Computer Vision Based Fruit Detection and Sorting System

[1]Swapnil S. Pawar, [2]M. P. Dale

[1,2]M.E.S. College of Engineering, Pune
Email: [1]visionpower91@gmail.com, [2]mpdale@mescoepune.org

Abstract—This paper presents a computer vision based system for automatic detection and sorting of fruits. Detection is important because it is fully automated system, sometimes input to system may be other than fruit which is having same color and size as that of particular fruit. In this work we are capturing two images to make our system more accurate and cover maximum area of fruit. Image analysis is done on both captured images and raspberry pi will take decision to which class fruit will be sorted. Sorting is categorized into four classes. A single motor is used to rotate four baskets. After decision is taken by raspberry pi motor will rotate at particular angle for sorting of fruit.

Index Terms— Binarised Image, Computer vision, Lemon detection and sorting, Raspberry pi

I.INTRODUCTION

Indian economy based on agriculture, so automation of agriculture and agriculture related industry plays important role. Post-harvest process of fruits is completed in several steps: washing, sorting, grading, packing, storage and transporting. The fruit sorting is considered the most important steps of handling. Product quality and quality evaluation are important aspects of fruit production. Sorting of agricultural products is accomplished based on appearance, texture, shape and size. Manual sorting is based on visual quality inspection performed by human operators, which is tedious, time-consuming, slow and non-consistent. It has become increasingly difficult to hire personnel who are adequately trained and willing to undertake the tedious task of inspection. A cost effective, consistent, superior speed and accurate sorting can be achieved with machine vision assisted sorting.

Computer vision and image processing techniques have been found increasingly useful in the fruit industry, especially for applications in quality inspection and defect sorting applications. Research in this area indicates the feasibility of using computer vision systems to improve product quality while freeing people from the traditional hand-sorting of agricultural materials. The use of computer vision for the inspection of fruits has increased during recent years. Nowadays, several manufacturers around the world produce sorting machines capable of pre-grading fruits by size, color and weight. Nevertheless, the market constantly requires higher quality products and consequently, additional features have been developed to enhance computer vision inspection systems. Automated sorting had undergone substantial growth in the food industries in the developed and developing nations because of availability of infrastructures. Computer application in agriculture and food industries have been applied in the areas of sorting of fresh products. The new technologies of image analysis and computer vision have not been fully explored in the development of automated machine in agricultural and food industries.

An intelligent vision system to evaluate fruit quality (size, color, shape, extent of blemishes, and maturity) and assign a grade would significantly improve the economic benefits to the orange and tomato fruits industries. Research efforts have concentrated on the implementation of computer vision to replace manual sorters.

Therefore a new method for detection and sorting of lemons is developed. Sorting categorized in four classes (four baskets) first basket for green lemon, second basket for yellowish green lemon, third basket for yellow lemon and fourth basket for defected lemon.

II. LITERATURE SURVEY

Sorting of fruits (Mango, Tomato) can be based on color of that particular fruit, for mango sorting is based on its variety, the shape of mango image is compared with reference shape, hue moment is used for shape analysis. When hue difference is zero it is considered as perfect match. For grading of mango pixel value is considered, if pixel value greater than 100 then skin of mango is pure. It shows an overall accuracy of 83.33% [1].

The sorting of mango can be done based on its maturity level, CCD camera is used to capture video sequence, pseudo median filter is used to remove noise, for edge detection and boundary tracking image is converted to binary image . It shows an overall accuracy of 90% [2].

The qualities of fruits, a new method based on HSI color model [3].An image of fruits was taken and transferred from the RGB color model to the HSI color model. Its simplified histogram of hue H was calculated, which was used as the input of a designed BP network. The output of the BP network was the description of evaluated quality of the fruits. After training, the quality of fruits was identified by the BP network according to the simplified histogram of H of their colored image.

A working model of a date fruit grading and sorting system including both the hardware and the software is built [4]. The hardware includes the conveyer, camera control and helm control systems. The software system analyzes the fruit image and classifies them. The maximum accuracy of the system is 80% which is attained by model 2 in classifying the grade 2 fruit. They observed problems in detecting the flabbiness from the color. An impact sensor might improve flabbiness detection.

The paper [5] reviews the fundamentals and applications of computer vision for food color measurement. Introduction of color space and traditional color measurements is also given. Advantages and disadvantages of computer vision for color measurement are analyzed and its future trends are proposed. This review covers fundamentals and typical applications of computer vision in food color measurement.

The paper [6] presents a novel automatic defective apple detection method by using computer vision system combining with automatic lightness correction, number of the defect candidate (including true defect, stem and calyx) region counting, and weighted relevance vector machine (RVM) classifier.

III. METHODOLOGY

The Fig.1 represents the block diagram of the developed system.

The system consists of 3 main stages:

Stage1: Acquiring the image of the Lemon:

It involves the capturing of the two images of the lemon using pi camera and web camera. The side views of the lemon are captured using both cameras. Two cameras are used to cover maximum area of lemon. Fig.2 shows captured image of lemon. For image analysis both images are processed simultaneously. These images are then sent to the raspberry pi for detection of lemon and sorting

