INTEGRATING MULTIMEDIA WITH EXPERT SYSTEMS FOR CROP PRODUCTION MANAGEMENT

A. Rafea S. El-Azhari E. Hassan

Central Lab. for Agricultural Expert Systems
El-Nour Street
P.O.Box 100 Dokki, Egypt
email:rafea@esic.eun.eg

Abstract: This paper presents a framework for integrating multimedia with expert systems for crop production management. The main components of an expert systems for crop production management is introduced. The multimedia types suitable for usage with each component are suggested. Experience with integrating images with an expert system for Cucumber production management under plastic tunnel is described.

Keywords: Agriculture, Expert systems, Knowledge-based systems, Multimedia, Production systems, Decision support systems

1. INTRODUCTION

Expert systems was identified seven years ago ,by the Egyptian Ministry for Agriculture(MOA) , as an appropriate technology for transferring knowledge and expertise of agriculture specialists to extension service (Rafea and El-Beltagy, 1987). In 1989, the Expert Systems for Improved Crop Management (ESICM) project was initiated with two main objectives: building an expert system laboratory within MOA that has the capacity to identify, develop, and maintain expert systems, and second developing two expert systems for the production management of cucumber under plastic tunnel, and citrus in the open field. Since that time several expert systems for these two crops were developed, (Rafea et al,1991), (Rafea et al,1992), (Salah et al, 1992), (Salah et al,1993), and [El-Dessouki et al, 1993) .In addition a knowledge engineering methodology was evolved starting by waterfall-like methodology (Rafea et al, 1993a), and ending by a KADS-like methodology (Rafea et al, 1993b), (Rafea et al,1994). A knowledge representation object language (KROL) on top of Prolog was also developed to implement the production versions of these expert systems.

In all these expert systems Multimedia technology is identified as an essential component for the success of the expert systems for the following reasons: acquiring symptoms of plant disorders using words is very difficult and error-prone, explaining agricultural operations to be done effectively is almost impossible using text, and describing some common terms that are spoken but are not used to be written, is also very confusing when reading them.

2. EXPERT SYSTEMS FOR CROP PRODUCTION MANAGEMENT

Crop management can be defined as the set of agricultural operations done to produce that crop. Advises about these operations are given by specialists in: soil and water management, plant pathology, entomology, production, breeding, and horticulture. Analysis of these operations has revealed that an expert system for crop management is a family of expert systems that work together to generate a schedule for agricultural operations. The functionality of these operations was analyzed and consequently classified into these categories: irrigation,

fertilization, plant caring, and disorder remediation. Figure 1 depicts the overall structure

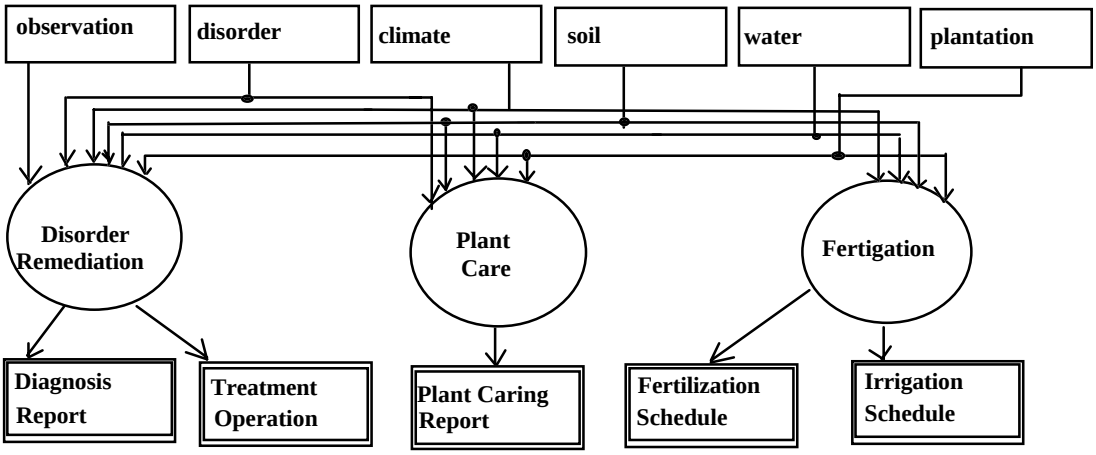

Fig. 1 Overall Strucure of a Typical Expert System for Crop Production Management

of a typical expert system for crop production management.

The analysis also revealed that knowledge behind advising about these operations is also dependent on a certain crop though the same categories stand for any crop. The human experts involved in each category for the selected crops (cucumber, and orange) were identified, and an expert system for each category, and for each crop was built . As the expert systems for each crop use some common data and knowledge about the domain, a common knowledge base was built to be shared by these expert systems. In the following subsections, a brief description is given for each of these expert systems using the ones developed for cucumber as examples.

