Real Time Fruit Sorting Using Computer Vision and Machine Learning

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Abstract : Agriculture is one of the important sector which helps to support the Indian economy. The India is one of leading country which exports the fruits to the World. The export quality of the fruits needs to maintain high. So there is a need of implementation of the automatic fruit sorting system which will grade the fruits into raw, good and damage quality. In the proposed system, the real time tomato fruit sorting system has been design to automatically sort the fruits into respective qualities. The image processing algorithm is used to preprocess and feature extraction purpose while KNN a machine learning algorithm is used for the classification of the fruit into different classes. The system is implemented on Raspberry Pi using OpenCV library. The proposed system achieved the accuracy of 88%.

IndexTerms **-Fruit Sorting, Fruit Grading, GLCM, KNN, Raspberry Pi, OpenCV**

I. INTRODUCTION

Agriculture plays a most vital role and is that the integral a part of overall economic development in Asian nations. Agriculture is the only way to live for two thirds of the Indian population. On comparing the development of electronics and automobiles with the development of agriculture, it is observed that the development in agriculture is sluggish. Hence, it is essential to move towards the innovative plan to raise the impact factor agriculture development. Fruits and vegetables market is subject of choice. Thus it is more important to check the quality of fruits before deliver to the customer. Currently, human experts classify agricultural products based on their optical characteristics. Nevertheless, manual inspection causes the inaccuracy, inconsistency and inefficiency on defaming the quality of agriculture goods.

It is human nature that grows tired and bored or becomes inattentive after a certain period of time. The improvement in the automatic grading system of fruit on the basis of quality will results in accurate, efficient and consistent outputs. As a result, it save time and human labors and will give a handful of help to the economic development. Hence there is need of automatic fruit sorting system which will be helpful for faster, accurate fruit sorting. In the proposed approach, the computer vision and machine learning based tomato fruit sorting approach has been presented.

II. RELATED WORK

Image processing and analysis is the main task of computer vision with numerous algorithms and methods available to achieve the required classification and measurements. Three methods are analyzing the characteristics such as color, shape and size are combined together to increase the accuracy of classification in the food industry. Normally, by increasing the characteristics used, it is possible to increase the performance of the proposed methods.

Hongshe Dang et al. [1] have proposed a fruit inspection system based on size and shape of the fruit. The system uses ARM 9 as a processor and developed size based fruit segregation program using image processing as software and QT as hardware platform.

John Njoroge et. al [3] developed an automatic grading system using image processing wherever the main target is improvement on fruit quality and minimize defects. The system consists of six CCD cameras, two cameras are mounted on the top, and another two cameras mounted on the left and right side of the fruit. X-ray imaging is used for inspecting the biological defects. Image processing is used to investigate the fruit's features such as size, color, texture and therefore the grade is set supported the features.

J. Frances et al. [4] given a procedure to boost the performance, whether or not increasing speed or accuracy, of the load-cell-based weighting system exceedingly in very fruit segregation and +1 gram accuracy obtain bye grading system.

Wong Bing Yit et. al [5] presented new system that is MMS-based designed with signal process of fruit grading for customers. The image space, integration of wireless electronic communication system with signal process between mobile customers for development functions was studied, planned and designed.

Dah Lee (2011) [6] designed an immediate color histogram technique for getting the color of fruit. This method is advantageous as it adjusting the color choices or grading parameters. It's a user friendly technique.

D. Savakar [7] had planned "Identification Identification and Classification of Bulk Fruits Images using Artificial Neural Networks." He had graded five different types of fruit images (Apple, Chickoo, Orange, Mango and Sweet Lemon). Total 5000 sample images had been captured, i.e.1000 images of each type of fruit. The algorithm had been developed by extracting 18 colors and 27 texture features. The qualities of the shading are ascertained by isolating the RGB parts (red, green and blue).The RGB image was then born-again into associate HSI model and its elements were separated. Mean, variance and vary were calculated on an individual basis for every RGB and HSI element. The characteristics of the weft have been calculated using the

Co-occurrence at the gray level (GLCM) matrices The study disclosed that the classification of Chickoo, apple, genus Citrus, orange and mango was ninety four, 94%, 93%, 93%, 92%, 92% respectively[7].

Deepa [8] proposed a method for evaluating the extracted characteristics used for the classification. Sorting of defective and non-defective fruit the image database included two hundred Mosambi fruits. The characteristics of fruit intensity and feature extraction will be done. This information was then classified in step with the PNN and also the result showed that the characteristics form, intensity and texture gave respectively 100%, 92%, 96% identification [8]

Mustafa [9] presented a new approach to the fruit classification system. Five fruits (apples, bananas, carrots, mangoes and oranges) were tested during this process. The characteristics of type and color were extracted from sample of fruit images. The morphological characteristics are used to differentiate between related shapes and sizes such as apple and orange or bananas and carrot. The color properties were used to reduce the improper classification between apple and orange or banana and carrot and improve accuracy to 79-90%.

