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FIELD STUDY BASED ON SOFT COMPUTING TECHNIQUES

[1]KARTHIGA. N, [2]B. SANTHI

[1]PG Scholar, School of Computing, SASTRA UNIVERSITY, THANJAVUR, TAMIL NADU

[2]Prof., School of Computing, SASTRA UNIVERSITY, THANJAVUR, TAMIL NADU

E-mail: [1]karthiganesamani@gmail.com, [2]shanthi@cse.sastra.edu

ABSTRACT

Usage of soft computing techniques in field study saves human labor. Field study plays a vital role in the economic importance of agriculture which in turn results in poverty reduction. Farmers guess the solutions to the disease based on the loss of plant life that occurred previously. Technology is used to support farmers and botanist which give precise solution for the vague input information. The human labor used in the existing system is replaced with technology in the proposed system which reduces the time complexity, increases the performance and overcomes the lack of satisfaction. Decision Support System is the computer-based expert information system to predict the output response of field with respect to the input parameters. Fuzzy Control application is programmed in Fuzzy Control Logic (FCL). In fuzzification the value of the input variables are converted into degrees of membership for the membership functions defined on that variable. Fuzzy set is any set that allows its members to have different grades of membership in the interval [0, 1]. Smartness of the fuzzy depends on the rule evaluation. The performance of the fuzzy machine is restricted by the capability of human brain. DSS based fuzzy system provides interactive, flexible and quick decision making. Use of latest technology provides profitable performance to the farmers. The limitations in existing system are overcome by using relational database which is used as database in field study through which large queries can be handled easily. Fuzzy logic is a powerful concept of handling non-linear, time-varying, adaptive systems. The knowledge-driven DSS is created for crop management in proposed system.

Keywords: *Soft Computing techniques, Decision Support System (DSS), Fuzzy Logic (FL)*

1. INTRODUCTION

Soft computing techniques are interactive techniques to conventional, mathematical and analytical methods. The decisions are made similar to the way human brain thinks. The problems such as NP-complete problems are solved.

Zadeh in 1965 introduced Fuzzy Sets which describes the complex system without the requirement for precision in input parameters. Many expert systems use fuzzy logic to capture and integrate the data using IF-THEN rules.

Decision Support System is the computerized system for making decisions. The Decisions are made with the non-clear input parameters which are very much useful in making decision in real time environment where the input is always a range of vague values. Fuzzy Logic is used in the decision support system for interactive decision making.

Relational database management system which is introduced by E. F. Codd is the most popular database where large number of data can be stored and large number of queries can be processed. This adds the additional condition that the system supports a tabular structure for the data, with the enforced relationships between the tables. RDBMS define the integrity constraint for the purpose of holding ACID property. Also the security of the data is maintained in this system. This study is essential for preventing the loss of plant life and wastage of human resource. Section 2 deals with the literature review of the papers regarding the idea of Decision Support System in agriculture with fuzzy logic. Section 3 proposes an artificial intelligence algorithm. Section 4 evaluates performance and efficiency of the proposed system. Section 5 explains the future work of the system.

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2. RELATED WORK

Human resource is used in larger amount. Interactive communication is involved with the labor. Co-ordinator acts as intermediate communicator between the farmers and the experts [1]. Recent Technologies which are much more feasible and interactive have not been used.

Time complexity is very high. Human labor is used for transporting information to the system and for explaining farmer about the expert's advice. It's not cost effective because the information is sent through internet or parcel service [1]. Communication of the system is complex. Privacy and security is not being maintained also the system is not satisfactory to the farmer because selection of the experts is not according to the farmer's choice. The system is accessed by only experts not by farmers so the system communication is only one way. The system is neither feasible nor interactive.

Dan Simon explained about how fuzzy logic imitates the logic of human thought [3], which is much less rigid than the calculations computer generally perform.

D. J. Power Editor gave a neat description regarding the origin of DSS, Theory development and DSS Application Development [2].

Nam Nguyen, Malcolm Wegener, Iean Russell reported the use of Decision Support System [9] in agriculture is a state of art and the disadvantages of DSS in being adopted by farmers.

