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Hybrid of the Fuzzy C Means and the Thresholding Method to Segment the Image in Identification of Cotton Bug

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Abstract

With the increase of the population the supply for agricultural products are always high in demand so if there is a disease in the crops there is significant reduction in quantity and quality of the crop leading to multiple problems. In this paper a new approach is proposed to find the diseased crop. To find the diseased crop the system will not only use the Image processing but also segmentation and neural networks to refine the results up to 80% accuracy. With this accuracy, the result will be more reliable. Here for image processing the features like Area, Orientation and many other features are taken out. For the segmentation purpose the Fuzzy C Means and thresholding are used and Lastly Neural Network is applied to refine the result.

Keywords: - Crop Disease, FCM, Thresholding, Image Processing, Neural Networks.

INTRODUCTION:

Around 25 percent area in India amongst the world's area is occupied by cotton plants also 16 percent of its world's total production. Maharashtra state is well known in India for growing cotton which has 31.32 lac hector area with a production of 62.99 lac bales (2008-09), making it the 2nd largest cotton producer in the world. Near about 2.9 million farmers typically in backward region of Marathwada and Vidarbha are involved in cotton cultivation in the state [1].

In Vidarbha region,cotton is the most significant cash crop which is grown on an area of 12.99 lacs hectors with production of 26 lacs bales of cotton (2008-09). The cotton productivity [1] is mainly declined by the disease attack, resulting in reduced productivity up to 26% of total production.

The infected area of the crop is used to identify the disease of the crop. The detection and identification of crop diseases was generally done with the help of naked eyes by the experts in ancient times. But this requires unremitting nursing by the Experts and it demands high cost when used for large fields [2]. Therefore farmer have to take lots of efforts in many underdeveloped countries

If machine vision technique is used, the plants can get identified and classified more faster at every phase. Specifically the machine vision system comprise of digital camera and computer software related to particular application. The application software has various kinds of applications. Image analysis is one of the most important method that helps segment image into required objects and background. Feature detection is one of the crucial steps in image analysis. The input data is renovated into the set of features is a process named as feature extraction.

Now a day, for the analysis of various features of the crop, widely used technique is image processing, which gives a new approach to explore the field of agriculture in a different way. The image processing techniques had been continuously applied in the agriculture related applications for the succeeding purposes [3].Initially to detect diseased stem, leaf, fruit. Afterwards to find affected area grabbed by disease, third to find shape of affected area. And fourth to calculate the shape and size of fruits.

LITERATURE REVIEW

Computer vision is a technique used now a day in the agriculture to identify and diagnose cotton disease. The process is feature selection is used in pattern recognition which provides sufficient input for the classifier design and performance

Various papers are suggesting diagnosing the cotton leaves with the help of different approaches signifying the variety of implementation ways as illustrated and discussed below.

Disease Detection on leaves of Cotton and its Possible Analysis was projected by researchers [1] Specified that by using self-organizing feature map in cooperation with a back-propagation neural network the features could be extracted to recognize color of image. Cotton leaf pixels are segmented using this information within the image. Image under consideration is appropriately analyzed and afterwards depending upon this software performs further analysis is carried out which is based on the nature of this image. According to this research, the system provides 84 to 90% of precise disease detection which additionally depends upon the image quality supplied by the portable scanner and the training. A very efficient diagnosis of the cotton leaf disease is made by more train networks.

Otsu Thresholding and k-Means Clustering [2] are carried out in Infected leaf analysis and compared two main techniques used for image processing, concluded that k-means is better as compared to Otsu thresholding because differences extracted for Otsu threshold are more than the same extracted value for k-means clustering.

