Apple Fruit Disease Detection using Image Segmentation Algorithm

[1]Mr.Abhijeet V. Jamdar, [2]Prof. A. P. Patil

[1]Department of E&C, [2]Department of Electronics,
J.J.M.C.O.E
Jaysingpur, India

***Abstract*: Plenty fruits are exported from our country such as oranges, apples, mango, grapes etc. Diseases in fruit cause devastating problem in economic losses and production in agricultural industry worldwide. Manual identification of defected fruit is very time consuming. But there are few segmentation algorithms that can identify diseases of fruits. In this paper, we suggest a solution for the detection of disease on fruit by using K-means clustering segmentation algorithm. We used color images of fruits for defect segmentation. . Firstly, the colour image is transformed to Lab colour space from RGB. Clustering is then done by taking the absolute difference between each pixel and the clustering centre in Lab colour space. We have taken apple as a case study and evaluated the proposed approach using defected apples. Our results show more than 95% segmentation accuracy for three common diseases on apple.**

***Keywords*: K-means clustering segmentation algorithm, defect segmentation,**

I. INTRODUCTION

India is developing country. In this development there is major contribution of agricultural field. There are so many fruits like apple, oranges, mango and grapes etc. that are exported from India and give more profit to the farmers.

Diseases in fruit cause devastating problem in economic losses and production in agricultural industry worldwide. This is traditionally diagnosed by experts or pathogenic identification, which is time-consuming and delays the optimal treatment time. Computer vision can conduct real-time diagnosis for diseases accurately, rapidly and effectively. Automatic detection of fruit diseases is essential to automatically detect the symptoms of diseases as early as they appear on the growing fruits. This system helps to detect the diseases of fruits easily. By using this system we can avoid the economical loss of farmers.

A typical image recognition process includes image preprocessing, segmentation, feature extraction and pattern recognition. Image segmentation is one of the key steps, and the precision of the segmentation directly influences the reliability of feature extraction and the accuracy of recognition.

Image segmentation refers to the process of partitioning a digital image into multiple segments i.e. set of pixels, pixels in a region are similar according to some homogeneity criteria such as colour, intensity or texture, so as to locate and identify objects and boundaries in an image. Practical application of image segmentation range from filtering of noisy images, medical applications (Locate tumors and other pathologies, Measure tissue volumes, Computer guided surgery, Diagnosis, Treatment planning, study of anatomical structure), Locate objects in satellite images (roads, forests) etc.

Apple fruit diseases can cause major losses in yield and quality appeared in harvesting. To know what control factors to take next year to avoid losses, it is crucial to recognize what is being observed. Some common diseases of apple fruits are apple scab, apple rot, and apple blotch [5], as shown in Fig. 1. Apple scabs are gray or
brown corky spots. Apple rot infections produce slightly sunken, circular brown or black spots that may be covered by a red halo. Apple blotch is a fungal disease and appears on the surface of the fruit as dark, irregular or lobed edges.

(a) (b) (c)
Fig.1 Three common diseases on Apple fruit:
(a) Apple Scab, (b) Apple Rot, (c) Apple Blotch

This paper presents an efficient image segmentation approach using K-means clustering technique based on color features from the images. Defect segmentation is carried out into two stages. At first, the pixels are clustered based on their color and

spatial features, where the clustering process is accomplished. In order to validate the proposed approach, we have considered three types of the diseases in apple; apple scab, apple rot and apple blotch.

II. LITERATURE REVIEW

Shiv Ram Dubey and Pushkar Dixit (2013) presented a novel defect segmentation of fruits based on color features with K-means clustering unsupervised algorithm. They used color images of fruits for defect segmentation. Defect segmentation is carried out into two stages. At first, the pixels are clustered based on their color and spatial features, where the clustering process is accomplished. Then the clustered blocks are merged to a specific number of regions [1]. They had taken apple as a case study and evaluated the proposed approach using defected apples.

Xiaojing Niu (2014) proposed an automatic and efficient solution for diseases on wheat leaves with K-means clustering. Firstly, the colour image is transformed to Lab colour space from RGB. Clustering is then done by taking the absolute difference between each pixel and the clustering centre in Lab colour space [2]. Efficiency of this method is more than 90%.

