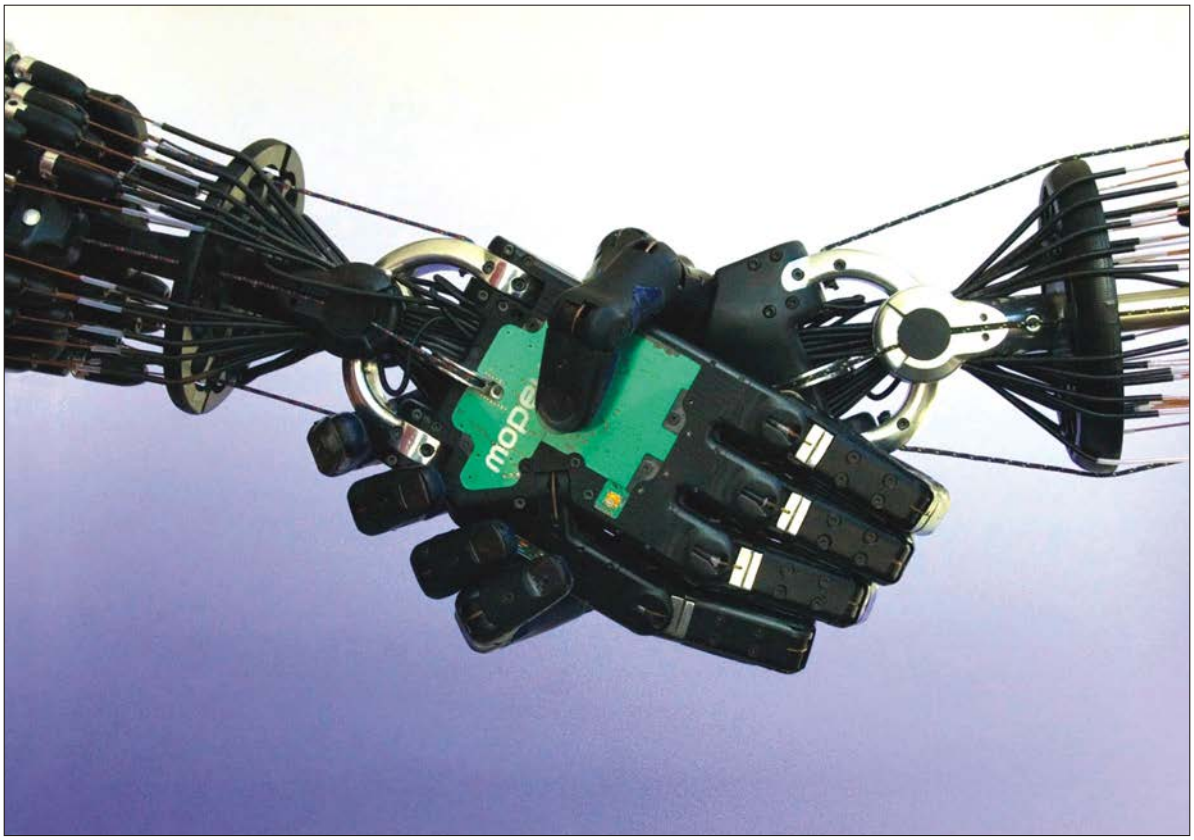

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Developing an Expert System for Plant Disease Diagnosis

S.S. Abu-Naser, K.A. Kashkash and M. Fayyad
Faculty of Engineering and Information Technology, Al-Azhar University, Gaza, Palestine

Abstract: Plant diseases are one of the most important reasons that lead to the destruction of plants and crops. Detecting those diseases at early stages enable us to overcome and treat them appropriately. This process requires an expert to identify the disease, describe the methods of treatment and protection. Identifying the treatment accurately depends on the method that is used in diagnosing the diseases. Expert systems help a great deal in identifying those diseases and describing methods of treatment to be carried out taking into account the user capability in order to deal and interact with expert system easily and clearly. This requires that the user should be competent in using expert systems. An expert system was developed using two different methods of plant diagnosis: Step by step descriptive and graphical representational methods. Present expert system plays the role of an agricultural engineer and provides the user with different methods of diagnostic and treatment. An initial evaluation of the system shows a positive impact on the expert system with graphical representational method.

