IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

FRUIT RECOGNITION AND MATURITY MONITORING SYSTEM

[1]Sreejith PS,[2]Aswani PP,[3]Misha TM,[4]Rajeswari KR,[5]Shahidha Abdul Kareem

[1]Assistant Professor, Department of Computer Science And Engineering, *Universal Engineering College, Vallivattom, Thrissur, India.*

[2,3,4,5]B.Tech Student, Department of Computer Science And Engineering, *Universal Engineering College, Vallivattom, Thrissur, India.*

Abstract:In our nation, fruit recognition and its maturity monitoring is a difficult task due to the mass production of fruit products. In order to determine and evaluate the quality of the fruit accurately. The project presents, In real time with camera developing a sorting machine for classification of multiple fruits and checking the time they survive and evaluate the rank of the fruits based on its quality. Firstly, the algorithm bring out the RGB image values and the background of image was disengaged by the split-and-merge algorithm. Secondly, the extracted multiple features are namely its color, statistical, textural and geometrical feature. Geometrical features are used in the evaluation of quality of the fruits. Additionally four different classifiers k-nearest neighbour (k-NN), support vector machine(SVM), sparse representative classifier(SRC) and artificial neural network(ANN) are used to classify the fruits. The SVM classifier has seen to be more effective in quality evaluation. Using k-fold cross-validation techniques validates the system performance by considering different values of k. The classification is among Rank1, Rank2 and defected one. The system achieved maximum accuracy for fruit detection and classification.

***Index Terms*– Fruit quality, Defect detection, Geometrical feature, Textural feature, Statistical feature**

I. INTRODUCTION

Fruit production in India is second largest in the world. Agriculture is most important and plays a major role in socioeconomic development of India. Harvesting involves processing an image to identify the fruit among various types and checking the time they survive and grade the defected one. Classification and identification of the grading of fruit is the difficult challenge due to the increase of fruit production. To have the realistic classification, this project presents a system, it determines first rank, second rank and rejected one. The algorithm extracts the changes based on color. statistical, textural and geometrical features. Classification and grading of the fruits are done with four classifiers namely k-nearest neighbour(k-NN), support vector machine(SVM), sparse representative classifiers(SRC), artificial neural network(ANN). In this system algorithm uses four different types of fruits apple, mango, orange, banana. The system involves two main phase namely detection of fruit type and grading of fruit type. Detection of fruit type involves several steps image acquisition, image pre processing, feature extraction and classification of fruit type. Grading of fruit type involves several steps segmentation, feature extraction, classification and grading of fruit type. Using image acquisition and pre processing stage convert RGB images into a greyscale images. Feature extraction in first phase represented by geometrical and color features and in second phase represented by multiple features namely, statistical, textural and geometrical features. The system execute better classification and fruit detection with maximum accuracy and enhance the production yield.

II. THEORY

2.1Image acquisition and Pre processing

The first step involves the rearranging the color space into a suitable one for detecting the defects easily. The images obtained by the digital cameras are of RGB (red, green, blue) color model. It is difficult to separate color information from brightness if RGB color space is non linear, therefore, it is not able to analyse the fruits properly. To overcome this problem RGB images are converted into a greyscale image to reduce the processing time.

Gaussian filtering is mostly used to reduce image noise and it used as a pre processing stage in order to enhance the image structures at different scales.

A. Fuzzy Segmentation

Various noises are observed by the camera which reduces the appearance of the image. So, the image upgrading is done by adjusting the image intensity value. Hence, it is needed to segment the defects separately because of its size, type, texture, and color variations for the different defects. Here, images are taken on a black background and while monitoring the defected parts can be separated from the background easily by thresholding. Along with segmentation fuzzy c-means clustering, and converting RGB picture into HSI model.

B. Feature Extraction

The system involves two main phases. Specifically, two sets of features were used. The first phase with color and geometrical features and the second phase with multiple features namely color, statistical, textural, and geometrical features.

