasoning as information and knowledge for the community. In this study, the factors that influence the identification of soybean varieties are divided into several factors including: leaf shape, seed shape, feather color, seed color, seed size and plant height. From the results of the identification of the characteristics of soybean varieties, the results of system identification with the results of the confusion matrix calculation show that the accuracy of the accuracy of varieties with the number of cases is 96.66%, the accuracy of positive predictions that are correctly identified is 96.66%, the correct positive accuracy is 100% and the accuracy of the identification inaccuracy with the number of all cases is 3.34, and the results of the system validation test with experts identified two types of varieties whose output results are not in accordance with the expert conclusions.

INTRODUCTION

Soybean is a plant originating from Manchuria and parts of China, and there are wild types of soybeans belonging to the species *Glycine ussuriensis*. Then it spreads to the tropics and subtropics and breeding is carried out so that it produces various types of superior cultivated soybeans . Previous research was conducted by [1]. In his research, there were several obstacles in the process of planting soybeans, namely the occurrence of climate change which resulted in the intensity of pest and disease attacks, and a lack of agricultural extension personnel. Then the research conducted by [2], in his research that with the many types of pests and diseases that attack with different control methods, the symptoms need to be identified carefully, so that the exact cause can be identified so that control efforts can be carried out quickly and effectively. In the harvest season, farmers select soybean plants that are ready to be harvested, after the soybean plants have been harvested then the farmers give the harvest to the extension workers to group them between superior and less superior soybean plants.

The superior soybean plants will be further investigated by researchers in the laboratory, while the less superior soybean plants will be separated. Then when researchers conduct research on superior soybean plants, sometimes there is uncertainty in determining the type of variety based on the characteristics of the soybean plant variety, because each soybean variety has characteristics such as leaf shape, seed shape, coat color, Different seed colors, seed sizes and plant height When the research process is completed, the results of the research are documented in book form, and the book is specifically used as information for extension workers and is generally used as information for various circles of society. Description of previous research and also the problems that exist above, the author will conduct research and manufacture a system of "Variety Identification System in Soybean Plants Using Fuzzy Tsukamoto Method and Website-Based Case Based Reasoning". It is hoped that making this expert system can be used by researchers. i in determining the correct types of new varieties and old varieties of soybean plants. This expert system can be used to assist extension workers in providing information on types of pests, diseases and varieties specifically for farmers in Puslitbangtan and in general for the community.

The purpose of this study was to develop a system for identifying varieties of soybean using the Tsukamoto fuzzy method and website-based case-based reasoning. The benefit is to help make it easier for researchers to determine the types of old varieties and types of new varieties in soybean plants appropriately and to make it easier for the public to find out the kinds of diseases, pests and varieties of soybean for learning and information.

RESEARCH METHODS

Expert system development uses the ESDLC (Expert System Development Life Cycle) model approach with several adjustments at the analysis and design stages. In the expert system analysis stage, it is based on the expert system development stage, namely the engineering process [3]. The research stage is shown in Figure 1.

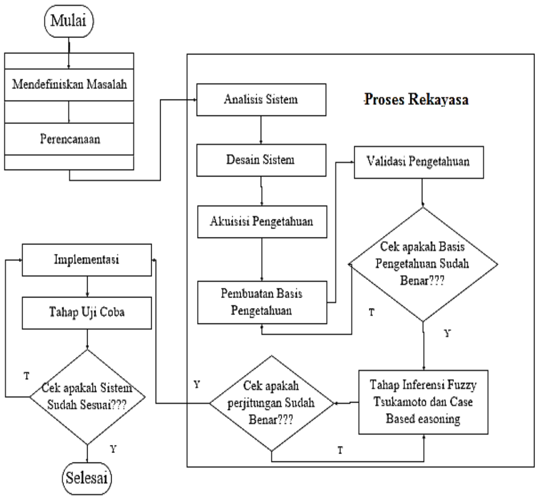

FIGURE 1. Expert System Development Life Cycle

a. Planning Stage

The stage where research is carried out on the case or problem to be resolved. By carrying out a feasibility study to determine. research topics as a discussion that will be developed in this study [4].

b, System Analysis Stage

According to Buono, the analysis stage is the stage of analyzing the system flow from input to output [3]. The flow of the system to be developed can be seen in Annex 8.

c. System Design Stage

According to Buono, is a system identification stage required system design used in the initial steps to create and develop a system [3].

