A Seminar Report On

AgPest: An Efficient Rule-Based Expert System to Prevent Pest Diseases of Rice and Wheat Crops

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CERTIFICATE

This is to certify that the seminar work entitled **"AgPest: An Efficient Rule-Based Expert System to Prevent Pest Diseases of Rice and Wheat Crops "** is a bonafide work carried out by RISHABH RASTOGI [1DS12CS076] in a partial fulfilment for the 8^{th} semester of Bachelor of Engineering in Computer Science and Engineering of the Visvesvaraya Technological University, Belgaum during the year 2015-16. The seminar report has been approved as it satisfies the academic requirements in respect of Seminar Work prescribed for Bachelor of Engineering Degree.

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Abstract

Agriculture is a major source of income in India. Pests result in the degradation of quality and quantity of the major crops such as Rice and Wheat. This is due to the lack of knowledge about technical and scientific methods to prevent pest diseases. The architectural framework of an agriculture Expert System, the design and development of the rule based expert system for rice and wheat crop pest management is described. The designed system is intended for the diagnosis of diseases caused by pests in the rice and wheat plants. It also facilitates decision support module with interactive console base user interface for diagnosis on the basis of user response, made against the queries related to particular disease symptoms. The Explanation block of the system provides explanation for a particular decision taken by the system. It gives the clear view of logic followed by kernel of the expert system.

Contents

1. Introduction

An expert/knowledge-based system is a computer program that is designed to mimic the decision-making ability of a decision-maker(s) (i.e., expert(s)) in a particular narrow domain of expertise [1].The primary intent of expert system technology is to realize the integration of human expertise into computer processes.

1.1. Structure of Expert Systems

An expert system was used to denote a system whose knowledge base and Student Author reasoning mechanisms were based on those of a human expert. A system will be called an expert system based on its form alone and independent of its source of knowledge or reasoning capabilities. The major components which form expert system kernel are

- Knowledge Base
- Inference Engine
- Explanation Engine
- User Interface

1.2. Agriculture Expert system

Pest disease control is an area where farmers need expertise from the researchers and specialists of that field. There are various pests which destroy the crops at various stages of their growth. One of the main reasons for this is the lack of knowledge about the advanced fertilizers and pest management information. The modern farmer relies on agricultural specialists and advisers to provide information for decision making to achieve good results. But agricultural specialist assistance is not always available when the farmer needs it. To overcome this problem, expert systems were identified as a powerful tool with extensive potential in agriculture [2].

2. Literature Survey

1. ***"Amarapalika: An expert system for diagnosis of pests, diseases, disorders in Indian mango"***, Rajkishore Prasad, A.K. Sinha, Kumar Rajeev Ranjan, Knowledge Based Systems, 19(1):921, 2006 .

   The expert system is developed using Expert System Shell for Text Animation (ESTA), for the diagnosis of diseases occurring in Indian mango. The objective is to provide computer-based support for agricultural specialists or farmers. The knowledge base of the system contains knowledge about symptoms and remedies of 14 diseases of Indian mango tree appearing during fruiting and non-fruiting seasons. The picture base of the system contains pictures related to disease symptoms and are displayed along with the query of the system. The result given by the system has been found to be sound and consistent.

2. ***"Decision support system crop-9-dss"***, Ganesan V., Proceedings of the World Academy of Science Engineering and Technology, ISSN 1307-6884 PWASET, March,2006

   An expert system developed with Macromedia Flash MX Professional 2004 6.0 [7]. The system is developed for the purpose of the identification of diseases and pests with control measures, fertilizer recommendation system, water management system and identification of farm implements for leading crops of Kerala. It is composed of a knowledge base (information, heuristics, etc.), inference engine (analyzes knowledge base), and end user interface (accepting inputs, generating outputs). It incorporates all modern features like, graphics, photos, video clippings etc. It will act as an expert system to agricultural officers, scientists in the field of agriculture and extension workers for decision-making and help them in suggesting suitable recommendations.

3. ***"Web-based expert system for diagnosis of micro nutrients deficiencies in crops."***, S.S.Patil, B.V.Dhandra, U.B.Angadi, A.G.Shankar, Neena Joshi, Proceedings of the World Academy of Science, Engineering and Computer Science, Vol 1 WCECS, October 2009.

   The crop yield losses are estimated to an extent of 10-20 percent with or without-visual symptoms (Hidden hunger). Of the several nutrients, P, Fe, Zn, B and Mg are reported to be in short supply for plant growth and productivity globally. Especially the low level of Fe and Zn has a bearing on human nutrition also. This system aims to provide a guide to identify deficiency of nutrients in crops, i.e., disorders in leaves, stems and roots of a plant. To avoid diseases caused by deficiency, and to solve the problems, the expert system is developed using virtual diagnosis framework. Mineral Information System is a knowledge based information system, which gives detailed information on characteristics of minerals, availability in soil, role and deficiency symptoms in plant growth, prevention and management to correct the nutrition deficiency, and sources and cost of minerals.

