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Assignment title:	For writers
Submission title:	Development of Application for Pest…
File name:	Journal.pdf
File size:	1.18M
Page count:	11
Word count:	3,933
Character count:	20,626
Submission date:	24-Jan-2020 03:13PM (UTC+0800)
Submission ID:	1245785083

International Journal of Agriculture and Biological Sciences- ISSN (2522-6584) Nov & Dec 2019

December 31, 2019

Development of Application for Pests and Diseases of Corn Android Based System

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Received Date: 14-Nov-2019 Accepted Date: 30-Nov-2019 Published Date: 31-Dec-2019

Abstract
The research objective is to produce an Android-based expert system software that is capable of detecting pests and diseases in corn plants and is useful in providing information about symptoms and its control through image processing. This expert system program is processed through digital signal processing which consists of four (4) main parts, namely preprocessing, color feature extraction, texture feature extraction, and classification. The color feature extraction method used is The Color Moment as color feature extraction and GLCM (Gray-Level CooOccurrence Matrix) as a texture feature extraction. The classification method in this system uses K-Means clustering by dividing images into 4 clusters based on the color and texture of image objects. Training data using Multi SVM (Support Vector Machine) method. The result of this software program is named Corn Expert System (CES) which is installed on the desktop and the Android Cellphone (HP). This CES system application begins with taking pictures of corn leaves that are attacked by pests and diseases using Android phones by farmers in cornfields and sent to the desktop that is operated by the operator at the Agricultural Extension Office. Data from the desktop processing is sent back to the farmer via an android phone. The results of the detection of this CES program for pests, leaf scrapers and rust disease, leaf spot, leaf blight, and froth blight, have an accuracy level of up to 90%.
Keywords: *Corn Expert System (CES), Diseases of Corn Plants*

Introduction

Corn as a strategic commodity after the rice has always been cultivated by farmers in Gorontalo. This is also supported by the agropolitan program, as a form of accelerating regional growth and overcoming food crises (Lihawa, et al., 2010; Witjaksono, et al., 2011; Ilahude, Z., 2014). One of the factors that can affect the production of corn is Aphis (aphids), leaf slicer and rust disease, leaf spot, leaf blight and fronds (Semangun, H., 1991; Surtikanti, 2009; Soenartiningsih, et al., 2013; Tenteyali , et al., 2017; Talib, A., et al., 2018; Lihawa, et al., 2018; 2018). To anticipate pest and disease attacks on corn, many efforts have been taken to keep corn production stable, including planting corn varieties that are resistant to pests and diseases, regulating cropping patterns, regulating planting time, introducing natural enemies, be it predators, parasitoids, entomopathogens and antagonistic microorganisms.

Every pest and disease attack on a plant, before reaching a more severe and widespread stage, begins with symptoms of a mild attack and the spread rate is still low. Agriculture experts can have the ability to analyze the symptoms of pests and plant diseases, but to overcome all the problems faced by farmers, agricultural experts are still constrained by time and distance, considering the many farmers who have problems with their crops. Besides the limited information and the lack of available sources of information about pests and diseases in the field and the equipment used to capture the information is still conventional, resulting in late handling of pests and diseases in the field when an explosion of pest populations and the severity of the disease, which causes crop failure.

This study makes the application of an expert system that can detect, diagnose symptoms of pests and diseases in corn plants, as well as provide a solution to overcome them, in reducing the risk of crop

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This study makes the application of an expert system that can detect, diagnose symptoms of pests and diseases in corn plants, as well as provide a solution to overcome them, in reducing the risk of crop

damage. This pest and disease detection system are named Corn Expert System (CES), which is digital image processing based on desktop and android. The application of the CES program was developed to be able to recognize the symptoms and diseases of corn plants which are expected to replace the role of an expert or extension agent in dealing with pest and disease problems and provide an explanation of the symptoms and solutions for their handling.

How to use the CES program that is, users only take photos of corn leaves that are attacked by pests and diseases through the Android version of the CES program and then send them to the desktop version of CES that can identify pests and diseases using artificial intelligence technology or Artificial Intelligence (AI) through image processing (Qur'ania, A., et al., 2012). Image processing through color feature extraction using the Color Moment method and texture feature extraction using the GLCM (Gray-Level Co-Occurrence Matrix) method (Sanyal, P., et al., 2007; Permata Sari, I., et al., 2016). For pattern recognition using K-Means clustering where images are divided into 4 clusters based on color and texture of image objects and training of image data using the Multi SVM (Support Vector Machine) method. The program produced in the CES system can able to detect the symptoms of pests and diseases using the mobile android phone on time (Syarifudin, A. et al., 2018). So that more speed up decision making action control of Pests and Corn Diseases by farmers or other users.