Identification of the cotton leaf spot diseases [4] proposed a system that makes uses of mobile captured symptoms of cotton leaf spot images and helps in the classification of the disease using neural network [5] for identifying the nitrogen deficiency in cotton plant by using image processing considered the pattern that the leaf possess for detection of disease. The various feature such as area, shape of holes present on the leaf, diseases spot of image of leaf are extracted A different image processing technique is used to extract these features. These extracted features are used to determine the occurrences of particular deficiency related to primary nutrient of cotton leaf. The two preliminary steps for detecting Nitrogen deficiency are histogram analysis and measurement of leaf area. The leaf with deficiency and a normal leaf werecompared, the leaf with deficiency has reduced area compared to that of normal leaf.

PROPOSED SYSTEM

In this section the solution to the problem of crop disease detection is explained in brief. The problem is solved in three steps, the first step is the pre-processing step- In this, the image of the crop is processed on the basis of the features namely, and Area, Eccentricity, Orientation, Length of Major and Minor Axis, The brief discussion on each of them is carried out in the following paragraphs.

Once the pre-processing phase is over, the image is forwarded for the evaluation phase where the Image is segmented using the Fuzzy C Means and the thresholding method. After segmentation, the result is processed for refining which is done in this system by means of Neural Networks to increase the efficiency of the output. The modules are explained as follows:

A. Image Processing:

In terms of computational complexity and retrieval efficiency, Shape map has shown better performance. The most extensively used feature in image similarity retrieval is shape. The computer results of color similarity are similar to the results derived from human visual system that can differentiate between infinitely large numbers of colors. An intensity variation is created texture from pixel to pixel in an intensity image.

Shape based image retrieval depends on similarity between shapes represented by their features; Simple geometric features can be used to describe the shape. But geometrical features can only discriminate large differences and hence different aspects are used to perform it. These aspects are center of gravity, axis of inertia, Average Bending Energy, Eccentricity, Circularity Ratio, Ellipse Variance and Rectangularity

- Centre of Gravity: The center of gravity or the centroid has its position fixed in relation to the shape. The centroid of a particular region is calculated as:

$$\begin{cases} g_x = \frac{1}{N}\sum_{i=1}^{N} x_i \\ g_y = \frac{1}{N}\sum_{i=1}^{N} y_i \end{cases} \quad (1)$$

Where N is the number of points in the shape.

- Axis of Least Inertia (ALI): It is unique property of the shape. It acts as a unique reference line to preserve the orientation of the shape. The ALI is termed to the line for which the integral of the square of the distances to points on shape boundary is minimum. The inertia is given by

$$I = \frac{1}{2}(a+c) - \frac{1}{2}(a-c)\cos(2\propto) - \frac{1}{2}\, b\sin(2\propto) \quad (2)$$

Where:

$$a = \sum_{i=0}^{N-1} x_i^2 \,, b = 2\sum_{i=0}^{N-1} x_i y_i \,, c = \sum_{i=0}^{N-1} y_i^2 \quad (3)$$

- Average Bending Energy: Average binding energy can be calculated using:

$$BE = \frac{1}{N}\sum_{s=0}^{N-1} K(s)^2 \quad (4)$$

- Eccentricity: It is the measure of aspect ratio, the ratio of length of major axis to length of minor axis. It can be calculated using the Principle Axis method (PAM) or the Minimum bounding rectangle (MBR). In PAM the principle axes of the given shapes can be defined as two segments of lines that cross each other orthogonally in the centroid. Whereas the MBR is the smallest rectangle which can contain the shape.
- Circularity Ratio (CR): CR represents how the shape is similar to a circle using its three definitions: Circularity ratio is the ratio of the area of a shape to the area of a circle having the same perimeter, secondly Circularity ratio is the ratio of the area of a shape to its perimeter square, Circularity ratio is also called circle variance.
- Ellipse Variance: Eva is a mapping error which occurs when a shape to fit an ellipse that has an equal covariance matrix as the shape:

$$C_{ellipse} = C.$$

- Rectangularity: it represents how much rectangular a shape is and how much area is filled in the minimum bounding rectangle which is calculated using:

Rectangularity: A_S / A_R ,(5)

Where As is the area of shape and A_R is area of rectangle.

