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Automatic Sorting Using Computer Vision & Image Processing For Improving Apple Quality

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Abstract:
Automated inspection of apple quality involves computer recognition of good apples and blemished apples based on geometric or statistical features derived from apple images. This paper presents the recent developments of image processing and machine vision system in an automated fruit quality measurement system. In agricultural sector the efficiency and the accurate grading process is very essential to increase the productivity of produce. Everyday high quality fruits are exported to other countries and generate a good income. That is why the grading process of the fruit is important to improve the quality of fruits. However, fruit grading by humans in agricultural industry is not sufficient, requires large number of labors and causes human errors. Automatic grading system not only speeds up the process but also gives accurate results. Therefore, there is a need for an efficient fruits grading or classification methods to be developed. Fruit's color, size, weight, component texture, ripeness are important features for accurate classification and sorting of fruits such as oranges, apples, mangoes etc. Objective of this paper is to emphasize on recent work reported on an automatic fruit quality detection system. This paper presents the image processing techniques for feature extraction and classification for fruit quality measurement system.

Keyword: *Image analysis and Processing, Computer vision, Fruit, Grading and Sorting, Machine Vision, Online inspection, PIC microcontroller, conveyor belt, grading system*

1. Introduction

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. Handling process of agricultural produce is performed in several steps like first cutting of fruits or vegetables from the farm, washing, sorting, grading, packing, transporting and finally storage. Amongst all these steps sorting and grading are major processing tasks associated for preserving the quality of fresh-market stuff. Sorting of agricultural products is done based on appearance of fruits. 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.

2. Computer Vision Quality Inspection

A computer vision system is a cost effective system and gives consistent performance, a superior speed and accurate sorting and grading of fruits. Computer vision based sorting and grading had undergone substantial growth in the field of agricultural sector in the developed and developing countries because of availability of the infrastructures.Computer vision is the construction of explicit and meaningful descriptions of physical objects from images. The basic principle of computer vision is described in Fig. 1. Image processing and image analysis are the core of computer vision with numerous algorithms and methods available to achieve the required classification and measurements.

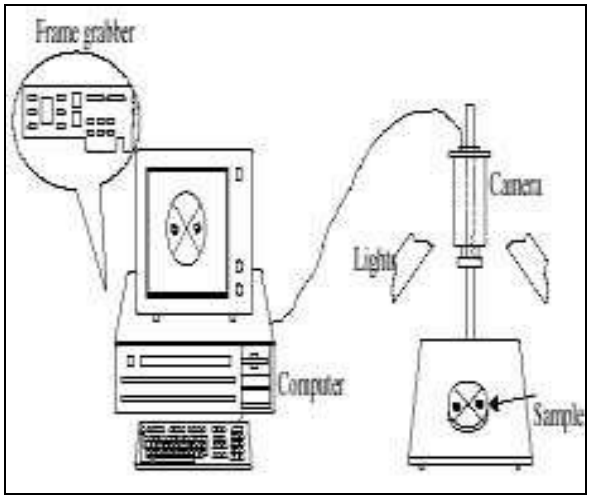

Figure 1: Components of a Computer Vision System

Nowadays, most of the commercial fruit have been graded by the machine-vision technology such as orange, peaches and apples and mango, bananas. The machine-vision technology is the technology that consist a color camera equipped with an image grab device, a bi-cone roller device controlled by a stepping motor, and a lighting source to grade fruit based on the characteristic such as color, size, shape and defection. Computer application is useful in agriculture and food industries in the areas of sorting, grading of fresh products, detection of defects such as cracks, dark spots and bruises on fresh fruits and seeds. The new technologies of image processing and computer vision have been emerged in the development of automated machine in agricultural or food industries. There is increasing evidence that machine vision or automated grading system is being adopted at commercial level. In automatic fruit grading system, shape, color and size is generally utilized to classify the fruits grade. Color gives necessary information in estimating the maturity and examining the freshness of fruits. Color is one of the most important criteria related to fruit recognition and fruit quality and it is a good indicator for ripeness.