III. BLOCK DIAGRAM

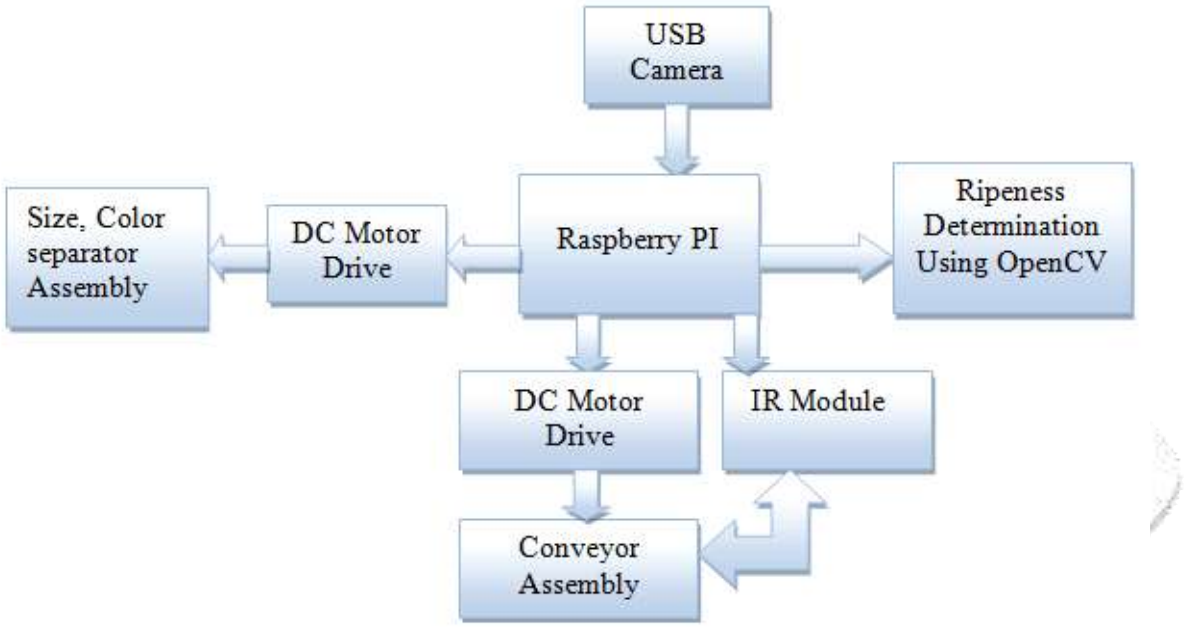


Fig.1.Block Diagram

The hardware part consist of Raspberry Pi as a main unit and motor driver with 12V DC motor to rotate the conveyer belt and two USB web Cameras as a peripheral devices. The detailed information of block diagram is explained in detailed. Raspberry pi is the minicomputer which is used to manage the whole Database and Programming. The USB camera is used to capture the fruits images in real time. The IR sensor is used to stop the conveyer belt till two images captured by both the side of tomato. The conveyor Belt is used to carries the tomato and worked according to input programming and also DC motor is used for rotate of conveyor belt.

Fig. 2: Hardware Setup of system

IV. SOFTWARE

A. Image processing library: OpenCV 3.6

Open source computer Vision (OpenCV) is an image processing and computer vision library mainly developed for artificial vision. It has a BSD license (free for commercial or research use). OpenCV was originally written in C but currently it's a whole C++ interface and there's additionally a full Python interface to the library. Open source computer Vision Library, also called OpenCV, is associated in freeware software package that is aimed toward computer vision. It is used in this project because of its versatility as well as the fact that it has a C++ interface. OpenCV runs on most of the major Operating Systems (OS), which makes it useful when using another computer to program or test.

B. Language: Python

Python is a high-level programming language widely used for programming. Python, an interpreted language, supports several programming scripts and a syntax that allows you to use programs in most languages such as C ++ or Java. The language provides constructions designed to permit clear programs at each scale. Python is easy and simple to know, the python code is way easier than alternative languages.

C. Anaconda

Anaconda is open source distribution of the python libraries. It includes data processing and predictive analysis. This distribution provides the number of libraries within the single package called conda.