Key words: Artificial intelligence, expert system, plant disease, CLIPS

INTRODUCTION

Identifying the plant diseases is not easy task; it needs experience and knowledge of plants and their diseases. Moreover, it requires accuracy in describing the symptoms of plant diseases. A person can depend on a system that posses experience and knowledge (expert systems) to enable him/or her in identifying any type of disease, making the right decision and choosing the right treatment like the disease in Fig. 1.

The methods that expert system uses differ from one system to another because that depends on the user's primary knowledge of the case. Decision making depends mainly on the way of receiving that knowledge. In this study two different methods will discussed that were used by the expert system in identifying plant diseases; moreover the advantages and disadvantages of each methods will be outlined.

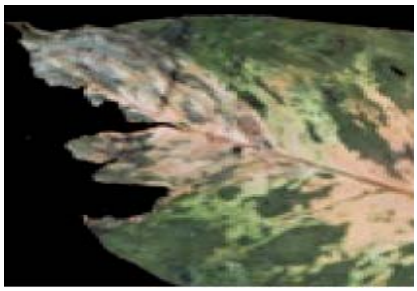

Fig. 1: Sample of a plant disease

Corresponding Author: S.S. Abu-Naser, Faculty of Engineering and Information Technology, Al-Azhar University, Gaza, Palestine Tel: (+9708)2824020 Fax: (+9708) 2832907

Artificial Intelligence and Expert Systems

Artificial Intelligence could be defined as: How to make the system think, ration, or act like human (Russell and Norvig, 2002). Expert systems, or knowledge-based systems, are a branch of artificial intelligence. An expert system is a computer program that attempts to replicate the reasoning processes of a human expert (Jackson, 1999; Giarratano and Riley, 2004; Shu-Hsien 2005; Azaab *et al*., 2000), can make decisions and recommendations and perform tasks based on user input. The expert's knowledge is available when the human expert might not be and so that the knowledge can be available at all times and in many places, as necessary. Expert systems derive their input for decision making from prompts at the user interface, or from data files stored on the computer.

Expert Systems in Agriculture

The first commercial Expert system evolved as a product of Artificial Intelligence and is now available in a number of fields that requires decision-making (Durkin, 1993). The suitability of this technology has been recognized and realized in the field of agriculture and a few successful expert systems have been developed (Freeman and Beattie, 2008; Durkin, 1994). Agriculture requires information and application of knowledge from different interacting fields of science and engineering to make a suitable decision-making that in turn depends on interplay of these data and knowledge. This needs agricultural specializations and technical awareness in farmer or a human expert to help the farmers in decision-making. Existence of agricultural specializations and full awareness with technological progress in a farmer is a very rare thing in our country. Human experts are not always available, may not be accessible to every farmer or if available consultation may be very expensive. The other complications are that the decisions in agriculture practice depend on large number of factors. Thus even for a human expert it becomes awkward to take all factors into consideration while making a decision. All such problems have resulted in the development and evolution of the concept of expert systems (Blackmore, 1999; Maloy, 2005). The use of information technologies improved the knowledge base and increased the capacity to control the production practices which in turn reduces the threat and uncertainty, improved the efficiency of decision making and better recognized the variations in diverse influencing features thus depicting enhanced management policies for the farm (Blackmore, 2000). In addition, it is possible to store much of the information that an expert needs to make decisions and can make them on hand for others; therefore the notion of knowledge based agriculture has an adequate prospective to improve the agricultural production.

Riley *et al*. (2002) have developed an expert system for Plant disease diagnosis based on visual observations of symptoms expressed by the infected plant. El-Dessoki *et al*. (1993) developed an integrated expert system for crop management of cucumber. Rajkishore *et al*. (2005) developed an expert system for the diagnosis of pests, diseases and disorders in Indian mango. Lopez-Morales *et al*. (2008) developed JAPIEST: An integral intelligent system for the diagnosis and control of tomatoes diseases and pests in hydroponics greenhouses. Gonzalez-Andujaret (2008) developed an Expert system for pests, diseases and weeds identification in olive crops.

