Segregation of Cashew Kernel and Areca Nut by Using Advanced Color Sorting Mechanism

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Abstract— **The food quality is very essential to the farmers as well as the end users. As we all know cashew kernels and areca nuts are the commercial commodities that gain foreign revenue in India. The classification is presently performed manually which is less efficient, low speed, expensive and tedious work. For this purpose we need to automate the classification which will lead to less production cost and improves the quality of food. The classification is based on color, texture, shape and size of the cashew kernels and areca nuts. Varieties of the cashew kernels and areca nuts had been collected to classify as the samples for the project.**

Index Terms— **Automation, Image Processing, Support Vector Machine, Comparison sort, Sorting**

I. INTRODUCTION

The cashew is one of the most popular and important commercial crop in India which was one of the four world famous nuts. Due to cashew's special shape and structure of the shell, the manufacturing of nuts sheller machine was difficult. India is one of the leading producer, processor and exporter of cashew kernels. The cost of the kernels depends on its quality. The comparison with other food products shows that the kernels' irregular and asymmetric shape makes it difficult to design a grading system. Most of the cashew industry grading and sorting is performed manually.

Computer vision technique uses computer and other equipments to simulate human visual system and achieve perception, recognition and understanding. Various researches focus on morphological, tonal, textural, size, shape and color features for classification. The computer vision technique can lower the production costs and increase quality. The objective is to design and implement a real time classification to automatically grade and sort different types of cashew kernels from their images.

This project provides classification of cashew kernels and areca nuts according to their shape, size, color and texture. The classification is performed using image processing techniques which classifies the kernels into five groups.

II. LITERATURE SURVEY

The author [1] has introduced an automated quality management system which helped in reduction of cost and improved the quality of the production. A real time classification system to automatically grade cashew kernels based on their color, texture, size and shape features are presented. The images are acquired using an efficient background subtraction technique. External features are extracted by using SVM and back propagation neural network classifiers. While in [2] five different classifiers were used and their performance in terms of accuracy was observed. Among the classifiers, Back Propagation Neural Network was proved to be efficient and it had an accuracy of 96.8% .The proposed system consists of four phases namely image acquisition, pre-processing, feature extraction and classification. After segmentation, morphological processing was applied to improve the background subtraction in which the unwanted small holes on the background region were identified and removed.

The author in [3] has addressed the problem of misclassification of betel nuts as well as wastage of manpower and material resources in sorting the betel nuts manually. The classification is done by extracting color, shape and texture features of betel nuts. The author used a fixed color CCD camera on production line to achieve automatic classification by using image processing techniques, which in turn transmits the signal of the result to achieve automatic sorting. In paper [4] classifications of diseased and undiseased areca nut have been determined using texture features of Local Binary Pattern, Haar Wavelets and Gabor. The methodology of this paper starts by transforming RGB image to HSI to YCbCr color model. It extracts saturation component for segmentation of areca nut from background .The segmented image is multiplied with color components in iteration. The diseased and undiseased areca nut classification has been done using KNN classifier with subset of texture feature.

III.PROPOSED SYSTEM

The system mentioned in literature survey ,we are further improvising this in our paper by adding some extra features such as sorting cashew kernels based on different colors and size available and along with that sorting of areca nut by its color. These days most of the existing systems used for checking the quality and superiority of the cashew have a drawback of low efficiency, high cost and low speed of grading. The quality and superiority of the cashew kernels can be predicted by its color. To make this prediction manually is time consuming and may not be précised and this requires continuous monitoring and management of experts which might prohibitively increase the expenses in large farms. Hence to overcome these parameters we are developing a model that checks the color, size and quality of the cashew kernels and areca nuts precisely and discriminates based on their quality.

