Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 4, April 2014, pg.522 – 527

RESEARCH ARTICLE

A Distributed Computer Machine Vision System for Automated Inspection and Grading of Fruits

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Abstract— a computer machine vision system that can be used for automatic high-speed fruit sorting and grading is proposed. The objective of the project is to develop the advanced quality control inspection system makes use of distributed network architecture to interface the camera unit to a computer system through GigE LAN environment in a flexible way. The development work activity involves in dynamic capturing of image signal from camera when the objects are moving on the conveyor in real time based on synchronized trigger events. This project planned to do in visual studio using OpenCV. The process involved for estimating the colour information and geometry parameters makes use of sequence of complex library functionality like removing the noise, detecting the edges, smoothing, dilate, erode, filling, debluring, filtering, histogram, colour values, pixel averaging, etc.

Keywords— Computer Vision, GigE LAN, Grading, Image processing, Shorting

I. INTRODUCTION

Most of the food processing industries in India employ manual labours for carrying our various process operations line with little scope for automation. The tailor made systems are not available off the shelf and have to be imported or custom built at a huge cost. Lots of manual interventions are required especially in the grading and sorting of fruits. Screening of good ones for quality and identifying defective ones by manual inspection is a difficult task and often fails because of human fatigueless. Fruits like mango, apple, orange etc., fetch more value in terms of export potential when they are screened for defects and graded as per required quality parameters.

The quality is very stringent and should meet the international standards. To modernize the food processing industries and to meet their quality standards this activity of machine vision inspection systems will be very useful. This include the PC based prototype of the 'On-line Grader and Sorter' for grading and sorting of fruits like Mangos. The image related parameters colour, size, and shapes are found in real time and the fruits are graded and sorted as per user requirement. Application of computer machine vision for quality inspection of fruits can solve many of the limitations related to the manual inspection. This has great potential for supplementing human labour for the visually intensive inspection work. Machine vision inspection involves determining the fruit quality by analyzing the images of the fruits. Machine vision based sorting system consists of a computer and video cameras to perceive fruit images, process their images, and make suitable inspection

decisions. Grading decisions required in many agricultural processes, which are otherwise difficult, can be taken up by machine vision.

This paper computer mission vision system essentially involves three main processes namely image acquisition, image processing and decision-making. Cameras under appropriate lighting conditions carry out image acquisition. The visual information is converted from analog to digital format. The acquired images are analyzed by image processing hardware and/or software to extract the required object features and quality parameters. Based on these results, a decision on the fruit quality is taken by software considering the end user's requirements.

This paper is organized as follows. Section I gives the introduction. Section II surveys some previous work of sorting and grade processing. Section III introduces the overview of proposed systems. Section IV gives results of proposed system. Section V concludes this paper.

II. LITERATURE SURVEY

Authors in [1] 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. Authors in [2] have developed an automated grading system using image processing in this paper focus is on the X-ray imaging. he used X-ray imaging is used for inspecting the fruits.

Authors in [3] have presented an Study on colour image processing based intelligent fruit sorting system. In this he used Fruit sorting by classic Bayes classifier, whose parameters were obtained by a study module.

Authors [4] define the process of colour classification, it involves extraction of useful information concerning 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.

The Nandi.C.S,[5] paper presents a computer vision based system for automatic grading and sorting of agricultural products like Mango based on maturity level. The application of machine vision based system, aimed to replace manual based technique for grading and sorting of fruit. In this paper they used MATLAB based computer vision technology.

The automated system collect video image from the CCD camera placed on the top of a conveyer belt carrying mangoes, then it process the images in order to collects several relevant features which are sensitive to the maturity level of the mango.

Here in all above work the grading is done by MATLAB image processing, LabVIEW platform, which results in cost ineffective for small scale industries. This paper suggests open computer vision library along with the user defined algorithm for the above process. According to colour and size or weight are measured by OpenCV and the data send automatically to main control office by using GigE LAN environment.

III. OVERVIEW OF THE PROPOSED SYSTEM

The proposed scheme for a real time machine vision inspection system based on diameter and weight fruit sorter makes use of distributed network architecture to interface the field IO devices and camera inspection system to the computer system through Gigi LAN environment in a flexible way. To develop the state of art technology in-house as per the industrial end user requirement in compliance with the international/Indian standards pertaining to grading and sorting. The criterion for the indigenous product to be developed should be cost effective, reliable without compromising the quality aspect and measurement accuracies.

The system employs the recent version of window operating platform and the application program will be conceived as an open platform for image processing, functional under the latest version of Visual Studio. The concept of object oriented programming will be implemented in the software development so that the functionality will be modular, can be evolve and avoids the obsolescence of its design program codes or phasing out of components.