Method

The CES (Corn Expert System) program is a combination of android and desktop versions of the program. The Android version of the CES program is installed on the cellphone via the website http://deksijagung.000webhostapp.com/index.phpm. Using the waterfall method, the desktop version of the CES program is installed on a computer-based on the Matlab program using an image processing detection system.

a. Waterfall Method

The waterfall method is a sequential software development process, which goes through the planning, modeling, implementation and testing phases. The main data needed is data on the types of pests and diseases, causes and methods of prevention, image / photos of types of diseases and pests on corn plants. These data will be processed and used as a basis for image detection. The stages of the waterfall method are as follows:

- System Requirements Analysis

The analysis phase begins with a description of a preliminary study and data collection of pests and diseases of corn plants in the Gorontalo area. After that, an analysis of the system requirements is required and needed by the user. Data for the analysis were obtained in 3 ways, namely, interviews, observation, and document analysis. Based on the results of the analysis of the current system, the new system proposal is described using a context diagram tool in describing the scope of a new system.

- Design / System Design

This stage will be carried out system design consisting of database design, software architecture, and interface design using UML tools. This stage translates software requirements from the needs analysis stage to the design representation so that it can be implemented into a program at a later stage (Ladjamudin, and Al-Bahra, 2006; Rosa and Saladin, 2011).

- Coding

This stage changes the design of the system into a software program using the concept of OOP (Object Oriented Programming) by using the MVC (Model, View, Controller) software architecture (Naista David, 2016).

- Testing

The testing phase focuses on the software in terms of logic and functionality and ensures that all parts have

been tested. This is done to minimize errors (errors) and produce the resulting output as desired. In this study, system testing is carried out using black-box testing. Black-box testing focuses on the functional requirements of the software.

b. Image Processing

Digital image processing (Digital Image Processing) is the use of computer algorithms to perform image processing on digital images (Jayamala, K. et al., 2011). Pre-processing is one of the initial stages in this study, which consists of saturation, grayscaling and thresholding processes. The purpose of this process is that the data used is easy to interpret and analyze. Also, so that the data used is following the application being built so that the results are optimal.

- Color Moment Method

Color Moments is a dense representation of color features in characterizing image colors. Some of the color distribution information is arranged in 3-moment sequences (Permata Sari, I. et al., 2016).

a. Mean :

$$\mu_c = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N} P_i^c \qquad (1)$$

where μ is the moment, c is the color component, P_{ij}^c is the pixel value (i, j) on the color component c, M is the height of the image, and N is the width of the image.

b. Standard Deviation :

$$\sigma_c = \left[\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(P_{ij}^c - \mu_c\right)^2\right]^{1/2} \qquad (2)$$

where σ is the standard deviation, c is the color component, P_{ij}^c is the pixel value (i, j) on the color component c, M is the image height, N is the image width, and $c\ m$ is the mean value on the color component.

c. Skewness :

$$\theta_c = \left[\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(P_{ij}^c - \mu_c\right)^3\right]^{1/3} \qquad (3)$$

where θ_c is skewness, c is the color component, P_{ij}^c is the pixel value (i, j) on the color component c, M is the height of the image, N is the width of the image, and $c\ m$ is the mean value on the color component c.

- Gray Level Co-Occurrence Matrix (GLCM)

In the statistical analysis of textures, texture features are calculated based on the distribution of combinations of pixel intensities at specific positions, each combination distinguished by first-order, second-order and higher-order statistics. GLCM is a way to extract second-order statistical texture features. The following is a formula for seeking entropy, contrast, homogeneity, correlation, and energy (Tansa, S., 2010; Permata Sari, I., et al., 2016) :

1. Contrast

$$\sum_{i=1}^{M}\sum_{j=1}^{N}(i-j)^2 P(i,j) \qquad (4)$$

The contrast feature measures the difference in intensity between pixels. Where M is the maximum value for the gray level in the first row, N is the maximum gray level value for the jth column, i = gray level value for the first row, j is the gray level value for the jth column, P (i, j) is opportunity value for gray level in the i^{th} row and j^{th} column.

