

An Expert System for diagnosis of diseases in Rice Plant

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Abstract

This paper presents an architectural framework of an Expert System in the area of agriculture and describes the design and development of the rule based expert system, using the shell ESTA (Expert System for Text Animation). The designed system is intended for the diagnosis of common diseases occurring in the rice plant. An Expert System is a computer program normally composed of a knowledge base, inference engine and user-interface. The proposed expert system facilitates different components including decision support module with interactive user interfaces for diagnosis on the basis of response(s) of the user made against the queries related to particular disease symptoms. ESTA programming is based on logic programming approach. The system integrates a structured knowledge base that contains knowledge about symptoms and remedies of diseases in the rice plant appearing during their life span. An image database is also integrated with the system for making the decision support more interactive. The pictures related to disease symptoms are stored in the picture database and the intelligent system module prompts these with the interface based on rule based decision making algorithms. The system has been tested with domain dataset, and results given by the system have been validated with domain experts.

Keywords: Expert System, ESTA, Agriculture, Rice disease, Knowledge Base, IS Experts.

1. INTRODUCTION

In any agricultural production system, accumulation and integration of related knowledge and information from many diverse sources play important role. Agriculture specialists and raw experiences are the common sources to provide information that the different stakeholders require for decision making to improve agricultural production. Agricultural specialists' assistance

is not always available when the need arises for their help. In recent years, tools, technologies and applications of information technologies have emerged as efficient and effective measures for upgradation of the whole agricultural fields, ranging from scientific studies to farmers help. Integration of expert system as a powerful tool for the stakeholders of agricultural production has extensive potential.

The main concern of the present study is in the design and development of such an expert system. The system background starts with the collection of disease symptoms of the rice plant appearing during their life span from agriculture experts, plant pathologists and literature and then the acquired knowledge is represented to develop expert system in prolog based expert system shell ESTA.

2. EXPERT SYSTEM IN AGRICULTURE

The applications of expert system are rapidly increasing. Such applications are very affective in situations when the domain expert is not readily available. In agriculture, applications of expert system are mainly found in the area of diseases diagnosis and pest controls. Many domain specific expert systems are being used at different levels. "AMRAPALIKA: An expert system for the diagnosis of pests, diseases and disorders in Indian mango" is an application of expert system in the agriculture domain developed by Rajkishore Prasad, K.R.Ranjan and A.K.Sinha[1]. In this system, the expert system is developed with rule-based expert system, using ESTA. Another expert system "Dr. Wheat: A Web-based Expert System for Diagnosis of Diseases and Pests in Pakistani Wheat," is also an expert system developed by F.S.Khan, S.Razzaq, K.Irfan, F.Maqbool, etc.[2]. The system is for the purpose of pest and disease control of Pakistani wheat. They had developed the system with web-based expert system using e2gLite shell. "Expert Systems Applications: Agriculture", is also the application of expert system in the agriculture domain developed by Ahmed Rafea[3]. "Decision Support System "Crop-9-DSS" for Identified Crops", by Ganesan V. is an expert system developed with Macromedia flash MX Professional 2004 6.0[4]. 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 ok Kerela. "Web based Expert System for Diagnosis of Micro Nutrients Deficiencies in Crops", by S.S.Patil, B.V.Dhandra, U.B.Angadi, A.G.Shankar, and Neena Joshi also describes application of expert system in agriculture particularly in the area of nutrient deficiencies in crops[5]. The system is a web based system using the ServCLIPS tool.

3. DESIGN AND DEVELOPMENT OF EXPERT SYSTEM

The idea behind creating an expert system is that it can enable many people to benefit from the knowledge of one person – the expert. Expert system simulates the judgment and behavior of a human that has expert knowledge and experience in a particular field. In the design and development of this expert system, we are using the shell ESTA. ESTA has the explanation facilities of the questions in the knowledge base and for the given advice. ESTA contains the rules represented in its own syntax for its knowledge base. It consists of the inbuilt facilities to write the rules that build the knowledge base.

