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Quality Determination and Grading of Tomatoes using Raspberry Pi

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***Abstract*—**In India cultivation of tomatoes is carried out by traditional methods and techniques. Today tremendous improvement in field of agriculture technologies and products can be seen. The tomatoes affect the overall production drastically. Image processing technique can be key technique for finding good qualities of tomatoes and grading. This work aimed to study different types of algorithms used for quality grading and sorting of fruit from the acquire image. In previous years several types of techniques are applied to analyses the good quality fruits. A simple system can be implemented using Raspberry pi with computer vision technology and image processing algorithms.

Keywords-*Raspberry Pi 3, USB Camera, Haar classifier, Contour, Conveyor system,filtering process, masking, color detection.*

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I. INTRODUCTION

India is well known for its agricultural economy. India ranks second worldwide in farm output. More than sixty percent of people depend on farming business directly or indirectly. Agriculture product contributes significantly in India's gross domestic product. Slow agricultural growth is main concern for Indian farmers. Traditional agricultural practices are neither economically nor environmentally suitable for agriculture development. There is requirement of precise and efficient technology for agricultural development. Agriculture quality production highly affected due to various environmental factors and false practices of farmers. Most of the quality issue occur on plant, goods, fruits etc. Hence area of interest is to find quality of goods, fruits, etc. In order to improving fruits quality and production efficiency, reduce labor intensity, it is necessary to research nondestructive automatic detection technology. Fruit nondestructive detection is the process of detecting fruits inside and outside quality without any damage, using some detecting technology to make evaluation according some standard rules. Nowadays, the quality of fruit shape, default, color and size and so on can not evaluated on line by the traditional methods. With the development of image processing technology and computer software and hardware, it becomes more attractive to detect fruits quality by using vision detecting technology. At present, most existing fruit quality detecting and grading system have the disadvantage of low efficiency, low speed of grading, high cost and complexity. So it is significant to develop high speed and low cost fruit size detecting and grading system.Image processing can give solution to find quality on the basis of their visual symptoms. Decide the quality of tomato on shape, size, color and texture grading by human eyes often leads to error due to visual stress is not accurate. A vision machine to replace human eyes can solve this weakness since a machine will not prompt errors due to stress. Human vision has limited ability in differentiating similar colors like pure green (100% green) with orange (90% orange), light red (60-90% red) with red color (>90% red). Human perception towards shape, size, color and texture is subjective and varies among different peoples. A same fruit may appear as light green for first human but pure green for second human. This leads to inaccuracy of the judgment for tomato maturity. Color grading is a main step in this system design for processing of fruits that directly affects profit, because the products quality is mainly associated with their color. The existing color grading systems use a set of color separating parameters to determinethe color quality. In this Paper 100% Red, 100% Orange color tomatoes is fully mature and ready to consume and 100% Green, 50% Green color tomatoes is premature and ready to transport. The proposed automated classification and grading system is designed to combine five processes such as Image Acquisition, Masking, Contour, Image Enhancement, and Color Detection. The entire system is designed over RASPBERRY PI software to inspect the shape, size, color and texture of the fruit. Here grading can be categories into four ways Red, Orange, Green, turning to Green. Work in this paper considered tomatoes as fruits having different shape, size, color and texture for finding quality and grading. In this paper simple and effective method will be used for evaluating maturity level of tomatoes. The visual features can be extracted from tomatoes images and classify them according to their feature using image processing techniques.

II. SYSTEM DESIGN

This tomato maturity estimator is developed to conduct tomato color grading using machine vision to replace human labor. Existing machine has not been widely applied. The major problem in tomato color grading by human vision was due to the subjectivity of human vision and error prone by visual stress and tiredness. Therefore, this system is carried out to judge the tomato maturity based on their color and to estimate the expiry date of tomato by their color. Evolutionary methodology was implemented in this system design by using several image processing techniques including image acquisition, image enhancement,filtering process and feature extraction. The quality of the collected images were being improved in the image enhancement phase; mainly converting to color space format filtering and threshold process. In the feature extraction phase, value of red-green is being extracted. The values are then being used as information for determining the percentage of tomato. Quality and maturity and to estimate expiry date of tomato. According to the testing results, this system has met its objectives whereby 90.00% of the tomato tested has not rotten yet. This indicates that the judgment of tomato maturity and the estimation of tomato's expiry date were accurate in this paper. Tomatoes having a different features like color is red, green and orange, also having different size and texture. For sort and grade the good quality fruits according to different attributes such as color, shape, size and texture use specific methods. The system Design is developed on Raspberry pi module. Raspberry pi is powerful credit-card sized single board computer can be used for many applications. It is the popular board format for small dedicated applications. Its key benefits are low cost, fast processing, low power requirement, compact board format and high reliability. Coding is done in python language as it is an object-oriented high-level scripting based Programming language. It enables the programmer to express his ideas in fewer lines of code without reducing any readability. The Python interpreter and the extensive standard library are available in source or binary form without charge. Initially image is taken from the training dataset. Preprocessing of image is done for further process. In preprocessing, image resize into 250x250 pixels. The image converts from RGB to HSV scale to reduce computation complexity. The scale invariant feature transform is applied to get highlighted features from the image.