Three feature analysis methods such as color-based, shape based and size-based are combined together in order to increase accuracy of grading in the food industry. Normally, by increasing the features used, the performance of the methods proposed can be increased. For example, Color and texture features are used to locate green and red apples. Here, the texture property plays two roles in the recognition procedure. Texture based edge detection has been combined with redness measures, and area thresholding followed by circle fitting, to determine the location of apples in the image plane. It was shown that redness works for red apples as well as green apples. This increased texture contrast helped to identify apples separately from background.

3. Proposed System

3.1. Block Diagram

A computer vision system as shown in fig 2 generally consists of basic components: power supply, a camera, computer hardware, keypad, MAX232, LCD display, conveyor belt, DC motors & PIC microcontroller.

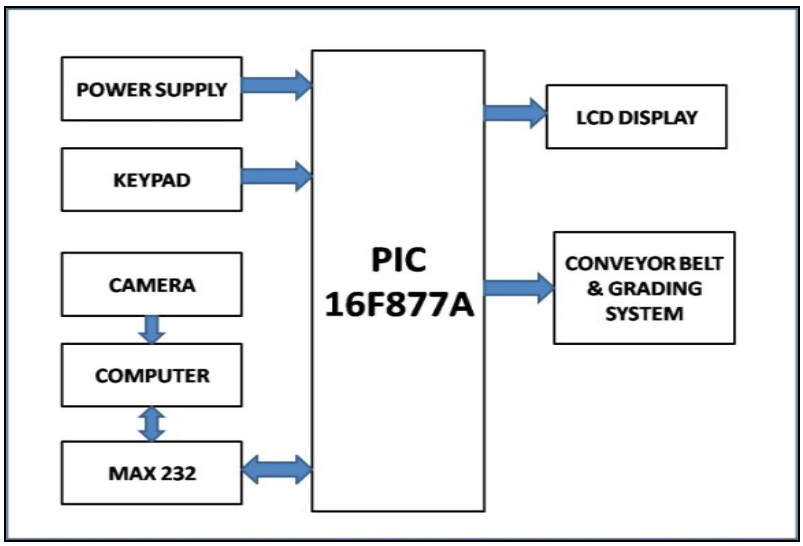

Figure 2 Block Diagram of a Computer Vision System Model

The system includes the capturing, processing, analyzing & sorting images, facilitating the objective and nondestructive assessment of visual quality characteristics in fruit products. First camera capture the image of apple then captured apple image send to computer for the purpose of analyzing using Matlab. Using Matlab calculate area & size of that captured apple image. The captured apple image can be compare with stored database and if match with database it will be selected for further process and sort the apples grade wise (Grade A or Grade B or Grade C) otherwise it will not selected.
A roller conveyor belt is built to hold and move apples in up to one lane. All apple samples are manually placed on the conveyer belt with a random orientation. The apples are rotating and moving when they pass through the field of view of the camera. The surface of each apple can be covered by the camera during the apple rotation. A drive controller, speed controller & dc motors are connected with PIC microcontroller that provides precise timing signals for both on-line mechanical and electrical synchronization for the grading purpose. After rotating apple on conveyor belt & passed through the field of view of the camera then that apple move in mechanical tray using dc motors which are connected with PIC microcontroller for grading purpose. LCD displays the grade of captured apple image.

3.2. Input & Output Details
This system proposes an apple grading method for apples quality classification by using image analysis (as shown in figure 3).
In this grading system input is in the form of image of testing apples. The database consist of good (Grade-A), medium (Grade-B) & bad (Grade-C) qualities of apples & then output is Segmented Image, plots of the quality ratings for the visual modality and graph of stability of the inspection system.

- Step 1: Image Read Module
  This module is designed to read Capture image and display the image.
- Step 2: Image Preprocessing
  This module is designed to extract features of apple image.
- Step 3: Create Database
  This module creates a sample of good, medium & bad qualities of sampled image.
- Step 4: Image Features
  This module calculates area & colour of apples.
- Step 5: Comparison
  The captured apple image can be compare with database and if match with database it will be selected for further process and sort the apples gradewise otherwise it will not selected.