The system should caters to the expectation in performance mainly in the processing speed of captured dynamic image signals in real time, accuracy of measurement and precision which is the basic of a proposed low cost architecture. The objective is to knock off the expensive imported PC add-on card and the glue logic boards and to develop the indigenous hardware. The isolated output power channels meets the industrial standard for driving the high power solenoid valves with power management control and the isolated input channel accepts the signals from the field sensors. Fruit classification is made according to their diameter and disturbing the fruits to the programmed or grated outlet at a maximum fruit rate of 5 to 10 fruits per second per conveyor belt approximately.

The other parameters like weight and colour information will also be included in the extended phase of the program for classification. The existing technology evolved from year 2000 to 2012 on apple and mango sorting with expensive hardware setup cannot be reused and does not support the recent version of windows operating system, the latest visual studio environment and the preferred hardware for high throughput rate by the industry.

In this scenario the present technology cannot be refined or redefined due to the technological advancement. Hence a new development activity has been proposed, the specification has been derived in-line with the user community requirements.

System Features:

- Affordable low cost colour camera inspection design for medium resolution.
- Controlled by a single computer.
- Fruit rate maximum 5 to 10 fruits diameter and weight as an optional parameter, often performance is limited by the mechanical design constraints and stability of the conveyor system.
- Auto indexing for successive fruit number identification by sensing presence.
- Fruit carrier cup event generation for cup number identification and sorting.
- Grading based on diameter (min, max, and average, reduced) and or weight. Can be extended for inclusion of colour (RGB, average) information as an optional feature.
- Unique system synchronizing signal for variable multi frame analysis (limitation depends on the camera setting and resolution) for each fruit image being captured.
- Implementation of real time hardware and software components.

Image Processing:

The fruit images are captured to analyze the fruit surface for extracting the colour, size and shape features. The fruit moving on the conveyer is oriented horizontally to its stem and calyx axis prior to reaching the field of view. It continues to rotate around its stem and calyx axis while passing through the field of view.

Multiple image frames of a fruit are captured while it is passing through the field of view. Each capture is done by the frame grabber card on an occurrence of a trigger on one of its digital input lines. Each of the fruit images represents a view of the fruit's surface in one of the six rotated positions, called postures, representing rotation in multiples of 60°. This scheme of image collection helps in analyzing the fruit's entire surface of the fruit.

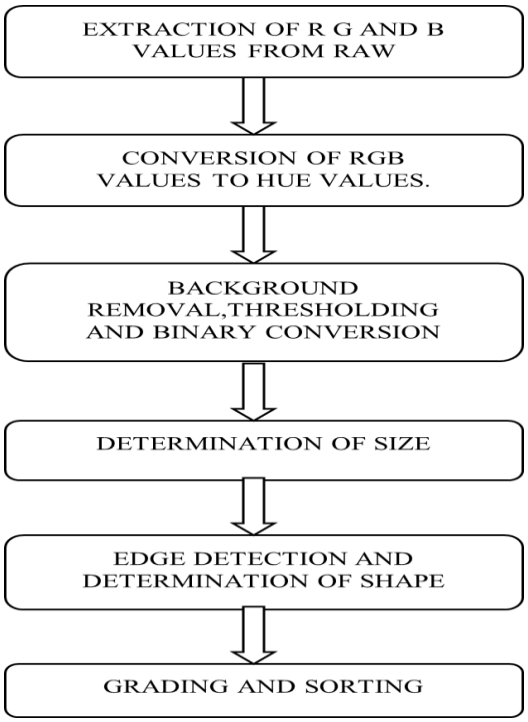


Fig 1 Steps Followed In Image Processing Using OpenCV

The rotation of the fruit and the image capture requires to be synchronized. At the start up, the synchronization starts when the trigger pulse is received due to the roller. This ensures that full image of the fruit is captured as it enters the field of view. The rotational speed of the fruit and the length of the field of view are such that the fruit will make one full revolution within the length and thus produces 6 trigger pulses during the period. The frame grabber card captures 6 frames, each containing 3 apples for one full revolution of a fruit.

The image-capturing device is a CCD camera that operates at high speed thus captures 6 images of the apple beneath it. This image is transferred to the host terminal. Here manipulations and calculations are performed and various parameters are obtained.

Block diagram:

The entire project is classified into two portions – hardware and software. To realize the entire understanding of this paper details of both the hardware and software are needed.

