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Fruit Grading System using k means clustering and Artificial Neural Network

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ABSTRACT
Automation is in great demand in the field of agriculture science, to check quality of fruits, vegetables and crops. Automation helps to increase quality of fruits, vegetables and crops results in economic growth and productivity of the country. Classifying fruits or vegetables into different grades helps to evaluate cost based on grading. Automatic quality evaluation is in great demand in the export market. Cost of fruits, the consumer's preference and choice are greatly depend on appearance of fruits and vegetables. In India mostly the sorting and grading is being done manually by human being but it is not consistent. It is also very time consuming process. In addition to this it is expensive and grading decision may vary by surrounding influence. Therefore an automated fruit grading system is required to grade the fruits. This paper proposing fruit grading system using fruit image processing and classification. Using fruit classification grades of fruits can be determined easily. Fruit grading is based on attribute of fruits such as size, color, texture, shape and defects or disease of fruit.

Key words : K means, Grading, Defects, ANN classifier

1. INTRODUCTION

Currently automation in the field of grading and sorting of agricultural products attracted lot of researchers because of growing demand in food quality evaluation process. Fruit produced in farm can be graded based on size, shape, color, texture, and defects or disease of fruit. In present scenario, grading of fruit is performed manually before export of fruits. This manual grading and sorting by visual inspection is needed extra man power and is also time consuming. In addition to this it also leads to inconsistent and inaccurate decision by different persons working in field. The sorting of fruits done by human being may be replaced by machine or computer vision with the great advantages of increase accuracy and processing speed of automatic sorting and grading systems [1]. The investigation and expansion of some important models of machine vision for quality of pear detection and sorting operations has been speed up the use of new techniques for the valuation of agricultural goods quality [2]. Many computer vision based systems have been developed for agricultural grading applications based on color content of food. Direct color mapping is used to evaluate the quality of dates and tomatoes [3].

2. LITERATURE SURVEY

Authors [4] proposed automated quality verification system for agricultural products. The system utilizes enhanced engineering plans and image-processing techniques to convey and grade products. In this paper [5] image processing is used to implement the monitoring the diseases on fruits during farming, right from plantation to harvesting. Neural network model is implemented for monitoring the diseases on fruits. Research work on fruit grading system using date [6] is also reported. Authors [7] proposed color information processing for potatoes and apples. Bell peppers sorting using computer vision [8] have been reported in this research area. Some computer vision systems are also planned automation tasks such as intelligent system for packing two dimensional uneven shapes [9], The camera image contrast enhancement for surveillance and inspection tasks [13] is also reported. Patterned texture material inspection is also done [14]. Vision based closed-loop online process control in manufacturing applications [15] is also reported. The proposed technique applied computer vision based system to predict the grades of apple fruit. Based on three characteristics like size, shape and color of strawberry, the strawberry grading system has been implemented [16].Apple grading work has also been reported using fuzzy logic [17]. Authors in [18] proposed Fruit Disease Detection Using Rule-Based Classification using fuzzy logic. Mrunmayee et al. [19] presented Pomegranate plant diseases using the neural networks. They performed disease detection and classification. Pranjali et al. [20] proposed disease detection using Grape plant . In their study they took the grape leaves into consideration. They focused on the bacterial, fungal and viral causes of the disease. Revathi et al.[21] classify cotton leaf disease using edge detection technique .Cotton fungal disease was studied and HPCCD algorithm is proposed for disease detection. Jun et al. [22] gave an automatic segmentation method to detect the defects on the citrus surface effected by diseases using circulatory threshold segmentation. Swati et al. [23] proposed apple fruit detection and classification using support vector machine and chain code.

3. PROPOSED METHODOLOGY

Proposed work is on grading apple fruit into two categories, premium and regular based on below quality parameters. Quality parameters are listed for premium and regular grade in table shown below. If it does not fall in both the category then it will be treated as rejected. Apple fruit image is given as input and defects are determined and based on defect present it will be categorized. If fruit does not contain any defect then it falls into premium grade and if defects with allowed defects are identified then it falls into regular category otherwise it will be rejected.