D. OS: raspbian

Raspberry pi is the debian based operating system. Since 2015, it's been formally registered by the single-card Raspberry Pi family of computers. Raspbian was formed for Mike Thompson and Peter Green. Raspbian is extremely enhanced for the low-performance ARM, CPU of the raspberry Pi. An operating system is formed in simple programs that are suitable for the performance of raspberry.

V. IMPLEMENTATION

The database is collected in real time on conveyor belt. The input image contains noise such as Salt and Pepper Noise which is removed using Median Filter [12]. The image is changing into binary using thresholding. Grey level Co-occurrence Matrix algorithm used for Quality features extraction. The extracted features are trained using supervised machine learning algorithm like KNN and save train model. The testing sample is classified into three grade raw, good and damage.KNN is a statistical classifier that focuses on similarity of samples. Assignment of data to the most representative category of it's closest sample. The different kinds of distances are used to calculate the closeness of the samples like Euclidean, cosine, cityblock etc.

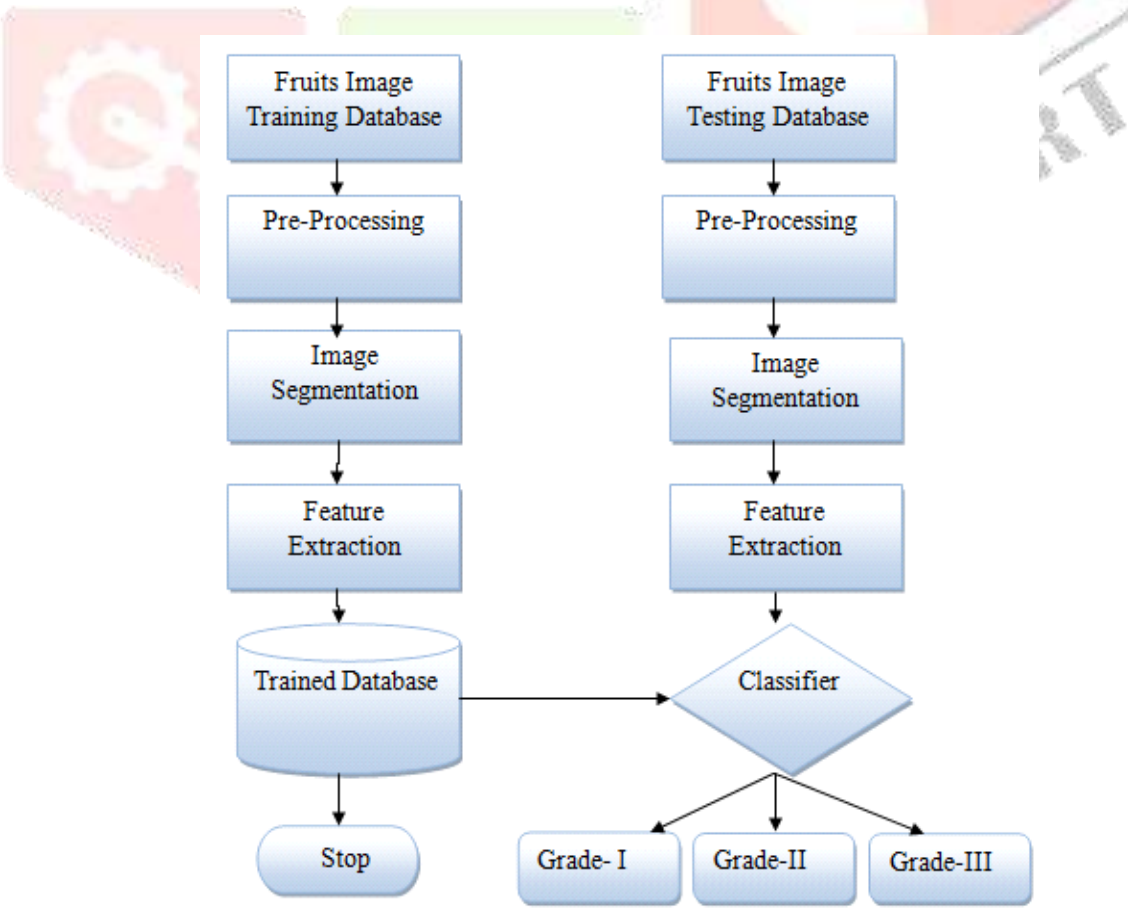


Fig.3. Flow chart of the proposed system

VI. FEATURE EXTRACTION

The feature is the statistical representation of the image. There are different feature extraction techniques. In this approach, the surface texture is useful for feature extraction. Gray Level Co-occurrence Matrix (GLCM) feature extraction technique is used to extract the quality features. The quality features are as shown in Table 1.