2. Correlation

$$\sum_{i=1}^{M}\sum_{j=1}^{N}\frac{(i-\mu_i)(j-\mu_j)P(i,j)}{\sigma^2} \qquad (5)$$

The correlation feature measures the degree of correlation between 2 pixels in pixel pairs. Where

$\mu_i = \sum_{i,j} i(P_{i,j})$ is the mean value of the i[th] row, $\mu_j = \sum_{i,j} j(P_{i,j})$ is the mean value of the j[th] column, $\sigma^2 = \sum_{i,j} P_{i,j}(i - \mu_i)^2$ is the standard deviation value.

3. Energy

$$\sum_{i=1}^{M} \sum_{j=1}^{N} P^2(i,j) \qquad (6)$$

The energy feature counts the same number of pixel pairs (concentration of pixel intensity pairs). Where M = maximum gray level value of ith row, N = maximum gray level value of jth column, i = gray level value of ith row j = gray level value of jth column, P (i, j) = opportunity gray level values in the i row and jth column.

4. Homogeneity

$$\sum_{i=1}^{M} \sum_{j=1}^{N} \frac{P(i,j)}{1 + |i-j|} \qquad (7)$$

The homogeneity feature is the opposite of contrast measuring the homogeneity (similarity) of pixel intensity. Where M = maximum gray level value of ith row, N = maximum gray level value of jth column, i = gray level value of ith row j = gray level value of jth column, P (i, j) = opportunity gray level values in the i row and jth column.

Results and Discussion

Corn Pests and Diseases

Pests and diseases on corn plants that were detected were symptoms of aphis pests, leaf scrapers and rust disease, leaf spot, leaf blight, and midrib blight.

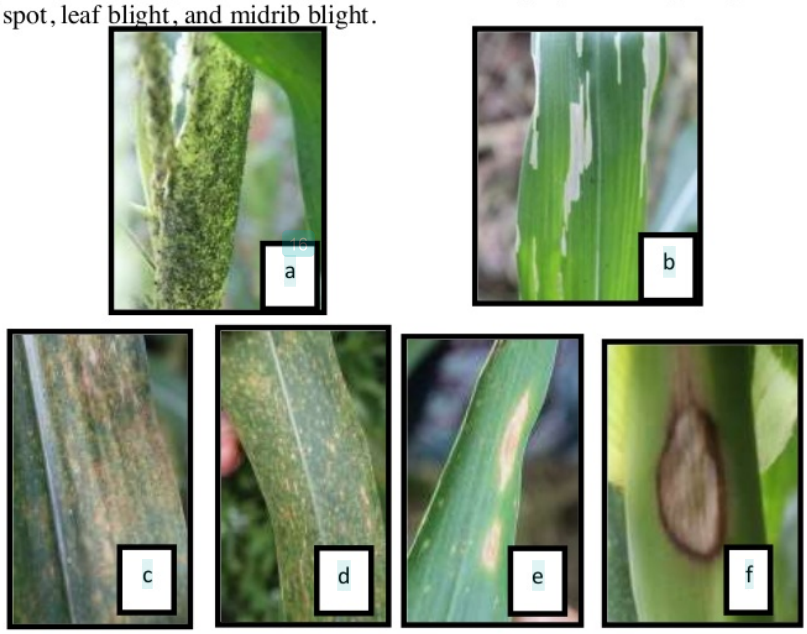


Figure 1. Photograph of disease symptoms in corn plants, a) aphis pest, b) leaf scrapers, c) rust, d) leaf spot, e) leaf blight, and f) frond blight (Research results, Lihawa, M., et al. , 2019)

