A Comprehensive Survey on Image Processing Methods in Cotton Detection and Identification

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***Abstract*— In India agriculture plays a vital role in Indian Economy. Major contribution towards agriculture GDP is done by cotton. During harvesting time cotton requires excess labor and also manual picking will degrade the quality, so Automation is very much required for the better yield and also to preserve the quality of the cotton. This survey paper describes some of the methodologies where image processing techniques are used in cotton detection and identification.**

Keywords*— *Image Processing, Machine Vision, Neural based classifier, segmentation

I. INTRODUCTION

Agriculture is the backbone of Indian Economy, because major contribution for the growth of GDP is done by agriculture. India ranks first globally with highest net cropped area followed by US and China [1]. India is one of the largest producers as well as exporters of cotton. According to Economic survey statistics export of Indian agriculture was 5% of total production of the world.

Cotton which is popularly known as cash crop of India. Among all the cash crops it is also known as "king of fibers". India is the second largest producer of cotton, it provides basic raw materials to cotton textile industry. India is the only country which cultivates four species of cotton i.e Gossypium arboreum, Gossypium barbadense, Gossypium herbaceum, Gossypium hirsutum. G.arboreum and G.herbaceum are desi cotton where as G.hirsutum and G.barbadense are American cotton.

This paper is divided into six sections. Section II presents the study of various species of Cotton. Major Cotton species grown in India are discussed along with their characteristics in the same section. Section III presents the general approaches for detection and classification with different techniques with respect to Image Processing. Section IV Findings of the literature survey and comparison between different segmentation and classification techniques are also discussed in the same section. Section V describes our survey on detection and classification of cotton. The survey is carried out on number of parameters such as image processing steps, segmentation technique, extracted features and accuracy. Section VI describes the proposed work to detect and classify cotton leaf disease. Section VII presents the summary of proposed work in the form of conclusion. Future work is also presented in the same section.

II. TYPES OF COTTON SPECIES AND THEIR CHARACTERISTICS

Gossypium arboreum: It is having long trailing thin branches and stems. For these species young branches, petioles, peduncles and bracteoles are of deep glossy purple colour. The Blade of the leaf has five to seven lobed. Its flowers are yellow with purplish red petal spot, tapering capsule.

Gossypium herbaceum: It is having hard stems and branches are round slightly bent at the joints. Leaves are reticulate and leathery in nature. Bracteoles are large and green in colour. Flowers are not very large, yellow with purple claws, rounded capsules.

Gossypium hirsutum: Stem tip is green to pigmented and also glabrous to densely hairy. It has heart shaped leaves that are three to five lobed. Leafs are broad to very narrow. Its flowers are white to yellowish up to 3.5 inches across.

Gossypium barbadense: It has broad leaves, slightly hairy or deeply coated with long grey hair. Its stems are weak, bracteoles are fused at base. Flowers are initially yellow later pink with reddish spot and coarsely pitted capsule.


G.Arboreum


G. Herbaceum


G. Hirsutum


G. Barbadens

Fig. 1 Four Species of Cotton grown in India

With all these wide range of physio geographical climate in India for cotton is a boon. But, during its harvesting time cotton is resulting in fewer yields because of decrease in labour population. Introduction to Automation is very much necessary in order to reduce the monotonous work of manual labor and also to raise the quality of produce.

This gives scope for tremendous technological improvement in this sector. There is scope for automation that could help the farmer in producing both quality and quantitative produce.

Some of the challenges in detection and identification of cotton are i) cotton with various sizes and shape ii) detection during changing illumination. iii) Occlusion with respect to cotton.

Image processing techniques can be used for mechanization of efficient picking process of cotton. Machine vision is a fast growing technology which provides image based automatic inspection and analysis in agricultural sector [2].Hence there is a need for automation in agricultural field to resolve the real time problems.

