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Citrus Fruit Classification

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***Abstract*: Usually in the citrus industries, fruit grading is performed by humans through visual inspection. Manual inspection implies several problems in maintaining grading consistency and sorting uniformity. Citrus classification is normally achieved based on external visible criteria, such as size, shape and color. This problem has been addressed using computer vision algorithms, but an automatic grading machine based on computer vision usually requires large computational resources in order to perform the classification due to the complexity of the computer vision operators. This paper describes an embedded color-based citrus selection system implemented on a raspberry pi device.**

***Keywords*: RGB color space, Raspberry pi kit, Citrus filter, Thresholding, Mean filter, Pixel classification counter.**

1. Introduction

Commonly, citrus quality grading is performed by humans manually by visual inspection of external visible criteria, such as size, shape and color. Manual inspection implies several problems to maintain consistency in grading and uniformity in sorting due to observer subjectivity.

Thus, an embedded automatic vision system for citrus classification in the industry is highly desirable. Image pre-processing operations can be performed using a dedicated hardware implementation, which might exhibit a faster processing, by performing several tasks in parallel with the additional advantages of low power consumption and small size.

Nevertheless, the embedded implementation of any of these techniques using a Raspberry-Pi kit has not been explored. Raspberry-pi kits are suitable for the addressed application since they potentially provide a high computational power to achieve high performance with reduced design cycles.

2. Literature Survey

Capizzi G, G. Sculto [1] "Automatic classification of fruit defects on co-occurrence matrix and neutral networks" here in

This process to calculate three co-occurrence matrices to extract effective features using RBPNN to categories the defect areas the accuracy is 97.23%

Krithika L. S, jayasnakara, karthika B [2] "Fruit freshness detection using raspberry pi" this model shrinks the board down to about a size it deals with manipulation of digital images to detect a light wave length in the infrared spectrum. It also tends to change in dimension

Ferrai C, G foca [3] "Classification of large hyperspectral image dataset for easy bruise detection on apples" It acquires hyperspectral images that can evaluate the image areas to complete hyperspectral images segmentation to construct the appreciate hyperspectogram to classify the extent of fruit bruises.

Damesheari Sahu, Chitesh Dawagan [4] "Classification of mango fruits using image processing" here input is pre-processed, image binarization, image filtering intermediate involves processing it also includes background subtraction and at the last to calculate the number of pixels.

3. Methodology

The proposed block diagram is shown in Fig 1. It consists of six blocks respectively Separation of R, G and B layers, Gaussian filter, Thresholding, Mean Filter, Pixel classification counter, Data output.

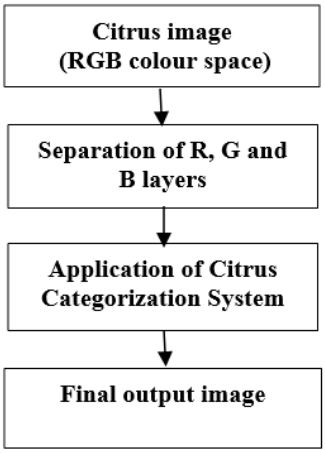

Fig. 1. Flow diagram of the proposed methodology

1) Input block: The input citrus image captured will be in color format i.e. it consists of Red Green and Blue (RGB) components. The input image is divided into different types depending upon its color and size. It provides information

of various ripeness level fruits that are given as the input. It is basically the collection of numerous citrus fruit images which are mainly used in future for the better grading in order to fetch enhanced revenue in national and international market. It includes raw, semi ripe, fully ripe and rotten citrus fruit images.

2) RGB layer separation block: Each R, G and B layers of images are separated to which the citrus categorization scheme is applied separately.
3) Citrus categorization block: The categorization system is shown in Fig. 1 The citrus categorization system itself consists of Gaussian filter, Thresholding, Mean filter and a pixel classification counter.
    1. The input image consists of noise; hence it removed using Gaussian filter.
    2. Thresholding: Binarization is the operation of converting a grey-scale image into a binary image to identify the objects of interest from background. Binarization is a widely applied pre-processing step for image segmentation. Often, the burden segmentation is on the threshold image leads to better segmentation. In the proposed project, in order to keep the hardware as simple as possible, a global binarization with a fixed threshold is to be performed.
    3. Mean filter is used to remove additional noise and blur effect of the image.
    4. A pixel classification is performed by counting the number of pixels of the region of interest that belongs to each one of the classes among four classes (raw, semi ripe, fully ripe and rotten.

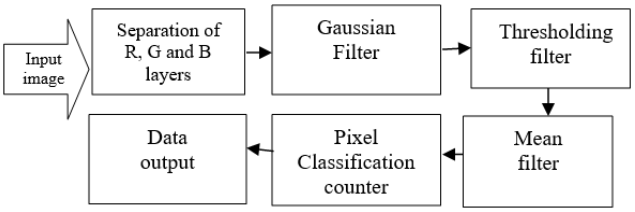

Fig. 2. Block diagram of citrus categorization

A pixel classification is performed by counting the number of pixels of the region of interest that belongs to each one of the classes among four classes (raw, semi ripe, fully ripe and rotten citrus fruit images). Finally, the output image is obtained through which it easily classifies the different level of citrus fruit. It is done in the following steps:

1) Initially the layer with maximum value between red and green layers of the image is considered and set as S.
2) It is to be right shifted by 1 bit in order to have appropriate comparison between blue layer and the maximum of red and green layers.
3) Two counters are maintained at this point where 1st counter holds the count in which the maximum value is more as compared to blue layer and 2nd counter holds the count in which the blue layer has more value as compared to the other when both are given as input to comparator.
4) If the maximum value is more as compared to blue layer, then the fruit is in the good/ripe condition else bad/rotten condition.


Fig. 3. Raspberry Pi

Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi foundation to promote the teaching of basic computer science in schools and in developing countries. Among various series of Raspberry pi this project has used Raspberry Pi 0W. This model is a creative, miniature version of the Raspberry Pi that shrinks the board down to about a size of a stick of gum, but one such problem with it is the lack of wireless features.

4. Conclusion

The proposed architecture will be able to perform a real-time classification of fruits acquired in high resolution images. The implementation is validated on a Raspberry pi kit that provides compact design. Implementing this project on Raspberry pi yields faster result which will be useful for the farmers to decide upon the right price depending on quantity and also for APMC to select good quality.

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