

Real Time Automatic Bruise Detection in (Apple) Fruits using Thermal Camera

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ABSTRACT

New sheltered and quick techniques for evaluating of fruits have critical place in agricultural economy. At present times traditional grading methods have been used broadly. But high cost and some inconsistencies guide post harvesting industry led to automation applications in classification operations.

Recent, Undertakings slant towards mechanization frameworks for expanding working limit and diminishing working expenses. Inconsistencies associated with manual grading decrease when automated grading systems are used. Thus, error rate and costs decreases while speed increases. As known size, shape, shading and tissue are fundamental criteria the classification procedure. In this study, automatic evaluation by utilizing thermal camera and modernized image processing method is proposed. It is very tedious and hectic job to monitor fruit bruise manually and time consuming process so BDS (bruise detection system) is used for the detection of fruit diseases.

Tedious human inspection task for sorting fruits is reduced by designing an automated system consisting of developed algorithm and conveyer platforms.

Keywords

Artificial Neural Network (ANN), Grey Level Co-occurrence Matrix (GLCM), K-means Clustering Segmentation, Thermal Imaging

1. INTRODUCTION

India is an agricultural nation where around 70% of the population relies on farming. Farmers have extensive variety of differences to choose reasonable food grown from the ground crops for ideal yield and quality created is very specialized. It can be enhanced by technological support. As known size, shape, shading and tissue are fundamental criteria in the classification procedure. The administration of fruit wounds requires observation that can influence generation altogether and consequently the post reap life. Fruit wounds have transformed into a bad dream as it can bring about critical lessening in both quality and amount of horticultural items, along these adversely affected nations that are agribusiness subordinate economy basically rely on farming on its economy. Yuhki Shrivaiishi, this algorithm of inspecting shape uses only some rectangle of object. Therefore difference of shapes is not proper for classification result [1]. K. vijayrekha, in her paper discusses multivariate image analysis technique [2]. Brench Yana they use neural network for spheres of object classification [3]. The proposed SDEM Algorithm gets less time than the std. EM algorithm [4]. They represents GUI technology that helps medical professionals to get idea about patient bruising [5]. They concluded that average of cross correlation that happens to be better result for classification of apple [6]. For classification and detection all have been using k-means clustering and glcm algorithm

method [7-13]. After detection and segmentation, they used ANN for classification of fruits and leaf but using IR and web camera [14-16]. The time spent for accumulation, stockpiling and transportation of fruit in the end endure vibration affect and different sorts of harm fruit restrain in their previous quality. The important commitment of works is created by physical model that contain the exhibited outwardly diagrams in other paper regard to utilized the artificial neural and co-occurrence method all features utilizing thermal procedures, in a genuine model capable of recognize wounds in fruit progressively. Image analysis can be applied for the following purposes.

- To detect bruises in fruits
- To find boundary of the affected area
- To classify fruits

2. SYSTEM MODEL AND ASSUMPTION

With increased expectation of high quality and safety in food products, the experiment represents method of detecting bruises by image processing which includes capturing of images, processing and analyzing the thermal images and assessing the visual quality characteristics in fruits by non-destructive method.

This project not only aims to detect a bruise in fruit as well as to reduce the wastage of the fruits during storage time. "Fig. 1" shows basic step of algorithm.

2.1 Image Acquisition

The images of the fruits are caught through the thermal camera (RGB picture). Image obtaining is the initial phase in framework advancement to get the specimen or the image. "Fig 2" shows web cam image and thermal image