3. Design Analysis

AgPest uses forward chaining mechanism. Symptoms are considered as conditions. If a particular condition is satisfied then the successive conditions related to that particular disease are checked. The same procedure is followed till sn symptoms are satisfied. Let s1,s2.....,sn are symptoms related to the disease d1. The rule base is then formulated as If (s1) Then (s2) Else (No Match)

3.1. Rules formulation for Rice pest-diseases

AgPest takes users response as an input for the questions related to symptoms of a particular disease. It executes the rules related to the given responses and finally displays the decision about particular disease. Color division module provides plant pest visuals. These visuals helps user to identify the color of the diseased plant.

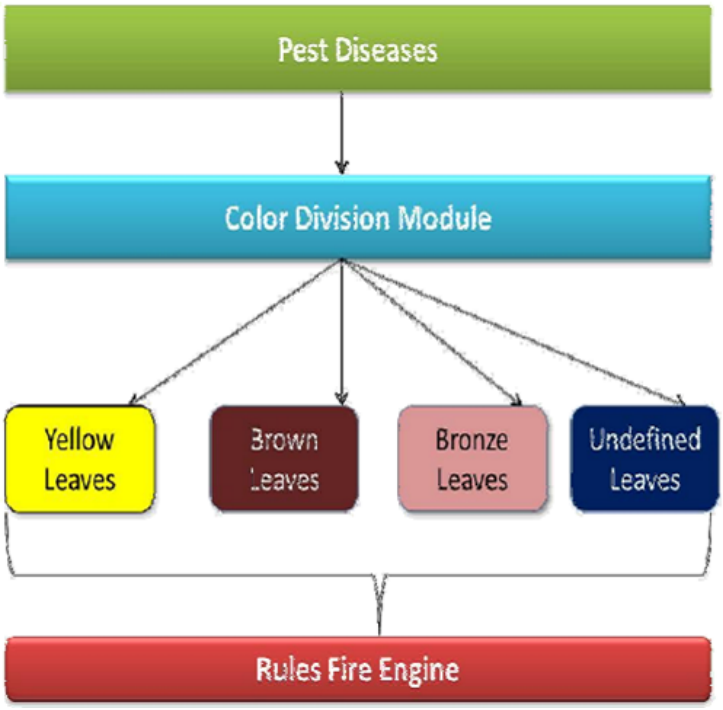

Figure 1: Rice Pest Disease knowledge base classification

Pest diseases are divided according to leaf color. Once the leaf color is known, the rules related to it will be executed and gives disease name and advice.

3.2. Rules formulation for Wheat pest-diseases

The rules are formulated using same techniques as rice model, but most of the rules are fired sequentially. The symptoms related to the Wheat pest diseases are different from rice pest disease symptoms, so expert system evaluates the rules sequentially till it arrives to conclusion.

4. Implementation

The development of AgPest involves following processes

- Knowledge Acquisition
- Knowledge Representation
- Implementation in CLIPS 6.0

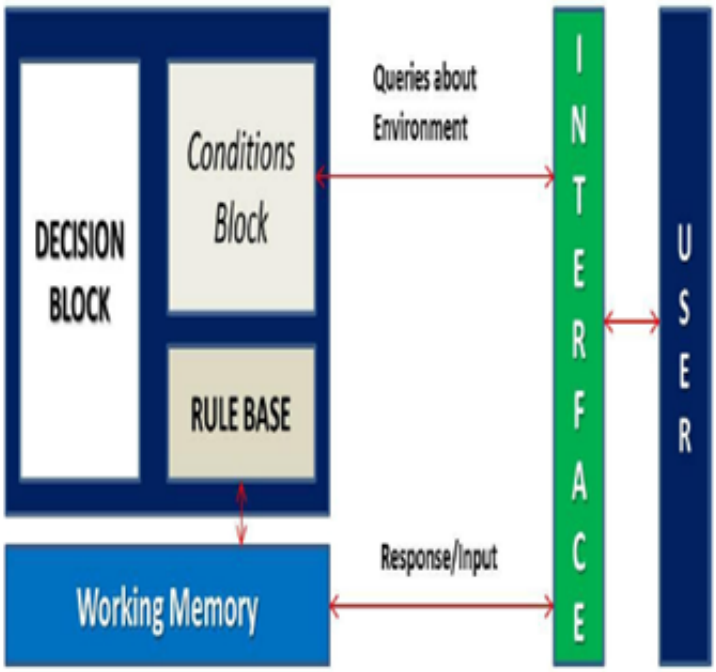

Figure 2: Sequential flow of Execution Wheat Model

In the above figure first wheat module executes the common rule whose RHS field is empty. This is the starting point for execution in this module. Facts will be assigned during runtime and those facts will be stored in working memory, using these facts different rules get fired and decision is displayed through the standard output.