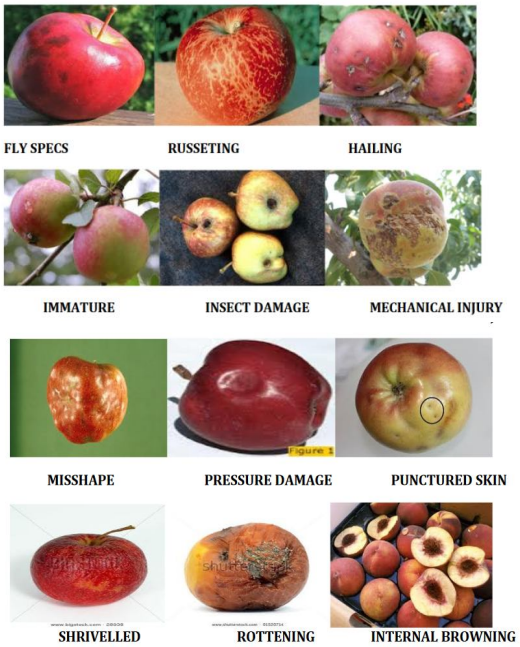

Figure 1: Defects in Apple fruit

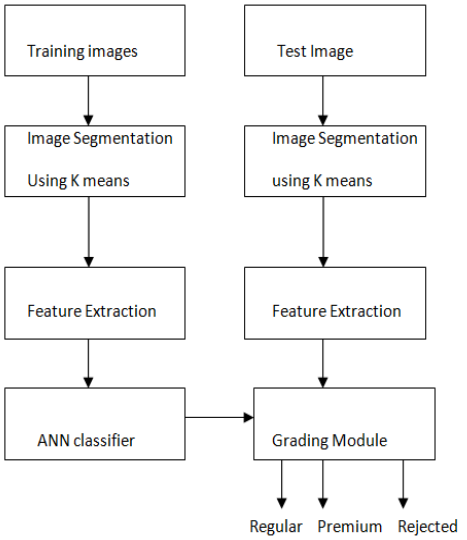

Figure 2: Work flow diagram for automated grading system

Table 1: Grading Parameters

Defects	Premium	Regular
Fly Specs	Not permitted	Not permitted
Russeting	Not permitted	Permitted
Hailing	Not permitted	Permitted
Immature	Not permitted	Not permitted
Insect Damage	Not permitted	Not permitted
Mechanical Injury	Not permitted	Not permitted
Misshape	Not permitted	Permitted
Pressure Damage	Not permitted	Permitted
Puntured Skin	Not permitted	Not permitted
Shrivelled	Not permitted	Permitted
Rottening	Not permitted	Not permitted

Quality parameters for grading apples are listed in table1. For premium category any defect is not permitted i.e. apples without listed defects are considered in premium grade. Whereas some defects such as Russeting, Hailing, Misshape, Pressure Damage, Shrivelled are acceptable in regular grade. Dataset of apples with defects is to be prepared. Eleven classes are created for all defects listed in table1. Apple image is first segmented using K means clustering and corresponding features are extracted and then apples are enrolled in training set .Training is to be done using ANN classifier and apples are labeled with its defect in training set. When test image of apple is given for grading first image segmentation is done and feature extracted then test apple image is to be matched with training image and corresponding class (defect) is then identified. Based on information of class (defect) identified for test apple image and grading parameter information ,grading module will categorized grade test apple. Performance comparison of related work is as shown in table 2.

4. Image Segmentation using K means clustering

K means clustering is color based image segmentation method. It is used to find out the natural groupings of pixels present in an image. K-means segmentation treats each image pixel (with rgb values) as a feature point having a location in space.