2.1 Irrigation expert system

The main function of this expert system is to generate an irrigation schedule that includes water quantity and application frequency during a month, a week, or a day. The inputs to this expert system are mainly the properties of soil, water, climate, and some factors related to the plantation itself such as the irrigation system, the drainage quality, and others. The specialties of human experts collaborating in this expert system are soil and water management, and production.

2.2 Fertilization expert system

The main function of this expert system is to generate a fertilization schedule that includes the amounts and application frequency of different fertilizers during a month or a week. The inputs to this expert system are approximately the same as the irrigation expert system in addition to some factors related to the fertilizers to be used and the expected yield. This system is highly related to the irrigation expert system, and the specialties of human experts are the same.A typical output screen that combines the outputs of both irrigation, and fertilization expert systems for cucumber is given in figure 2. Detailed description of similar systems for Orange can be found in (Salah et al,1993).

Soil Texture : Sand Expected Yield = 3.88 ton							
Pre Cultivation gm/540 m^2			3057 N	7962 K_2O_5	1417 MgO		
Fertilization Schedule gm / 540 m^2							
Week No.	Starting Date	N	P_2O_5	K_2O_5	MgO	Water Qty (lt./540 $m^{2)}$	Interval in days
1	1/9/94	----	----	----	----	882	1
2	8/9/94	147	0	82	7	830	1
3	15/9/94	182	0	102	8	1030	1
4	22/9/94	329	58	184	10	1240	1

[ESC] exit [ENTER] detailed information

Fig. 2 Typical Output Screen of Fertigation Expert System

Date		Chemical	Operation Schedule	
8/2/95	Disorder	Method	Material name	Quantity
	root_lesion_nematode,	spray	vidate	500 gm/100 lt
15/2/95	root_knot_nematode			
	root_lesion_nematode,	spray	vidate	500 gm/100 lt
16/2/95	root_knot_nematode			
3/3/95	fungi, spiders	dusting	agricultural_sulphur, dithane_m45	100 gm + 100 gm
16/3/95	fungi, spiders	dusting	agricultural_sulphur, dithane_m45	100 gm + 100 gm
1/4/95	fungi, spiders	dusting	agricultural_sulphur, dithane_m45	150 gm + 150 gm
16/4/95	fungi, spiders	dusting	agricultural_sulphur, dithane_m45	150 gm + 150 gm
1/5/95	fungi, spiders	dusting	agricultural_sulphur, dithane_m45	200 gm + 200 gm
	fungi, spiders	dusting	agricultural_sulphur, dithane_m45	200 gm + 200 gm

[Navigation keys] move around [ESC]exit [ENTER] detailed information

Fig. 3 Typical Output Screen of Plant Caring Expert System

2.3 Plant caring expert system

The main function of this expert system is to generate three types of the caring agricultural operations to protect plants from weeds, insects and diseases, and to keep the plantation in an optimal condition. The first type of operations must be done before cultivation, the second type is the routine operations that should be done after cultivation, and the third type is the preventive chemical operations, if any. Figure 3 depicts a typical output screen of the Plant caring expert system.

2.4 Disorder remediation expert system

The main function of this expert system is to generate a prescription to protect a certain disorder or a set of disorders. In case that the user suspects the cause of disorder(s), he/she can provide the system with his/her suspicion, and the system confirms or rejects this suspicion. If the user has no suspicion, he/she can provide the system with the symptoms of the disorders, and the system identifies the cause(s) of the disorder(s). Figure 4 depicts a typical ouput screen of disorder remediation expert system

Treatment Operation
Detailed Operation Information

Date : 28/6/94
Disorder : white_fly
Material Name : actellic 50%
Mode of entry : contact
Quantity : 300 ml/100 L
Method : foliar application
Tool : sprayer
Application : avoid high temperature
Time during spraying
Advice : install nets before transplanting
spray only when number of
insects reaches 2-3 per leaf,
make deep harvest before
spraying

Fig. 4 Typical Output Screen of the Disorder Remediation Expert System

3. FRAMEWORK FOR INTEGRATING MULTIMEDIA WITH CROP PRODUCTION MANAGEMENT EXPERT SYSTEMS

Integrating multimedia with expert systems is a hot topic that is booming nowadays. The integration with images was frequently done to more efficiently acquire the user inputs, whereas other types of media such as sound, and video are also addressed.

