Diagnosis System for Disease in Wheat plant using Intelligent Expert System: Design and Implementation

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Abstract

A number of diseases cause considerable damage to wheat. Among these, leaf, stem and root are considered the major constraint. To diagnose these disease from huge economic loss there is need of agricultural specialists to identify the disease and make the necessary measurement but these agricultural specialists are not available when needed by farmers. So this paper deals with the diagnosis of disease in wheat plant using Intelligent Expert System. Artificial Intelligence is defined as ability exhibited by an artificial unit. For the system development data are obtained from different documents and modeled by using decision tree. The proposed system uses Jess (Java Expert System Shell) for diagnosis and treatment of wheat plants. To minimize these problem and to save the time and make decision expert system is very use full.

Key Words:Expert systems, Java Expert System Shell, Jess.

1 INTRODUCTION

In 2050, our planet will have some 9 billion inhabitants (between 8 and 11 billion) according to estimates published by the United Nations in 2001[1].In order to feed such a population properly, without shortages agricultural activity will have to be extended on a long term basis in every region of the world where that is possible. The total demand for foods are growing more slowly, for satisfying the expected food the demand will require the increase of global food production to feed the population of the world which expected to reaches about 9 billion by 2050. Some study shows that there is world agriculture sustains average losses around 16 %(in terms of monetary value) annually as result of plant disease. Artificial Intelligence is defined as a Computer system that act like human being. Many researches have been done in Artificial Intelligence such as diagnosing different disease of human and plants[2]. Expert System is computer program in which we represent the knowledge of specific expert for diagnosis of disease on specific field such as Agriculture and other in order to give treatments. The primary function of expert system is for the incorporation of human knowledge into computer. The proposed system for diagnosis of wheat disease was implemented by rule based Java Expert System Shell and knowledge represented by using IF_THEN representation technique.

2 LITERATURE REVIEW

Expert system are applied in many areas. Agricultural specialists and advisors are very important in modern agriculture for providing information on time that is used for decision making. Unfortunately these experts are not always available.

[3] They discussed different types of expert systems used agriculture with their methodology and different diagrams. Authors pointed out the advantage and disadvantage of expert system as well as comparison of different expert system that have been discussed in paper. At the final the authors agree that expert system was time saving and immediate decision making

[4] They proposed sound based expert system for farmers that sends information to remote users who want experts knowledge from specialist through voice service system. The algorithm which based on sound has the ability to identify disease of cattle.

[5] They develop an expert system for the disease of rice, maize and wheat leaf. They develop system use image of infected leaf that is taken from field and it also use text as input to identify the disease. This system makes farmers for understanding of disease.

[6] They developed an expert system which help the farmers or researchers that work in coffee plantation for diagnosis of coffee plants. The authors used fuzzy expert system and decision tree techniques.

[7] The authors develop expert system that increase yield crop, conserve nature and suggest the amount of pesticide that farmers use for infected crops. The system provides simple approach for better solutions to the users/farmers and recommend crop selections that based on markets and presents reports of soil test, weather conditions as well as audio and visual response for illiterate users.

[8] The authors analyzed the survey on Education, Automobile and Agriculture for duration from 2010 to 2014 in different countries. From this papers they agree that to bring quality production it is important for all to discover an expert in different domains.

[9] The authors develop an expert system that diagnosis disease in rice plants. The expert system developed by these authors composed of knowledge base, user interface and control structure. Rules are designed in the form of *IFTHEN*. To give solutions the inference engine looks the data for current problem from working memory and tries to map with the contents of knowledge base to see which rules to be fired.

[10] The authors developed an Expert System that can intelligently diagnose diseases in plants. They develop an expert

system that is based on question and answering system. The authors takes different characteristics to model disease and the diagnosis based on calculation of utility value of its characteristics. For disease modeling all information about each disease is brought together using the concept of a disease model where a model fundamentally contains all the characteristics of one disease. The model contains characteristics of disease and the decision making process in diagnosis is calculation of weight measure for the characteristics. They use Multi-Criteria Decision Making technique that is a hybrid of Analytic Hierarchy Process and Sensitive Simple Additive Weighting. The author of this paper took different parameters like relative weight, scale are calculated and these calculated values are verified by using different ways, like AHP in order to map the disease of plant to the modeled disease.

[11] They develop expert system that diagnosis wheat disease depend on early detected symptom by automatic image analysis. To develop algorithm that efficiently identify the disease they took 36 different image of wheat and identify three different wheat disease.

