Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X
IMPACT FACTOR: 7.056

IJCSMC, Vol. 10, Issue. 8, August 2021, pg.51 – 59

A STUDY OF TOMATO FRUIT DISEASE DETECTION USING RGB COLOR THRESHOLDING AND K-MEANS CLUSTERING

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DOI: 10.47760/ijcsmc.2021.v10i08.009

Abstract— The agriculture field plays vital role in development of smart India. To increase economic level the production of fruits, crops and vegetables can use CAD technique using image processing tools. Identifying diseases in fruits is an image processing's big challenging task. This can done by continuous visual photos or videos monitoring system. The automated image processing research helps to control the pesticides on fruits and vegetables. In this paper we focus to detect the diseases of tomato at earlier stage. The proposed system shows how different algorithms such as color thresholding segmentation techniques and K-means clustering are used. In proposed system shows the K-means Clustering is better than RGB color based colorthresholder method for detecting tomato diseases in beginning stage.

Keywords— Tomato disease, Threshold, Colorthresholding segmentation, K-means Clustering segmentation

I. INTRODUCTION

Image Segmentation[1] is an important part for processing the segment of an image into many disjoint small area based on the certain principle, and it is one of the most basic area of research in the image processing. Image segmentation[1] is used in many applications such as film and photo analysis, geo information systems, medical image analysis, satellite image analysis and etc. Image segmentation of tomato images is the most important stage in detecting diseases. This stage carries to next process namely classification which classifies the tomato images in detail. There are many more segmentation methods and algorithms available in object detection.

II. RELATED WORKS

Qimei Wang, MingheSun, JianhuaQu and JieXue authors Identify tomato diseases[2,14] and Detect the infected areas using CNN and Object Detection Techniques. Experimental result Indicate that ResNet -101 has the highest detection rate but take longest time for training and detection.

Huiqun Hong, Jinfa Lin, Fenghua Huang highlight to detect and diagnosis the tomato diseases by using deep learning. This method used to reduce size, time and computational cost. This paper supports for the further development of tomato disease diagnosis system based on smart phones.

Jun Liu and Xuewei Wang focus on the detection of tomato diseases based on Yolo V3 Convolutional Neural Network. Through this research, it provides reference for intelligent recognition of fruit diseases[3] and pest detections.

Manisha A. Bhange, Prof H.A. Hingoliwala detect pomegranate fruit disease based on three features such as texture, color and morphology. Here use two dataset namely training and testing.

III. MATERIALS AND METHODOLOGY

A. Image Acquisition

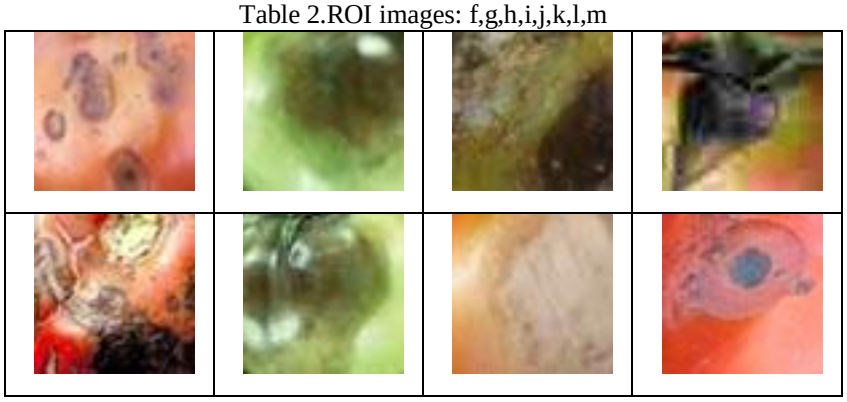
A sample of 10 diseased tomato fruits[3] are captured by camera and pre-processed by mat lab. All input images are converted into the size of 60x60. They normalized in equal size.

Table1 - Input images: i1, i2, i3, i4, i5, i6, i7, i8, i9, i10

B. Region of Interest(ROI)

ROI is a process of filtering particular portion from an input image. By using input images from table1 are cropped the defected portion as shown in below

