Fruit Quality Management using Image Processing

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ABSTRACT

This paper aims at presenting the concept of fruit quality management,In recent years automatic vision based technology has become more potential and more important to many areas including agricultural fields and food industry.The desired system which determines the quality of fruit by its color, size and weight. Sorting tons of fruits manually is a time consuming, costly, and an inaccurate process and to developed in order to increase the quality of food products made from fruits. The sorting process depends on capturing the image of the fruit and analyzing this image using image processing techniques to discard defected fruits. Color is most striking feature for identifying disease and maturity of the fruit.The main emphasis is to do the quality check with a short span of time so that maximum number of fruits can be scrutinized for quality in minimum amount of time. The absolute reference point is the way to perceives and interpret the quality of fruit. The present assessment of fruit quality requires new tools for size and color measurement and capturing the fruit side view image, some fruit characters is extracted by using detecting algorithms. This system performs the sorting using MATLAB software and gives some advantages over traditional practices.

Keywords: ***Fruit, Sorting and Grading, Image processing and analysis, microcontroller, MATLAB, Conveyor belt.***

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1. INTRODUCTION

In India the ever-increasing population, losses in handling and processing and the increased expectation of food products of high quality and safety standards, there is a need for the growth of accurate, fast and objective quality determination of food and agricultural products.

Agriculture is one of the largest economic sectors and it plays the major role in economic development of our country. In our country the ever-increasing population, losses involved in processing and the increasing demand of fruits of high quality with good appearance, there is a need for the development of accurate, fast and focused quality determination of food and agricultural products like fruits and vegetables. Whereas grading is done based on the overall quality features of a fruits by considering a number of attributes like shape, size, color etc. Classification is necessary for the quality evaluation of agricultural produce like fruits and vegetables. Fresh market fruits like Apples, Oranges, Bananas are graded into categories based on several factors such as color, shape, size and presence defects or bruises, blemishes on it. Fruit market is getting highly selective, requiring their suppliers to distribute the fruits of high standards of quality and presentation as well. So there is a increasing need to supply quality fruits within a short period of time has given rise to the development of automated Grading of fruits to improve the quality.

As the major source of national income is from agriculture, it becomes the backbone of Every countriesEconomy .India ranks first among the other countries in the world, in the production of milk, pulses, jute and jute-like fibres; second in cereal crops, cotton, vegetables and fruits production; and is one of the leading producer of spices and plantation crops as well as fisheries and poultry .If the overall production is good then it will directly increase the annual income of the cultivators and ultimately the national income of the country. Therefore currently researchers are trying to develop innovative and automated methods using science and technology to increase the production of agricultural industry .

Generally, the quality of fruit shape, color and size, default and so on cannot evaluated on line by the traditional methods.The development of image processing technology and computer software and hardware, it becomes more attractive to detect fruits' quality by using vision detecting technology. At present, most existing fruit quality detecting and grading system have the disadvantage of low efficiency, low speed of grading, high cost and complexity. So it is significant to develop high speed and low cost fruit size detecting and grading system. They are mainly two choice provide for grading either by color and size. In first case we are going to sort circular shaped fruits according color and grading is done according to size. The proposed automated classification and grading system is designed to combine three processes such as feature extraction, sorting according to color and grading according to size. Software development is highly important in thiscolor classification system and for finding size of a fruit. The entire system is designed over MATLAB software to inspect the color and size of the fruit.
It mainly contains four parts: the system overview, fruit size detecting and grading, experiments and results, conclusion. The four parts will be introduced as follows.

LITERATURE SURVEY

Hongshe Dang, Jinguo Song, Qin Guo [1] have proposed fruit size detecting and grading system based onimage processing. The system takes ARM9 as main processor and develops the fruits size detecting programusing image processing algorithms on the QT/Embedded platform.Authors in [2] have proposed system which finds size of different fruits and accordingly different fruits can be sorted using fuzzy logic, here author proposed MATLAB for the features extraction and for making GUI. John B. Njoroge. Kazunori Ninomiya. Naoshi Kondo and Hideki Toita [3] have developed an automated grading system using image processing where the focus is on the fruit's internal and external defects. The system consists of CCD cameras. The image could be captured using regular digital camera. X-ray imaging is used for inspecting the biological defects. Image processing is used to analyze the fruit's features; size, color, shape and the grade is determined based on the features. The developed system is built from a combination of advanced designs, expert fabrications and automatic mechanical control. J. V. Frances, J. Calpe, E. Soria, M. Martinez, A. Rosado, A.J. Serrano, J. Calleja, M. Diaz [4] presented a procedure to improve the performance, whether increasing speed or accuracy, of the load-cell-based weighting subsystem in a fruit sorting and grading machine to achieve an accuracy of + l gram. Wong Bing Yit, NurBadariah Ahmad Mustafa, Zaipatimah Ali, Syed Khaleel Ahmed, ZainulAbidinMdSharrif [5] proposed new MMS-based system design

2. IMAGE PROCESSING

Image processing is any form of information processing for which the input is animage, such as photographs or frames of video; the output is not necessarily an image,but can be for instance a set of features of the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal processing techniques to it.

