Prepackaging Sorting of Guava Fruits using Machine Vision based Fruit Sorter System based on K-Near Nearest Neighbor Algorithm

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ABSTRACT

In the present work, a general approach is developed to estimate the ripeness level of Guava fruit without touching it. The fruits can be classified according to different conditions as pre-harvest, postharvest harvest, storage conditions in controlled environment or harsh environment. In this study the fruit under test were classified at the time of harvest in four different classes as green, ripe, overripe and spoiled using a web camera based computer vision system. This paper presents a simple method that uses a combination of digital web camera, computer and indigenously developed graphics software to measure and analyze the surface color of fruits for ripening state recognition. The recognition was done by the nearest neighbor classifier engine uses the HSI color distribution in selected ROI of fruits. Experimental results on a database of 200 guava fruits from 4 different ripening states confirm the effectiveness of the proposed approach.

Keywords: HSI Color space, fruit ripeness, computer vision, nearest neighbor, Machine vision, Guava fruit sorting.

I. INTRODUCTION

Now days machine vision based techniques have been found increasingly useful in the fruit industry for quality inspection, detection of ripening stage and defect sorting applications. The harvested fruits are computational facility adds an opportunity to apply sorted according to quality and maturity level and then machine vision based system to assess this problem [3-transported to different standard markets at different 4]. The human sensory panel based sorting of fruits distances based on the quality and maturity level replaced by machine vision with the advantages of [1]. Sorting of fruits on the basis of their ripening stage non-contact detection, high accuracy, uniformity and has been an issue faced by producers as well as sellers high processing speed is an inevitable trend of the due to the sheer volumes handled and the delicate development of automatic sorting and grading systems nature of the fruit [2].

Conventionally fruit sorting is done by trained human There are many reported machine vision and image graders according to maturity level as they percept by processing systems have been developed for fruit their experience. This manual sorting by visual classification and grading applications which include inspection is labor intensive, time consuming and system to evaluate the quality of tomatoes and dates [6], suffers from the problem of inconsistency and inspection of golden delicious apples [7],peach inaccuracy in judgment by different human as they grading8], date fruit grading [9], potatoes and apples
Color is the fundamental property of natural images, and plays an important role in visual perception. Color has been a great help in identifying objects for many years. Color classification process involves extraction of useful information related to the spectral properties of object surfaces and discovering the best match from a set of known descriptions or class models to implement the recognition task. Color features have been extensively applied for guava fruit quality evaluation mostly for defect detection and grading. For instance, color features of each pixel in images obtained in three components of HSI spaces could be successfully used for grading of guava fruits on the basis of their ripening stage.

This paper explains the use of a low cost machine vision based fruit sorter system with appropriate pattern recognition algorithm for sorting guava fruits with specific ripening category as green, ripe, overripe and spoiled. The system is having ability of automated sorting. The system is integrated with image acquisition, image processing and decision making algorithm. The system used low-cost webcams that required no frame grabber hardware, thus making the overall system cheaper and flexible from the design point of view. The Color images were acquired in computer by indigenously developed image acquisition software programmed using LabVIEW2012 with Vision development suit. The mean HSI values were evaluated from ROI of the image. The developed system was used to collect the color data, which is then processed using nearest neighbor pattern recognition methods. The system is programmed for classification of guava fruit in four ripening states as green, ripe, overripe and spoiled. The system hardware, software development and results obtained are discussed in the paper.

II. METHODOLOGY

A. Fruit sorter system design

Figure 1 shows the design of computer vision based fruit sorter system for automatic sorting of guava fruits. Conveyor movement is controlled by the ac gear motor with VFD. Fruit presence on the conveyor is detected by IR proximity sensors. The application specific software is programmed using LabVIEW for handling the overall process of fruit sorting. The useful information related to the spectral properties of application specific software is programmed using object surfaces and discovering the best match from a LabVIEW for the overall process of fruit classification. Fruits are pushed into bins in accordance with the classification, by extending the classification for defect detection and grading. For instance, control valve. The appropriate hardware and software color features of each pixel in images obtained in three components of HSI spaces could be successfully used for grading of guava fruits on the basis of their ripening stage.

The automated system collects video image from the CCD web camera placed on the top of a conveyor belt carrying Guava fruits, then it processes the images in order to collect several relevant features which are sensitive to the maturity level of the guava fruit. The ROI of the collected image is used to estimate the parameters of the individual classes for prediction of maturity. The recognition is achieved by the nearest neighbor classifier engine uses the HSI color distribution in selected ROI of fruits. Figure 2 shows the actual photograph of the system.

Figure 1. Fruit sorter system design

Figure 2. Machine vision based fruit sorter system
B. Experimental procedure:
There are two sections involved in the proposed work frames which are training and classification. The block diagram of software GUI from the video images having frame rate proposed method is shown in figure 3 of electronic 30 frames /second. The proposed algorithm was machine vision based system for automatic guava fruit implemented in LabVIEW12 Real Time Environment sorting into four different classes as green, ripe, with vision development suit. Video signal capture overripe and spoiled. The images were acquired using from web camera found to be contaminated with iball made 12 megapixel webcam in the indigenously motion blur artifact and noise, thus proper extraction of developed GUI software developed in LabVIEW12 images from video frames and then filtering is needed. with vision development suit. The camera was The extracted images have background color hence interfaced with a computer through USB port. This needed feature was extracted from only selected region software is capable to segment the specific ROI location of interest (ROI). of image into equivalent HSI values. Some fruit images were used for training purpose and remaining for recognition. The decision making was done using nearest neighbor classifier based algorithm.