- Convexity: it is the ratio of perimeter of the convex hull Oconvexhull over original contour O:

Convexity: = $O_{convexhull}$/ O (6)

- Solidity: it defines the extent to which the shape is convex or concave which is defined by

Solidity = As /H, (7)

Where As is the area of shape region and H is the convex hull.

- Euler Number: it is the relation between the number of contiguous parts and the no. of holes on a shape and can be defined as

$$\text{Euler} = S - N \quad (8)$$

  Where S is the contiguous part and N is the holes.

- Profiles: it is the projection of the shape to x-axis and y-axis on Cartesian coordinate system which can be defined in the two dimension function as follows:

$$pro_x(j) = \sum_{j=jmin}^{jmax} f(i,j) \text{and} pro_y(j) = \sum_{i=imin}^{imax} f(i,j) \quad (9)$$

- Hole area ratio: it is defined as

$$\text{Hole} = A_h / A_s \quad (10)$$

  Where A_h is the total area of holes and the A_s is the area of the shape

B. Segmentation

Once the features of the image are achieved, processed them to find the disease by separating the healthy and the diseased part by using segmentation. There are multiple ways in which the segmentation can be done but in this system we will be particularly using the FCM and thresholding both the techniques are explained as follows:

C. Fuzzy C Means:

The FCM or the fuzzy C means which was introduced by Dunn and extended by Bezdek is the clustering algorithm whereas in this system the clustering of healthy and diseased pixels are required therefore the FCM is applied. This algorithm is an iterative clustering algorithm which has the capability to produce an optimal c partition by reducing the weight or the intensity of group and sums the square error objection function J_{FCM}, [7] It is denoted by

$$\text{JFCM} = \sum_{k=1}^{n} \sum_{i=1}^{c} (uik)^2 \; d^2 \; (xk\,, vi)$$

In the above mentioned algorithm

$$X = \{x_1, x_2, \cdots, x_n\} \subseteq R^p$$

is termed as the data set of the p-dimensional vector space. Here h ten is the number of data item, c is the number of clusters where c can be 2 till n. $u_{ik}$is the degree of membership of any value of x in any cluster, q is weighting exponent on each fuzzy member. $v_i$is the center of cluster i, d^2 (x_k,v_i) is a distance between the cluster center and the fuzzy component x. The solution can be found with the help of the following algorithm: [8]

1. Set values for q, c&ϱ.
2. Initialize the fuzzy partition matrix $U = [u_{ik}]$.
3. Set the loop counter $b = 0$.
4. Calculate the c cluster centers n$v_i^{(b)}$o with $U^{(b)}$:

$$v_i^{(b)} = \frac{\sum_{k=1}^{n} \left(u_{ik}^{(b)}\right)^q x_k}{\sum_{k=1}^{n} \left(u_{ik}^{(b)}\right)^q}$$

5. Calculate the membership $U^{(b+1)}$. For k = 1 to n, calculate the following:

$$I_k = \{i | 1 \le i \le c,$$

6. d_{ik}= kx_k− v_ik= 0}, 6 I; for the k^{th}column of the matrix, compute new membership values:

(a) if $I_k = \varphi$, then

$$u_{ik}^{(b+1)} = \frac{1}{\sum_{j=1}^{c} \left(\frac{d_{ik}}{d_{jk}}\right)^{\frac{2}{(q-1)}}}$$

else$u(ikb$+1) = 0 for all i 6∈I and Pi∈$Ikuik$(b+1) = 1; next k.

7. if ││ $U^{(b)}$ - $U^{(b+1)}$││, stop;
   Otherwise, set $b = b + 1$ and go to step 4.