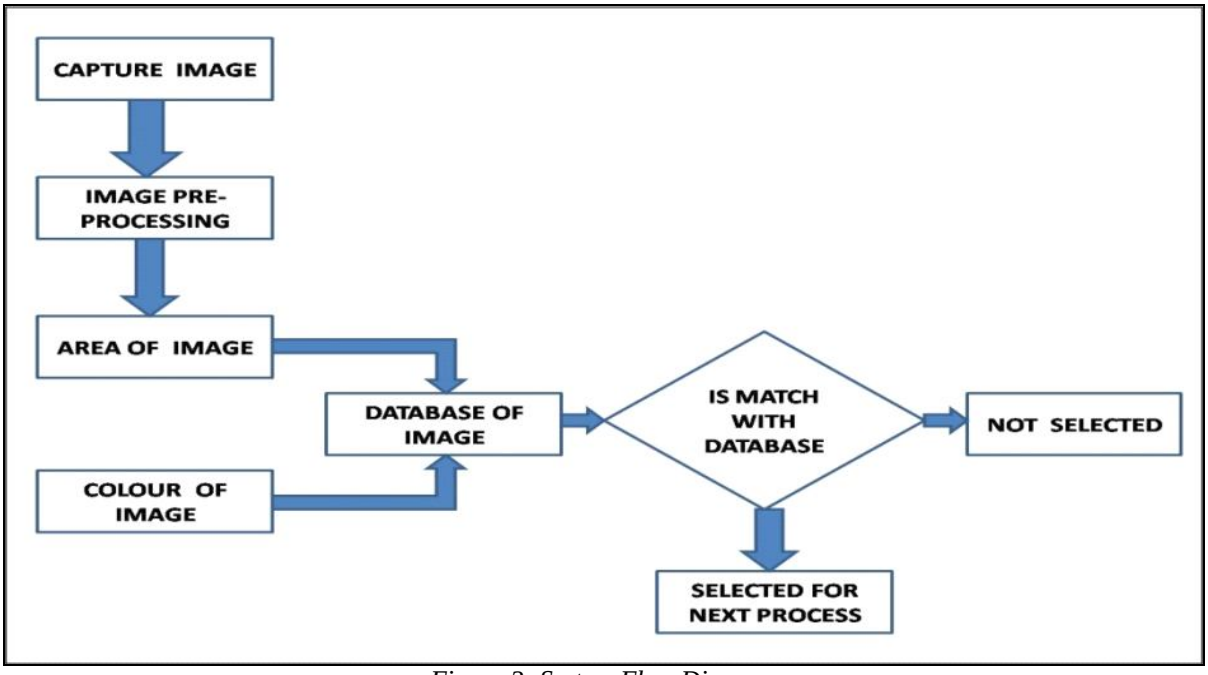

Figure 3: System Flow Diagram

3.3. Results
In system image analysis can be applied to make apple grading in Matlab by combine the digital image processing and classification. So its phase will discuss about the result that obtains from this system. Digital image processing in Matlab had been used actually is to extract the parameter or attribute of apple which is size and colour in order to prepare the input for classification. The threshold does not need to be sensitive. In fact, sometimes we face additional edges inside the object and affected the size negatively, so to remove these edges and keep the border. For the colour process, the average from colour components is obtained and based on the number of

edges we determined the skin image. Then, in classification part, the result from the digital image processing is used in the second part, the logic reference. The final grading result based on the logic reference is obtained. The result of apple is shown in table 1.

Sampled Image						
Area or Size	**1200000**	**900000**	**800000**	**1100000**	**600000**	**700000**
Colour Intensity	**80**	**90**	**91**	**82**	**100**	**95**
Grading	**Grade A**	**Grade B**	**Grade B**	**Grade A**	**Grade C**	**Grade C**

Table 1: Result of Grading

4. Conclusion

A computer vision & image analysis method has been proposed for apple quality grading. There are two majors part that involved in apple grading. The first part is a digital image processing that prepared grading factors which implement different algorithms and methods and the second part was classification that will also enhances the classification system and makes it moves like the human classifiers. This system also will replace the human expert burden by grading apple.

The method has been implemented using Matlab language and is suitable for various environments that involve uncertainty. The main advantage of this method is the used of interference engine without depending on the human expert. The approximate reasoning of method allows the decision maker to make the best choice in accordance with human thinking and reasoning processes. This is important to ensure the consistency of the decision.

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