Manpreet Singh, Parvider Singh and Sumitter Bir Singh gave an idea of creating computerized Decision Support System for Farm Management [5]. A model of integrated system is explained.

Prof. Mrs. J. R. Prasad, Prof. R. S. Prasad, Dr. U. V. Kulkarni discussed the various types of DSS and the usage of linguistic variables and values in Decision Support System [11].

Caroline Parker [7] describes how to increase the feasibility of DSS by making it user-centered.

3. SYSTEM MODEL

The system contains the Decision Support System (DSS) based on Artificial Intelligence (AI) algorithms, which tell the plant's disease based on the information collected from the plant. Relational database is maintained in the server side where large numbers of dynamic data are stored through self observation. The telemedicine with current DSS algorithm using fuzzy logic is used for caring plants. Fuzzy Logic used here provides robustness, ease of control, simplicity and completeness of relevant detail. Fuzzy logic imitates the logic of human thought [4]. The output parameters for the range of input parameters are determined. Fuzzy does not require precise input, range of values are enough which are called as fuzzy quantities. Fuzzy membership functions quantify the degree to which some variables belong to some classes.

The system is represented in 3-tier architecture, which contains client, application and the data layers. Three–tier is a client-server architecture in which the user interface, functional process logic, data storage and data access are developed. Client Tier contains the user of the system. The system consists of two clients, farmer and expert; both clients can access the application in a varying manner. Application Tier contains the web server, which contains the DSS for accessing the information and finding the corresponding disease and its stage. Data Tier contains the databases regarding disease details, expert's information and advice given by experts. Online supervision system is maintained for supporting dynamic data.

Fuzzy control system is a control system based on fuzzy logic which is a mathematical system that analyses analog input values in terms of logical variables that take on continuous values between 0 and 1. The input variables in a fuzzy control system are mapped to the sets of membership function called "Fuzzy Sets". Fuzzy controllers consist of three stages. They are: input stage, processing stage and output stage. The common shape of fuzzy membership function is triangle. Basic tools of this logic are linguistic variables.

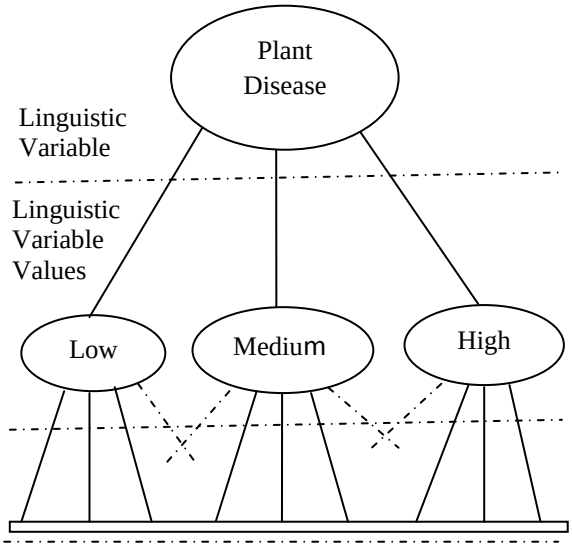

Figure 1. Linguistic variable and its values

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Fuzzy logic provides an alternative way to represent linguistic and subjective attributes of the real word in computing. Fuzzy is designed using set of rules which are based on IF-THEN rules. Those rules are applied with linguistic variables.

Algorithm: DSS Using Fuzzy Logic
Input: Symptoms, Water Resources, Climatic Conditions, Soil Conditions

Output: Decision regarding disease and its stage

Step 1: Select the plant and get the symptoms from database maintained in the server.

Step 2: Input and Output parameters are defined in FUNCTION_BLOCK. Input parameters are mapped to fuzzy membership functions which are linguistic variables.

VAR INPUT

S1: REAL

S2: REAL

END VAR

VAR OUTPUT

result: REAL

END VAR

Step 3: IF-THEN rules are applied to the linguistic variables for decision making of which disease the plant is affected with and the stage of the disease.

IF {S1 IS LOW AND S2 IS LOW} THEN {result IS LOW}

IF {S1 IS HIGH AND S2 IS HIGH} THEN {result IS HIGH}

IF {S1 IS LOW AND S2 IS MEDIUM} THEN {result IS LOW}

Step 4:The output result is mapped for the corresponding input parameter using Fuzzy Inference System.