IV. METHODOLOGY

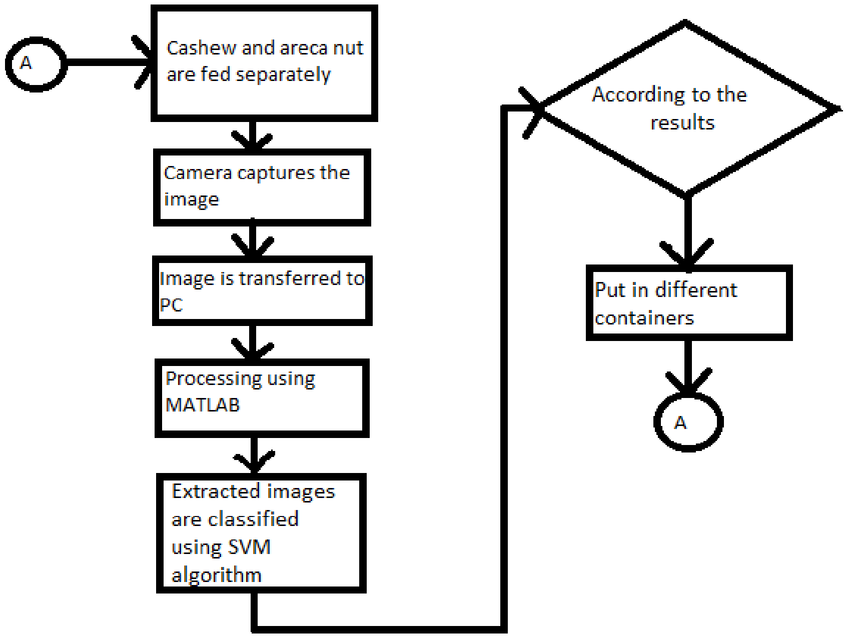

Fig. 1 Flowchart

As shown in Fig 1, the cashew kernels are fed into the container. The mesh in the container consists of servo motor which allows one kernel at a time on the conveyer belt. The conveyor belt thickness is two inch and the length is two meters. For the conveyor belt to rotate, two motors are connected. Once the kernel reaches the area under the camera's scope, the conveyer halts for three seconds for the image to be captured. The web camera of 8 megapixel is used to capture image. The captured image is processed using MATLAB. The processed results are sent to arduino. Based on the results arduino signals are sent to the servo motor. The servo motor will drop the kernels at an angle of 0, 45, 90, 135 and 180 degrees according to the size and color. Each angle of the servo motor corresponds to a kernel of particular color and shape. The conveyer belt continues to sort the kernels according to the color and size.

- **Image Acquisition**

The object i.e. the cashew or areca nut was placed at the base and the camera was placed at a height of 10cm above the base. Cashew kernel images were acquired using Image acquisition toolbox of MATLAB 2016 software.

- **Image Preprocessing**

Image preprocessing techniques can be applied to make the subsequent steps easier and error free. Certain samples were blurred and hence lucy filter has been applied to eliminate the blurring effect. Then a High pass sharpened image can be obtained using wavelet transform which provide good result for accurate segmentation.

Edge enhancement can be done using second level contourlet transform using 'haar' pyramidal filter and 'pkva' Directional filter. Then Image segmentation techniques have been applied to split the pixels of the image in to two subsets: object area, and the background. In this work, a black-gray background has been used, aiming to choose backgrounds with different spectral characteristics than the cashew kernel. In this way, maximal contrast between the white/ivory cashew kernel and the background was achieved. In real-time experiments also the color of the conveyor belt where the cashew kernel is passing through, is chosen as black.

- **Feature Extraction**

The extracted features act as input to the classifier. The various features extracted for subsequent classification were color, texture, shape and size. Since RGB is not recommended for color analysis, HSV color moments such as mean, standard deviation and skewness were extracted as most of the color information is contained in these three moments. Out of these fourteen features, five of the textural features are considered to be most relevant for this proposed method. Those features are Energy, Contrast, Correlation and Homogeneity and entropy.

Algorithm for Feature Extraction

Step 1: Decompose input image using 2-D Wavelet or Contourlet transform after converting RGB image into grayscale.

Step 2: Derive Co-occurrence matrices for high frequency sub bands of wavelet or contourlet with 1 for distance and 0; 45; 90 and 135 degrees for θ and averaged.

Step 3: From these co-occurrence matrices, five Haralick texture features called Co-occurrence Texture features are extracted. The size feature was calculated by counting the number of non-zero pixels in the segmented image and then normalizing it with the total number of pixels. In order to extract the shape features, Fourier coefficient method has been used. This method involves the following steps to estimate the shape feature.

1. Estimate the outermost boundary points of the cashew kernel region, Let N be the total number of pixels.
2. Determine the centroid (x_c , y_c) of the kernel region.
3. Find Euclidian distance R (k) from each boundary point (x_k , y_k) to the centroid.
4. Discrete Fourier Transform is applied to R (k), resulting one dimensional feature vector of the cashew kernel. Only the first few coefficients are distinct and can be used to distinguish the difference between cashew kernel shapes.