As a general framework, distinction is made between the knowledge representation and knowledge presentation. A knowledge representation is a symbolic representation of the domain to make knowledge explicit for the purpose of manipulation and inference. A knowledge presentation, on the other hand, is a replica or prototypical model of the domain comprised of a sequence of media forms, including visual, animation, audio, graphics, and/or text.

In this section a framework for integrating multimedia with crop production management expert systems is presented. This will be done through discussing where each multimedia type could be used to enhance the utilization and performance of the expert system. Providing explanations during consultation and/or after reaching a conclusion can also be enhanced using all types of multimedia.

3.1 Images

It was found that describing symptoms in words is very difficult and sometimes is very confusing. Therefore, images are identified to be used for two main purposes: describing a disorder symptom, and confirming the diagnosis of the cause of a certain disorder. Detailed images for all symptoms, and unique images that confirm the occurence of disorders at different stages should be collected.

Although images are very useful in acquiring the user inputs, the uncertainty problem is still there. Therefore, giving the user the option to select an image with a degree of certainty should be provided. Providing more than one picture for the same symptom can reduce the user uncertainty, but this will lead to exerting more efforts in collecting and classifying the images.

3.2 Video

As already explained, the output of an expert system for crop production management, is a set of agricultural operations. Describing how to perform an agricultural operation in words, is very hard and one can never guarantee that the user can understand what has been written. Displaying a video for a professional doing the recommended operation would be very educational.

3.3 Sound

The sound is essential because sometimes, it is not easy to write terminologies used by growers in daily life. In addition, combining the video with sound is also recommended to comment on how the operation is done.

4. EXPERIENCE IN INTEGRATING IMAGES WITH AN EXPERT SYSTEM FOR CUCUMBER DISORDERS REMEDIATION

Integrating images with the expert system for cucumber has passed into three steps: the identification of images to be included, collection and scanning of images, and modifying the knowledge base to integrate the images.

4.1 Images Identification

The identification of images was by studying the relation between the knowledge representation and its presentation. For example, the value of the attribute "leaf spot color" of the object "leaf spot" has a set of images for different colors. For each color, there may be more than one image pending on other attributes of the spot such as its shape, its position,... . Another example is the images of a diagnosed disorder which may differ according to the severity of this disorder. Therefore thorough examination of typical obseravtion has been conducted to identify proper images.

4.2. Collection and scanning of images

Four sources are recognized to get the identified images: the slides used by domain experts in their presentation, the extension documents, books, and picutures taken from the field,when no available images were available.

A combined slide, and flat bed color scanner with a resolution up to 1200 dpi was used for scanning pictures and slides. However, scanning with this high resolution needs a lot of disk storage. We have found, practically, 300 dpi is sufficient to produce a good image. A typical size of the images used in the system ranges from 60 to 369 KB. This difference is due to the size of the image to be displayed. In order to solve the problem of the disk storage space, we decided to distribute the Expert Systems with images on CD's in the future.

4.3 Knowledge Base Modification

The observation class was modified to include links to images, and additonal rules were added in order to enable the image display method to select the appropriate image out of a set of related images and then present it to the user.

For example, when the system is to ask about the leaf spot color, and the user wants to retrieve the image related to a white spot, there should be a method to select the appropriate image among the set of images linked to this attribute value. If the shape of the spot is irregular , and we have four images of white spot, then the system should select the irregular white spot image.

Another example is displaying images at the end of consultation session. . If the result of diagnosis expert system was nitrogen deficiency and the severity of this deficiency is low, then the system should select the appropriate image among all the images describing low nitrogen deficiency, taking into account the responses provided by the user during the consultation session.

The knowledge base was modified and the additional rules and methods were implemented. The expert system is distributed on 6 compressed 1.44 MB floppy disks. The total number of images included in the current version is 33 images which is approximately 1/3 of the total number estimated to cover all symptoms.

5. CONCLUSION

The work presented in this paper gives a general framework for integrating crop management expert systems with multimedia. The experience of integrating images with the expert system of cucumber has revealed the implementation problems to be addressed when images are to be enclosed in the expert system. These problems can be classified according to the steps followed for integrating the images with the expert system namely: images identification, collection and scanning of images, and knowledge base modofication.

Studying, the presentation of observation into images, and identifying these images are very important in order to save efforts in collecting, scanning, and storing images which may not be used later.

Collection of images should take into consideration the local environment and should not depend completely on images in international books. Scanning with the least possible resolution that does not affect the clarity of the image is recommended in order to save storage space.

Knowlege base part related to observations relations should be linked with images, and additional rules have to be added in order to handle different situations. This addition of extra knolwedge is necessary to display images intelligently.

Currently, integrating sound, and video with expert systems is being investigated, along with the efforts exerted to add more images and enhance the link between the knowledge base and the image base.

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