3 RESEARCH METHODOLOGY

To conduct the research there are different methods to be followed for the development of expert system such as collecting Information from knowledge experts, modeling of knowledge to develop the system, Representation of knowledge , and Expert system development for wheat disease diagnosis and Evaluation of the system. The knowledge used for the development of Diagnosis System for Disease in Wheat plant using Intelligent Expert System is obtained from related documents, agricultural website and different papers that are published.

After knowledge obtained from the above sources it is modeled by using decision tree and knowledge represent by decision tree is used to develop rules. After modeling the acquired knowledge by using decision tree, it is represented in a format that is both understandable by humans and executable on computers.

Production rules are the most popular form of knowledge representation which is an easy way to understand and reasonably efficient in diagnosing problems. The proposed system for diagnosis of wheat disease was implemented by rule based Java Expert System Shell and knowledge represented by using IFTHEN representation technique.

4 DESIGN AND ARCHITECTURE OF THE PROPOSED SYSTEM

The proposed system composed of a knowledge base, Inference engine and user interface. The inference engine of the proposed system using backward chaining mechanism for reasoning the set of to satisfy the goals.
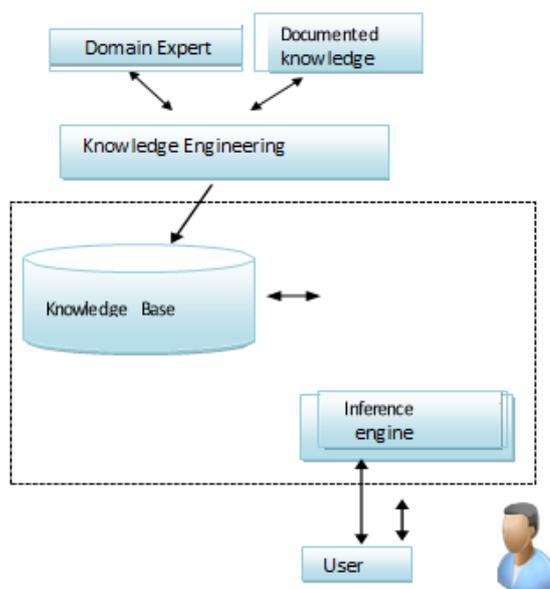

Fig 1. Architecture of Diagnosis System for Disease in Wheat plant

5 IMPLEMENTATION AND RESULTS

The proposed expert system will ask the user to choose the correct option of the displayed ones in each screen through the user interface starting with the most general information and ending with the diagnosis of the disease. After the user select one of disease category then the system display symptoms of selected disease category and user can check or select known symptoms of the disease to identify or diagnose the disease. Based on the users response, the system provides conclusions for the users request through the user interface.

6 SYSTEM TESTING AND EVALUATION

After Diagnosis system for disease in wheat plant using Intelligent Expert System is developed, it is important to evaluate and taste its performance and accuracy to ensure that the developed system fulfill user requirements and applicable in area of wheat crop disease. The proposed system should have to evaluate and taste at the final stage of research/projects to assure the objective of proposed system is correct or not. There are many types of testing but in this project the researcher selects system testing and user acceptance testing to check that the system fits its purpose.

7 USER ACCEPTANCE TESTING

This testing is done to evaluate the performance of Diagnosis system for disease in wheat plant using Intelligent Expert System from domain experts perspective to show how the system skillful in the agricultural area. To evaluate the system there are questionnaires and the result of questionnaires answered by the experts values for all attributes are given as **excellent = 5, very good = 4, good = 3, fair = 2 and poor = 1**. Thus this method is used to evaluate users acceptance based on their response.

$$AS =$$
$$SVx * \frac{NBatSx}{TNB} + SVy * \frac{NBatSx}{TNB} + ... \sum_{k=1}^{n} SVi * \frac{NBatSVi}{TNB} ....(1)$$

Where, AS=Average score,SV=Scale value,NB=Number of respondents,TNB=Total number of respondents S x=Scale x and ,S y=Scale y. To get all user acceptance result it is important to calculate average performance out of 100 which was done by the following formula.

$$AVEP = \frac{AS}{SV} * 100 (2)$$ where AVEP=Average performance

Table 1 List of questionnaire

No	List of Questions	Poor(1)	Fair(2)	Good(3)	Very Good(4)	Excellent(5)	Average Score	Average Performance
1	Does the user Interface simple to use	0	0	0	1	5	4.833	96.67
2	How the system correctly categorize disease	0	0	0	2	4	4.67	93.33
3	Does the system cover domain area	0	0	0	1	5	4.833	96.67
4	The ability of Expert system in making correct conclusion and recommendations	0	0	0	3	3	4.5	90
5	significance of the system in the domain area	0	0	0	0	5	5	100
6	Simplicity to use and interact with the System	0	0	0	1	5	4.833	96.67
						Total Average	4.778	95.56

based on the responses from six system evaluators the average performance got 4.778 on the scale of 5.This value is obtained from the value that is assigned for each scale of open ended questions and the obtained result is about 95.56% of respondents are satisfied by the developed system. From this we it is possible to conclude that the system performs well in making right decision on diagnose and treating disease of wheat.