Classification is the final stage in the cashew grading process. Support Vector Machine (SVM) is a powerful binary supervised classifier and accurate learning technique. SVM can be used for classification or regression challenges. It is very suitable for nonlinear classification. Here the basic idea is to map feature vectors nonlinearly to another space and learn a linear classifier there. The linear classifier in new space would be an appropriate nonlinear in the original space. Kernel functions effectively map the original feature vectors into higher dimensional space without explicit calculation.

- **Data base Creation**

For the classification to be done first the different types of cashews and areca nut are stored in the database by taking pictures of the cashew and areca nut on the conveyor belt using the same webcam and the features are extracted. The features of the pictures of the cashews and areca nut taken during the working of the project are compared with the database created as shown in Fig 2.

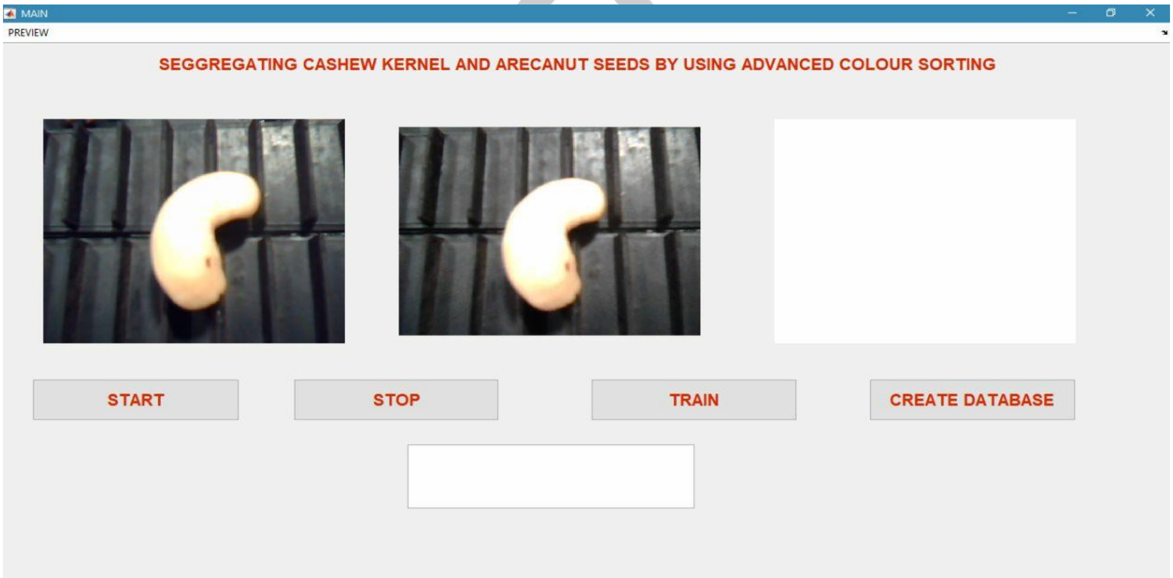

Fig. 2 Graphical User Interface

- **Arduino Uno Board**

It is a basic single board microcontroller designed to make applications, interactive controls, or environments easily adaptive. It consists of features like USB interface, analog inputs and GPIO pins which allow the user to attach additional boards. The arduino is used to run the DC motor and servo motors.

Fig. 3 Arduino Uno Board

- **Conveyor Belt**

The conveyor belt is the carrying medium of the conveyor belt system. A belt conveyor system consists of two or more pulleys with endless loop of carrying medium that rotates about them. One or both the pulleys are powered, moving the conveyor belt and the material on the belt forward. There are two main classes of conveyor belt, namely material handling and bulk material handling. In this project we use material handling type of conveyor belt.

- **DC Motor**

It is a rotary electrical machine that converts the direct current electrical energy into mechanical energy. DC motor is used to control the movement of conveyor belt.

- **Camera**

The camera being used in the project is the web camera of Logitech. A webcam is a video camera that feeds or streams its images in real time to or through a computer to a computer network. Once the image is captured, the video stream may be saved, viewed or sent on to other networks.

- **Servo Motor**

It consists of DC motor, potentiometer and a control circuit. As the motor rotates, the potentiometer resistance changes so the control circuit can precisely regulate how much movement there is and in which direction. When the shaft is in desired position, the power supplied to the motor is stopped.

V. RESULTS

Step 1: The cashew kernel is made to drop on the conveyor belt using the servo motor as shown in the Fig 4.

Fig. 4 The Cashew kernel being Dropped on the Conveyor Belt

Step 2 : The cashew kernel is stopped in front of the camera so that the image is captured. It is shown in Fig 5.