Rajeshwar Dass, Priyanka and Swapna Devi (2012) described the different segmentation techniques used in the field of ultrasound and SAR Image Processing [3]. Image segmentation is the process of partitioning an image into multiple segments, so as to change the representation of an image into something that is more meaningful and easier to analyze. Several general-purpose algorithms and techniques have been developed for image segmentation.

Manisha Bhange and H.A.Hingoliwala (2015) suggested a solution for the detection of pomegranate fruit disease (bacterial blight) and also the solution for that disease after detection is proposed. Web-based system used to help non experts in identifying fruit diseases, based on the picture representing the symptoms of the fruit. Farmers can take the photo of the fruit disease and upload it to the system. Then system will show to the farmer is the fruit is infected by the bacterial blight or not. The image processing based proposed system uses two image databases, one for training and other for testing. The images are classified and mapped to their respective disease categories on basis of three feature vectors namely, color, texture and morphology [4].

In [5] Shiv Ram Dubey (2012) proposed an image processing approach has been used for fruit disease identification. The research has conducted for apple disease namely apple scab, apple rot, apple blotch. K-means clustering technique is used for image segmentation. Feature extraction is done from segmented images. Features considered for feature extraction are color histogram, color coherence vector, local binary patterns and complete local binary patterns. Multiclass support vector machine is used for fruit disease identification.

Tejas Deshpande (2014) proposed an automatic grading of disease on the pomegranate plant leaves. Bacterial blight disease is chosen for the research work. Manual grading is time consuming so automatic grading system becomes beneficial. K-means clustering method is used for conducting image segmentation and disease detection. Total leaf area (At) and total disease area (Ad) is calculated. After calculating At and Ad, disease grading has been done [7].This system is useful for plant pathologists and not for the farmers directly.

III. IMAGE COLLECTION AND PREPROCESSING

The images used in this study consist of images of apple scab, apple rot and apple blotch that were gathered from Internet. Figure 1 lists the apples with diseases (Figure 1(a)(b)(c)) .

Image pre-processing includes contrast enhancement. Contrast enhancement is a process that makes the image features stand out more clearly by making optimal use of the colors available on the display or output device.

IV. K - MEANS CLUSTERING SEGMENTATION ALGORITHM

K-Means clustering technique is used for the image segmentation. K-Means clustering algorithm was developed by J. MacQueen (1967). K-means is generally used to determine the natural groupings of pixels present in an image. It is attractive in practice, because it is straightforward and it is generally very fast [1]. It partitions the input dataset into k clusters in which one cluster contains the majority of the diseased part of the image. Each cluster is represented by an adaptively changing center (also called cluster center), starting from some initial values named seed-points. K-means clustering computes the distances between the inputs (also called input data points) and centers, and assigns inputs to the nearest center.

The basic aim of the proposed approach is to segment colors automatically using the K-means clustering technique and L*a*b* color space. The introduced framework of defect segmentation operates in six steps as follows,

Step 1. Read the input image of defected fruit.

Step 2. Transform Image from RGB to L*a*b* Color Space. We have used L*a*b* color space because it consists of a luminosity layer in 'L*'channel and two chromaticity layer in 'a*' and 'b*' channels. Using L*a*b* color space is computationally efficient because all of the color information is present in the 'a*' and 'b*' layers only.

Step3. Classify Colors using K-Means Clustering in 'a*b*' Space. To measure the difference between two colors, Euclidean distance metric is used.

Step 4. Label Each Pixel in the Image from the Results of K-Means. For every pixel in our input, K-means computes an index corresponding to a cluster. Every pixel of the image will be labeled with its cluster index.
Step 5. Generate Images that Segment the Input Image by Color. We have to separate the pixels in image by color using pixel labels, which will result different images based on the number of clusters.
Step 6. Select the segment containing disease.

Figure 2 shows the framework for the segmentation of diseased part of apple fruit.

