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# Fuzzy C-means Clustering and Pseudo-coloring-based Pest detection of Ripe-Fruit Health Monitoring System using 2-D Aggrotech Images

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***Abstract*—Fruits are the gift of almighty to nature. Fresh fruit promote good health and having rich source of micronutrients, vitamins and fiber value. But due to its high sugar level on ripping stage different type of pest are attracted by its smell and effects on harvesting. This paper focuses on identification of the pest on ripe fruits using Fuzzy C Means (FCM) clustering for segmentation and simultaneously highlights the segmented insects with Pseudo-coloring using Pseudo-color image processing techniques. IoT integrated Drone based images are inputted as the dataset to perform detection of pest on fruit monitoring system. Before clustering-based segmentation the images undergo preprocessing stage for tone correction and noise removal. Hybrid FCM with Pseudo-color image processing method supersedes many segmentation algorithms by performance.**

***Keywords-component Fuzzy C mean, pseudo color, Contrast stretching, Denoising.***

## I. INTRODUCTION

Fruits are a very good source of nutrition. These are an eminent source of many necessary vitamins, different minerals, and fibers. Intake of fruit can reduce the chance of various diseases like hypertension, heart diseases, eyes, and digestive disorders, even helpful in minimizing the chance of some types of cancer; it also helps in maintaining the body weight and blood sugar [1]. So, consuming fruit provides good nutrients as well as works as a medicine for good health.

Only taking fruit is not enough for good health, but taking healthy fruits is necessary to enhance good health. But fruit pests are the main cause of fruit disease. Pests like Aphid, Thrips, Corm weevil, etc. cause different diseases in mango, banana, pomegranate [2]. So, pest control is an essential step to yielding healthy fruit, leading to the good health of the consumer. But the primary step of pest control is to detect the specific pest on fruits. We can also use the traditional method of detecting the fruit pest, but since nowadays fruit is produced on a large scale, the traditional techniques are not so efficient in detecting the various types of pests. So, we need a more advanced and effective technique for this purpose. Using Artificial intelligence, we can develop such techniques.

We can use the image processing technique to identify the pests from the image of the fruit taken from the CCTV camera, a drone camera, or any other means. In our paper, we are using the Fuzzy C Mean technique and Pseudo coloring to achieve the goal. Not only in insect detection, but we can also use these techniques in various fields like medical diagnosis such as brain tumor's detection [4], in smart farming [5], etc.

## II. ABOUT DATASET

To detect the pests over fruit for its health monitoring 2-D image dataset is utilized [7, 8, 9]

### A. *Data set used*

| Data set Details / serial No | Used Image Data | | |
|---|---|---|---|
| | Fruit Specimen | Botanical Name | About pest |
| 1. |  | Fragaria Anamosa(strawberry) | In animalia kingdom Armyworms is a family of noctuidae. It is considered as a pest and can damage and destroy a wide verity of crops. |
| 2. |  | Mauls(Apple) | Plum curculios are firmly attracted to the fruit. This insect is easy o identify by is curved muzzle which looks like a miniature elephant's trunk. |
| 3. |  | Citrus sinensis(Orange) | The queensland fruit fly, Bactrocera tryoni occurs in climates ranging from 65-degree F it is the type of pest with which pome and sone fruit growers have to contend, and at items it has been a very destructive pest of citrus. |
| 4. |  | Pisdium guajava(guava) | Bactrocera correcta is a family of tephritid fruit flies that is found in south east Asia. It is a dangerous pest species environmental characteristic and caused measure infestation in Vietnam and Thailand. |
| 5. |  | Vitas(Graph) | The grape berry moth damage in the larva stage damage is caused by the larva feeding in flowers and fruits get damaged. It changes the colour and drop from the steams. Larger fruit get rot in that place. |
| 6. |  | Brassica oleracea bar. Botrytis(califlower) | The diamondback moth is a family of plutellid and genus plutella. The species may have originated in Europe, southafrica and now it spread all over India. |
| 7. |  | Grapholita packardi zeller(blueberry) | The cherry fruit worm grapholita packardi zeller is widely spread throughout the northern two-thirds of the United States where it feeds on a number of host plants. This species is fairly common in North Carolina. |
| 8. |  | Apocarpus heterophyllus(jackfruits) | Ochyromear is genus of leguminous seeds weevils in the beetle family curculionidae. There are more than described species in ochyromear. |