Table 2.ROI images: f,g,h,i,j,k,l,m



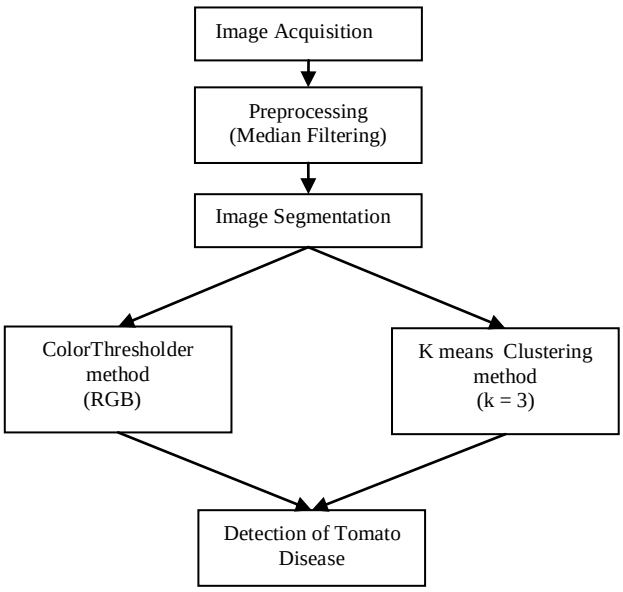


Fig 1.Work Flow Diagram

C. Pre-processing

Filtering[11] act as an important technique for modifying or enhancing the quality of an image. Filtering gives smoothing, sharpening and clear edges of an image. Image processing supports different types of filtering such as Gaussian filter, Bilateral filter, Linear filter, Sigma filter[16], Median filter[11], etc. In this study, apply median filter for removing noise from an image. It is a non-linear based filtering. In median filter, the center pixel of an MxN neighbourhood is replaced by the median (middle) value of the corresponding window. It can be calculated by sorting all the pixel values from the matrix into numerical order and replace the pixel value by using the median (middle) pixel value. In this paper apply 3x3 sampling window for filtering an images.

IV. TECHNIQUES USED IN SEGMENTATION PROCESS

Segmentation Techniques	**Advantages**	**Disadvantages**
Threshold[9,16]	It is a simple method and involves comparing each pixel values of an image. It is applicable for only gray scale images.	It is not suitable for blurred, outlier and noisy images
ColorThresholder	It is an advanced method of Threshold[9]. It used colorimage[10] for comparing each pixel values for segmentation.	It is not suitable for edge based computation.
K-means Clustering[12] (k=3)	It is more easy way to segment an image. Also it used to eliminate noisy spots in an image	More expensive for computation.

V. RESULTS AND DISCUSSION

A. Image Segmentation

ColorThresholding Method

To reduce noise, Median filter method[11] is applied to images. The Colorthresholder enables to create a segmentation mask of a tomato[6] color image based on the exploration of different color spaces like RGB[15], HSV and La*b. As the fig. shows segmented area of tomato. Threshold[5] only works with grayscale images. The image type is 8 bit. It is converted to RGB stack. Color image is split into channels. Then adjusted Color Threshold values which are from 0 to 255. Segmentation[1] achieved when Red, green, blue channels are adjusted. Green channel values are dominated than red and blue. Secondly red takes good role in display segmented area. Blue channel has very least role in colorthresholding segmentation.

Segmentation using colorthresholder algorithm

Input: Color images

Output: Detect the infected areas in the tomato

Step1: Read color images

Step2: Apply red color range between 0 and 255, then find threshold value. If threshold value reached then go to step5

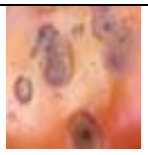
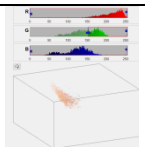
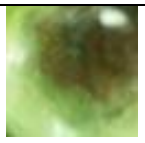
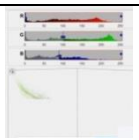
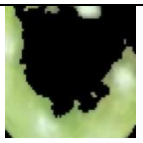
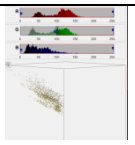
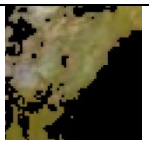
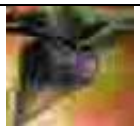
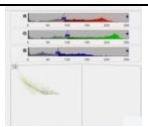
Step3: Apply green color range between 0 and 255, then find threshold value. If threshold value reached then go to step5

Step4: Apply blue color range between 0 and 255, then find threshold value. If threshold value reached then go to step5

Step5: Stop the process

Step6: Finally compared the threshold values of each color and find which color is best for finding the infected area of an image.