D. Thresholding

Thresholding is the most widely used method of image segmentation. In this method the pixels are portioned depending on their intensity value. It is divided into three major groups, global thresholding which uses an appropriate threshold value T [9] Second group is of variable thresholding, if T is varying in the image then this type of thresholding is applied to segment the image which is further divided into two sub groups: local or regional thresholding where T depends on a neighborhood of (x,y). Last is the multiple thresholding which is combination of both global and variable threshold, to choose such kind of threshold to use in the system the histogram of the image helps. The peaks and the valleys of the image histogram can approximate a value to choose the best kind. In global thresholding an initial estimate of T is made from the histogram of the image, the crop is of green color and the disease is of red color there is an intensity difference in the colors and hence T is calculated in more suitable manner to remove the green intensity pixels from the red so that the disease is analyzed. Similarly a fixed or approximate value is required. In Local or Variable Thresholding, the segmentation is purely based on the local properties such as statistics help in adapting the threshold. Any linear equation can also be used to determine the threshold where the segmentation is operated using a suitable predicate. This technique is also generalized to multiple threshold. Multiple Thresholding is sometimes complex to implement as it is to be used for both Global and Local. To simplify the method Otsu's method can be applied.

In this system the hybrid of the FCM and the thresholding method is used to segment the image.

E. Neural Networks:

For the purpose of classification neural network as shown in Fig 1 is used. But in general Neural networks are used perform any of the six task of image processing. Here our main aim is to use it for object detection, for which the NN are widely used. One of the techniques to find the object is by the help of pixel data and the method which is less used is to map the contents of a window onto a feature space that is provided as input to a neural classifier. Both the methods are explained as follows:

1) ***Classification Based on Pixels:*** This method has multiple variants such as the feed-forward-like ANNs, variants using weight sharing, recurrent networks. All these novel methods are developed specifically to cope up with the object in the image like the variation in position scale and rotation.

The algorithm used to train the system is back-propagation. The gradient descent is used to update the weights so that the squared error between the output values and the target values is minimized. A typical model consists of three layers - hidden layer, an input layer and an output layer. For this model the error is back-propagated to the hidden layer every time and subsequently to the input layer with each passing iteration. The values connecting the input neurons to the hidden layer neurons are changed randomly to minimize the distance between the desired values and the actual output.

The SSE and RMSE are used for performance evaluation and are denoted by:

$$SEE = \sum (Tpi - Ypi)^2$$

$$RMSE = \sqrt{MSE} = \sqrt{SSE/n-p}$$

The following depicts the network architecture, there are three layers input hidden and output. The network has R, G, and B [10] values of every pixels as input in the input layers. This network is trained by image set to give best performance.

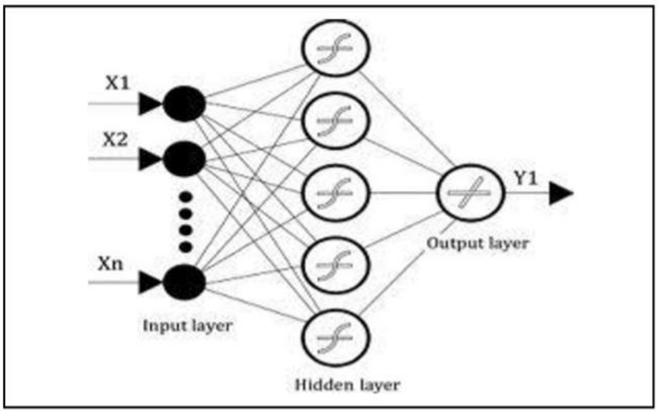

Figure 1: Neural Network for Pixel Classification

2) ***Classification based on Features:*** Another method is the classification by features, comparatively smaller research is done and a smaller variety of neural architectures developed for feature based object classification [11]. The most common thing for the feature based recognition is that variations in rotation and scale are coped with by the features such as statistical moments. Only a small amount of noise will influence the feature and detection and will hamper the performance. Therefore a large object is required so that the noise cannot effect the hamper.

The properties required to classify using features are as follows:

Gabor filter banks,

Dedicated features: like stellate and OCR,

High curvature points,

Projection of image in x and y axis,

The Fourier description from images,

The Zernike moments.