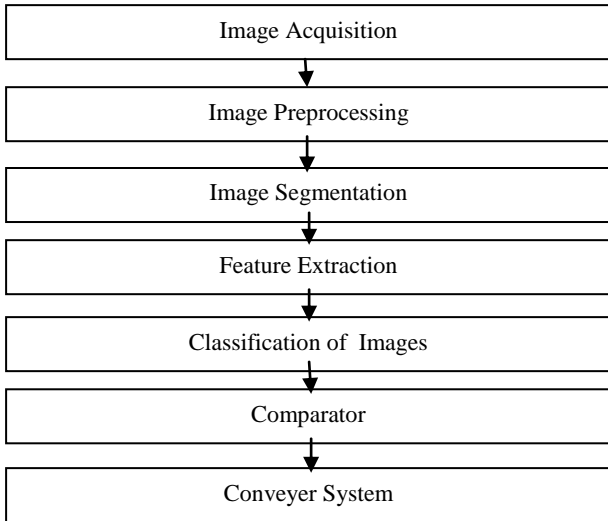


Fig.1. Basic steps for apple fruit detection

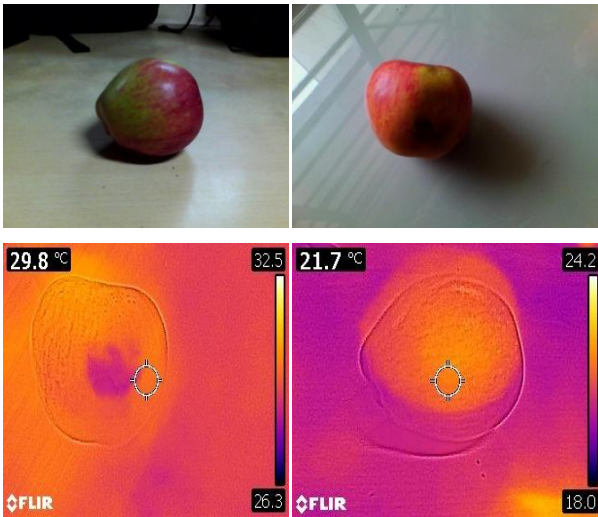


Fig.2. Web cam image and thermal image

2.2 Image Pre-processing

In pre-processing, noise shown in image is evacuated and also image upgradation is finished. Image improvement is finished by utilizing contrast stretching. Intensities are distributed using histogram equalization. Histogram applies on the image for enhancement of fruit image.

2.3 Image Segmentation

Image segmentation implies dividing of image into different parts having same components or closeness. The division is done utilizing different techniques k-means clustering, "otsu" strategy and changing over RGB picture into HIS model and so forth.

Converting RGB to gray scale image

The segmentation and pre-processing undertaking are the underlying stage before the picture is utilized for the following procedure. The principle target of this procedure is to acquire the binary image. The RGB gray scale is the such a particular segment of a similar hued pictures. Where in one pixel point change in the range between 0-255, the same as the depiction of the shading image of the gray scale image.

2.4 K-means clustering

Image Color Segmentation utilizing K-Means clustering. Change over Image from RGB Color Space to L*a*b* Color Space and The L*a*b* space comprises of a radiance layer "L*", chromaticity-layer "a*" and "b*" yet all shading data is in the "a*" and "b*" layers. Arrange the hues in a*b* shading space utilizing K-implies grouping. Since the image can have 3 hues make 3 groups. Measure the separation utilizing Euclidean Distance technique. Condition of the Euclidean separation technique is given as follows.

$$D(i, j) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad (a)$$

2.5 Feature Extraction

Color and texture features can be used to identify bruise fruit and non bruised fruit.

Color co-occurrence Method

Let i and j are the coefficient of co-occurrence matrix at the co-ordinates (i,j) and N is the dimension of the co-occurrence matrix.

Texture extraction

2.5.1 Energy (E) can be characterized as the measure of the degree of pixel match repetition. It gauges the consistency of a image. At the point when pixels are fundamentally the same as, the vitality esteem will be vast. It is characterized in Equation as.

$$En = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} P_{a,\theta}(i, j)^2 \quad (1)$$

2.5.2 Entropy (E) Texture of the image is characterized by using entropy. Its esteem will be greatest when every one of the components of the co-event framework are the same. It is additionally characterized as in Equation as

$$Ep = \sum_{n=0}^{Ng-1} n^2 \left\{ \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} P_{a,\theta}(i, j) \right\} \quad (2)$$