C. Image acquisition and illumination:
Images were captured using image acquisition software developed in LabVIEW with Iball made webcam connected to USB. Fruit Samples were illuminated by using two fluorescent lamps with a color temperature of 6500K (Philips, Natural Daylight, and 18W) and a color rendering index (Ra) near to 95% [15]. This illumination system gave a uniform light intensity over the fruit sample plane. A digital web camera was located vertically at a distance of 10 cm from the sample. The angle between the camera lens axis and the lighting sources was around 45°. Images were captured at resolution 640x480 pixels.

D. Pre-processing of images
The performance of the classifier system depends on the quality of the captured images by the web-camera, since various features to be evaluated from it. The still

E. Color image segmentation:
The goal of segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyze. The HSI representation is selected due to its invariant properties [16]. The Fruit recognition system shown in Figure 2, need a change in the color space of the images, in order to obtain one channel containing the luminance information and two other channels containing chrominance information. The hue is invariant under the orientation of an object with respect to the illumination and camera direction and hence more suited for object retrieval [17]. The HSI color space is very important and attractive color model for image processing applications because it represents colors similarly how the human eye senses colors. The HSI color model represents each color with three components: hue (H), saturation (S), intensity (I).

F. Training of classifier
Color classifier uses color features to identify fruit samples. In present study the NI color classification training interface was used to train the neural network. The four classes were created as green, ripe, overripe and spoiled. The guava fruits samples of different ripening stages were used for training. Nearest neighbor classifier engine was used for classification. The trained classifier file was used in indigenously developed software GUI. The front panel of NI color classifier is shown in fig.4

![Figure 3. Block diagram of Machine Vision System](image-url)
Color Classification Training Interface was used to train a color classifier by manually classifying color samples into new or existing color classes. Based on those samples, the color classifier can classify unknown samples into a known class.

There are various color classification algorithms available in NI color classifier such as k-Nearest Neighbor, Nearest Neighbor and Minimum Mean distance but nearest Neighbor is preferred for this application as per our experimental experience. Nearest Neighbor based classification is most direct approach to classification. In nearest neighbor classification, the distance of an unknown color sample from another class is defined as the distance from the closest samples in the neighbor class. The figure 5 shows complete steps of training the ANN using NI color classification training interface.

The classification score is the degree of certainty that a sample is assigned to one class instead of another class. The identification score is the degree of similarity between a sample and samples in the class to which the sample is assigned. The closest sample image is the learned sample that most closely matches the sample in the ROI. The proper option from the metric list was selected to configure how the classification engine calculates the distance between samples. Sum—Metric used in the classification applications. Sum is also known as the Manhattan metric or Taxicab metric. This is the default Metric value [18].

III. RESULTS AND DISCUSSION

For the experimental work Lucknow type guava fruits of four ripening states as green, ripe, overripe and spoiled (50 samples each state) were collected from orchard located in the Rahata tahsil of Ahmednagar district from Maharashtra state, India at altitude 520 m, latitude 19.72° North, longitude 74.28° East. Three independent human sensory panel experts having more than 10 years of experience of fruit sorting were selected for manual classification of guava fruits in four ripening classes. In nearest neighbor classification, the different ripening states as discussed earlier. From distance of an unknown color sample from another human sorted fruits 50 % fruits from each group were class is defined as the distance from the closest samples used to train the Ni color classifier and the remaining in the neighbor class. The figure 5 shows complete images serves as the testing or prediction set.

For classification of guava fruits in four different classes, the indigenously developed software GUI has been used as a pattern recognition tool. This software uses nearest neighbor engine to execute the color classifier designed around sum metrics for classification of unknown class of fruits. The software is programmed in LabVIEW environment. The executed color classifier employs HSI color space to calculate a color feature for every sample to be classified. The front panel of the software is shown in figure 7. In the classification, the

![Image](image_url)
process of labeling a color based on previously learned. The average efficiency achieved using developed colors was used as a machine vision tool to deciding classifier system is 90%, if human grading taken as reference level is assumed to be 100% accurate. However, 10% variation is also due to individual judgment of human-graders in perceiving the ripening level of fruit during manual grading, which of course is inevitable. The repeatability of the developed system is found to be 100% from rigorous experimental work.

IV. CONCLUSION

The developed system can be used effectively to classify Front panel of the software is the screen, which indicates the ripening stages of fruit. The panel consists Nearest Neighbor Classifier employing Sum Metric of gauge which indicates the acquire image and showing good results for said application. It is found selected ROI for classification. HSI values calculated that efficiency increases as increasing number of from acquired image. The software uses trained training samples. By analyzing percentage accuracy classifier file previously prepared using NI color getting with this system, it is concluded that system is classification training interface as described earlier. The capable to translate effectively human visual perception software identifies an unknown color sample of a ROI about guava fruit classification in to machine vision. in image by comparing the region’s color feature to a The system predicts the right class of guava fruit set of features that conceptually represent classes of successfully when checked for complete set of fruits known samples (trained classes).The developed used for training as well as in classifying phases. The intelligent grader software was used practically to proposed system has a good future in the field of discriminate the guava fruit ripening state in four machine vision based classification and grading of fruits. classes. In operational the software acquires the fruit The study reveals that, the developed system images automatically. As soon as the image of the guava performance is near to the human sensory panel fruit under test is acquired, it automatically displays its experts, where they judge the ripeness level not only ripening state. The conveyor carry the fruit in by the skin color but also with firmness and smell.

V. REFERENCES


[18]. www.ni.com