System Design

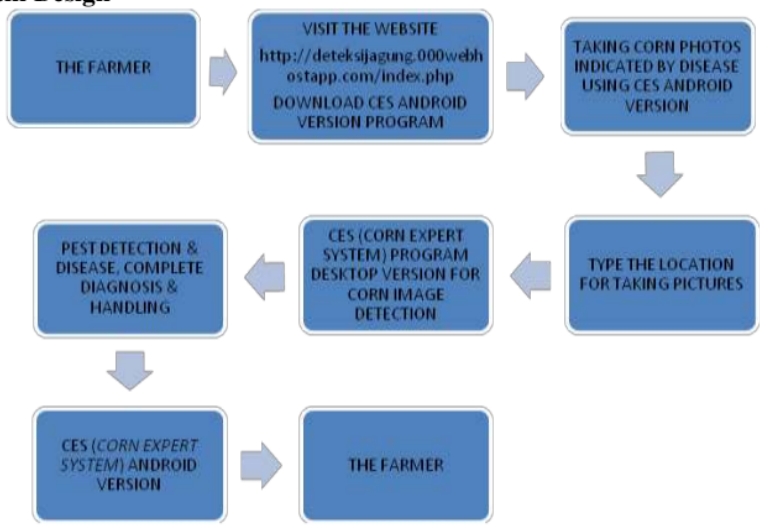


Figure 2. Design of CES (Corn Expert System) Program Design

At the design stage, there are 2 stages: stage 1, the design of the Android version of the CES program uses a system design consisting of database design, software architecture, and interface design using UML tools, then coding (coding) using the concept of OOP (object-oriented programming) by using the MVC software architecture (Model, View, Controller) (Naista David, 2016).

The design of the desktop version of the CES program uses image processing analysis using the Matlab program by using the Color Moment and Gray Level Co-Occurrence Matrix (GLCM) feature extraction.

Stages of Designing the Android version of the CES (Corn Expert System) Program

- Application architecture

In the development of database applications, this corn plant is used. For appearance, use HTML5 and Bootstrap 3 for mobile responsiveness. This MVC architecture separates data (model), interface view (view) and how to call both using the Controller (Naista David, 2016). When a user requests to the system, routing identifies the controller and what method is used to handle the request. Then the controller calls the appropriate data from the database. Data that has been taken from the database is displayed by the controller to the view to be seen by the user (Kamil, 2017). The architecture of this application can be seen as in Figure 2 below :

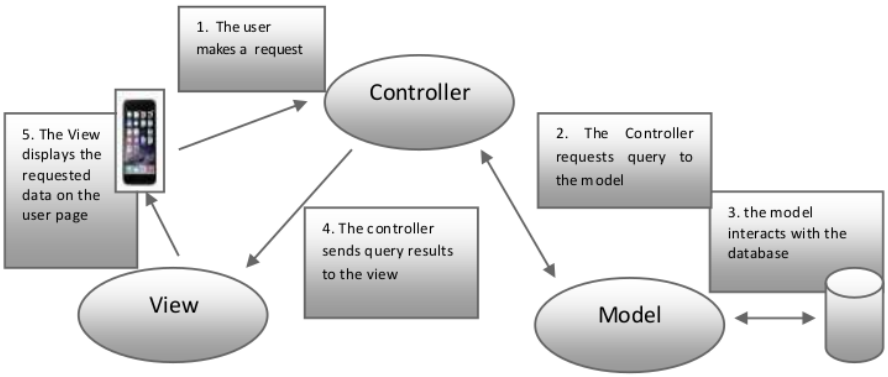


Figure 2. Application architecture

- Database Design

Database design starts with structuring the database based on the entity used and its relationship with other entities. The entity and its relationship are described in an ERD that represents the data model in the system. The tables consist of three tables that have relations with each other. The database in this application is named db_cornexpertsystem.sql, which consists of a user table, a disease table, and a detail_gambar table. For more details, can be seen in Figure 3.

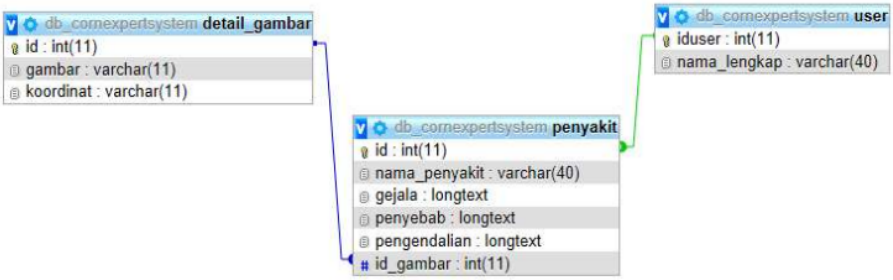


Figure 3. CES (Corn Expert System) database design

- Coding

Web service on this system is made using the PHP programming language Version 5.6.15. The web server uses Apache Version 2.4.17. Web server is used to run the PHP programming language in the browser. For data storage, MySQL Database Version 5.0 is used. Web applications that are built can be accessed by users using a web browser. The URL address can be accessed by entering the address http://deksijagung.000webhostapp.com. This page is used as a web service for sending disease data on android applications. In addition to the android application can be downloaded on this website as well. Furthermore, to be able to run the Corn Expert System (CES) android application which is the first time you have to register on the application (Figure 4).