C. Color Features

The observable color feature is widely used in image indexing and retrieval. This feature take out the color information easily. The RGB color space is commonly used for observing the color of the fruit in detection phase.

D. Statistical and Textural Feature

Statistical features measures by observing the random grey pixels values, which include mean, standard deviation, variance, smoothness, RMS, inverse difference moment, kurtosis, and skewness. Textural features measures by observing the pixel pairs which include contrast correlation, energy, homogeneity, and entropy.

E. Geometrical Features

The geometrical features are used to detect the type of fruit and a combination of statistical and textural features are used for grading (Rank 1/Rank 2/Defected) of fruits. Geometric features are measured by observing the points, lines, curves or surface which includes area, convex, major length, minor length, eccentricity, cantered, boarding box and solidity.

F. Classification

In classification stage images are turn down to useful information. The images from the extracted features have been used to categorize and grade the type of fruits. A better set of feature has been chosen using sequential forward selection which helps to maximize the performance of the classification.

III. RELATED WORK

Here we introduce each papers based on the technologies used in the fruit and this are arranged in technologies bases

The aim of this paper [1] is to measure the severity of the disease This automatic Banana plant disease recognition system can replace the manual method for recognizing the diseases and is going to be very helpful for the farmers or plant pathologists in determining the disease and its control measures, as it is more accurate than manual method. This approach will increase the production of crops. The drawback of this paper is that the segmentation is complex.

The aim of the paper [2] is used to find the regions of banana streak virus infection in banana leaves. The system uses the image processing tool, Open c v to process the captured banana leaf images. The proposed algorithm is HSV which differentiates the affected and non affected regions in the leaf images. Here the Image processing is done by open c v software which is preinstalled in embedded LINUX board. The technique is based on hue and saturation value, for separating green colour from the image by setting constant hue value of green colour. The drawback of this paper is that it cannot optimize the better result and accuracy.

The aim of the paper [3] is used to study the visually observable patterns seen on the plant. Health monitoring and disease detection on plant is very critical for sustainable agriculture. It is very difficult to monitor the plant diseases manually. It requires tremendous amount of work, expertise in the plant diseases, and also require the excessive processing time. Hence, image processing is used for the detection of plant diseases. Disease detection involves the steps like image segmentation, feature extraction and classification. This paper discussed the method used for the detection of plant diseases using their leaves images. Deep learning algorithm gives the appropriate result of the diseases. The drawback of this paper is that it consumes time during the training process.

The aim of the paper[4] is to review various techniques of plant disease detection and discuss in terms of various parameters. The paper is organized into the following sections. First section gives a brief introduction to the importance of plant disease detection. Second section discusses the existing work carried out recently in this area and also reviews the techniques used. Section three includes basic methodology followed for developing disease detection system. Lastly, fourth section concludes this paper along with future directions. The systems have so far resulted to be fast, inexpensive and more accurate than the traditional method of manual observation by farmers. The drawback of this paper is that it contains average classification accuracy.

The aim of the paper[5] is used to serve a decision support tool to help farmers to identify the disease in the banana plant. The proposed model can serve as a decision support tool to help farmers to identify the disease in the banana plant. Hence, the farmer can take a picture of the leaf with the symptoms and then the system will identify the type of the disease. Our main contribution is to apply deep neural networks to detect two famous banana diseases which are banana sigatoka and banana speckle in real scene and under challenging conditions such as illumination, complex background, different images resolution, size, pose and orientation. After several experimentations our system was able to find good classification results. This has proven that the proposed method can significantly support an accurate detection of leaf diseases with little computational effort. Encouraged by

the obtained results, we intend in our future work to test more banana and plants diseases with our model. Besides, we will target the automatic severity estimation of the detected disease since it is an important problem that can help the farmers in deciding how to intervene to stop the disease

The aim of this paper [6] is Automated inspection system for colour and shape grading of star fruit using machine vision sensor. A prototype machine vision station was developed for quality grading of the unique star shape and rich Golden colour carambola fruit. The grading criteria were based on the Malaysia's federal Agriculture Marketing Authority standards for star fruit export. A Fourier-based shape separation methods was developed for shape grading ,whereas colour recognition was established using multivariate discriminate analysis .The methodology used in this system is CCD method. The main advantage is it help standardize quality evaluation of star fruit but low accuracy.