III. GENERAL IMAGE PROCESSING METHODS FOR DETECTION AND IDENTIFICATION

General approach for detecting and classification of cotton is composed of three steps Image Pre-processing, Image Segmentation, Image Classification.

Image Acquition: The process acquiring an image using a sensor or a camera. These images are then fed into the system. An acquisition process can request an image from several environments. The acquired image has to be compressed depending on our requirement to reduce their storage size and time required for processing.

Types of image compression:

1) Lossy compression: This technique is used whenever the image can be compressed and the data lost will be negligible, although acceptable.

2) Lossless compression: This technique is used whenever the data should not be lost when the image is compressed.

Image Pre-processing: The process of improving the image that removes unwanted distortions or enhances some image features important for further processing.The general process in image pre processing is conversion of original RGB image into grey scale image. This makes the further processing of the image simpler because the images will have only one channel where as the RGB image will have three channels. Gray scale image has a single color representation which stores the intensity of light. The aim of pre-processing is to improve the quality of image by removing unwanted noise from the image. There are different types of noises which are present in the images.

1. Gaussian Noise: This noise is caused by natural sources like thermal, vibration of atoms and radiation of objects.

2. Brownian Noise: This noise is a form of coloured noise. This is caused by Brownian motion.

3. Impulsive Noise: This is also called as the salt and pepper noise. This is caused by sudden and sharp disturbances in the image signal. Here sometimes, some of the white pixels are represented as black pixels, and some of the black pixels are shown as white pixels.

4. Multiplicative Noise: This is a kind of noise where dark pixels appear near the dark region of the image and light pixels appear in the light region of the image. This keeps multiplying further over transmission.

There are different techniques to filter the noise, they are:

1. Average Filter: This technique takes the average of all the pixels in the image and converts each of the pixels into the average value.

2. Median Filter: This technique sorts all the pixels in ascending order and calculated the median of these pixels and converts each of them into the median value. This is the best filtering technique because all the pixels are considered.

3. Minimum Filter: This technique considers the minimum of all the pixels and converts each of the pixels to that minimum value of the pixel.

4. Maximum Filter: This technique considers the maximum of all the pixels and converts each of the pixels to that maximum value of the pixel.

In most of the cases Mean and median filters are used to remove noise.

Image Segmentation: Image Segmentation is dividing the image in to multiple segments. The main objective of segmentation is to find the area of interest and to remove unwanted region. It also identifies the boundary of the object. Different types of segmentation techniques are

- Thresholding method: Here, the image pixels are divided with the help of intensity level of the image. This method distinguished between foreground and background. Example for this method is the Otsu's Method.

- Color based method: This method is based on monochrome segmentation approaches operating in different color spaces. This separates the relevant information from the ones not needed based on the color of pixels. Example for this is the K-means Method.

- Edge Based Method: In an image the connected pixels on the boundary of the region s are called as edges. The pixels on an edge are called as the Edge Points. Edge can be calculated by finding the derivative of an image function.[3]

- Clustering Based Method: This method segments the image into clusters having pixels with similar characteristics. There are two basic categories of clustering method:

1) Hierarchical Method: This is based on concept of trees where root of the tree represents the whole database and the internal nodes represent the cluster.

2) Partition based Method: This method uses the optimization methods iteratively to minimize the objective function.

Image Classification: There are many techniques available for classification.All the classification algorithms are based on the assumption that the image depicts one or more features and that each of the features belong to one of several distinct and exclusive classes.

- Support Vector Machine: Support Vector Machines are based on the concept of decision planes, it is the one that separates between a set of objects having different class memberships which in turn defines decision boundaries. It performs classification tasks by constructing hyper planes in a multidimensional space that separates cases of different class labels. SVM is used for both linear and

non linear classification. Samples can be separated easily in linear when compared to non-linear[4]

- Neural network: Neural networks consist of individual units called neurons. Neurons are located in a series of layers. Neurons in each layer are connected to neurons of the next layer. Data comes from the input layer to the output layer along these compounds. It is basically interconnected processing elements which process the information. Each individual node performs a simple mathematical calculation. Then it transmits its data to all the nodes it is connected to. Compared to other types of neural networks back propogation networks are slower to train.