d. Knowledge Acquisition Stage

According to Buono, in this study, the knowledge acquisition stage was to collect knowledge about the types of varieties, the characteristics of varieties in soybean plants from interviews with experts from the Center for Food Crops Research and Development in Bogor City. In addition, knowledge is also obtained from reference books and previous research journals[3].

e. Knowledge Base Creation

According to Buono, the knowledge that has been collected is then rereleased. The rules in this study consist of the characteristics of each type of variety in soybean plants [3].

f. Knowledge Validation Stage

According to Buono, at this stage, the knowledge and rules that have been made are validated by a predetermined expert [3].

g. Inference Stage

According to Buono, at the inference stage, fuzzy tsukamoto is used to determine the type of variety in soybean plants based on the characteristics of the variety and also uses case-based reasoning to calculate the value of similarity by comparing new cases with cases. long time on soybean plant varieties [3].

h. System Implementation Stage

The implementation stage in this research is the stage of making a system, the system will be built using the PHP and HTML programming languages, for the database using MySQL (XAMPP) as a web server (localhost), for the editor program using sublime text. At this stage, the design that has been made in concept begins to be applied into the actual design [4].

i. Testing Phase

System testing is carried out in order to find out whether the information system developed has been running well and is functioning properly, if the system is not functioning properly, then return to the design stage to make improvements to the system. Testing with Black-Box Testing, seeing the results that have been designed or planned whether they are appropriate or not, each menu will be tested, and this test is not only once but can be repeated depending on how the testers are testing it, generally in this test it will be carried out sequentially based on the series of use of a software [5].

RESULTS

Variety data tables are used to determine the types of varieties present in soybean plants. Variety type determination is based on variety characteristic data. This variety data was obtained from the results of interviews with experts and from the book descriptions of the superior varieties of food crops 2010-2016. In the variety data Table 1, there is a variety code that shows the variety code sequence and data on soybean plant varieties.

TABLE 1. Data on soybean varieties and variety codes

No	Variety Code	Variety Names
1	V01	Mutiara1
2	V02	Mutiara 2
3	V03	Mutiara 3
4	V04	Gema
5	V05	Dering 1
6	V06	Detam3 prida
7	V07	Detam 4 prida
8	V08	Gamasugen 1
9	V09	Gamasugen 2
10	V10	Demas 1
11	V11	Dena 1
12	V12	Dena 2
13	V13	Devon 1
14	V14	Dega 1
15	V15	Deja 1
16	V16	Deja 2
17	V17	Devon 1
18	V18	Detap 1
19	V19	Derap 1
20	V20	Demas 2
21	V21	Demas 3
22	V22	Grobogan
23	V23	Arjasari
24	V24	Seulawah
25	V25	Ijen
26	V26	Baluran
27	V27	Edamame R305
28	V28	Edamame R75
29	V29	Merubetiri
30	V30	Anjasmoro
31	V31	Kaba
32	V32	Lawit
33	V33	Mahamero
34	V34	Menyapa
35	V35	Nanti
36	V36	Sibayak
37	V37	Sinabung
38	V38	Tanggamus
39	V39	Bungrangrang
40	V40	Manglayang
41	V41	Argo Mulyo
42	V42	Bromo

No	Variety Code	Variety Names
43	V43	Kawi
44	V44	Leuser
45	V45	Vima 1
46	V46	Pangrango
47	V47	Slamet
48	V48	Cikuray
49	V49	Kipas Putih
50	V50	Krakatau
51	V51	Malabar
52	V52	Singgalang
53	V53	Tampomas
54	V54	Dieng
55	V55	Jayaijaya
56	V56	Lawu
57	V57	Tengger
58	V58	Lompobatang
59	V59	Lumajang beok
60	V60	Petek

The variety characteristic data table is used as the knowledge base to be compared with a number of varieties. This variety characteristic data is used as a basis for comparing a user's consultation with a pre-existing knowledge base. In the variable feature data table, there is data on the characteristic code showing the sequence of the characteristic code, pictures of soybean characteristics and characteristics of the variety.

DISCUSSIONS

In this discussion, we will discuss the things that underlie the system, this application is used by researchers in determining the types of new varieties and types of old varieties in soybean plants appropriately and also this application is used by extension workers and other users to help provide information on types of pests, diseases and varieties. To find out what percentage of echo varieties and other varieties were identified in soybean plants, data on the characteristics of a soybean variety were obtained from interviews with experts, namely Dr. Ronald Timbul Pardamean Hutapea and also data from the book Description of Superior Varieties of Food Crops 2010-2019, by inputting 6 characteristics of existing soybean plant varieties, namely leaf shape, seed shape, coat color, seed color, seed size and plant height. For the basis rules obtained are about 2,304 rules and only 60 rules are used according to expert data and these rules can be seen in Appendix 9.