Step 5: If the value is inbetween 0 and 4, the name of the disease by which the plant is affected with along with its stage as "LOW" are displayed as result.

Thus the decisions (output) for the corresponding plants are labeled by accepting the non-precise input parameter.

3.1 Fuzzification

Fuzzy Logic is a problem-solving methodology. The linguistic variables are assigned a range of values which are called as linguistic values for the variables. The fuzzification is done using fuzzy sets. Based on these IF-THEN rules fuzzy system acts and gives solution like a human brain which takes decision based on assumptions rather than precise values.

The fuzzy system analyses the data and finds the disease information and stage of the disease. The solutions to the diseases are stored in the database maintained in the server side which is viewed by the farmers. Also advice is given to farmers about the implications if the advice not taken seriously.

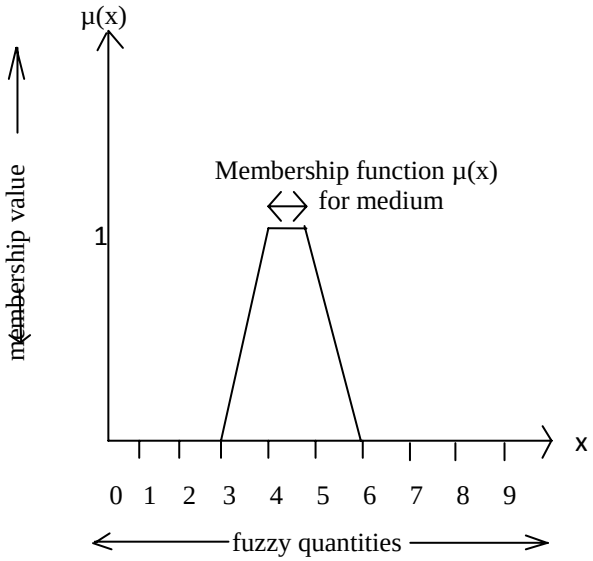

Figure.2. Fuzzy Range set for linguistic variable Medium

Thus the Fuzzy logic is used in the decision support system of artificial intelligence to make decisions such as these decisions are used in the field studies which are interactive and very feasible to the farmers.

3.2 Decision Support System

Decision Support system is an interactive system which is used to take decisions from the raw data collected. There is no universal taxonomy of DSS. Data processing is done through data input and query. The disadvantages of DSS [9] among farmers are: fear of using computers, time constraints, poor marketing, lack of local relevance, lack of end-user involvement, mismatched object between developer and user. The main problem of DSS is that it's created by developers in such a way that it's feasible for developers not for farmers.

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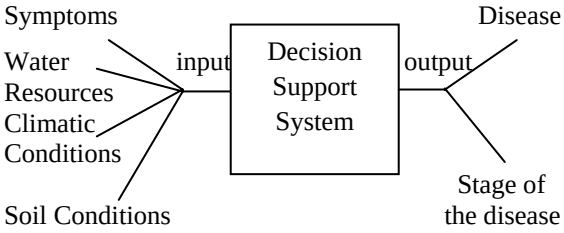
DSS should be designed in such a way that it should be widely [7] accepted by farmers. The newly developed DSS is feasible to farmers. The input parameters are the information given by farmers so the decision support system will operate in the way similar to the thinking of human mind so that it's simple and user friendly.

Decision making is processed using fuzzy rule. The attributes considered for taking decision are symptoms submitted by farmer, soil conditions, climatic conditions and water resources. By using fuzzy rule, the above parameters are analyzed and decision is made regarding the disease and stage of the disease. The main advantage is that the input attributes are submitted by farmers so DSS is not developed only in developer's point of view. The output of the data is mentioned in various ways like graph, table or map. The decision made is used by the botanist to give advice to the farmers; this reduces the time complexity for the botanist. DSS is created in simple way as the farmers don't have the knowledge about computers. Its location specific, relevant, user friendly, integrated, cost effective and adoptable by farmers.