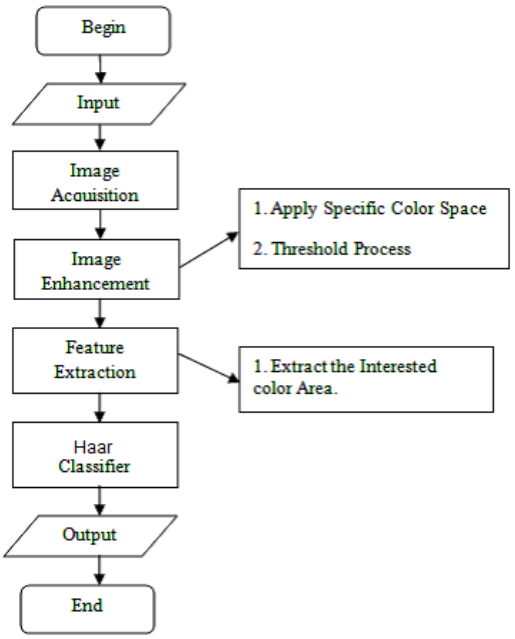

Figure 1: Flowchart

To test the image, at first the image is taken from USB camera. Then all the processing is done to compare its Features with the model file of HSV. At last the result is displayed on display as class label.

III. RESULT

An example of Determination and grading of good quality tomatoes, figures shows Result screenshot:

Figure 2: Good Tomato image

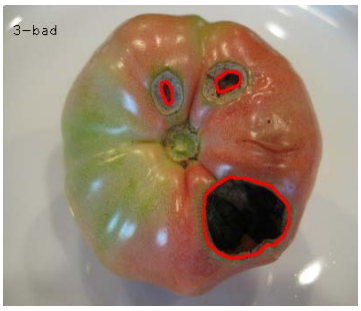

Figure 3:Bad Tomato image

Figure 4: Bad tomato Mask image

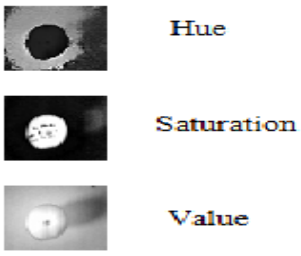

Figure 5: HSV image

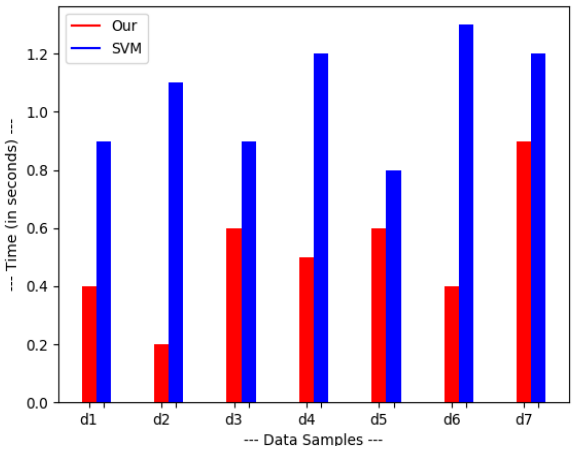

Figure 6: Computational time graph

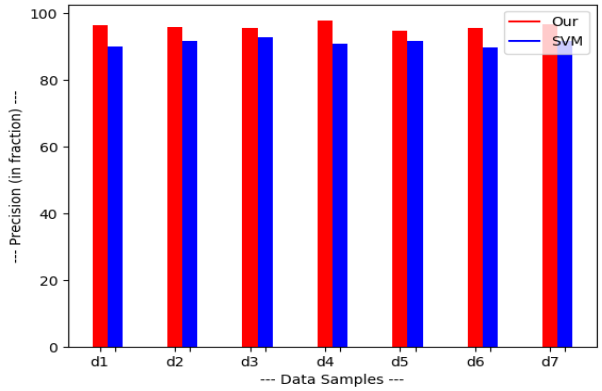

Figure 7: Accuracy graph

The approach used here, mainly focuses on HSV color space, red color, RGB image is converted into HSV and HSV color range is used as filter to mask the red region in the image, and anything other than red region is highlighted in white color , the black spots which are normally appears on infected fruits, are showed in white region and rest is masked with black color, then the contour area for every infected region is calculated, and if the size of area is greater than threshold value then , it's marked as infected, and if more than one infected area detected then it's treated as bad fruit.The proposed approach is efficient as compared to other machine learning based techniques like SVM, as SVM needs learning dataset in order to train it over positive and negative samples, but in proposed approach training dataset is no more required, as the given problem definition is more suitable in the context of unsupervised learning based techniques, the computational time of SVM is large that is 1.02 seconds and accuracy is just 85%, but our proposed system have lowcomputational time that is 0.52 seconds and have high accuracy that is 95%, hence the proposed method works more efficiently in case of both time complexity and overall accuracy of the system.

A. Prediction of defective foods: Image of tomatoes is predicted defective after the mask filter, Different defects show different visual features. Defects like black spots on tomatoes shows as white region in HSV image. This features are extracted from image to detect the local features of defective fruits.

*B. Computational Time:*Computational timecan be improved by proper implementation of algorithm. With limited hardware processing capacity choice of algorithm plays important role in performance of system. The use of algorithm also depends on application requirements. Computational time is data sample versus Output time (in second). It shows the how fast our result will executed, In example Computational time is 0.52 second.

*C. Accuracy:*High accuracy requires both high precision and high trueness, our system have both good precision and high trueness as compare to SVM. SVM have 85% accuracy and our system is better and have 95% accuracy.

IV. CONCLUSION

Several process is use for determining good quality and grading of tomatoes. It had 4 level of grading (Red, Orange, Green and Turning to Green) with some images of tomato. In this paper, we have done the comparison between different method uses by different authors and studied various algorithm in different ways for finding a good quality of tomatoes. The proposed system is a demo version, the identification of good and bad tomatoes based on quality in image processing using raspberry pi 3 is successfully done with low computational time 0.52 and high accuracy 95%. The use of image processing for identifying the quality can be applied not only to tomatoes but also to other fruits such as oranges, apples, melons etc. and also vegetables with more accuracy. This work presents new integrated techniques for sorting and grading of different fruits. In order to improve the functionality and flexibility of the recognition system hardness, softness features can be combined together with shape, size, color and texture feature.

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