Explanation block contains set of Cause [ ] Effect [ ] Decision [ ] type statements.These statements give user clear picture about the decision procedure followed by AgPest during runtime. These statements are displayed sequentially

In AgPest explanation block is implemented using CLIPS 6.0 File system constructs. In CLIPS rules are declared using defrule construct, facts are declared using assert construct. CLIPS provide a library construct called salience. This constructs sets the priority level for different rules during execution. In CLIPS values assigned to the variables using construct called bind.

5. Experimental Setup

The serial code was run on Intel(R) Pentium(R) Dual core 2.20 GHz processor with 4GB RAM on Ubuntu 10.04 LTS and Windows 7. The domain knowledge information is gathered from Agroweb, a publicly available repository for Pest management information.

5.1. Testing and Verification

There are two different types of testing and verification procedures for the expert systems. The first type of verification criteria is focused on the global relationships between the rule clusters (sets of conditions which satisfy common conclusions) such as reachability and dead-end IFs. The second type of verification criteria is concerned with the local properties of a specific rule cluster such as missing rules and inconsistent rules.

5.2. Local Verification Criteria

Verification of missing and inconsistent rules is done. Also exhaustive testing is performed due to smaller size. All values must be consistent with the domain. Input and data type are tested for correctness.

- fire(no).dat is a temporary file used for communication among rules.
- xpl(no).dat stores the user input for a query.
- var(no) is a variable to assert Fact-(rule ?var(no)).

LHS field of rule is empty, RHS field consists of file constructs. Main attributes to fire a rule are Initial Facts and Salience Priority. Also s(rN) denotes Salience of rule N.

5.3. Global Verification Criteria

Tested through

- Attribute Dictionary which contains the definitions and sources for each condition and conclusion.
- Rules Dictionary which contains conditions and conclusions used in rules, information about state and location of the AgPest.

Instantiation Criteria comprises of outputs created for all possible conditions. Domain Constraints are file constructs used to store temporary values generated due to rules fired.

6. Results

AgPest is tested for all the possible test cases. It is found that the decision making capability of the AgPest is correct for all possible valid inputs. The response time for an interactive session is good, these results shown in the Tables for rice and wheat modules of the AgPest. These two tables represent complete statistics of AgPest. These tables are mainly focused on the performance in terms of speed of execution. These tables contain total time taken to process a decision, mean value of the rules fired per session, number of facts used during an interactive session. These tables also show number of rules fired per second for each disease during its interaction with the user.

Table 1: Rice Pest Management Module

Disease	Runtime	Rules Fired	Rules per second	Mean no of facts
Bacterial leaf blight	0.0159	4	250.0	12
Foot Rot	0.0160	4	249.9	11
Yellow dwarf	0.0470	5	106.38	15
Blast Pyricularia Oryzae	0.014	4	266.6	12
Brown spot	0.047	8	170.21	24
Narrow brown spot	0.046	7	148.93	21
Grassy stunt	0.0310	3	96.774	9
Bunt kernel smut	0.031	5	161.29	15
False smut	0.030	7	225.80	21

Table 2: Wheat Pest Management Module

Disease	Runtime	Rules Fired	Rules per second	Mean no of facts
Black Point	0.016	4	249.0	11
Foot Rot	0.0310	7	225.86	20
Kamal Bunt	0.0469	7	148.93	20
Leaf Blight	0.0469	8	170.21	25
Leaf Rust	0.0619	11	177.41	32
Stem Rust	0.0469	9	191.48	26

7. Conclusions and Future Work

The main focus is on design and implementation of pest disease diagnosis expert system, AgPest. It is observed that after conducting many tests and real time usage simulation environment, advice or decision given by the AgPest is consistent, accurate and complete. This expert system not only gives accurate results but has a quick response time. Explanation block is implemented for each module independently. It is very useful in real time to get better understanding about a particular decision taken by the AgPest.

The logic used to develop Explanation block for AgPest can be used for any other rule-based expert system developed using CLIPS. AgPest can be used as a basic prototype to build expert systems for pest management. It is possible to build a distributed AgPest, where different crops pest management information can be maintained by isolated servers located at different locations in the world. During the computation time according to the location of a particular crop those servers located in that area can be queried. AgPest can be parallelized using for quick response time.

8. References

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