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Research Article

Expert System to Detect and Diagnose the Leaf Diseases of Cereals

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Abstract

This paper presents a proposed expert system to identify the leaf diseases of three cereal crops (rice, maize and wheat). Keeping in view the advances in the field of agriculture and need of farmers, this expert system has been proposed. The identification of plant diseases is usually a difficult task and requires a plant pathologist or well-trained technician to accurately describe the case. Moreover, there are some diseases which have similar symptoms, thus making it difficult for non-experts like farmers to distinguish between diseases correctly. This expert system will use the colored images of the defected cereal plant leaves as well as the textual input to identify the disease. It will enable users/ farmers to identify any disease, makes the right decision and chooses the right treatment.

Keywords: *Expert System, Affine Transformations Edge Detection, Pixel Comparison*

1. Introduction

Expert systems are intelligent computer programs that are capable of offering solutions or advices related to specific problems in a given domain, both in a way and at a level comparable to that of human experts in a field. One of the advantages of employing expert system is its ability to reduce the information that human users need to process, reduce personnel costs and increase output. Another advantage of expert system is it performs tasks more consistently than human experts. Some diagnosing expert systems depend on the ability of an end user to understand abnormal symptoms of the plant and to convey these symptoms through a textual dialogue. Depending on the user's level of understanding of the abnormal observations, the expert system can reach the correct diagnosis. If, however, the end user interprets the abnormal observations in a wrong way and chooses a wrong textual answer to a presented question, then the expert system will reach a wrong conclusion.

Devising a method whereby abnormalities are automatically identified, would greatly reduce the risk of human error and would accordingly lead to a more accurate diagnosis. This could be achieved through the integration of an image processing component with a diagnostic problem solver. Image processing is a powerful tool for which the input is an image and the output will be an image or a set of characteristics related to an image. It has been applied in many domains such as intelligent remote sensing via satellite, medical image analysis, radar, sonar, robotics, agriculture and automated inspection. Image information can play a crucial role in the diagnosis of different diseases in the agricultural domain where the understanding of image symptoms is often essential to problem solving.

2. Literature Review

El-Dessouki, Edrees and El-Azhari studied CUPTEX, an expert system developed and deployed for cucumber production management. It was used by agricultural extension service within the Egyptian Ministry of Agriculture (MOA) and by private sector. The main objective of developing such systems is to transfer new technology in agro management to farmers through packaging this technology using expert systems. This will lead to increasing the production and hence the national income, from one hand, and reducing the production cost from the other hand.

El- Sayed, Hesham and Rafea studied a real-life pest control expert system for tomato. The system involves two main subtasks, namely diagnose and treat. The diagnose subtask finds out the causes of the grower's complaints, while the treat subtask finds out a treatment plan for these causes.

Xin, Beck, Hasley, Fletcher, Zazueta and Momol studied a Web-based Distance Diagnostic and Identification System (DDIS) and it was developed at the University of Florida. County extension agents were trained to submit field data and digital media of pest, plant disease, insects, animal, weed, management and plant nutrient problems to specialists statewide for rapid diagnosis through Internet. The system provided an

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effective collaboration environment for extension agents and specialists to share information on pests, plant disease, insects and plant management problems. Specialists around the state can perform distance diagnosis and make recommendations to extension agents. Through direct interaction with specialists, county agents become more familiar with plant disease problems. Turnaround time was reduced from days to hours. The system creates a digital image library with associated site, crop and pest or disorder data that could be used in educational programs, assisted diagnosis and data mining.

El- Helly, Rafea and El-Gammal concluded that image processing system is very capable of diagnosing three disorders of cucumber crop, downy mildew with percentage 84%, leafminer with percentage 74% and powdery mildew with percentage 94%. Also, the system is capable of deciding the normal leaves with a percentage 98%. Moreover, the system is capable of recognizing the unknown disorder with a percentage 92%.

Gonzalez-Andujar concluded that identification of weed seedlings is a difficult task. An expert system to help farmers and extension workers to identify weed species in cereals has been developed. The expert system uses a hierarchical classification and a mix of the text description, photographs and artistic pictures. The system is supported by a data base containing information about 41 weed species and 128 color images. The expert system was evaluated following the conventional expert system evaluation methodologies. The results of the validation indicated that non-expert users were able to make identification using the expert system. A total of 149 identifications were performed and 63% were identified correctly.