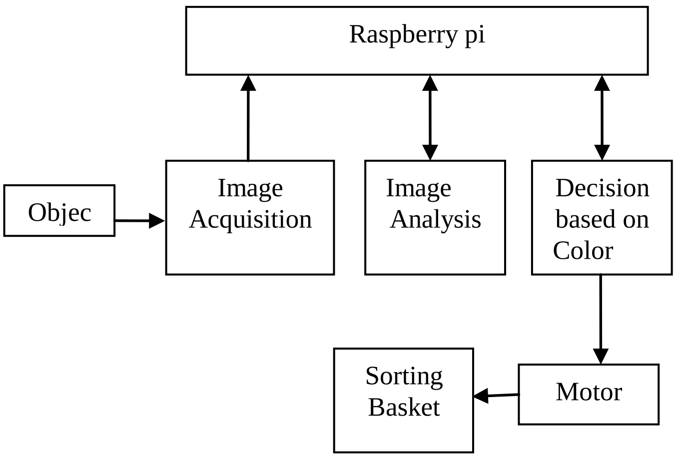

Fig.1. System Block Diagram

Stage 2: Detection process:

There are several methods for detection of lemon. Mostly fruit recognition techniques which combine different analysis method like color-based, shaped-based, size-based and texture-based, for different fruit images color and shape values are same, but not robust and effective to recognize and identify the images [8]

Lemon detection can be done by using Gabor transformation and K-nearest neighbor algorithm.

The proposed methodology in this paper, to perform the analysis for image features extracts using following steps

1. Capture input images using pi camera and web camera
2. Crop the area of fruit
3. Calculate shape by threshold segmentation (remove noises, Morphological operations)
4. Calculate geometrical properties (Area and perimeter)
5. Calculate the roundness value
6. Calculate entropy values
7. Use nearest neighbor classification algorithm to identify whether the given fruit is lemon or not.

Fig.2. Side view image of lemon

Stage 3: Detection of defective lemon and sorting:

Find out defective lemon is one of the most important preprocessing steps. The area of defective skin is calculated. A color image of the lemons was used for the analysis. If the pixel value is less than the selected threshold value then it is considered as a part of defective skin. Any pixel value greater than the selected threshold value is a part of pure skin .The image is binarised then pure part of the image indicated by black while the damaged ones white. The Fig. 3 shows the original image and the binarised image were white represents the defective skin. Then the total number of white pixels are calculated which will be equal to the total number of pixels corresponding to damaged skin. Once it is obtained, the area of damaged skin is calculated by:

Total defective area = N x 4.3677 x 10^{-6} cm^2

Where N = no: of defective pixels.

The lemon sorting is done into four classes green lemon, yellowish green lemon, yellow lemon and defected lemon. The sorting of lemon is done based on its color. The RGB components are calculated from image. The color histogram matching is also used for sorting of lemon into three classes green lemon, yellowish green lemon, yellow lemon.

(a) (b)

Fig. 3: (a) Original Image of defective area (b) Binarised image were defective skin is represented as white

IV. RESULTS AND DISCUSSIONS

The algorithms for detection and sorting of lemons were implemented using python language in openCV. Ubuntu 12.04 LTS platform is used for python programming. Raspberry pi model B+ is used initially but due to less RAM as compared to Raspberry pi 2, the time required for image processing is more. The time required for image analysis (binarisation and thresholding) using both models is presented in TABLE 1

TABLE 1: Time required for image analysis (binarisation and thresholding) using raspberry pi models

Model	Time required for image analysis (seconds)
Raspberry pi B+	10s
Raspberry pi 2	5s

The number of pixels in that one square centimeter was calculated, which was found to be 228953 pixel for the particular camera used. Then the area of each pixel was calculated as follows:

No of pixels in $1cm^2$ = 228953 pixels

So 1 pixel = 1/228953=4.3677 x 10^{-6} cm^2

Thus the area corresponding to one pixel was calculated to be

4.3677 x 10^{-6} cm^2

Using these calculations the number of defective pixels and defective area was found and certain threshold is set for defected class.

V. CONCLUSION

In this work we are using raspberry pi model 2 instead of raspberry pi B+ model to achieve high speed. System is independent of CPU therefore hardware cost is less. For rotation we are using single motor for all four baskets to reduce hardware requirements.

Due to use of two images for analysis system will be more accurate.

REFERENCES

[1] Leo Pauly, Deepa Sankar “A New Method for Sorting And Grading Of Mangos Based On Computer Vision System”, 978-1-4799-8047-5/15/$31.00_c 2 IEEE

[2] Bipan Tudu, Chandra Sekhar Nandi, Chiranjib Koley “An Automated Machine Vision Based System for Fruit Sorting and Grading”, 2012 Sixth International Conference on Sensing Technology (ICST)

[3] Yanhua Cui, Yizhong Wang, Shaohui Chen, Ping Zhang, Huafang Huang “Study on HSI Color Model-Based Fruit Quality Evaluation”, 2013 3rd International Congress on Image and Signal Processing (CISP2010)

[4] Yousef Al Ohali “Computer vision based date fruit Grading system: Design and implementation”, Journal of King Saud University – Computer and Information Sciences (2011) 23, 29–36

[5] Di Wu and Da-Wen Sun “Color measurements by Computer vision for food quality control e a review”, Trends in Food Science & Technology 29 (2013) 5e20

[6] Wenqian Huang, Baohua Zhang, Liang Gong, Jiangbo Li "Computer vision detection of Defective apples using Automatic lightness correction and weighted RVM Classifier", Elsevier-Journal of Food Engineering 146 (2015) 143–151

[7] Dr. S. K. Bodhe, Suchitra Khoje "Determination of Applicability of Mother Wavelet for Coarse and Fine Grading of Mangoes", ICATE 2013 Paper Identification Number- 119

[8] Shikha Pandey, Pragati Ninawe "A Completion on Fruit Recognition System Using K-Nearest Neighbors Algorithm", International Journal of Advanced Research In Computer Engineering & Technology (IJARCET) Volume 3 Issue 7, July 2014