A pixel, short for picture element, can be thought of as a tiny dot containing information about the picture. When you snap a picture, these tiny bits of informationare gathered by the camera's sensor.

The information is being stored in a 3 plane ofinformation. Each plane represents three colors that are red, green and yellow plane.Each plane has the intensity from 0 up to 255 or 8-bit of information per plane. Thesethree color combination makes up all the color we could see in an RGB images.Simple calculation of this are 8-bit information is as follow:-

2n = bit, 28 = 256

The origin of this size started when the byte was introduced back then in theorigin of information capacity now have its standard. Many of the techniques of digitalimage processing, or digital picture processing as it was often called, were developed inthe 1960s at the Jet Propulsion Laboratory, MIT, Bell Labs, University of Maryland, anda few other places, with application to satellite imagery, wire photo standardsconversion, medical imaging, videophone, character recognition, and photoenhancement. Digital processing is most of the time preferable because of cost issueon top of falling trend of digital devices.

2.1 HARDWARE

IR Sensor Unit

There are two IR based sensors, one is for detecting the fruit on the conveyor belt and the other is to detect the presence of fruit in front of the camera. After the first IR sensor gives the high to low pulse that is the fruit is detected on the conveyor belt, the belt starts to move in the forward direction. Next, the second IR sensor gives a low to high pulse when the fruit has reached below the camera. After this pulse is detected the µC then stops the conveyor and gives an indication to PC via RS232.The camera then clicks a photo of fruit and MATLAB software on PC further analyses the captured image in RGB format.

Web Camera

A Webcam is a video camera that feeds or streams its image in real time to or through a computer to a computer network.When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks via systems such as the internet, and emailed as an attachment. Webcam typically include a lens, an image sensor, support electronics, and may also include a microphone for sound.

Now, the capability is bigger and not impossible to increase in the near future. To enhance the capturing ability, the camera used is using CCD as a sensor. CCD stands for Charge Couple Device, which is not regarded as more superior against CMOS or Complementary Metal Oxide Semiconductor type of sensor.

With three layer of CCD, each capturing each plane consisting of Red, Blue and Green respectively giving a more vibrant and sharp images. This factor also contributing to the resolution and frames per second performance on capturing images. CCD is less prone to noise.

LCD Display Unit

The 16 character by 2 line display in our project. The main objective to use LCD is to display the weight of the fruit and also to display the various processes and results obtained once the sorting process is complete.

PC Unit

In our project we are using MATLAB software on PC. The MATLAB language is used to mathematically analyse the color and also to determine the size of the fruit.

DC MOTOR Unit

Generally DC Motor required current 12V DC motor to drive the DC motor based conveyor. The µC cannot provide the current required by the DC motor, so we are interfacing a DC motor driver , which is used to drive the 12V DC Motor.

2.2 SOFTWARE

The ARM microcontroller used the KEIL software which includes the µVision. The process of extracting the features of the image captured by the camera and analyzing those features for sorting of the fruits is done by the MATLAB software based on image processing. The Graphics User Interface (GUI) in MATLAB is used to set the reference points for the calculating the size, height and weight of the fruit on the basis of which the fruits are sorted and the parameters,height, weight, width, number of tested fruits as well as accepted and rejected fruits are displayed.

2.3 SYSTEM ARCHITECTURE

This system consists of automatic designed over MATLAB software to inspect the color and size of the fruit. The capturing live image of a fruit the camera is continuously scanning the conveyor belt in video mode. The fruit is initially placed on the conveyor belt. The conveyor stops when fruit is detected by the IR sensor and camera captures the image of the fruit and this captured image is given as an input to the MATLAB software which extracts the color, height, weight and shape of the fruit. This data is transferred to ARM based system by using RS 232 and com port and accordingly control action takes place. The fruits fall on a plate after falling off the conveyor and then the flapper sorts the fruit one by one according to its features extracted. The graphics user interface displays the characteristics (color components, width, height, etc.) of the image captured and also the number of accepted and rejected fruits.