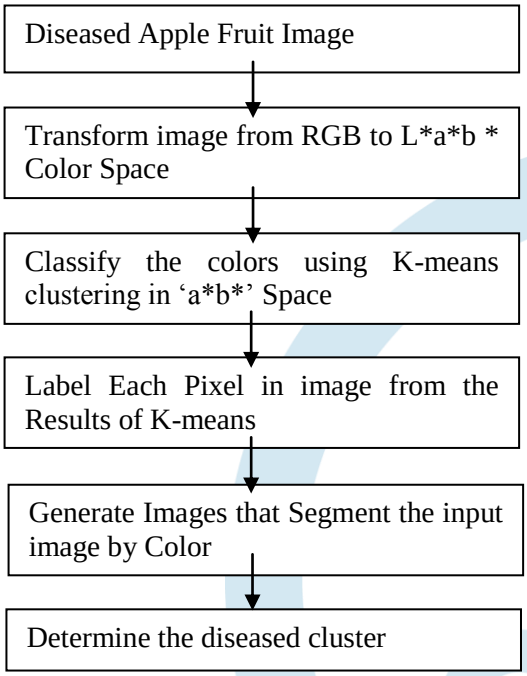
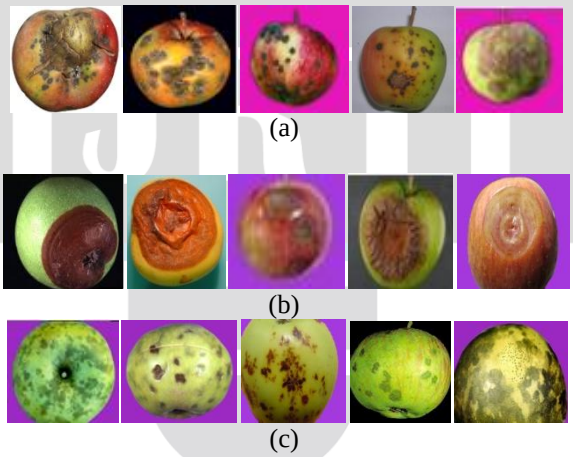


Fig.2 Apple Fruit Diseased part Segmentation

V. EXPERIMENTAL RESULTS



(a)

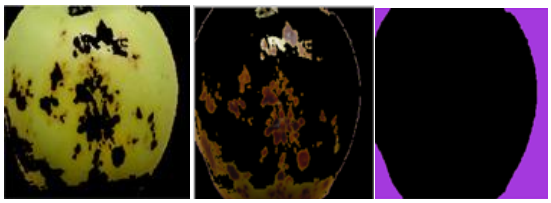
(b)

(c)

Fig.3. Sample images from the data set infected with (a) apple scab, (b) apple rot, and (c) apple blotch diseases.

The introduced method is evaluated on the defected apples. We have taken three common diseases of the apples such as apple scab, apple rot and apple blotch for the segmentation of diseased part of apple. Figure 3 shows some images of the data set infected with various diseases. Presence of a lot of variations in the data set makes it more realistic.

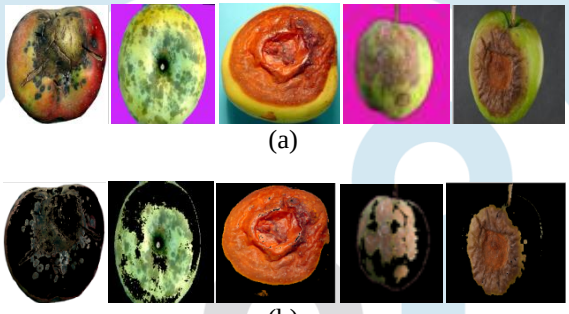
(a)



(b) (c) (d)

Fig. 4. K-Means clustering for an apple fruit that is infected with apple blotch disease with three clusters (a) The infected apple fruit image, (b) first cluster, (c) second cluster, (d) third cluster

Figure 4 shows the segmentation result of an apple fruit infected with the apple blotch disease using K-means clustering technique. We have segmented the input image into three clusters in Figure 4 and it is clear that second cluster correctly segment the diseased portion of the image. From the empirical observations it is found that using 3 clusters yields good segmentation results. So, in this experiment input images are partitioned into three segments.



(a)

(b)

Fig. 5 Segmentation results (a) Images before segmentation, (b) Images after segmentation.

Figure 5 shows more segmentation results using proposed approach of diseased part segmentation of apple fruit using K-means clustering technique. The experimental results suggest that the introduced method for diseased part segmentation of an apple fruit is robust because it can accurately segment the diseased part of an apple.

VI. CONCLUSION

A framework for the diseased part segmentation of apple fruits using images is proposed and evaluated in this paper. The proposed approach used K-means clustering technique for segmenting diseased part of apple with three clusters. The experiments on apple fruit images with three common diseases proved the satisfactory performance of our method in terms of accuracy, efficiency and automation. Simulation results suggest that the proposed approach is able to accurately segment the defected area of apple fruits present in the image database.

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