IV. RELATED WORK

A through literature survey is carried out to find the existing systems used for cotton identification and classification for automated harvesting.

A novel approach is proposed [5] for harvesting of cotton using shape and fractal features. Cotton images are acquired and converted in to gray scale image from a RGB image which in turn converts to binary by thresholding. Fourier transformation is used for image analysis. After Fourier transformation, fractal dimension analysis is used on the images. Fuzzy neural based classifiers are used for classification after the decision of features. Set of features has been computed like area, mean, standard deviation, variance, skew, entropy, energy, mod, median, RMS for each required area identified as buds. From the Fractal analysis of the image of both premature and mature cotton bolls are taken and the variation of intercept and slope is much higher for mature buds compared to premature cotton buds. Standard deviation parameter also helps in distinguish between premature and mature stage of cotton ball. They have proposed decision making model where the matured cotton balls are picked up.

Yanan Li [6] proposed infield cotton detection from a region based semantic segmentation. Every in-field image is composed of regions generated by super pixel grouping by spatial location and colour relationship between super pixels. Super pixel algorithm segment images into super pixels as supporting regions for feature vectors and primitives to reduce computational complexity.

Generally texture and colour information is useful for cotton detection. Histogram-based colour and texture features are used for training samples to implement the semantic labelling by means of random forest. Proposed method significantly improves the performance of cotton detection with highest performance.

USN Rao [7] proposed an Automated Cotton Picking Robot (ACPR) based on machine vision together with Image Processing and Microcontrollers for identification, recognition, and processing of the cotton image. Color subtraction module is used to identify different parts of cotton Plant and also Dynamic Freeman chain coding is used to remove the noise which in turn helps in better accuracy. In this paper machine vision cotton picking robots are used for better yield which in turn leads to maximum production per hectare. These intelligent robots use variety of visual sensors to detect objects with respect to their identity, position, colour, orientation in 3D pattern at the fields. This paper also proposes at the new algorithms in Image processing of the cotton to extract the feature, modelling and matching.

V. SURVEY ON DETECTION AND IDENTIFICATION OF COTTON

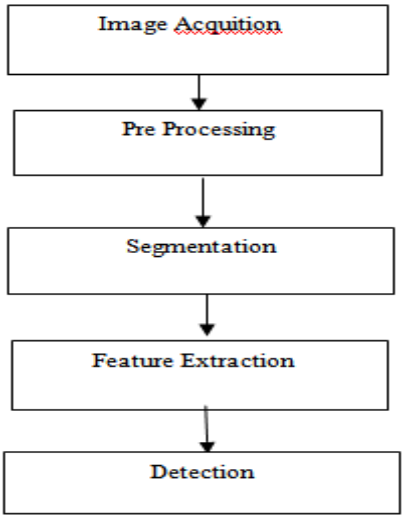

Fig. 2 General Approach for Detection andClassification of cotton

Image Pre Processing: We capture the cotton image from the natural background. ColorSubtraction Module used to correctly identify cotton from the background in real time. According to color Analysis, it can be seen that the color values of red, green and blue of cotton flowers are quite the same, whereas for Leaves and Stems are quite different. Hence, this characteristic can be used to differentiate cotton from the other two.

During acquition there is always a chance of noise which we have to remove by applying proper filters. Various types of noises are shadow, reflection of the sunlight. These types of noises can be remove by converting image from RGB to HSV and thresholding is applied to remove the noise. Median filter is used for image smoothing which in turn enhances the image

Image enhancement is very much required for further processing. Image enhancement converts the image to a particular form that can be easily understandable by machines. For image enhancement Histogram Equalization is used to enhance contrast image which gives better result.

