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Implementation of Fruit Detection System and Checking Fruit Quality using Computer Vision

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ABSTRACT- *In this project, we are building a model for classification of fruits and are detecting quality of fruits along with it we are grading the fruits. We have divided our model into different parts for our convenience. For grading purpose, we have built conveyor assembly by using hardware which is used to separate good and bad fruits on either side of conveyor belt. For classification of fruits, we first converted the input image into desired size and then it is converted into gray scale image and finally we apply SVM algorithm. For detecting the quality of fruits, we have used neural network. By using tensor flow library, we have built our neural network model for training and testing purpose. The whole arrangement is connected to one another. For detecting real time images of fruits, we have used OpenCV library present in python software. For establishing the communication between hardware and software we are using serial communication.*

***Keywords*: OpenCV, python, tensor flow, support vector machine, Arduino nano.**

1. INTRODUCTION

Fruits provide an essential role as a food in our everyday life. It provides nutrients vital for our health and maintenance of our body. Those who eat more fruits as a part of a healthy diet are likely to have reduced risk of some chronic diseases. However, not all fruits are treated equally and it is a matter of concern that not every person knows about every fruit well. With the help of Artificial Intelligence (AI) and Machine Learning (ML) we can develop an automatic fruit recognition system with an information dataset of each fruit. This system can help us to select fruit that is suitable for us and teach us about the characteristics of that particular fruit. These types of systems can help us to educate children and familiarize them with fruits. Furthermore, these systems can be used to teach a robot to find the correct fruit for its user and this becomes much important for those robots which are being used for fruit harvesting related works.

In today's technological era it is necessary to have a good fruit quality for good health of human being, and it is possible by grading the fruits according to size, test, or we can say quality of fruit. But for such grading large man power is required. To overcome this, it is necessary to have an automatic fruit grading system for quality fruit production. Today it is somewhat difficult to detect fruit shape, size, colour because of poor process, but it is now easy to detect correct fruit 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 [1]. One of the important quality features of fruits is its appearance. Appearance not only influences their market value, the preferences and the choice of the consumer, but also their internal quality to a certain extent. Computer vision and image processing techniques have been found increasingly useful in the fruit industry, especially for applications in quality detection. Research in this area indicates the feasibility of using computer vision systems to improve product quality. The use of computer vision for the inspection of fruits has increased during recent years [2].
The automatic fruit classification system is a process of shorting fruit automation to be implemented in the fruit industry of the farm. There are three important processes in the fruit classification system, namely image pre-processing process, feature extraction and pattern matching. Image pre-processing process is the step for processing the image before it extracted in the feature extraction technique in order of getting the information to be used as input to the patter matching step. There are many steps in the image processing step, such as covert of the colour image to Gray image, then the edge of the image is calculated from the Gray image. The edge image is then extracted in order of getting the information of the image. Features are some quantities, which are extracted from pre-processed fruit image and can be used to represent the fruit image signal [3].[4] shown the classification of fruits approach which makes to overcome the cost of recognizing the fruits manually. In the image processing approach as it is known that filtering technique is to be applied first, then segmentation followed by feature extraction and training

and testing using the Neural networks. In the part of the proposed work median filtering technique is applied in the pre-processing and the K-Means clustering approach is applied for segmentation and here statistical features are extracted using Mean, Kurtosis, Skewness and Standard Deviation. CNN, BPNN (Back Propagation Neural Network), Support Vector Machine (SVM) are applied for Classification.

2. LITERATURE SURVEY

H. Patel et.al. [5] proposed work for detecting orange quality for which they have used apparatus for size, colour and texture estimation. Basically, they used two classifiers was used for classifying the object based on feature and ANN for having any possibility of high degree of non-linearity. They explained four features shape, size, colour and texture for feature selection. There work suggested that SVM classification result changes when training/testing ratio changes. Zeehan et al. [6] used computer vision and support vector machine (SVM) for classification purpose. The work was carried out in various stages. Firstly, they resized the image to 256*256 resolution then they created feature space by extracting the colour, texture, and shape features. Further principal component analysis (PCA) is applied to reduce the dimensions of the feature space to overcome the curse of dimensionality. Finally, the SVM is used for training the data. Nandhini. P et al [7] Thus, this paper provides various steps for identifying defects in the food material using the computer vision systems. Various steps in computer vision system are image acquisition, Pre-processing, image segmentation, feature identification and classification. The proposed framework provides the comparison of various filters where the hybrid median was selected as the filter with the high PSNR value and is used in preprocessing. Image segmentation techniques such as Colour based binary Image segmentation, Particle swarm optimization are compared and image segmentation parameters such as accuracy, sensitivity, specificity are calculated and found the colour based binary image segmentation is well suited for quality evaluation. finally, this paper provides an efficient method for identifying the defected parts in food materials.