Table 3.Colorthresholder Images and its color spaces

Input image	Color space	Output image
		
		
		
		

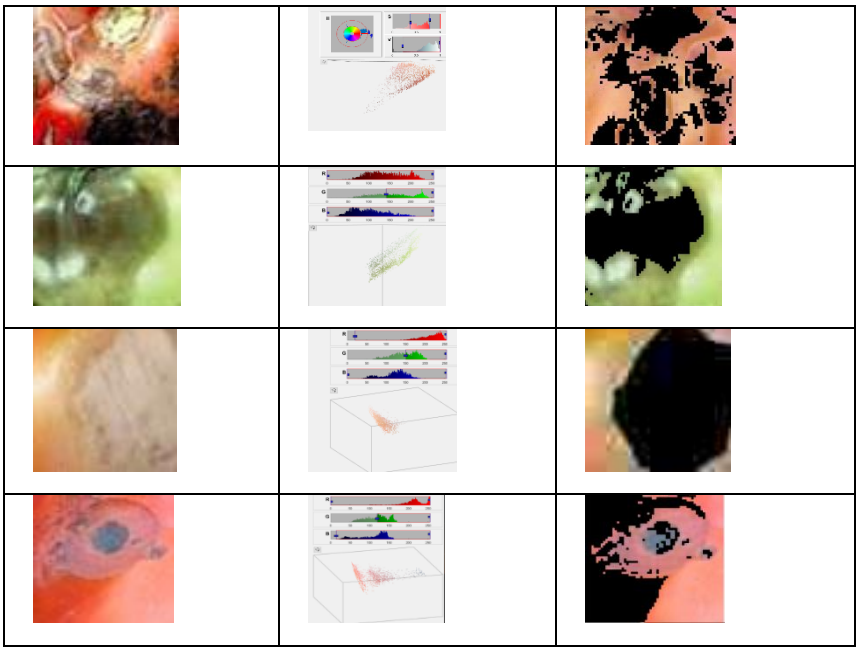


Table4: Qualitative analysis of segmented area (ColorThresholding method)

Images	Mean	Standard deviation
f	58.7	48.49
g	53.9	50.52
h	56.73	42.30
i	124.95	84.97
j	80.57	70.41
k	31.64	21.05
l	147.61	107.59
m	106.47	68.83

K-means Clustering

Data Mining is a process of extracting information from raw data. Data mining is an inter-process knowledge which includes statistics, image processing, data base, machine learning and artificial intelligence. The different data mining techniques are classification, clustering and regression, sequential pattern recognition and outlier detection. Clustering belongs to unsupervised learning. A cluster is a subset of similar objects. Some of the clustering algorithms are Kmeans, hierarchical, fuzzy c means[17] and DBSCAN algorithm. Kmeans clustering method is used for conducting image segmentation and disease detection. In this study Kmeans clustering algorithm is used for grouping related pixels which helps to detect the disease in tomato fruit image.

Segmentation Using K-means Clustering Algorithm

Step1: Read Image

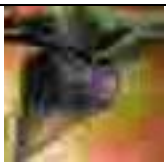
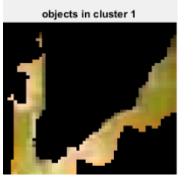
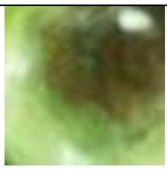
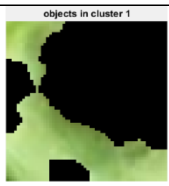
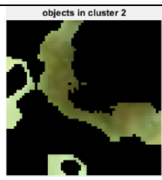
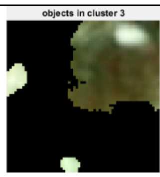
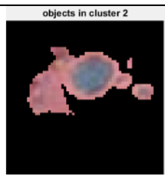
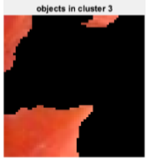
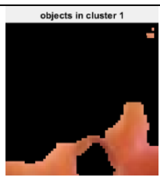
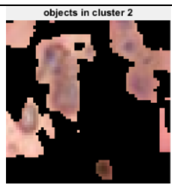
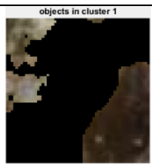
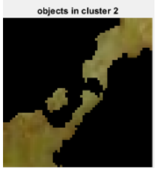
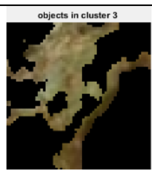
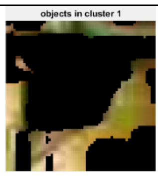
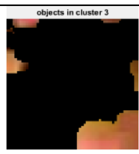
Step2: Convert image from RGB color space to La*b* color space