Image Segmentation: For Cotton segmentation, growth state and illumination are the vital element in dataset collection. After collection of dataset we have to segment using appropriate segmentation techniques. One of the methods in segmentation is thresholding method, it has high noise factor and it can be used to distinguish between background and foreground. When images are taken in natural background during sunlight it does not perform well. Another method is K means clustering which is unsupervised learning algorithm. In K means clustering we have to decide the k value but accuracy in detecting cotton is not up to the mark. It does not perform well for smaller datasets [8].

To segment the cotton efficiently we can use canny and sobel segmentation and region based segmentation method. In canny and sobel edge segmentation detects all the details of the plant like

stem, branch, sky and cotton which is easy for detecting the cotton. Region based segmentation method improves the segmentation performance in cotton detection by the spatial location and colour relationship between super pixels, every image captured in the natural environment is composed of regions generated by super pixel grouping. Region based methods is more efficient compared to other techniques because they cover more pixels than edges and thus we have more information available in order to characterize our region of Interest.

Feature Extraction: It extract the relevant information from an image to detect cotton. In an image we have to extract three features i.e shape, colour, and texture. Colour histogram is used to extract the colour feature from the image. It is independent to size, rotation and the accuracy of the captured image.

For shape extraction region based technique is used. In this technique all the pixels within a shape region are taken into account to obtain the shape representation, rather than only use boundary information. Region based method is more effective as whole shape region is considered for descriptor where every pixel of shape is considered. [9].

For texture based extraction spatial texture method is used because it can extract information from any shape. Spatial texture method i.e Grey-level co-occurrence matrix (GLCM) is used. It distinguishes the relationship between the pixel of interest and the pixel to its immediate right is defined. GLCM features like contrast, correlation, energy and homogeneity are calculated from each image and stored in a feature vector. All the features describe the similarity and difference between the pixel patterns of an image.

After extraction appropriate classification techniques are applied to detect the cotton. For classification SVM and neural networks can be used. Support Vector Machine (SVM) is a binary classifier which finds an optimal hyperplane to classify dataset. The basic idea of SVM is to find the optimal hyperplane which separates the instances space. 90% accuracy can be achieved by SVM in detecting objects [10] neural networks technique gives better result due to powerful parallel mechanism of computation. We have to train a neural network that is capable of identifying cotton from images, this requires large number of dataset for training which is time consuming. More the layers in the network better the results. [11]

VI. SCOPE FOR RESEARCH

The scopes of this research work are as follows:

An image of the cotton plant is captured using digital camera in natural background. Digital cameras are used along with computers and appropriate softwares are used to segment leaves, stem and branch of the cotton plant.

Various images of four species of cotton are acquired and for all these images database is created and maintained. Further processing of the image is done in MATLAB. During image acquisition there is always possibility of occurrence of noise in the image. In order to resolve the noise and also to improve the quality of the image different noise removal techniques are used. Appropriate segmentation and feature extraction techniques are used to extract the important features from the image in order to recognize the cotton. The extracted cotton from the image is matched against a database to identify the type of cotton. Once the particular species of cotton is identified with no obstacles then automation can be easily implemented. Hence from automation quality of the cotton can be preserved which can directly elevate the economy of the country.

VII. CONCLUSION

In this paper, Survey on cotton detection and classification using image processing and machine learning techniques was carried out. Also the survey on classification and segmentation techniques was performed.

From this survey we can conclude that gray scale conversion is useful for image preprocessing. We have also observed that for noise removal median filter gives best result. For segmentation process, support vector machine is used which separate the object of interest from the natural background. We can also incorporate neural network for training the images which gives better result. A new technique will be adopted for preprocessing, segmentation, extraction and identification of cotton. It will be designed in such way that it use Effective Segmentation technique to segment the cotton and also it uses new technique for detecting cotton even with the occlusions. Various Algorithms can be developed for Automation in cotton picking. The accuracy of the proposed approach will be evaluated and compared with the existing techniques.

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