Segmentation of Crop Images for Crop Yield Prediction

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Abstract: - The crop yield prediction is very useful for the farmers to manage the farming practices. The prediction accuracy depends on various pre-processing tasks including but not limited to segmentation of crop images. There are several methods for segmentation of crop images but each of these methods suffer from one drawback or the other. In this paper, a segmentation based on k-means is presented. Prior to the k-means clustering, the input image is filtered using box blur kernel. The filtered image is histogram equalized using histogram equalization method. The method is tested on a huge dataset. The accuracy of the method is calculated, and it has been observed that the method outperforms existing methods and is computationally inexpensive.

Key-Words: - Crop yield prediction, segmentation, pre-processing, thresholding, image processing

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1 Introduction

The crop yield prediction is very useful for farmers to manage the farming practices. It has been seen that the prediction accuracy is not up to mark in many cases even though the model is trained with large number of crop images and is tuned well. The reasons for poor accuracy of the prediction model are the lack of proper pre-processing tasks applied on the crop images. Among many, histogram equalization [1], image registration [2], and image denoising [3] are commonly used. The dataset used is taken from [4].

The segmentation methods on the color images have been discussed [5]. The use of various segmentation techniques applied on the medical image sis given in [6]. The segmentation methods on the digital images with their use is discussed in [7]. The use of image processing techniques in high resolution images for the monitoring of cereal crop growth is presented in [8]. The use of thermal imaging for the crop canopy measurement is discussed in [9]. The SAR image segmentation and classification is done in [10]. The use of deep learning and machine learning techniques for the detection of diseases in tomato leaves is presented in [11]. The processing techniques for the multispectral images is given in [12]. The various methods for feature extraction based on shape, color, and texture is discussed in [13]. A semantic segmentation method for the segmentation of crops and weeds is presented in [14]. Fuzzy clustering for the crop image segmentation is done in [15]. The segmentation using k-means for embryo egg detection is done in [16]. The use of clustering for the monitoring of wheat yield is discussed in [17]. The identification of diseases in mango leaves is done using wavelet-based segmentation technique in [18]. The semantic segmentation of plants based on convolutional neural networks is presented in [19]. The use of deep learning-based methods for the segmentation and classification of crop weed is done in [20].

There are several methods for image segmentation such as pixel based, region growing, and deep learning-based methods. In an image segmentation, the entire image is split into avrious sub-regions. Each sub-region of the image represents a common attribute which can be a useful task for further processing of the image such as image classification. The segmentation methods can be divided into various categories such as pixel based, region growing, threshold based, edge based, clustering based, neural network based, and other machine learning based methods. The choice of one method over the others depends on various factors such as image size, image resolution, and number of channels, etc.

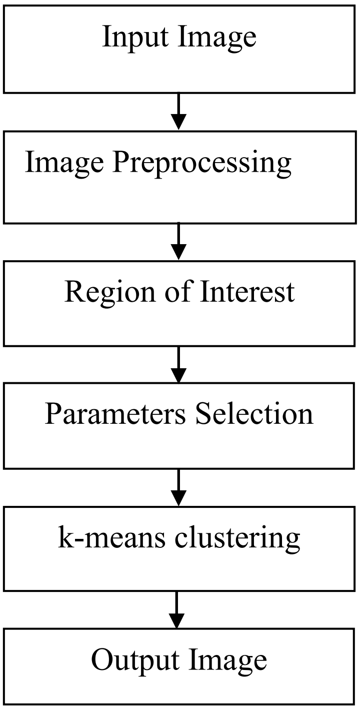

Fig.1. Image segmentation procedure

The rest of the paper is organized as follows. The image filtering is discussed in section 2. The contrast enhancement using histogram equalization is done in section 3. Section 4 presents the discussion on k-means clustering. The results and discussion is given in section 5. The conclusion is given in section 6.

2 Filtering the image

The input image is shown in Figure 2.