M. Nie et al. [8] an apple classification method based on BP neural network is proposed in this paper. The image of the Red Fuji apple is detected during the transmission process, and machine vision technology is used for classification research. Firstly, through morphological operations and hole filling, and median filtering to remove noise, the target area of the fruit is extracted. Then, the binary image is obtained by Canny algorithm. The apple fruit shape, fruit diameter, color and defect characteristics are respectively extracted. Finally, the genetic algorithm is used to optimize the BP neural network, establish and train the network structure to determine the type of test sample. The experimental results show that the BP neural network optimized by genetic algorithm is used in the classification of Red Fuji apple, and the accuracy rate is 91.67%. In this paper, features such as color, fruit shape, fruit diameter and surface defects are extracted. On this basis, the apple grading problem based on BP neural network is studied. The main contribution of this paper is that the target area of Red Fuji apple is extracted through the commonly used Canny algorithm, hole filling and morphological operations. Then, the external quality characteristics of the apple's color, fruit shape, fruit diameter, and defects are extracted separately.

T. Gayathri Devi et al. [9] In this paper, an image processing system for automatic segmentation and yield prediction of fruits is proposed on the basis of color and shape features is being performed. Initially the pre-processing is done on input fruit tree images. Then it is converted from RGB to HSV colour space to detect the fruit region from its background. Color thresholding is used to mask the desired colors. Gaussian filter is used to remove noise. The contour of the image is taken. Then these images are processed by image processing algorithm. Color and shape-based counting of fruit is presented at the output. The edge detection and combination of a circular fitting algorithm is applied for the automatic segmentation and automatic counting of fruits in the image. Different types of fruits (orange/tangerine, pomegranate, apple, lemon, mango, cherry) are used for automatic counting. Open CV Python software is used to perform the required image processing operations. The proposed algorithm can be improved to design an automatic crop health monitoring in future. Segmentation of fruits is achieved using OpenCV python with more than 98% accuracy. In addition, this proposed system reduces the cost spend on the manual process of counting the fruits and also reduces the false estimation.

3. SYSTEM BLOCK DIAGRAM

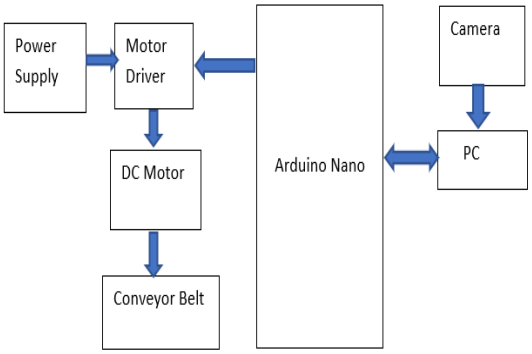

Figure 1: System block diagram

Building the block diagram for an idea is necessary part in order to examine the overall operations of the defined solutions. The above figure 1 shows the block of the project. This automated system is designed to overcome the problems of manual techniques. Here the hardware model is designed which contains conveyor system, motor driver circuit, dc motor is connected to the motor driver circuit, digital camera, microcontroller, external power supply of 12V. The external power supply of 12V is connected to the motor driver circuit to drive the motor driver circuit. The output from motor driver circuit is given to the dc motor to start the conveyor system. The microcontroller is connected to the motor driver circuit and PC or laptop. The scopes of objective are to develop a complete system to undergo fruit detection before quality analysis and grading of the fruits by digital image.