To find out the results of these 6 characteristics, calculations are carried out using the Tsukamoto fuzzy method if inputting the characteristics. Variety corresponds to the old case, while for the new case the calculation using the Tsukamoto fuzzy method and case-based reasoning only determines between the old case and the new case. For the calculation of the fuzzy Tsukamoto, the domain value of the characteristics of each type of soybean plant variety must be determined. Then from the 6 characteristics of these varieties, rule inference is carried out, namely entering these values into the rule then as an example the rules are shown in Table 9. Then the min value of each value is searched and the defuzification process is carried out to get the final value. For calculations using the casebased reasoning method in the old case there are several stages in casebased reasoning including: Retrieval, Reuse, Revise and Retain, then the system will calculate with the equation formula (5), where the number of similarity characteristics of varieties and will be divided by the number of elements on a case basis and produces a similarity value (similarity) to the old case [6]. To find out the results of consultations on the system regarding soybean varieties, users can see the consultation results page in Figure 13.

System accuracy analysis aims to determine system information in providing correct output according to data obtained from experts. To test the accuracy of this system, namely by comparing soybean variety data with system data, whether the prediction the system is correct with expert predictions, for accuracy trial data using 180 data from the types of soybean varieties [4].

Accuracy of the Fuzzy Tsukamoto Method and Case Based Reasoning

In the Confusion Matrix for the accuracy of varieties in addition, the assessment of the Tsukamoto fuzzy method predicts 60 cases according to 60 expert data taken from the number of assessments a, b, c, and d [4]. You can calculate the Accuracy, Recall, Precision and Error rate values, which are as follows:

Accuracy = $\frac{a+d}{a+b+c+d} = \frac{0+160}{0+0+20w+160} = 0{,}8888$

Recall = $\frac{d}{c+d} = \frac{160}{20+160} = 0{,}8888$

Precision = $\frac{d}{b+d} = \frac{160}{0+180} = 1$

Error Rate = $\frac{b+c}{a+b+c+d} = \frac{0+20}{0+0+0+160} = 0{,}1112$

Information:
- A is if the system result is negative and the expert value is negative,
- B is if the system result is positive while the expert value is negative,
- C is if the system result is negative while the expert value is positive,
- D is if the system result is positive and the expert value is positive.

Accuracy of the Accuracy of Calculation Method Results

Based on Table 11, the accuracy of the accuracy can be calculated using the Confusion Matrix, each accuracy method can be calculated for the accuracy of its value. It is known that expert confidence is a reference for comparison with the results of calculation methods [4].

From the results of confusion matrix calculations carried out in the classification process in the classify module. Shown in the Table 2.

TABLE 2. The calculation results of the confusion matrix

System Results and Accuracy	amount	Accuracy (%)	Recall (%)	Precision (%)	Error Rate
A	-				
B	-				
C	20	88,88	88,88	100	11,12
D	160				

In the Tsukamoto fuzzy method and case based reasoning, the accuracy of varietal accuracy with the number of all cases was 88.88%, the accuracy of positive predictions correctly identified was 88.88%, the accuracy of correct positive results was 100% and the accuracy of the incorrect identification with the number of all cases was 11.12%.

CONCLUSION

Based on the research that has been done, it can be concluded that the Tsukamoto fuzzy method can be used as an option in solving the identification problem of soybean plant varieties, while the case-based reasoning method can be used to determine old cases and new cases that are in the case basis. This system can only choose one feature from each characteristic of the variety so that when choosing more than one for each characteristic of the variety, the system only reads one feature that is input. This system is able to produce identification results of 70.75%, it is identified. The inputted characteristics are new cases that do not exist in the case basis while the calculation of the similarity value in the training data results in 81.73% that the new case is almost similar to the old case, namely the echo variety with a percentage of 81.73%. This system is able to generate accuracy values using confusion matrix with an accuracy of 88.88%, a recal of 88.88%, a precision of 100% and an error rate of 11.12% with 180 data input, 18 data from the characteristics of soybean varieties and 60 data. soybean varieties. Then this identification system is tested with black box testing in order to find out whether there are still errors in the identification system or there is a need for additional features in this website-based identification system. From the test results between the system and the expert's conclusion that of the 180 data tested, there were only 160 data in accordance with the expert's conclusions and 20 test data that did not match the expert's conclusions.

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