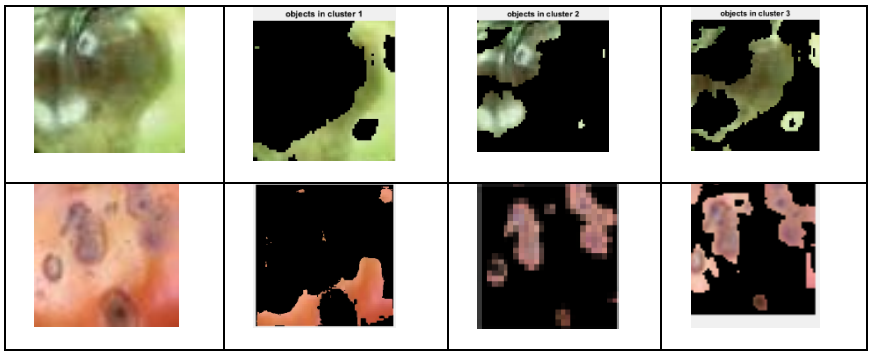
Step3: Classify the colors in "a*b*" space using kmeans clustering

Step4: Label every pixel in the image using the results from kmeans

Step5: Create images that segment the tomato image by color

Table 5.Segmented images using Kmeans Clustering technique

Input image	Cluster1	Cluster2	Cluster3
			
			
			
			
			
			



The above images are the results of k-means[1,9,12] cluster method. As a result of k-means cluster the resultant images are categorized as Cluster 1, Cluster 2 and Cluster 3. Here K = 3. All Cluster images are not unique. Cluster 1 is different from cluster 2 and cluster 3 and vice versa. The advantage of K-means[1,9,12,13] method is one can choose a best segmentation from any of the clustered image. Hence, tomato diseased[2,14] portion can be easily detected by Computer Aided Design(CAD) system.

Qualitative Analysis

Table 6. Qualitative Analysis of Color based segmented image using K-means clustering technique

Images (jpg)	**Mean**	**Median**	**Mode**	**Variance**	**Standard deviation**
f	147.54	149.80	130.58	254.61	15.95
g	136.41	135.97	135.55	1.3	1.14
h	158.89	158.07	140.19	365.3	19.11
i	140.88	141.17	136.09	21.66	4.654
j	145.83	146.13	131.15	211.40	14.53
k	135.47	136.61	131.11	15.37	3.92
l	150	148.07	129.6	457.3	21.38
m	154.25	151.82	145.57	102.30	10.11

Mean and Variance

The simple statistical method is used for calculating the mean and variance of the pixel levels.

Mean, $\mu = \sum z_i * p(z_i)$ where $z_i \in S$ --------- (1)

and

Variance $= \sum (z_i - \mu)^2 p(z_i)$ where $z_i \in S$ ---------- (2)

Here z_i are the gray level values of the pixels in S and $p(z_i)$ are the corresponding normalized histogram values.

Mean value of K-means algorithm[2,12,13] varies from 135.47 to 158.07 where the variance values starts from 1.3 to 365.3. Mean value 135.47 to 158.07 contributes individual pixel intensity for entire tomato segmented image. The variance values help to find each pixel varies from center pixel. This helps to classify into three different clusters. The results of Kmeans clustering is for better than FCM clustering method in visual as well as numerical measures[5].

Signal-to-noise ratio (SNR)

To find image quality, the SNR evaluation method is applied. Among image quality measurements, SNR always best for analysis. SNR is given as the ratio of mean value of image and the standard deviation of the noise.

Generally, higher SNR value could give more quality of image than lower values. SNR value lesser than 1 would not be good enough in images.

In this study, Kmeans clustering and color threshold methods are given more than 1 and are tabulated as below.

Table 7. Comparison of SNR Value

Image(jpg)	Colorthresholder Segmentation(dB)	K-means Clustering technique(dB)
f	9.7	10.47
g	11.39	13.22
h	11.55	12.32
i	10.12	10.32
j	10.88	11.50
k	10.28	10.58
l	12.55	12.72
m	11.34	11.99

In table.7, SNR values of K-means clustering[2,12,13] shows better than color threshold segmentation. The K-means method gains more SNR value as follows 0.77dB, 1.83 dB, 0.77 dB, 0.2 dB, 0.62 dB, 0.3 dB, 0.17 dB and 0.65 dB than other methods. The results of K-means clustering helps to detect the types[6,7,8] of tomato fruit disease such as Late Blight, Fungal, Early Blind, Sunscald, Rotted tomato, Tomato Blossom end rot, Tomato puffy fruit and damage tomato.

VI. CONCLUSION

Comparison of three factors such as mean, variance and SNR, this proposed system shows K-mean clustering[1,12,13] technique for segmentation is better than colorthresholder segmentation method for detecting tomato diseases. In future research, a new algorithm using data mining techniques is framed for effective detection and accurate classification of citrus fruit diseases.

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