2.5.3 The contrast (Con): It is characterized in Equation, is a measure of power of a pixel and its neighbor over the picture.

$$Con = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} P_{a,\theta}(i, j) \log(P_{a,\theta}(i, j)) \quad (3)$$

2.5.4 Variance is measure of the scattering of the qualities around the mean of mix of reference and neighbor pixels.

$$F4 = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} (i - \mu)^2 P_{a,\theta}(i, j) \quad (4)$$

2.5.5 Correlation: Linear dependency of grey level matrix depends on value of correlation feature in co- occurrence matrix. It speaks to how a reference pixel is identified with its neighbor, 0 is uncorrelated, 1 is flawlessly related.

$$F5 = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} P_{a,\theta}(i, j) \frac{(i - \mu_x)(j - \mu_y)}{\sigma_x \sigma_y} \quad (5)$$

2.5.6 Inverse Difference Moment acquires the measures of the closeness of the circulation of the GLCM components to the GLCM advanced. IDM weight esteem is the reverse of the difference weight, with weight diminishing exponentially far from the corner to corner.

$$F6 = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} \frac{1}{1 + (i-j)^2} P_{a,\theta} \quad (6)$$

2.5.7 *Meanmoment1*: average value of pixel denoted by mean.

$$M1 = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} (i - j) P_d(i, j) \text{-----} (7)$$

2.5.8 *Standard Deviation* moment (m2) is the standard deviation that can be denoted as follows

It shows difference between group values of mean and group values of standard deviation.

$$M2 = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} (i - j)^2 P_d(i, j) \text{-----} (8)$$

2.5.9 *Skewness* (degree of asymmetry) m3skewness is asymmetry in measurable conveyance in which bend seems contorted or skewed either to left side or right . Skewness can be evaluated to characterize the degree to which a circulation contrasts from a typical conveyance.

$$M3 = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} (i - j)^3 P_d(i, j) \text{-----} (9)$$

2.5.10 *Kurtosis m4*

kurtosis shows how the peak and tails of conveyance contrast from the normal distribution .Use kurtosis to help you at first comprehend general qualities about the dissemination of your information.

$$M4 = \sum_{i=0}^{Ng-1} \sum_{j=0}^{Ng-1} (i - j)^4 P_d(i, j) \text{-----} (10)$$

2.5.11 *Classification*

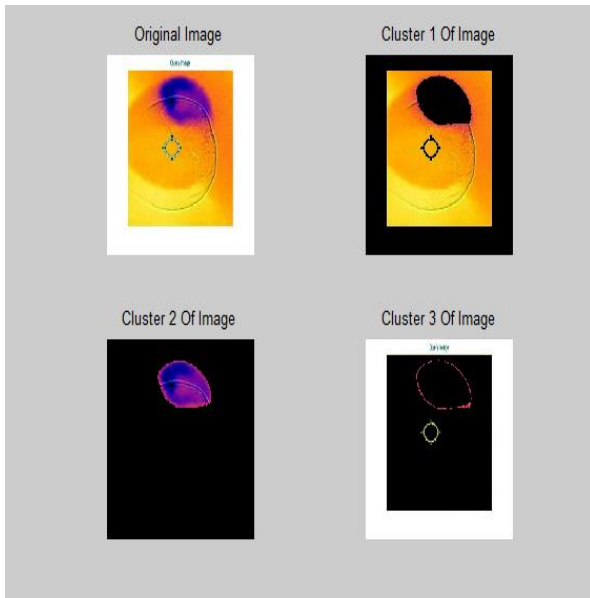


Fig 3. Result of clustering

Artificial Neural Network

Now, Extract another features from the segmented image form k means clustering. Convert RGB image to grayscale then convert gray scale image to black and white using otsu' method. Create the Gray Level Co-occurrence Matrices (GLCMs) from black and white image and following parameters are calculated using GLCMs matrices (Contrast, Correlation, Energy, Homogeneity, Mean, Standard Deviation, Entropy etc). The SVM is characterized for two class issues it searched for ideal hyper-plane, which amplified the separation, edge between the closest cases of both classes, named SVM. A present well known characterization apparatus utilized for example acknowledgment and other arrangement purposes. SVM are a gathering of directed learning techniques that can be connected to characterization or relapse. The standard SVM classifier takes the arrangement of information and predicts to group them in one of the main two particular classes.