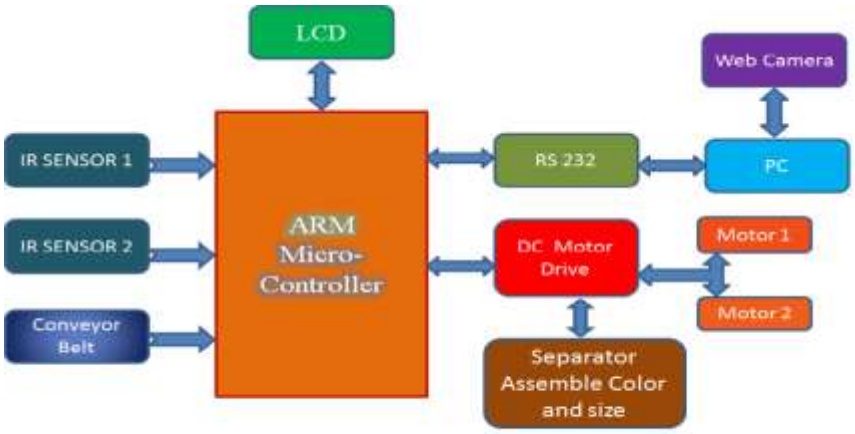

Fig-2:System Architecture

The system consists of fruit grading using firstly camera position is adjusted in such a way that for capturing live image of a fruit in the camera. There is continuously scanning the conveyor belt in video mode, when conveyor stops as fruit is detected by IR system camera can capture top view image of fruit. The system consists of CCD cameras. The image could be captured using regular digital camera. The black background color in image is easier to extract the fruit edge characters later [1] so black color is used for the conveyor system. The captured image is given as an input to the MATLAB software which extracts (detects) color and size of a fruit, this data is transferred to ARM based system by using RS232 and com port and accordingly control action is taken place, later conveyor starts and then fruit is collected in desired box container separation depend upon desired fruit quality condition of grading assembly.

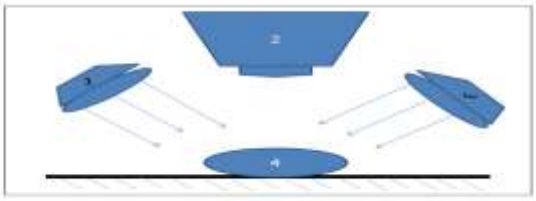

Fig-3:Fruit Size Detection

(1,2-light; 3-cmos camera; 4-fruit & conveyor belt;)

Fruit Size Detecting And Grading

A. **Processing flow**

B. **Color Detection**

C. **Edge Detection**

D. **Fruit size Detecting Algorithm**

E. **Fruit size Grading**

A. Processing flow

Fig-4:Process Flow

Take apple as the processing example, according to [1],the apple size is its diameter, which is the longest distance in the apple's cross section. So the detecting program is focused on how to calculate the diameter in an apple side view image. The fruit image size detecting and grading processing flow is shown in Fig.3

B. Color Detection

In the process of fruit color is detected according to RGB values [5], here fruits are sorted according to color and size. So for e.g. two fruits are considered say Apple,Tomato having red color and Kevi(Guava) having green color, so in this step work is going to find out color of a fruit by using RGB values of an image taken from the camera, this image can be processed by using MATLAB software and accordingly color can be detected i.e. green or red.

Color detection algorithm:

1) Start
2) Read the input color image using imread function.
3) Read the input pixel of color image in three different planes (RGB) and store it into three variable r, g, and b.
4) Read the small region of fruit to detect color of fruit.
5) Store in different variable r1, g1, b1.
6) Calculate the mean of r1, g1, b1 and store into variable r2, g2, b2.
7) Compare the value with threshold.
8) If g2>threshold, Color detected is green.
9) If r2>threshold, Color detected is Red.
10) End.

C. *Edge Detection*

Once color is detected, there is a need to find out size of a fruit. The size of circular shaped fruit is its diameter [1]. The edge extraction is key factor for size detecting. After gray image, the most powerful edge-detection method that finds edge is the canny method

The Canny method differs from the other edge-detection methods [7] in that it uses two different thresholds (to detect strong and weak edges)and includes the weak edges in the output only if they are connected to strong edges. This method is therefore less likely than the others to be fooled by noise, and more likely to detect true weak edges.