Fig. 5 Camera Capturing the Image of Cashew Kernel

Step 3: The cashew kernel is sorted according to it's classes in the end which is depicted in Fig 6.

Fig. 6 The Cashew Kernels are sorted to Different Containers

Fig. 7 Types of Areca Nut

Each class of cashew can be classified as class1, class2, class3, class4 and class 5 respectively.

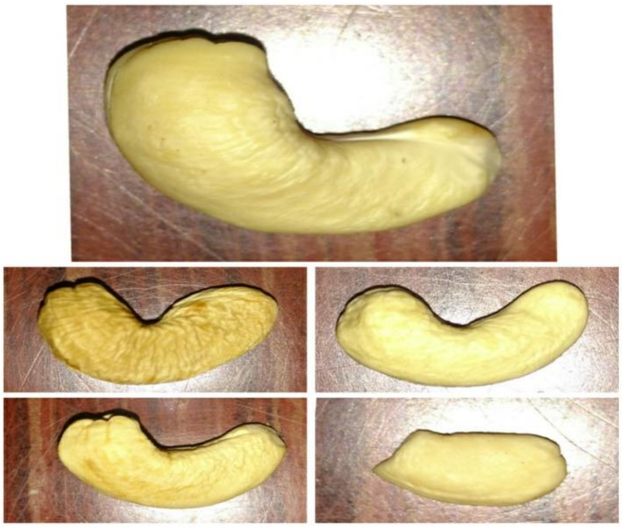

Fig. 8 Fives Classes of Cashew Kernels

The outcome of the complete project is to classify the five classes of Cashew Kernels and to classify the diseased and undiseased areca nut. The complete setup of the project is shown in Fig 9.

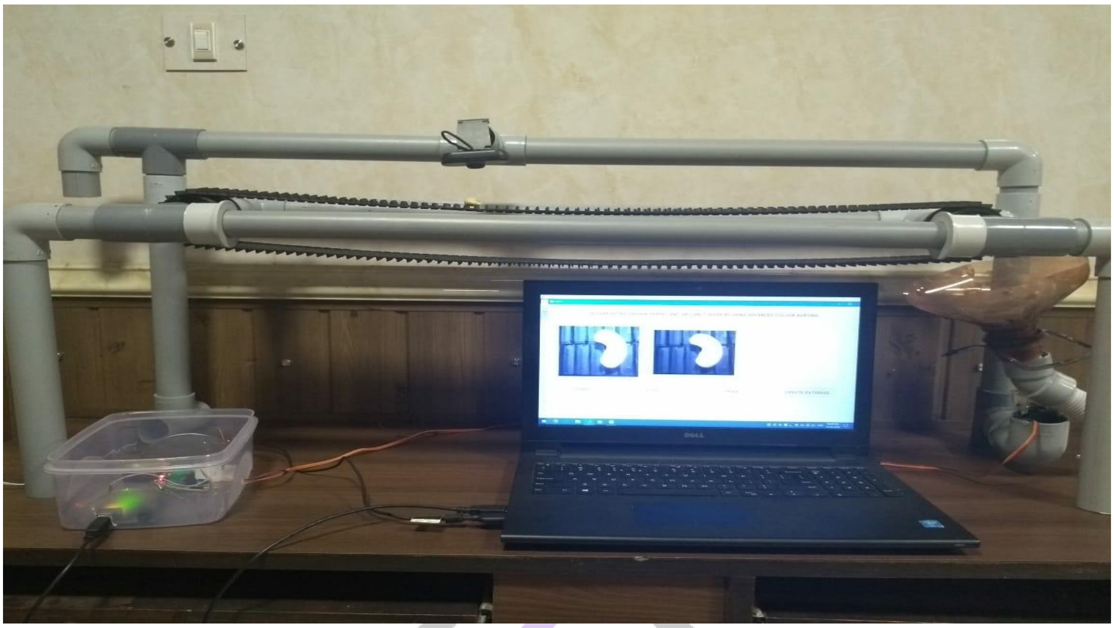

Fig. 9 Project Setup

The result of the classification is shown in the command window in Fig 10.