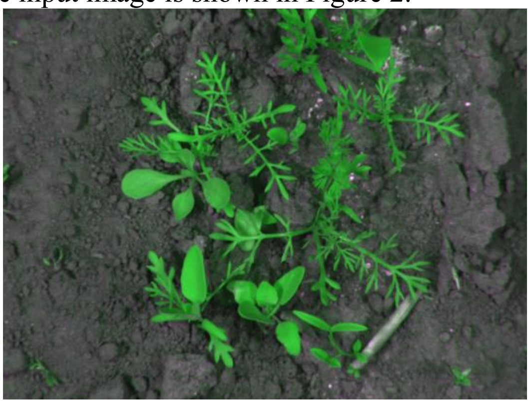

Fig.2. Input image

The input image is of size MxN. The total number of channels in the input image is 3, which are red, green and blue. The RGB image is converted into grayscale image. The grayscale image is shown in Figure 3.

Fig.3. Grayscale image

In order to enhance the image, the image is filtered using box blur kernel. The filtered image is shown in Figure 4.

Fig.4. Filtered image

3 Histogram Equalization

The histogram equalization of the image is done to adjust the intensity of image pixels in order to enhance the contrast.

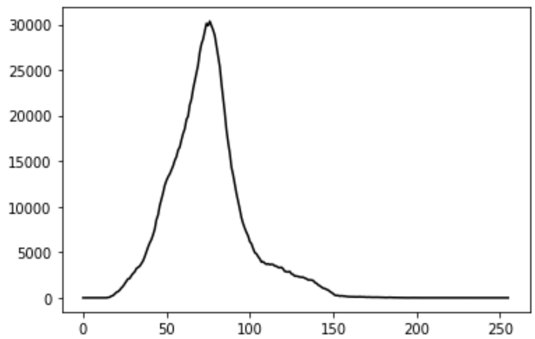

Fig.5. Image histogram

Let I be the input image of size MxN. The pixel intensity lies in the range from 0 to 255. The histogram of the image is shown in Figure 5.

The normalized image of the input image I for a bin p is given by equation (1).

$$p_n = \frac{m_n}{P} \quad (1)$$

Where n = 0,1, ,2 , ... L, m_n is the number of pixels having pixel intensity n and P is the total number of pixels in the input image I. The histogram equalized image J of the input image I is given by equation (2).

$$J(i,j) = floor((L-1)\sum_{n=0}^{MxN} q\_m \quad (2)$$

The J is the histogram equalized image. The equalized image is shown in Figure 6.

Fig.6. Histogram equalized image

4 k-means clustering

k-means clustering method is used widely in many applications in image processing and computer vision. The method works by grouping the similar pixels in the image into groups. the similarity of pixels in a group depends on various characteristics of the image pixels. using the grouping, the image can be split into various segments that might have several applications in crop yield monitoring.

Let X = {x_1, x_2, x_3,….., x_n} be the n number of set of data points and C = {c_1, c_2,…….,c_m} be the m centers. The procedure for k-means clustering is given below.

(i) Select p number of centers for the clusters randomly for m number of centers.

(ii) Calculate the Euclidean distance between all the data points in the image and all the centers of the clusters.

(iii) Mark the data point to a particular center of cluster out of all the centers of the clusters depending on the distance. The minimum distance is selected for this purpose.

(iv) Calculate the center again and repeat the procedure until there is no change in the assignment of data points to the cluster centers or after the maximum number of iterations are over.

5 Results and Discussion

The output segmented image which is obtained from the input image after filtering, histogram equalization, and k-means clustering is shown in Figure 7.

Fig.7. Segmented image

The segmented image can be used for various tasks in precision agriculture such as disease diagnosis, classification of crop, and crop monitoring, etc.

6 Conclusion

The crop yield monitoring using computer vision techniques is very useful for crop management. The segmentation of crop images can be done using one method or the other. Some methods work better than the other methods for a particular set of crop images. In this paper, k-means clustering based segmentation of crop images is done after applying the filtering method and histogram equalization method.

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Contribution of individual authors to the creation of a scientific article (ghostwriting policy)

Author Contributions: Please, indicate the role and the contribution of each author:
Example

John Smith, Donald Smith carried out the simulation and the optimization.
George Smith has implemented the Algorithm 1.1 and 1.2 in C++.
Maria Ivanova has organized and executed the experiments of Section 4.
George Nikolov was responsible for the Statistics.

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