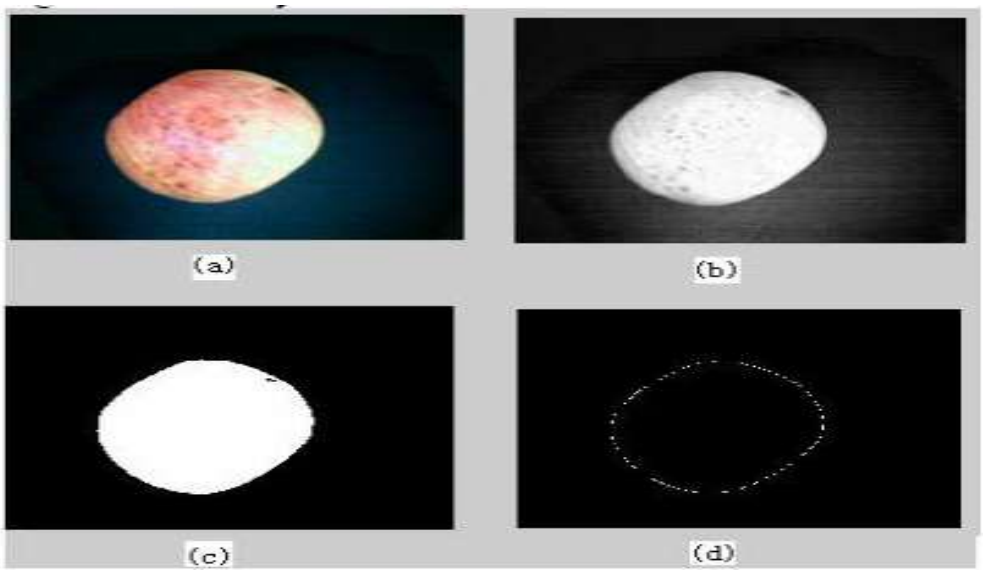

Figure 5: The processing fruit image. (a) the original image;(b)gray image;(c)diversion image;(d)tracking

D. Fruit Size detecting algorithm

In order to calculate this diameter, the fruit's natural symmetry is considered, so the fruit size detecting algorithm based on its symmetry mainly contains two parts: finding the center coordinates of fruit's shape in image and finding fruit's axis in image [7]. The algorithm is described as follows: 1) Finding the center coordinate of fruit's shape in image: The center coordinate can be easily calculated once finding the edge sequence points. Suppose the finding edge sequence point is q (xi, yi), i=1, n. the center coordinates of fruit's shape is (cx, cy), it can be calculated by (1) and (2) as in [1]:

$$c_x = \frac{\sum_{k=1}^{n}[y_k(x_k^2 - x_{k-1}^2) - x_k^2(y_k - y_{k-1})]}{2\sum_{k=1}^{n}[y_k(x_k - x_{k-1}) - (y_k - y_{k-1})]} \qquad (1)$$

$$c_y = \frac{\sum_{k=1}^{n}[y_k^2(x_k - x_{k-1}) - x_k(y_k^2 - y_{k-1}^2)]}{2\sum_{k=1}^{n}[y_k(x_k - x_{k-1}) - x_k(y_k - y_{k-1})]} \qquad (2)$$

2) Finding the fruit's axis in image: After get the center coordinates of fruit's shape in image, the diameter sequence from the edge point to the center can be also acquired, that is p(j) j=1,…, n. and then it's even points selected from p(j) called r(j) ,j=1,…,m. suppose h □ 1,...,m / 2 . So the r (j) can be divided in two parts by h, and then calculating the g, which is described by (3).

$$g = \sum_{l=1}^{m/2} |r(h+l) - r(h-l)| \quad (h=1,2,\ldots,m/2)$$

$$\text{If } |h-1| \le 1,\ r(h-1) = r(m+1-h-1) \qquad (3)$$

The direction of r (h) is the fruit's axis in image while g the getting its minimum. Following the below method, the fruit's axis point and center point is found in image as shown in Figure. 5. Once known the axis point and the center point, a line through the center point which is vertical to the line from axis point to center point will be crossed with the edge sequences, two edge points that on the line will be searched. Suppose the two points is (x1, y1) and (x2, y2) in order to improving the system's speed, the diameter is calculated by (4) indicates the fruit's real maximal diameter in image. From the detecting result in Figure 5,
This method can find the axis point accurately in a fruit image. And also, it still can find the two points while the fruit's location changed. So this method can satisfy the fruit size detecting on line which its location changed often.

Figure 5: Fruit's axis point and the center point location

F. Fruit Size Grading

According to apple state criterion, size grading is judged by the detected diameter of an apple, [6]. The algorithm was able to classify the fruit images based on two categories of the sizes.

(i) Big ≥ 60 mm diameter

(ii) Small ≤50 mm diameter

The inner contents of the fruit could also be analyzed for exotic class fruits using x rays [7]. In exotic fruits like peach the split ends of the peach could be detected using transmission images in real time to evaluate the water content distribution and internal structure of fruit.

3. CONCLUSION

The main objective of this paper is detection of Good or Bad Quality fruits efficiently. The specifically good quality fruit store in box container under desired artificial or natural condition store it. This detection is achieved by processing the image of fruit.This work presents new integrated techniques for sorting and grading of different fruits Algorithms are developed for checking different parameters which are responsible for the quality of fruits. The results obtained can be used for statistical analysis which further decreases the detection time.

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