These earlier expert systems concentrate on a specific type of disease and one methodology of diagnosis. In this research study, more options were covered like different methodologies of diagnosis and variety of diseases.

Knowledge Acquisition

The data and knowledge of this expert system are collected form different sources. The first primary source is agricultural engineers and farmers. The second source is from specialized databases and a few electronic websites. Once the Knowledge was collected, we encoded it in the CLIPS Language.

Knowledge Representation

The proposed systems are rule-based system and makes inferences with symbols, which require translation of plant diseases specific knowledge in the standard symbolic form. The facts and rules have been represented using CLIPS. CLIPS stands for C Language Integrated Production System (Giarratano, 2002). CLIPS is a forward reasoning and pattern marching Expert System shell. It provides a good inference engine mechanism that automatically matches facts against patterns in the rules then determines which rules are applicable. Then the chain of matching actions of applicable rules is executed. The executed rule generates new facts that make other rules applicable for execution. This process is continued until no more applicable rules are left. Furthermore, CLIPS has the ability to be integrated with any other high level languages the support graphical user interfaces.

The rules are in the format of If condition Then actions i.e., If X and Y then Z , which implies if the condition part X and Y is evaluated to be true then the action part Z should be performed.

MATERIALS AND METHODS

Identifying plant diseases is usually difficult task; it needs an agricultural engineer to describe the case accurately. Moreover, quite a few diseases have similar symptoms; consequently, it will be difficult for none-expert to distinguish between the types of disease. Using expert systems can help enormously in overcoming those difficulties.

As mention above, the methods that can be used by an expert system are different and various.

Two different methods were used in the diagnosis of plant diseases: Step by Step Description and the Graphical representational methods.

One of the most important method is the description of the concerned person about the symptoms for the disease; whereas, the concerned person provides comprehensive, accurate and gradual description (step by step) to get a complete view of the symptoms.

The other popular method of diagnosis is depending on comparing the concerned case with similar ones through one image or more of the symptoms stored in the knowledge base of the expert system.

Method 1: Step by Step Description

This method depends on the gradual description of the concerned person of the symptoms that he/she observed on the plant based on the choices provided by present expert system and the expert system form a complete idea about the infected part on the plant. This helps the expert system to make suitable decision and describe the relevant treatment for each case.

This method is attributed by its easiness in reaching the target disease and its low cost; but it depends on the capabilities of the person in distinguishing between the available choices and gradually moving from one level to another. On the other hand, this method mainly depends on the accurate description of the case from the user's point of view, but there are similarities in the symptoms of some diseases that require a specialist person to be able to make the right decision, Fig. 2-4 for a snap shot of the CLIPS consultation of the first method.

The system that adopt this method is considered to be a great one for those who have enough experience in this field and need something to help them in making the right decision in these cases. Some times the system needs to move gradually from one level to another; consequentially, some users may feel bored and lost in picking up some choices.

In designing this system, CLIPS language was used only in designing of the expert system.

Method 2: Graphical Representational System

This system is based on stored pictures of diagnosed cases and allows a user to browse the cases that are similar to the requested case and to compare the symptoms of the requested case with the

```
      Expert System for diagnosing
      plant diseases and treatment
      ----------------------------

                Main Menu
=========================================
 Which part of the plant is infected ?
          1- Root ...
          2- Leaf ...
          3- Stem  ...
          4- Quit the Consultation

Type number of your choice ==> 1
```