Figure 4. List of Users

After that, use the existing username and password to login to the application. After logging in successfully, a disease picture list will appear along with information on name, address, date (Figure 5).

Figure 5. Success Login

If there is an image or image that we want to process, then click the + (ADD) menu to take pictures directly from the camera or from the HP gallery. After that, enter the complete address in the form (Figure 6).

Figure 6. Add Image Location Data

Then just waiting for the process of image detection by the desktop version of the CES (Corn Expert System) program application for analysis of diseases in corn plants using the image processing method of Artificial Intelligence (AI). Then click the picture menu that has been sent previously to see the disease, its causes and how to overcome it (Figure 7).

Figure 7. Image Detection Results

Testing System

At this stage, testing is done on the Android and desktop versions of the CES (Corn Expert System) program application.

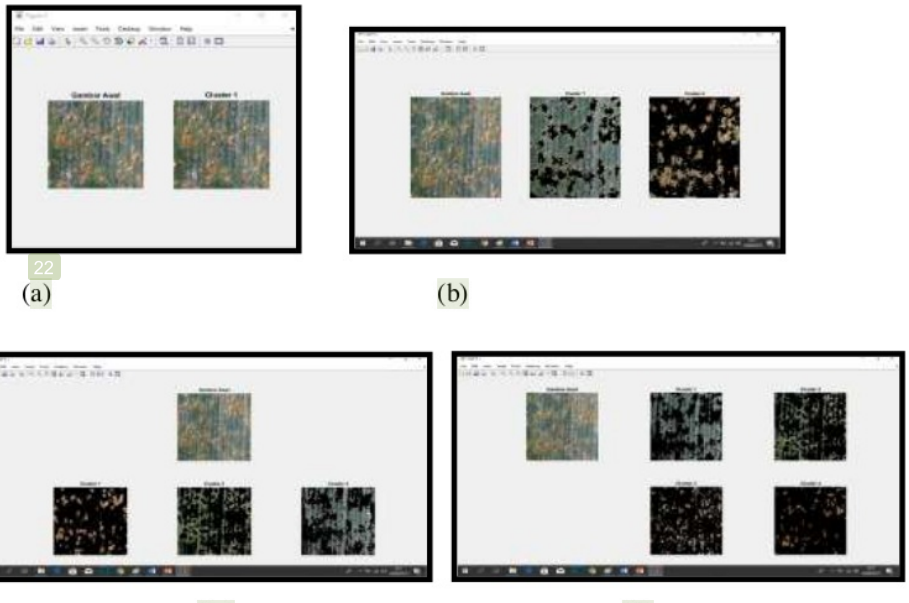
1. Testing the Desktop Version of the CES Program

The system testing process is also carried out by changing the k value parameter with the K Means Clustering method used in the classification process. For each training, image testing is done for clusters 1, 2, 3 and 4. For image training, 10 image data are used for each disease.

Table 1. Measurement Results of 4 Clustering Using K-Means Clustering

Pictures Clustering	Names of Diseases	Number of Test Images	True Amount	Accuracy (%)
1	2	3	4	5
Cluster = 1	Carat	10	0	0%
	Leaf Spots	10	10	100%
	Hawar Leaves	10	0	0%
	Hawar Midrib	10	0	0%
	Aphids	10	0	0%
	Leaf Slicer	10	0	0%
Cluster = 2	Carat	10	3	30%
	Leaf Spots	10	9	90%
	Hawar Leaves	10	9	90%
	Hawar Midrib	10	0	0%
	Aphids	10	0	0%
	Leaf Slicer	10	0	0%
Cluster = 3	Carat	10	0	0%
	Leaf Spots	10	10	100%
	Hawar Leaves	10	9	90%
	Hawar Midrib	10	9	90%
	Aphids	10	0	0%
	Leaf Slicer	10	0	0%
Cluster = 4	Carat	10	7	70%
	Leaf Spots	10	9	90%
	Hawar Leaves	10	9	90%
	Hawar Midrib	10	8	80%
	Aphids	10	6	60%
	Leaf Slicer	10	7	70%