## III. TECHNIQUES USED

### A. *Image Pre-processing*

The fruit images, collected from various sources, are pre-processed before going for segmentation. In this stage, images are upgraded to obtain a more fine and clear structure and for avoiding noise. In our paper for image pre-processing, we are using the techniques of contrast stretching and denoising. To increase the contrast of an image, enhancement techniques are used. By outspreading the range of scene illumination, we can enhance an image. This method is known as contrast stretching [6].

During the collection of images, the sensors captured some noise along with the pure image. These noises are usually caused due to imperfect instruments, disturbed natural phenomena, disturbance in transmission and compression of image [7]. Removing such noises from the image and obtaining the pure image is called image denoising.

### B. *The FUZZY C-means Algorithm*

The FCM algorithm is more suited to data that is more or less evenly distributed around the cluster centers. The FCM algorithm lumps the two clusters with natural

shapes but close boundaries into a large cluster. This method was developed by Dunn in 1973 and improved by Bezdek in 1981. It is often used in pattern recognition [3]. Similarly, many existing literatures used k-means clustering based segmentation approached in recent past depicts their application in different application area [13, 14].

*Algorithm:*

1. Initialize U = [ui, j] matrix, U(0)
2. At k-step: calculate vectors Ck = [cj] with U(k )

$$c_j = \sum_{i=1}^{N} (u_{i,j}^{m} . x_i) / \sum_{i=1}^{N} u_{i,j}^{m}$$

3. Update

$$u_{i,j} = 1 / \sum_{k=1}^{c} (||x_i - c_j|| / ||x_i - c_k||)^{2/(m-1)}$$

4. If ||U(k+1) -Uk|| <ε, then stop; otherwise return to step 2.[3]

### C. *Pseudo-colouring/ Grey to Pseudo-color Transformation*

Pseudo-coloring is a method that plot an artificial color to a black and white image. This pseudo-colored image is used for identifying easily and more clearly some certain features of the image [8]. In our paper we are using this technique to identify the pest on the fruits.

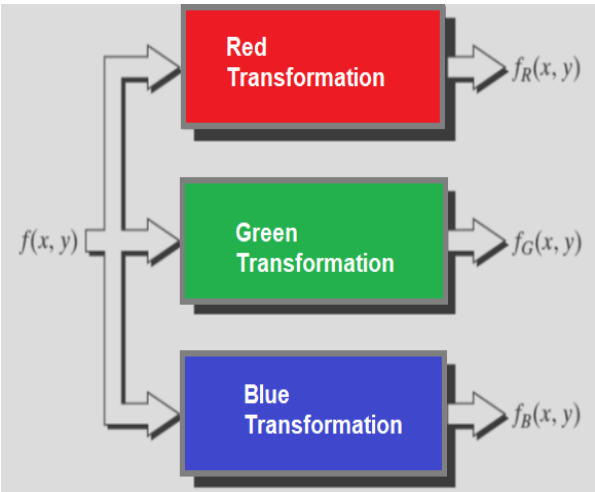



Figure 1. Grey to pseduo-colour Transformation

## IV. WORKFLOW DIAGRAM

To detect the pests on the fruit, first we have to collect images of fruits from various sources. Since, during the collection of images, the sensors may have captured some noise along with the pure image, so we have to first pre-process the images. In our paper, for pre-processing we are using two techniques. Those are contrast stretching and denoising. In Contrast stretching technique we can upgrade the contrast of the captured image by increasing the range of intensity values. Image denoising is to remove noise from a noisy image, to restore the true image. After getting a clearer and sharper image, we will go for image segmentation. For segmentation, we are using the image clustering technique. Clustering is to partition an image data set into several disjoint groups or clusters. In our paper, we are using the Fuzzy C Mean algorithm to get the clustered image. After that, we will go for the pseudo-coloring technique to get a pseudo-colored image, which helps us to easily detect the insect on the fruit [13, 14, 18].