Fig. 2: CLIPS consultation used in the descriptive method

```
                    ...   Root Diseases Menu..
=============================================================================
 1- Plants grown in pots that have accumulated salt may show browning of leaf
    tips or margins. Close inspection of soil, stems, and/or the bottom of the
    pot will show a white or yellow crust of accumulated salt

 2- Plants appear wilted and do not recover after watering. Roots appear brown
    and mushy.

 3- Soft areas develop on upper plant material. Plants may droop and/or collapse
    Root appears as abandoned

 0-  Return To Main Menu

  Type number of your choice

  Choice ==>: 1

Disease Name  :   SALT ACCUMULATION
Reasons       :   Salt accumulation is caused by an accumulation of unused salts from
                  hard water or fertilizers. Plant growth can be impaired when salts
                  reach a high level."
Treatment     :   When salt accumulation is severe, apply enough water to the soil so
                  That and through the drainage holes. Drain water from the water col-
                  lection tray to prevent over watering. Repeat once a month accumulat-
                  tion as long as salt is visible.

            Press 0 To Return To Previous Menu ...
```

Fig. 3: A snap shot of the conclusion using the descriptive method

Fig. 4: An image of the conclusion in descriptive method

stored ones. Then the user will choose the most similar case and browse its information to emphasize his/her choices. The system will process the user's choices and make a suitable decision.

It should be emphasized that present expert system provides a simple way in distinguishing among the symptoms through a comprehensive show of all symptoms based on the user's description, in addition to pictures, to clarify the differences among symptoms (Fig. 5, 6). Consequently, it is possible it give accurate results for the users who doesn't have enough experience in making decisions and can't describe the case clearly.

Fig. 5: Return all possible results from searching about any similar symptom

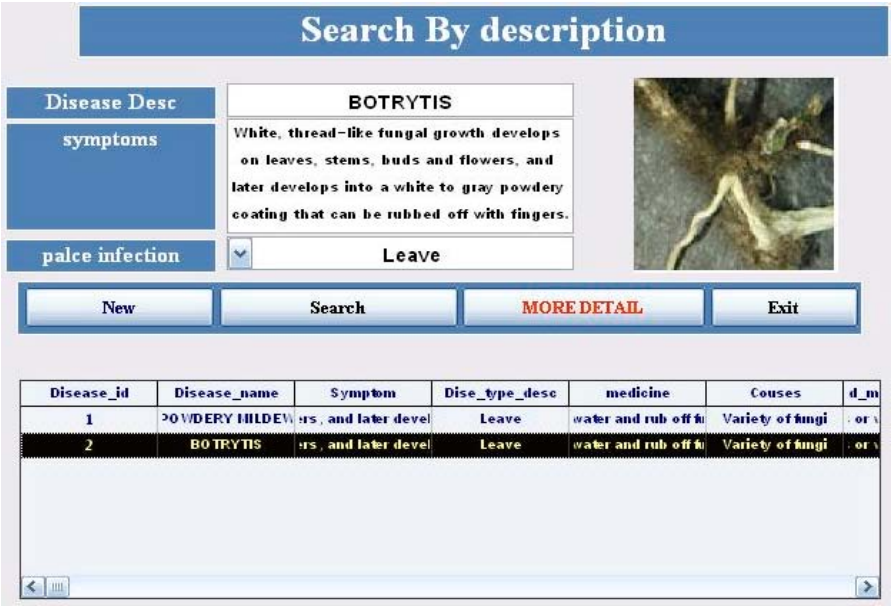

Fig. 6: View search result to insure decision accuracy

Another way users can use to searching about the goal, by using listing all diseases which could be infecting main parts of plant with sampling photos to be more clear (Fig. 7) then export the choices to CLIPS to process the information and given the feedback about this decision.

The result of the expert system is shown in Fig. 8 where, the complete details about the selected diseases are clearly shown.