Kumar, Lehri, Sharma, Meena studied the image based rapeseed-mustard disease expert system which is developed by integrating image and textual data. The system can be used by extension personnel, researchers and farmers to identify rapeseed-mustard diseases and enable their management. User can easily identify the disease on the bases of photos of symptoms and text description of disease. The user friendly software developed using windowing environment, thus provides enough facilities to identify the disease and to suggest the remedy conveniently.

Alshaban and Taher concluded that expert system for disease diagnosis is very useful, because any one can use it easily and can get good result. Medical diagnosis that depends on blood tests is very complex because the disease costs that are related to blood or else depends on it are too much. The blood test is entered manually in form to program. For future work, a device can be used that analyzes the blood and gives the analysis data directly to the expert system. Some diseases need an image or x-ray. It is useful to make the expert system include movies, sounds and images.

Lai, Ming, Li, Wang, Xie and Gao studied an image based expert system for corn diseases. Accurate identification and treatment depends on the method which is used in disease and insect pest diagnosis. The old adage ‘a picture is worth a thousand words’ is crucially relevant. Considering the user's capability to deal and interact with the expert system easily and clearly, a web-based diagnostic expert-system and frames with a color image database was developed and applied to corn disease diagnosis as a case study. Visual color image displays with the phrases of questions and answers from the expert system, enables users to identify any disease, makes the right decision and chooses the right treatment. This may increase their level of understanding of corn disease diagnosis. The expert system can be applied to diagnosis of other plant pests or diseases by easy changes to the knowledge base.

Devraj and Jain studied the design and development of an expert system for the diagnosis and control of diseases in pulse crops (PulsExpert). PulsExpert is an operational automatic diagnostic tool that helps farmers and extension workers to identify diseases of major pulse crops viz., Chickpea, Pigeonpea, Mungbean and Urdbean (highly consumed pulse crops) and suggests the appropriate control measures.

Automatic knowledge acquisition system of PulsExpert provides user-friendly interface to the domain experts for entering, storing and structuring the domain specific knowledge. The knowledge base of PulsExpert contains up-to-date knowledge about 19 major diseases of pulses appearing right from seedling to maturity. The system provides user-friendly interface to farmers and asks the textual as well as pictorial questions. The order of questions to be asked is decided dynamically depending upon the answers of the farmer. On the basis of answers, PulsExpert diagnosis the pulse crop diseases along with its confidence factor and suggests most appropriate control measures which are composed of cultural practices as well as chemical controls. PulsExpert was evaluated by a team of field farmers and State Agriculture Officers and it was considered good with an average rank of 2.745 by farmers and 2.075 by State Agriculture Officers with a statistic mode ranking 3 in both the cases.

3. Design and Development of Proposed System

Identification of plant diseases is the task handled by plant pathologists in various institutions where agriculture is studied as a subject. Krishi Vigyan Kendras has been set up by the government to facilitate farmers. Sometimes even the experts can interpret the wrong result if the diseases have similar symptoms. The farmers are not capable enough to identify the symptoms of the leaf diseases of the cereals. They can recognize the common disease symptoms only. Identification of leaf diseases of cereals and the other related information is totally dependent on the experts. This process is very time consuming and the valuable time of farmers gets wasted.
The proposed system is a web based expert system. The base of the proposed expert system is a database, which stores all the information pertinent to the leaf diseases of rice, wheat and maize. The database contains the general names and scientific names of 13 leaf diseases, their 30 colored images, symptoms and precautionary measures. Users can easily identify the disease on the bases of

images of symptoms and text description of leaf diseases of cereals (rice, wheat and maize). The user friendly software is developed using windowing environment, thus provides enough facilities to identify the disease and to suggest the remedy conveniently. The expert system will stay up to date with information about the existing as well as new cereals and their diseases.

The objectives of the proposed expert system are as follows:

- To develop software to diagnose leaf diseases of cereals (wheat, rice and maize) through image processing techniques.
- To reinforce through textual input if image is not available.
- To specify remedies for the identified diseases.

Fig.1 Brown leaf spot in Rice

Fig. 2 Rice leaf affected by rice blast

Fig. 3 Maize leaf affected by rust

Fig. 4 Yellow or stripe rust in wheat

3.1 Image Comparison Techniques in Java

3.1.1 Affine Transformation

In geometric image transforms the pixel coordinates themselves are mapped. This applet lets you change the parameters of a class of mappings called affine transforms. It includes scaling, rotation and translation. More specifically, the transforms are given as:

x′y′==a0x+a1y+a2b0x+b1y+b2

where (x',y') is where the point/pixel (x,y) is mapped, and *a*0,*a*1,*a*2,*b*0,*b*1 and *b*2 are real-valued parameters.