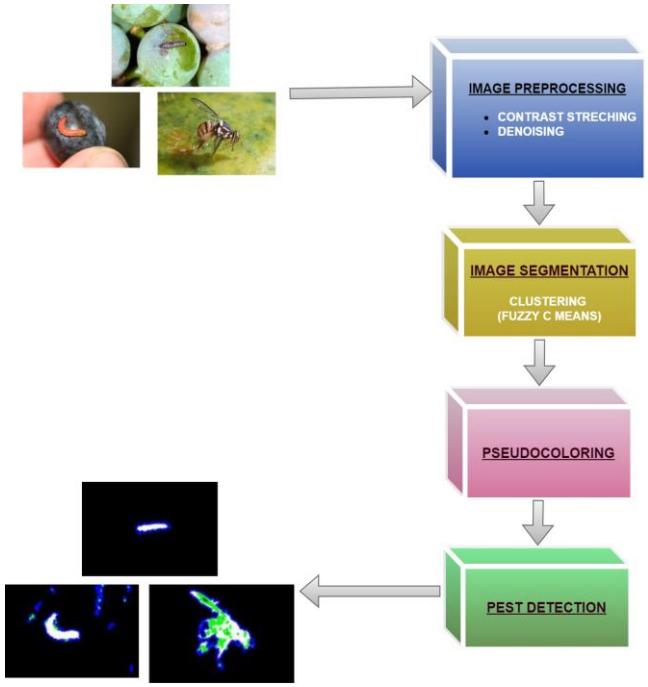
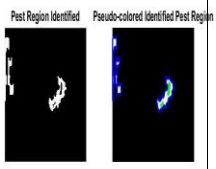
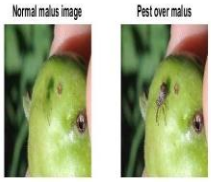
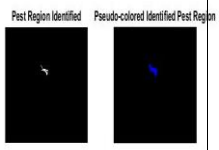
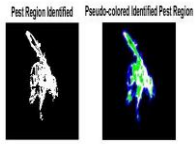
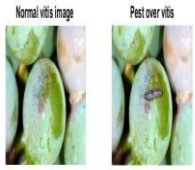
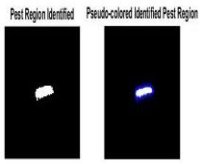


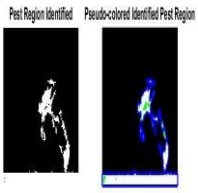
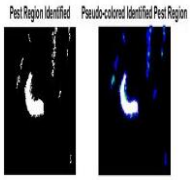
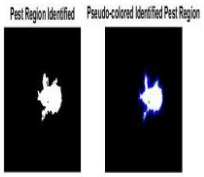

Figure 2. Block diagram for Pest detection from 2D Image

## V. RESULT AND ANALYSIS.

The input image is capture through drone or some are from the garden. In past literature many algorithms have been proposed to detect the pest and the diseases caused using image-based segmentation approaches [15, 16, 17]. The images are passed through the various stages in this process which detect the image by the process of dividing it

in to two parts first one the background image and second one is the pest region identified, for the result we find first normal image, pest over fruit after that pest region identified we have applied pseudo-color method to enhance the pest. It not only identified the big pest but also identified the minor pest [10, 11, 12].

| | Result image | |
|---|---|---|
| | *INPUT IMAGE* | *OUTPUT IMAGE* |
| 1. |   |   |
| 2. |   |   |
| 3. |   |   |
| 4. |   |   |
| 5. |   |   |

| | Result image | |
|---|---|---|
| | *INPUT IMAGE* | *OUTPUT IMAGE* |
| 6. |   |   |
| 7. |   |   |
| 8. |   |   |

## VI. CONCLUSION

The motive of this paper was to identify the pest from the image of the fruit taken from the drone camera or any other means. By using the fuzzy clustering, it places an important role in solving problem in the area of pattern recognition and fuzzy model identification. By using pseudo color, it deeply identifies the insects.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