Performance testing

The primary purpose of performance testing is to determine how well the system was able to act as a human expert and correctly diagnose wheat disease. This means it is important to evaluate the accuracy of developed system. To accomplish this the researcher use confusion matrix to compare the ground truth with the system response against the query asked by agricultural specialist. For this purpose the researcher selects two measures precision and accuracy.

Precision

This measures the system's ability to correctly return 'healthy' when the wheat is healthy or to detect a disease when the plant is diseased or when it predicts yes, how often is it correct?

$$\text{Precision} = \frac{NumberofTruePositive}{NumberofTruePositive + NumberofFalsePositive} \ldots \ldots (1)$$

Accuracy

This measures the system's ability to correctly diagnose the disease when a diseased plant is presented.

$$\text{Accuracy} = \frac{NumberofTruePositive + NumberofTrueNegative}{NumberofTests} \ldots \ldots \ldots (2)$$

To conduct the evaluation 64 tests were performed. Agricultural experts were ask to simulate different scenarios that used for different diagnosis. The precision metric was excellent as the process was able to determine if a plant was diseased or healthy almost perfectly (98%). Generally the correctness of developed system was very good about 98% of accuracy so the system was able to diagnose correctly the given disease.

8 CONCLUSION

Expert system is suitable in several circumstances and t hey can be easily used by users/farmers as an advisory system. It preserves and embraces significant levels of information. To minimize the problem which occur due to lack experts and to save the time and make decision expert system is very use full. There are many functions of expert system in agriculture such as increasing production and minimizing yield loss.

References

[1] M. Mazoyer and L. Roudart, A History of World Agriculture: From the Neolithic Age to the Current Crisis. NYU Press, 2006.

[2] E. Roventa and G. Rosu, "The diagnosis of some kidney diseases in a small prolog Expert System," in 2009 3rd

International Workshop on Soft Computing Applications, 2009, pp. 219224.

[3] P. M. N. Rani, T. Rajesh, and R. Saravanan, "Expert Systems in Agriculture: A Review," Int J Sci Technol Eng, vol. 3, pp. 5971, 2011.

[4] W. Li-shu, Y. Guang-lin, L. Zai-hua, and Z. Chang-li, "Scissors Branch Algorithms Application in Platform of Milk Cow Disease Diagnose Expert System Pronunciation," in Computer Science and Information Engineering, 2009 WRI World Congress on, 2009, vol. 4, pp. 680682.

[5] R. Kaura, S. Dina, and P. P. S. Pannub, "Expert System to Detect and Diagnose the Leaf Diseases of Cereals," Int J Curr. Eng. Technol., vol. 3, no. 4, 2013.

[6] W. A. Derwin Suhartono, M. Lestari, and M. Yasin, "Expert system in detecting coffee plant diseases," 2013.

[7] B. Maurya, M. R. Beg, and S. Mukherjee, "Expert system design and architecture for farming sector,"in Information & Communication Technologies (ICT), 2013 IEEE Conference on, 2013, pp. 1015.

[8] H. K. Jabbar and R. Z. Khan, "Survey on development of expert system in the areas of Medical, Education, Automobile and Agriculture," in Computing for Sustainable Global Development (INDIACom), 2015 2nd International Conference on, 2015, pp. 776780.

[9] H. Kalita, S. K. Sarma, and R. D. Choudhury, "Expert system for diagnosis of diseases of rice plants: Prototype design and implementation," in Automatic Control and Dynamic Optimization Techniques (ICACDOT), International Conference on, 2016, pp. 723 730.

[10] W. Goodridge, M. Bernard, R. Jordan, and R. Rampersad, "Intelligent diagnosis of diseases in plants using a hybrid Multi-Criteria decision making technique," Comput. Electron. Agric., vol. 133, pp. 8087, 2017.

[11] A. Johannes et al., Automatic plant disease diagnosis using mobile capture devices, applied on a wheat use case, Comput. Electron. Agric., vol. 138, pp. 200209, 2017.