IMPLEMENTATION

In this section of the paper the implementation of the proposed system is explained. Here the first module is image feature extraction, the second module is the image segmentation and last is the classification of the system. The details analysis and the flow of the proposed system is as follows:

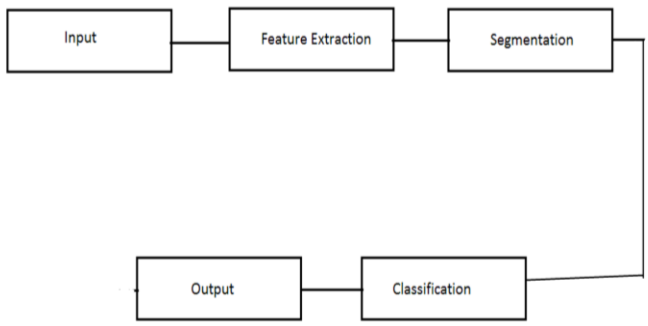

Figure 2: Flow of the Proposed System

As observed in the Fig. 2, there are five modules namely input, output, Feature Extraction, Segmentation and classification. All the modules have the following functions:

Input: This module focuses on the input section. The input is taken from a camera, if a farmer found some disease on his cotton crop the team will take the snapshot of the crop and will send it to analysis.

Feature Extraction: this is the important module as to identify the disease we require the features of crop as well as the features of the image to make the comparison. In this module the features such as area, eccentricity etc. are extracted and stored for further usage.

Segmentation: In this stage the features of the images are segment to create a differentiator between them. Here thresholding and FCM is carried out to segment the image properties.

Classification: Once the extraction and segmentation is done there is a need for classify to find the disease. This classification is fulfilled by Neural Networks. With the help of the extracted and segmented features the neural network classified the data and gives the result.

Output: This module focuses on the final output, if the cotton has some kind of bug. It will tell the bug name and the effects made by them.

RESULT

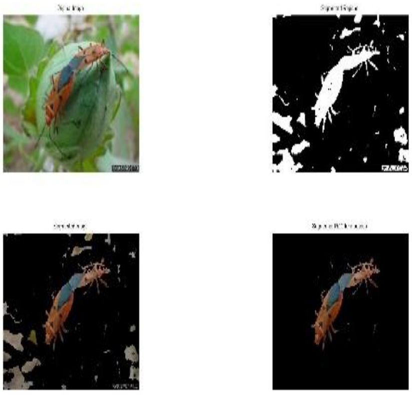

Figure 3: Crop Disease Detection

Fig. 3 shows the Crop Disease Detection system which is proposed and implemented. As observed, the left top part shows the original image for the disease detection. Firstly with the help of the hybrid segmentation technique which is a combination of FCM and thresholding segments the image the top right corner depicts the segmented part.

Once segmentation is done the features are extracted for the above image the features are Area: 16.00 sq. pixels, Eccentricity: 0.94, Orientation:-6.17, Major Axis Length: 8.34 pixels, Minor Axis Length: 2.84 pixels. With the end of extraction phase the features are then classified by the neural networks to give the best output. In this system the accuracy of the output is 80%. The Table1 below shows the accuracy rate.

Table 1: Accuracy of Proposed System

Number of Images Tested	Number of images classified accurately	Accuracy of system
10	7	70%
20	15	72%
50	36	73%
100	76	76%
200	152	76%
500	395	79%
1000	800	80%

Table 1shows the accuracy rate of the proposed system, when the system is given 50 images, the system perfectly classifies 36 images and that is approximately 73% accuracy whereas when the number of images is more the accuracy is moving upto 80%. Therefore we can say that the accuracy of the system is about 70% to 80%.

CONCLUSION

In the proposed research work, techniques of FCM and Thresholding are combined which gives very good segmentation accuracy, due to proper segmentation the feature extraction is also perfect. Thereby non-redundant features are achieved which describe the crop images perfectly. The neural network classifier performs well with an accuracy of more than 70% for crop classification, and has some scope of improvement. This work opens up avenues for researchers to identify and work on areas of semi-heighted crop based image processing which enhances the quality of farming by detecting and sometimes suggesting areas of improvement via classification of crops in the agricultural land

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