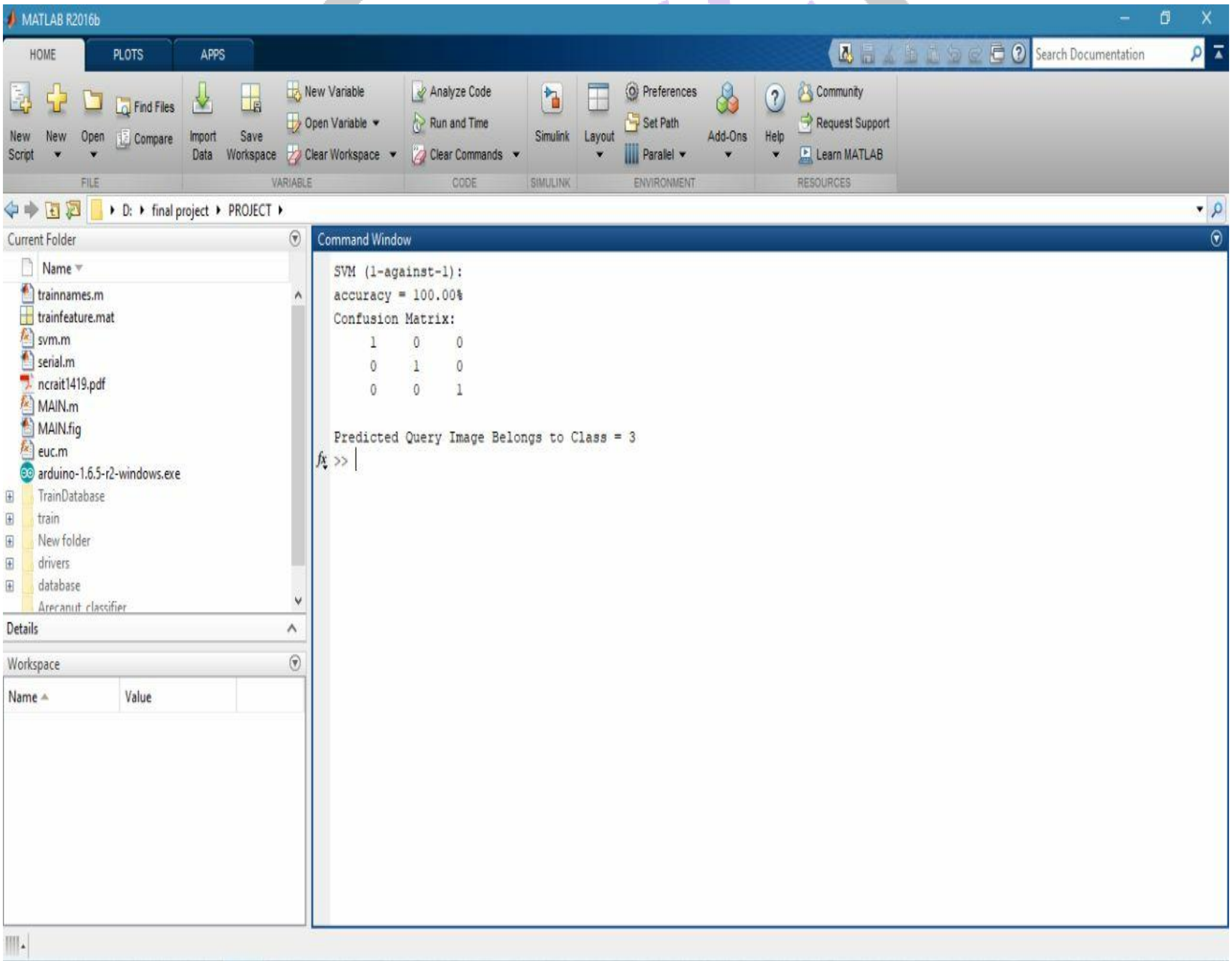

Fig. 10 Command Window for the Sorting of Cashew Kernel of Class 3 Type

VI. CONCLUSION

In this paper, Segregation of Cashew Kernel and Areca Nut by Using Advanced Color Sorting Mechanism has been developed. Various external features of the cashew kernel such as color, texture, shape and size are extracted from the captured image using divergent techniques. Areca nut has also been distinguished according to its color All these features are necessary to grade the various cashew kernels efficiently. Texture Features are extracted from the co-occurrence matrix of the second level detail wavelet coefficients and contourlet coefficients. Classification performed using three texture features individually (Energy, contrast, homogeneity) is found to be efficient in contourlet domain so that it can reduce feature vector dimension. Both SVM and BPNN are used for analysis of the performance but it is found that classifier with RBF kernel function provides high accuracy (99.6%) than BPNN.

VII. FUTURE SCOPE

a. A better resolution camera can be used to improve the quality of the images.
b. The project can be done using Raspberry Pi for better efficiency.

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