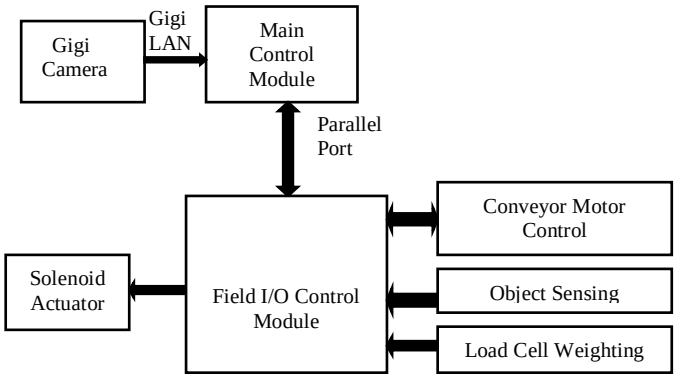


Fig 2 Block Diagram of Proposed System

All these components together form the entire system. The developed system consists of conveyor assembly, diffused uniform illumination system, CCD cameras and image processing algorithms. The system has been developed for sorting and grading of fruits like mango and the same can be used/extended to fruits like orange, apple, grape, tomato, etc., The system can perform complex color, size and shape based classification, comparable with human vision but with far greater speed, repeatability and reliability.

Main control module

PC embedded hardware and associated hardware components including internal data storage components are provided as per the requirement of customer design for the industrial process with touch screen monitor, communication port field IO data communication and user interface IO.

Field IP control module

Network optically isolated IO modules facilitate for interfacing the field sensor like proximity switches and actuator through power drivers. The intelligent digital signal conditioning module facilitates for interfacing two bridge type load-cell with lead wire compensation and communication through RS485 COMM port for data exchange with converter. The conveyor motor speed is programmable for fixing the fruit rate delivery under program control. High power high current SMPS harness the short duration high peak current demands of power actuators.

Machine vision inspection module

Gigi based digital colour camera with 5'' CMOS CCD array of pixel resolution 782 * 582 up to 64 frames per second or 659 * 494 up to 90 frames per second is used. Provision for continuous is synchronous trigger mode of operation.

IV. **DISCUSSION AND RESULTS**

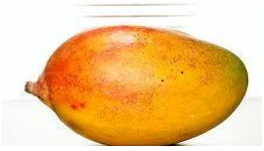
The result of this paper will provide the outcome of the system. When using OpenCV instant of MATLAB we can reduce the cost. And it is a open source so that we can easily develop the program code.

The performance of grading systems depends on the quality factors that are used in their design. For fruit grading there are many factors that farmers use for measuring the fruit quality. These factors can be classified into two groups – the external quality factors and the internal quality factors. The external quality factors can be defined and extracted from the visual appearance of the fruit. Commonly used factors are size, shape, color, gloss, surface defects and decay, and texture. The internal quality factors can be defined by the fruit smell like aroma, taste, flavor, sweetness and sourness, and fruit nutritive value like vitamins, minerals, nutrients and

carbohydrates, and other elements like dry matter content, total soluble solids content, sugar content, and juice acidity.

Size:

The fruit size is another quality attribute used by farmers – the correct size fruit is considered of better quality. The size is estimated by calculating the area covered by the fruit image. To compute the area, first the fruit image is binarized to separate the fruit image from its background. Consider following picture is a original picture captured by camera, this was taken by OpenCV to find shape by background extraction function.



Original Image

Background Extraction

Edge Detector

Shape:

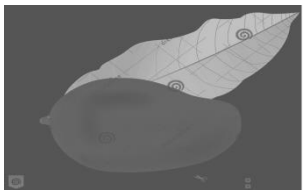
The farmers use shape irregularity as a quality measure. Fruits having regular shapes are considered of better quality. We estimated it from the outer profile of the fruit image. Using an edge tracking operator can estimate the out most edge points of the fruit image. Have many edge detecting techniques in this canny edge detector is used to detect the edges.

Colour:

Colour based identification is important to grade the fruits. The easiest way to detect and segment an object from an image is the colour based methods. The colours in the object and the background should have a significant colour difference in order to segment objects successfully using colour based methods. In database already all the data's are stored to find required one.

The OpenCV works under visual studio 2010.As per required the OpenCV libraries, distributed by us, on the Microsoft Windows operating system are in a **D**ynamic **L**inked **L**ibraries (*DLL*). These have the advantage that all the content of the library are loaded only at runtime, on demand, and that countless programs may use the same library file. This means you have ten applications using the OpenCV library, no need to have around a version for each one of them. But need to have the DLL of the OpenCV on all systems where you want to run the application.

Original Image



colour identification

V. **CONCLUSION**

The grading and sorting of the fruits is based on external parameters namely colour, size and shape. The images of the fruits were grabbed; features extracted and necessary operations were performed. All the processes were implemented by distributed network architecture to interface the camera unit to a computer system through GigE LAN environment. The fruits were classified into different grades on the basis of combination of the parameters mentioned above. This application runs under VC++ platform.

Future work that can be implemented in this project is, we can extend the single line mission vision inspection into multi line camera inspection. Since it employs distributed network architecture with additional suits of hardware and software modules. And we can increase the fruits quantity in scanning section. We can implement this in other fields by changing simple software and hardware.

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