3. PERFORMANCE RESULT

This system consists of two main parts software and Hardware, Software is nothing but an ANN (Artificial Neural Network) algorithm and Hardware is conveyer based fruit sorting system. The results are shown in "Fig.3" shows clustering result of fruit. "Fig 4, 5" shows result of bruised and non bruised detection.

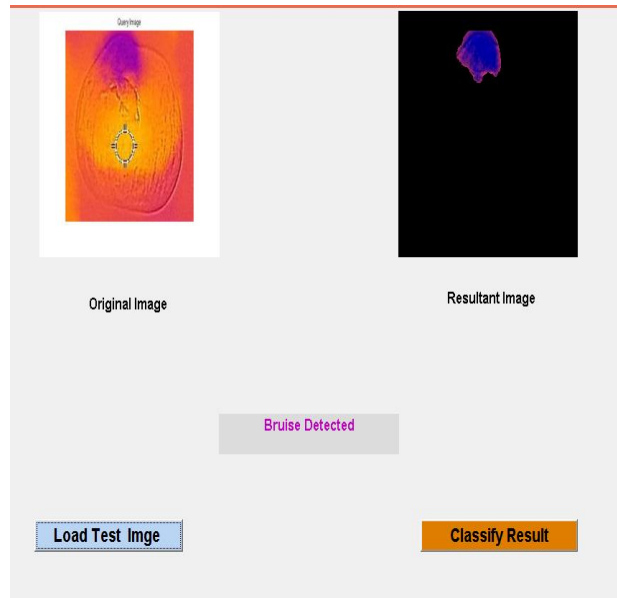


Fig 4. Result of bruised fruit

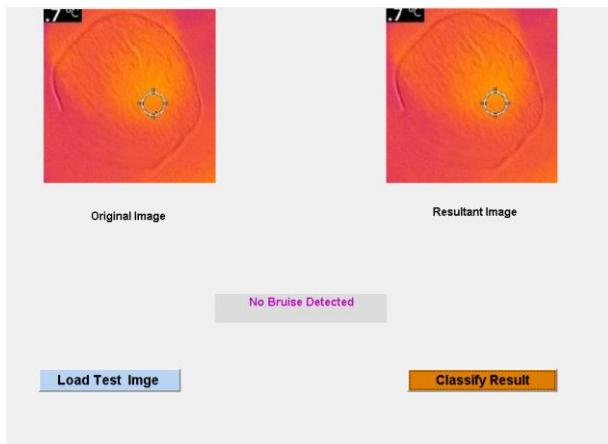


Fig 5. Result of non- bruised fruit

4. CONCLUSION

We have already tested some activity calculations for the decision of bruising in apple by occurring co-occurrence feature values. The effect of bruised region of apple was not perceivable with naked eye. Therefore we can expand prototype hardware and software algorithm for capture, rotation and automatic detection of bruising in apple. The method gives best result in calculating features of co-occurrence matrix. This data are average and compared with bruised and non bruised feature averaged with data in each section of same fruit. This disposes of subjectivity of customary techniques and human prompted errors. Conveyor system reduced staff of the centre. We have used thermal camera to detect internal disorder of the apple. Working in real time by using ANN we get sufficient speed and accuracy. We have checked web cam image efficiency. and thermal camera image efficiency. Results of thermal camera are really better than results of web camera. Image processing and analysis are recognized by computer vision. Tedious human inspection task will be reduced by series of image processing operations.

5. FUTURE SCOPE

As here we are trying to detect only some numbers of samples of bruised fruits. In future we can also implement for more types of bruises. We can also work on the different features of image classification. We can improve this, so that it can be used to detect bruises for others fruit too. Also it's a standalone application to improve the system so that it can support a web interface.

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