Algorithm: K means clustering
Input: Image and required clusters
Let $I=\{I_1,I_2.....I_n\}$ are data points in image and
$C=\{c_1,c_2.....c_n\}$ be the initial centers of cluster

1. Input image
2. Calculate the distance between each data point in image and cluster centers.
3. Assign the data point to the cluster center whose distance from the cluster center is minimum of all the cluster centers.
4. Compute the new cluster center
   C_i= sum of all data points in cluster / number of data points
5. Compute the distance between each data point and new obtained cluster centers.
6. If no data point was reassigned then Exit, otherwise repeat from step 3.
7. Exit

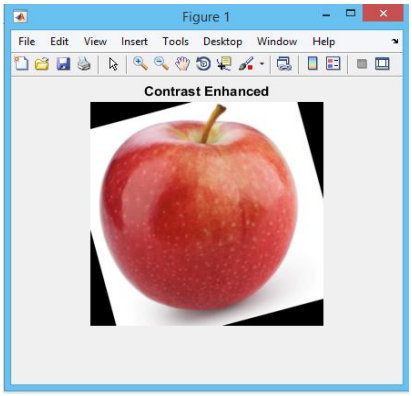

Figure 3: Apple image without defect

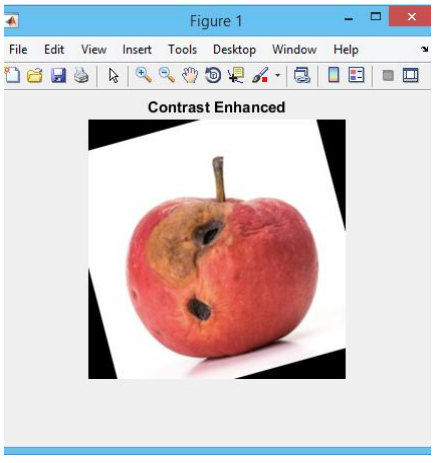

Figure 4: Apple image with defect

Table 2: Related work performance

Related work	Author	Accuracy
single-spectral systemto grade bi-colored apples	Wen ,Tao (1999)	85-90%.
mono-colored apples	Blasco et al. (2003)	86%
a single-spectral system with a B&Wcamera using basian and KNN	Kavdir ,Guyer (2004)	84-89%
multispectral machine vision system using LDA	Kleynen et al. (2005	90%
multiple color cameras to scan the surface of bi-colored apples,	Xiao-bo et al. (2010)	96%

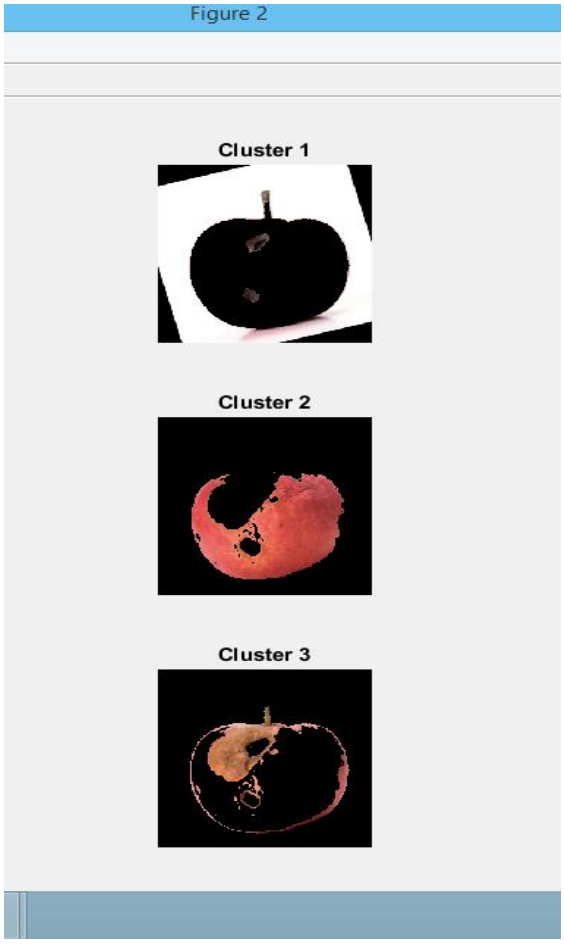

Figure 5: Segmented apple image of defected apple using k means

5. CONCLUSION

Fruit grading using machine learning and computer vision is in great demand in today's scenario as manual process is very time consuming and leads to variation in decision when judgment of grading is done by different person. This paper is proposing grading mechanism based on defects of apple fruit. K means clustering is used for image segmentation. Proposed work will be implemented using ANN classifier to classify defects and further this information is used for grading apple fruit into premium and regular grade. Training dataset is to be prepared by collecting sample images of different defects. Proposed system will be helpful for automatic grading of apples in future.

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