4. SYSTEM IMPLEMENTATION

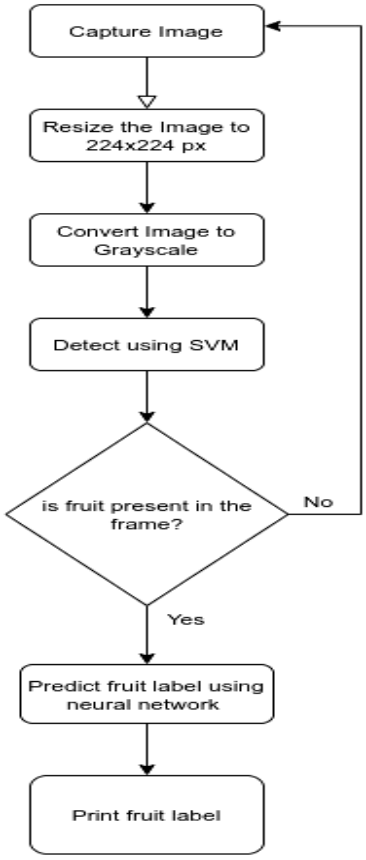

Figure 2: Proposed system for fruit classification and detecting quality of fruit.

The above algorithm shown in figure 2 works as follows:

- Firstly, the camera captures the real time images of the fruit. This image acts as an input of our system.
- The input image is then converted into normalized image of size 224*224 pixel.
- The normalized image is then converted into gray scale image by using HOG or Clahe function that is present in OpenCV library.
- The input image present in the data base and the normalized image that is obtained in previous steps are compared using SVM algorithm.
- The output obtained from previous step is used for the classification of fruit.
- If fruit is detected in the previous steps, then for checking the quality of fruit we are using neural network using tensor flow library

- If fruit is not detected, then the same algorithm is repeated from the start.

5. RESULT

The figure 3 (a) and (b) shows the output obtained from the proposed system. The output consists of detected fruit along with its accuracy.

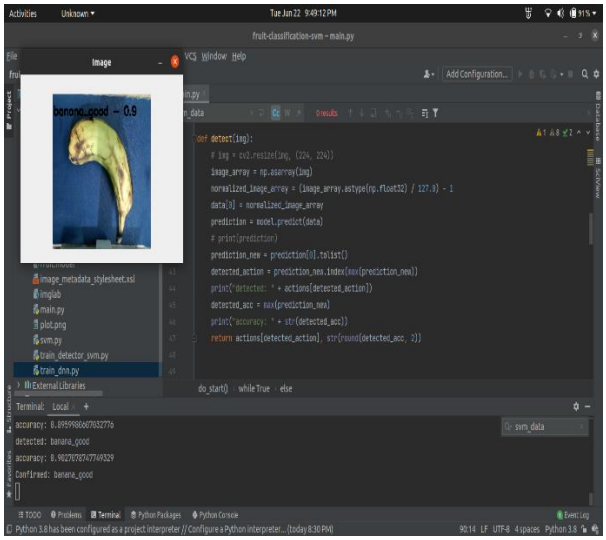

Figure 3 (a) Output image of good banana

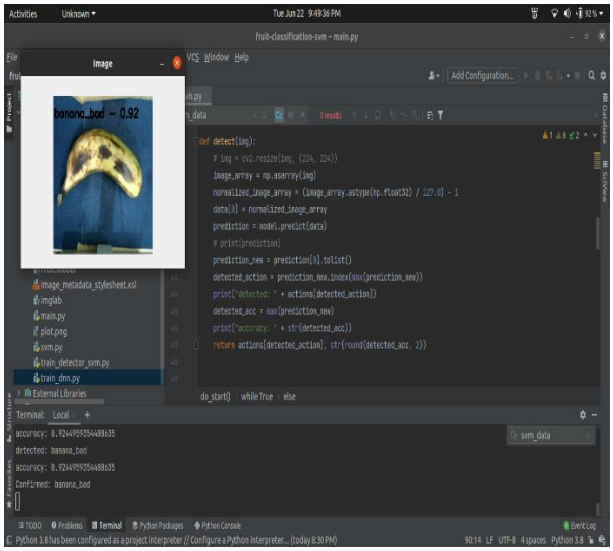

Figure 3 (b) Output image of bad banana

6. CONCLUSION

In this project we have successfully done the detection process of fruits and also checked the quality of fruits using computer vision technique. The hardware arrangement of the system is used for grading process of fruit such that good or bad fruits are collected automatically on either side of the conveyor. We have used OpenCV library for the real time detection of fruits using camera and classification of fruits is done using support vector machine algorithm. The quality of fruit is detected using neural network for which we have used tensor flow library. The training and testing model is built using neural network. After detecting the quality of fruit, the signal is sent to the hardware for grading process. The serial communication between software and hardware is done using pyserial library present in python software.

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