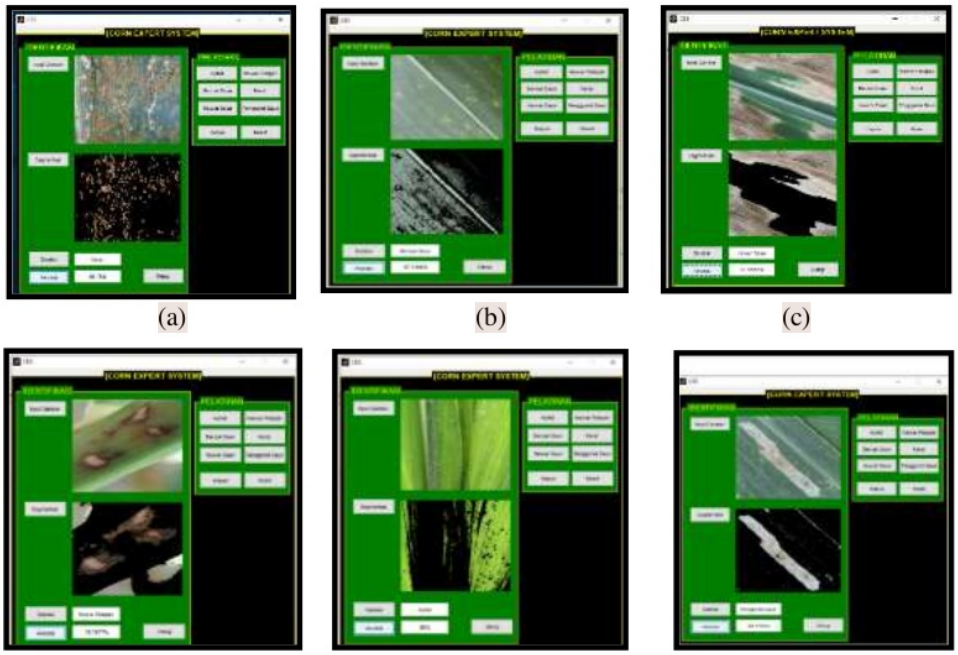
Based on the test results of the measurement of 4 Clustering using K-Means Clustering (Table 1), obtained an accuracy rate of 90% in Cluster 4, for leaf spot disease, leaf blight 90% accuracy rate. The level of accuracy is also largely determined by the technique of taking pictures of pest symptoms and plant diseases (Kiran R., MS., et al., 2014).



(a) (b)

(c) (d)

Figure 8. Testing 4 image clustering a) cluster 1, b) cluster 2, c) cluster 3, and d) cluster 4



(a) (b) (c)

(d) (e) (f)

Figure 9. CES desktop version testing for pests and diseases a) Rust b) Leaf spot c) Leaf blight d) Midrib e) Aphids f) Leaf Slicer

2. Testing the Android Version of the CES Program

Android version testing is done by using the black box testing method, which is a testing method that focuses on checking the availability of functionalities that have been designed on the application. Table 2 shows the results of functional testing. All functionalities that have been defined at the analysis stage are tested using the same method. The test results show the system has been made under the requirements specified at the analysis stage.

Table 2. System Test Results

No	*Use Cases*	Results
1	2	3
1	*User login*	Fulfilled
2	Add *user*	Fulfilled
3	Add picture data of corn plants diseases	Fulfilled
4	See the picture history of corn plant diseases	Fulfilled
5	Deleting and editing of corn crop disease image data	Fulfilled

Conclusions

a. The CES (Corn Expert System) application program is a unity of the android and desktop versions that can detect pests, leaf scrapers and rust disease, leaf spot, leaf blight and fronds blight on corn plants.

b. The Android version of the CES (Corn Expert System) program was built as a medium to be forwarded to the desktop version of the CES (Corn Expert System) program to detect pests and diseases through image processing.

Suggestion

To develop this application, a chatbox method can be added so that it can communicate with users.

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