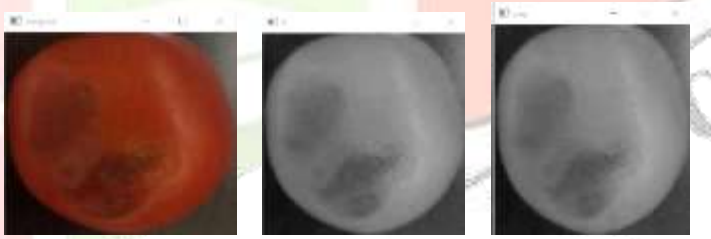
Table 1: GLCM Feature Extraction

Sr. No	Name of Feature	Formulae
1	*Contrast*	$\sum_{i,j} \lvert i-j \rvert^2 p(i,j)$
2	*Homogeneity*	$=\sum_{i,j} \frac{1}{1+(i-j)^2} p(i,j)$
3	*Energy*	$=\sum_{i,j} p(i,j)^2$
4	*Dissimilarity*	$=\sum_{i,j} \lvert i-j \rvert p(i,j)$
5	*ASM*	$=\sum_{i=0}^{L-1} \sum_{j=0}^{L-1} [\widetilde{P}(i,j,d,\theta)]^2$

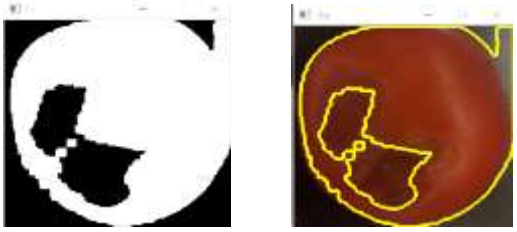
(a) (b) (c)

Fig. 4.Input sample images (a) Raw (b) Damaged (c) Good

The results of the presented system are evaluated in real time environment with qualitative and quantitative analysis. In qualitative analysis includes the preprocessing and segmentation.

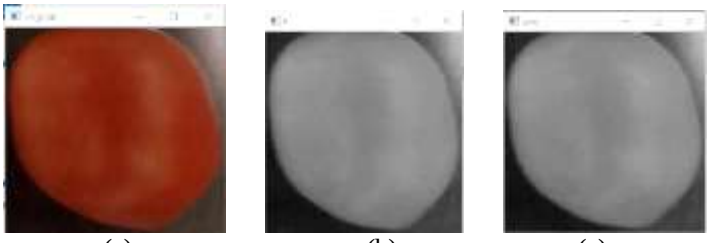


(a) (b) (c)

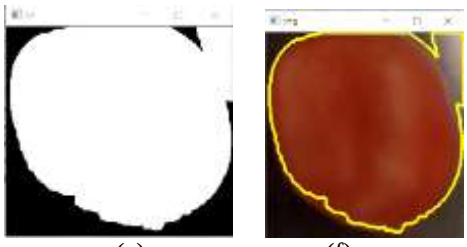


(d) (e)

Qualitative analysis of damaged tomato



(a) (b) (c)



(e) (f)

Fig.5. Qualitative analysis of Good tomato

Form Figure 5 and Figure 6, It is observed that the damaged part of the surface have the intensity variations hence it is segmented out using thresholding based segmentation technique.

The quantitative analysis with its output snaps in real time.

(a) (b)

Fig. 6. Real time output of the system (a) input Image (b) Output on python terminal

The performance evaluation of the proposed fruit sorting system is shown in Table 2. It is observed that the KNN performs well on real time tomato fruit database.

Table 2: Performance Evaluation

Sr. No	Performance Parameter	Result
1	*No. of training Image*	*884*
2	*No. of cross validation Image*	*116*
3	*Accuracy*	*88.88%*
	No. of training Image	*884*

VII. CONCLUSION

In this method tomato sorting has been implemented using image processing techniques. The machine learning approach is used to generalize the system and merits and demerits are described based on application. The KNN machine learning approach achieved 88% accuracy on validation database. This paper proposes a technique to find out better quality of fruits compare to other fruits sorting technique. This method is very easy and helpful for fruit grading and minimize the time and wastage of fruits.

VIII. FUTURE SCOPE

Agriculture and Food industry: The method used by the farmers and distributors to sort and grade agricultural and food products are through traditional quality inspection and handpicking which is time Consuming, laborious and less efficient.

Industrial Applications: Computer Vision (CV) is the process of applying a range of technologies and methods to provide imaging-based automatic inspection, process control and robot guidance in industry. Computer vision has been used for such tasks as shape classification, defect detection, quality grading and variety classification.

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