Table 1. Structure Of DSS



DSS can be in many different forms. Decision is made based on comparison of the attributes. DSS is the combination of integrated sources working together, decision is made from wide range of data. In Agriculture, the attributes are collected from farmers which are used for taking decision, the output of the Decision Support System are in linguistic variables which are easily understandable by farmers.

DSS designed are user centred. Grouping the decision involves one of three main types: state(questions concerning the state of a system), action (given that case then what should be done) and projection (what will happen if I do this?). The User-Centred DSS is adoptable to farmers and reduces the time complexity.

3.3 Types Of DSS

Types of Decision Support System [11] are as follows

Model Driven DSS – access to and vary the numerical, economical, optimization or imitation model. Model-driven DSS access the input parameters submitted by users in examining the circumstances. They are not essentially information-intensive.

Communication-Driven DSS - supports many people working on a common chore; example: integrated tools like Microsoft's NetMeeting or Groove

D**ata-Driven DSS (**data-oriented DSS) - access to and manipulation of a dynamic data set.

Document-Driven DSS – manages and alters the informal data in several electronic formats.

Knowledge-Driven DSS - specialized problem solving expertness which are stored as data, set of laws, actions, or in analogous structures.

This paper focuses on development of knowledge-driven DSS for crop management.

4. EVALUATION

System designed above is open, flexible and extensible. Also the use of RDBMS makes the system secure. Also it's highly reliable and scalable to support the deployment in large plant care environment. It's optimized for computing resources such that the application runs in inexpensive, low profile computing devices.

Highly interactive system. The communication of the system is simple. As the fuzzy logic helps DSS to make decision which finds the disease based on the symptoms submitted by the farmer. The experts refer to the decision made by DSS while giving advice to the farmers which saves time in larger amount so that the time complexity is maintained.

Use of technologies and algorithm increases the overall system performance and efficiency. The Function Block Types defined in Fuzzy Control Logic specify the input and output parameters and the Fuzzy Control specific rules and declarations. FCL language is used to find the diseases and the stage of diseases by which the crop is affected with using fuzzy logic. For running this FCL code in java , java library called JFuzzy is used.

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Table 2. Sample Data Set

Symptoms	Water Resources	Soil Conditions	Climatic Conditions
Mark on leaves	Heavy Rainfall	Moisture	Sunny and Hot
Spots on fruits	Watered regularly	Heavy and poorly drained soils	Cloudy and Cooler

Based on the stage which is found using fuzzy logic the corresponding fuzzy range values are stored in the relative database which is protective and secure. Using this fuzzy range values the equivalent linguistic variables gives the result of the disease and its stage. These results are analyzed by the experts for giving advice to the farmers. Due to this DSS the experts need not come to the farm for disease and its stage analysis which reduces the communication complexity of the system and feasibility of the system is increased in greater amount.

Also the charts can be drawn for clear representation of the disease and its stage to the experts. The bar and pie charts are drawn using the values stored in RDBMS. The input values are given in linguistic variables which are converted into fuzzy values and gets stored in the relative database. The results and charts are produced by taking the fuzzy values and converting it into linguistic variables using Fuzzy Logic. The final disease results and charts are in linguistic variables which are understandable.

5. CONCLUSION

The Decision Support System used here is simple and robust. Fuzzy Logic used in DSS is used to produce output with blurred input parameters. Fuzzy Logic depends upon only context not precise information. The performance of the system is increased by increasing the feasibility, scalability and efficiency and by reducing the time complexity of the system. This paper only designs the fuzzy model; in future it can be validated through real time data. Limitations of existing work are wastage of human labor, increased time complexity, no feasibility, no user satisfaction, absence of secure database and technologies are not being used.

Reviewing the existing work reveals the limitations thereby future enhanced model maybe generated and implemented. Future work involves Image Analysis System which is developed to assist the experts. The system takes apart the infected regions from the image. The image is being stored in the relational database. System takes the image from database and does morphological operations or segregating the infected part which is processed using fuzzy logic to find the disease and the stage of the disease. Proposed algorithm is implemented using sample data and the result is chosen by means of fuzzy language set which is obtained by processing those sample data. Comparing it with other existing technology gives clear help line chart to farmers. Thus this study provides guidelines for farmer to improve their profit and enhance their methodology.

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