After changing the pixel coordinates, the image must be resampled back into a square grid of pixel values. Common techniques are nearest neighbor and bilinear interpolation. Nearest neighbor simply chooses the pixel value of the closest neighboring pixel, while bilinear interpolation does a weighted averaging of the 4 nearest pixels. Higher-order interpolation techniques are also an option, but they are more computationally expensive. This is useful in satellite imaging where geometrically correct ground maps are desired.

3.1.2 Edge Detection

Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. The same problem of finding discontinuities in 1D signals is known as step detection.

The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. It can be shown that under rather general assumptions for an image formation model, discontinuities in image brightness are likely to correspond to

- discontinuities in depth
- discontinuities in surface orientation
- changes in material properties
- variations in scene illumination.

In the ideal case, the result of applying an edge detector to an image may lead to a set of connected curves that indicate the boundaries of objects, the boundaries of surface markings as well as curves that correspond to discontinuities in surface orientation. Thus, applying an edge detection algorithm to an image may significantly reduce the amount of data to be processed and may therefore filter out information that may be regarded as less relevant, while preserving the important structural properties of an image. If the edge detection step is successful, the subsequent task of interpreting the information contents in the original image may therefore be substantially simplified. However, it is not always possible to obtain such ideal edges from real life images of moderate complexity.

3.1.3 Pixel comparison

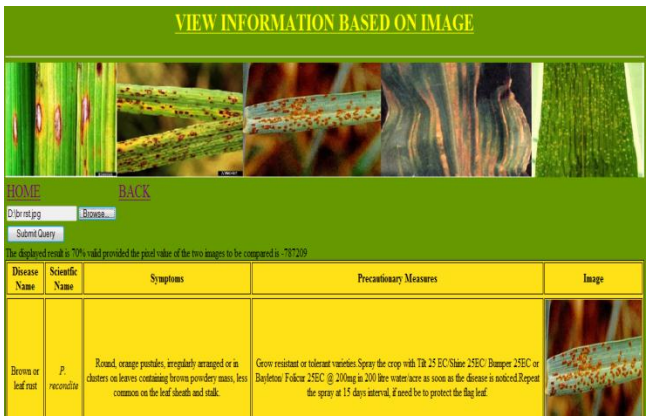

Fig. 5 Viewing information through image uploading

In the proposed expert system, pixel by pixel comparison algorithm has been implied to compare two images of the leaf disease of a cereal. The image of the infected cereal plant is compared with the images stored in the database.

The two images to be compared are stored in a BufferedImage and then using the method getRGB (int x, int y), the hex code of the RGB colors is calculated. This method compares each pixel of first image with pixel in the same index of second image. The system will display the accurate result if the two images are present in the database and their pixels have the same value.

4 Results and Discussion

The farmers and other people who are non- experts find it difficult to identify the symptoms of the diseases and also unaware of right precautionary measures to be taken. The non- experts are dependent on experts for the right information regarding the leaf diseases of cereals. Even some diseases have similar symptoms making it difficult for the non-experts as well as experts to identify the disease correctly and to specify the right remedy. The proposed expert system has been developed to provide a solution to this problem in an effective and efficient way.
The proposed expert system is a web based application which can be accessed from any web enabled computer. This web based application allows quicker, friendly and a positive user experience. The farmers can get all the information regarding the symptoms of the leaf diseases of cereals and the necessary precautionary measures to be taken to prevent the diseases without depending on the experts. This will save precious time of farmers and greatly reduce the losses happened to the crop as they get the required information on time.

5 Summary

This web based expert system can be accessed from any web enabled computer at any time. Multiple users will be able to login and logout from a web browser. The Administrator will have complete control of the services of the expert system. He/ she will be able to view the registered users and update the necessary information regarding the leaf diseases of the cereals. New disease names, symptoms, precautionary measures and new images of the existing cereals as well as new cereals can also be added. The users are authorized to view the names, symptoms, precautionary measures and images of the leaf diseases textually in case they do not have the images. The user can also upload an image of the infected cereal leaf to view the disease name, symptoms and precautionary measures. The user uploaded image is compared with the images in the database of the expert system through the image comparison algorithm. In case the user does not find the result through image uploading, he can send that image to the administrator.

6 Future Scope

The suggestions for the future research are:

- The expert system can be made more useful for farmers by converting the language of the system to Punjabi.
- More cereals and their leaf diseases with images can be added.
- This expert system can be made functional for other plant diseases also.

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