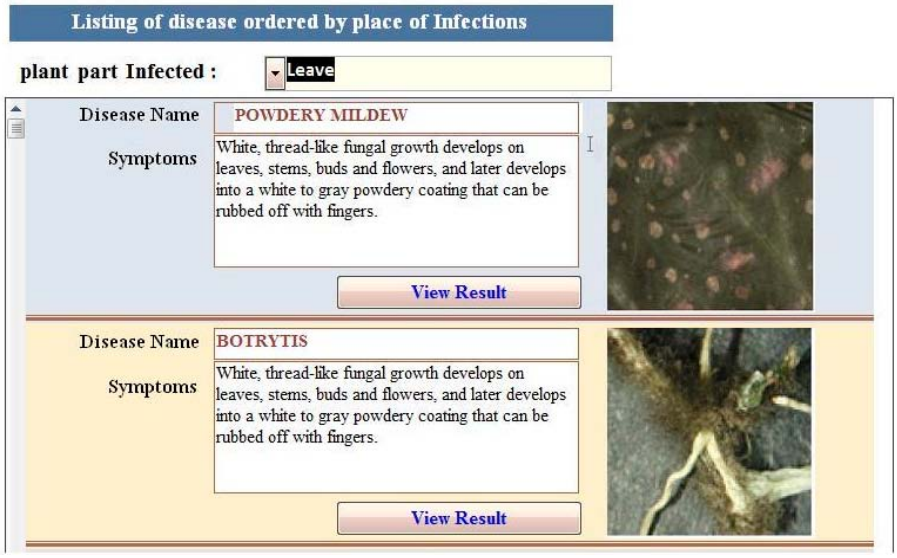

Fig. 7: Listing of disease ordered by part of infections

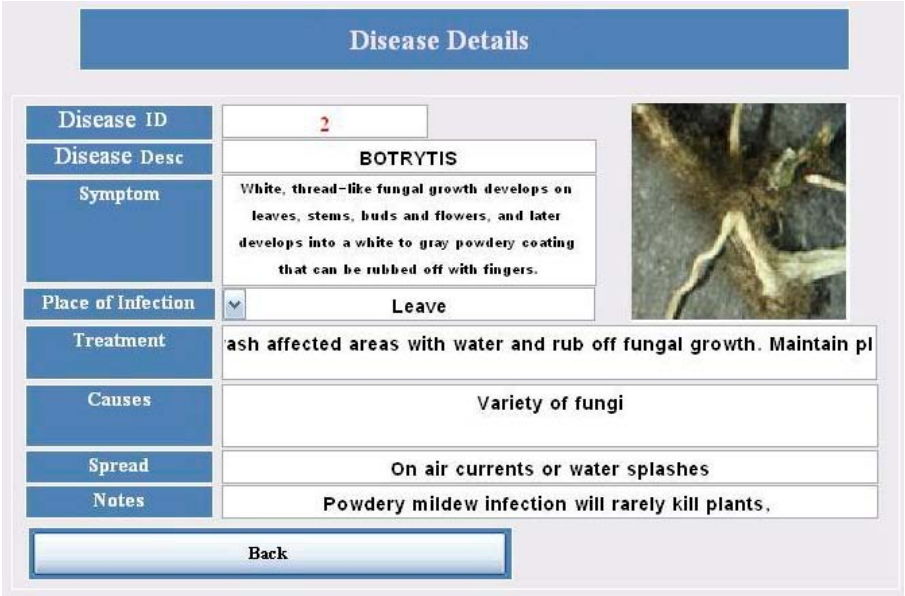

Fig. 8: A snap shot of the results from the expert system using method 2

In designing this expert system we used Visual Basic to support the Graphical User Interface (GUI) and CLIPS in making the decision according to the information received from the user.

TESTING AND RESULTS

A group of agricultural engineers, farmers and concerned persons in plants were consulted concerning the two methods of diagnosis used in the expert system. To a certain degree, the majority of the group preferred the second method in the expert system, the graphical representation because it gives more accurate results; especially when it comes to similar symptom between diseases.

CONCLUSION

In this research, the design and development of an expert system with two different methods for diagnosing plant diseases were presented. The first one is using the descriptive method (step by step) and the other one using the Graphical representation method. A preliminary evaluation of the system showed that the expert system with the graphical representation is more favorable than the descriptive one. This is due to the difficulties in describing the symptoms of the disease. One the other hand, a graphical picture of the symptoms does not require much description form the user. Expert Systems are considered one of the most successful methods used to help and support users in making the right decisions; were they lack knowledge in diagnosing plant diseases. Present expert systems saved a lot of time and effort in identifying plant disease due to the mechanism used in receiving the data and providing the decisions. It is clear that CLIPS is very effective in processing and performing such type of activities in an easy way and in a short time.

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