In an expert system development, knowledge base development is the most important part. The quality of an expert system depends on its knowledge base. Knowledge Base development with the help of domain specific expert in this expert system is developed with ESTA. The process of developing expert system using ESTA is a multi-step process which aims at developing a domain specific knowledge base. The steps for developing knowledge base in this system are identification of the input problem, knowledge acquisition and representation of knowledge into the knowledge base. We present here a comprehensive description of each of them.

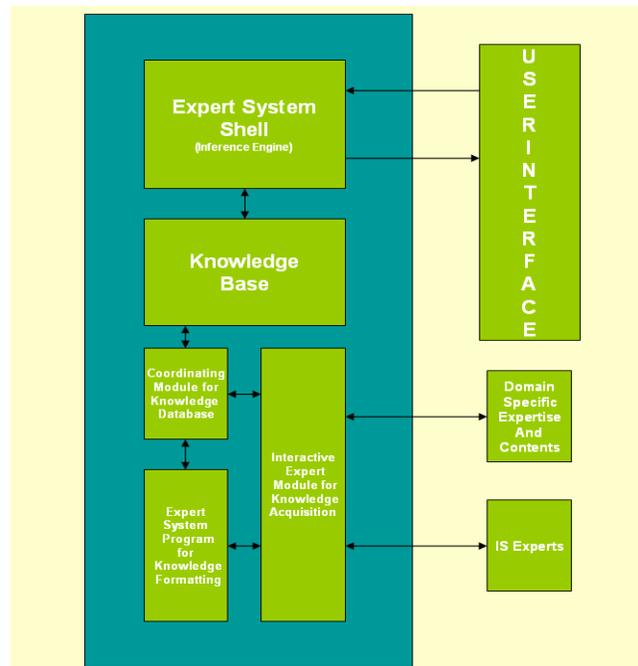


FIGURE 1: Expert System Architecture

3.1 Identification of the Input Problem

To develop an expert system, first we need to identify the problem and understand the major characteristics of the problem that we have to solve in the expert system. The input problem for our system is regarding the diagnosis of diseases in the rice plant occurring during their life span. The input problem is structured for the system and the expert module recognizes as a pattern and forwards for processing for providing diagnoses and remedies if there is.

3.2 Knowledge Acquisition

Acquisition process in this expert system has the following modules-Interactive Expert Module, Expert System Program and Coordinating Module for knowledge database. In the Interactive Expert module, the domain specific expertise knowledge is acquired from human experts. The acquired knowledge is analyzed and then processed to obtain a best conclusion for the problem. The knowledge is then transferred to the IS Experts to verify for converting into expert system program. The process is continued until the best conclusion for the problem is obtained. Once the knowledge acquired from domain expert or domain resources is verified by the IS Experts, then it is transferred from Interactive Expert module to the expert system program module for converting into expert system program. For our system, expert knowledge has been acquired from standard literatures related to the rice plants. "Illustrated guide to integrated pest management in rice in tropical Asia", International Rice Research Institute by W. H. Reissig, E. A. Heinrichs, J. A. Litsinger, K. Moody, L. Fiedler, T. W. Mew, and A.T. Barrion is a literature on rice plant used to get expertise knowledge about rice diseases in the development of the system[6]. In this book, most of the common problems related to the rice plant are described. "Diagnosis of common diseases of rice", by Francisco Elazegui and Zahirul Islam is also used to acquire knowledge about rice diseases in this expert system development[7]. The common diseases of rice plant are found in this book. The processed knowledge in the Interactive module is transferred to the Expert System Program module and then converted into expert system program for formatting and representing the knowledge into the knowledge base. Thus, our Knowledge acquisition process has been carried out through a series of interacting sub modules integrated with the coordinating module for creating the knowledge database until the best conclusion is obtained.

3.3 Representation of Knowledge

Knowledge representation is the last phase of the knowledge base development. In the representation of knowledge into knowledge base, the knowledge acquired from knowledge acquisition process is represented into structured form. There are many approaches for representing knowledge into the knowledge base. Such representation in ESTA is the rule-based representation in logical paradigm of simple *if-then* rules in backward or forward chaining. We have chosen here the backward chaining for knowledge representation with simple *if-do* pair in place of *if-then* rules. Here we have considered two major knowledge representations namely Sections and Parameters. The top level of representation of knowledge in ESTA is section. It contains the logical rules that direct the expert system how to solve problem, actions to perform such as giving advice, going to other sections, calling to routines etc. The first section in ESTA is always named as *start* section. The advice is given when condition(s) in the section is(are) fulfilled. Parameters are used as variable and it determines the flow of control among the sections in the Knowledge Base. A parameter can be one of the four types: Boolean or logical, Text, Number and Category parameters. These parameters serve different purposes. Boolean or logical parameter is used when the answer to asked question is either Yes, No, or Unknown. Text parameters are used for text object such as a person's height or favorite film, etc. Number parameter is used for numerical values. Category parameters are used when variable takes more than one of a predefined set of values. The value for any of the parameter is calculated from end-user's response to a question, through other parameters or as a result of application of rules. Any parameter consists of declaration of field, type field and number of optional field such as explanation field, rules field, picture field, question field etc.

The representation of the rules in the main section *start* is shown in figure 2. We have developed this section to perform transferring controls in accordance with the user's response. Each section contains classification rules placed in first come first served order. In figure 3, all the fields of a category parameter *disease_factor* are shown. The fields in this category parameter *disease_factor* are defined as options which are the causing agents of diseases.

```

1:1      Insert      Indent
section start : 'the main section'

if (disease_factor = 'fungi_factor') do fungi_fact
if (disease_factor = 'bacteria_factor') do bacteri
if (disease_factor = 'virus_factor') do virus_fact
if (disease_factor = 'nematode_factor') do nematod
    
```

FIGURE 2: Screen shot of the main section *start*

```

1:1      Insert      Indent
parameter disease_factor : 'the rice disease factor'
type category

explanation 'The explanation of the rice disease fa

options
fungi_factor - 'the fungi caused diseases',
bacteria_factor - 'the bacteria caused diseases',
virus_factor - 'the virus caused diseases',
nematode_factor - 'the nematode caused diseases'.
    
```

FIGURE 3: Screen shot of category parameter *disease_factor*

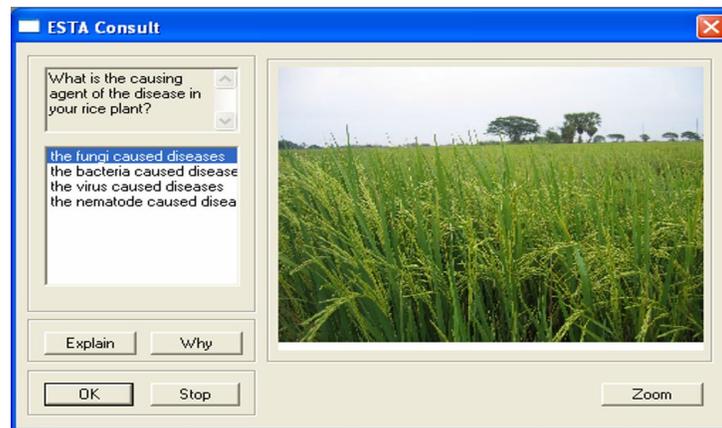


FIGURE 4: Screen shot of rice diseases in ESTA Consult

The interface of the system for the user is shown in figure 4. The left window shows the details of each of the causing agents of the diseases. The feature corresponding to this expert system is placed in backward chain rules including parameters. Each parameter contains explanations for questions, and background rules to decide value of parameters, question statements and pictures related to the particular question of the disease. Design of this system follows top down design approach. The developed knowledge base is stored in the compiled format for faster consultation.

4. CONCLUSION

This paper has presented the architecture, design and development of an expert system for diagnosis of diseases in the rice plant. It is easy to be accessed by the users as the knowledge base is being loaded in the memory in compiled format. Expert system tool forms the start section just after the program runs. This is the main section of the expert system and contains control rule of the system. The knowledge base contains the knowledge about the different diseases of rice plant represented in separate sections. Such system is especially useful for those farmers who are not getting the agricultural specialists at any time for their help to control the problems in their rice plant. The architecture presented here is an integrated system with interactive user interface, control and coordinating units, expert system shells, and structured knowledge representations. The design considered involvements of intermediate interventions in runtime, and also considered dynamic structuring of knowledge representations and rule applier.

5. REFERENCES

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