The aim of this paper [7] is Discrimination and Classification of fresh cut star fruit using automated machine vision system software for detecting the quality features of Golden delicious star fruit of Averrhoa Carambola L.genus were developed for automated vision technology. The feature considered were colour and shape .The use of artificial Classifier such as linear discrimination analysis and multilayer perceptron neural network as a tool to detect star fruit Maturity such as unripe, under ripe and over ripe in HIS colour space were investigated. The colour spectra of matured and un matured fruit were characterized using all colour features ranging from hue10 to hue74 and using principle hue generated by wilkslambada Analysis. The advantage of the system Hue value is comparatively stable and less sensitive to lightening condition .The disadvantage is it require HSI colour to transmission.

The aim of this paper [8] is the properties of commercially-graded B10 cultivar star fruit (Averrhoa carambola) namely length, diameter, mass, volume, the five colours values (L, a*, b*, C, h°), firmness, total soluble solids (TSS), titratable acidity (TA) and pH were measured. Coefficients of variation (CV), correlation and property tolerances were evaluated to develop a relationship between the non-destructively measurable external properties and the non-destructively immeasurable internal properties. The length, diameter, mass and hue were found to have low CV levels. Mass appears to have a very strong correlation with volume while hue has a strong correlation with firmness. The advantage of system is better Classification and disadvantage the system has low accuracy.

The aim of this paper [9] is Identifying computer generated images based on quaternion central moment in color.
This paper a novel forensic scheme for image is proposed in colour quaternion waverley transform(CQWT)domain waverley transforms and local binary patterns CQWT process a colour image as a unit and so it can provide more forensic information to identify the photograph(PG)and computer generated (CG) image by considering the quaternion magnitude and phase measures. Meanwhile two novel quaternion central moment for colour image that is quaternion skewness and kurtosis are proposed to extract forensic features. In the condition of the same statistical model as farid model the CQWT can boost the performance of the existing identification model. Classification accuracy of the CQWT improve the quaternion features approximately improve by2% more than traditional.

The aim of this paper [10] is New and efficient feature for skin lesion Classification based on skeletonization. This paper presents a new approach to detect and classify skin lesion for melanoma diagnosis with high accuracy skin lesion detection is based on an image decomposition into two components using Partial Differential Equation(PDE). The first component that sufficiently preserves the contour is thus exploited to have an adequate segmentation of image lesion while the second component provide a good characterization of the texture extracted by skeletonization of the lesion are presented. These features are compared and combined with well know features from the literature features engineering was applied to select the most relevant features to be retained for the Classification phase. The proposed approach was implemented and tested on a large database and gave a good Classification accuracy compared to recent approach from literature.

The aim of this paper [11] is automation plays an important role in fruit industries. The development of effective classification system is still a challenging task. Fruit classification system can be applied in fruit industry and supermarket application. It can be used for educational purpose to enhance learning. Color and texture of images plays an important role in visual perception. Color is a common descriptor used for classifying various kinds of fruits. In image processing, color of the image is processed based on their color model. The image captured using camera will be in RGB color model. The drawback with this color space is that color with the same chromaticity can be classified as different color, if their intensities are not equal. Hence we use HSV space to represent colors. Using HSV space, the difference in intensities does not affect the color classification. In addition to color feature, texture feature is used to discriminate different pattern of images. In this paper, we propose a classification system which is based on statistical features. A fruit classification system is discussed which contains three phases: pre processing, feature extraction and classification phase. Background subtraction is one of the pre processing steps in image processing. In feature extraction phase, statistical feature of color and texture feature from co occurrence matrix are derived. In classification phase, Support Vector Machine (SVM) classifier is used.

The aim of this paper [12] is reliable automatic classification of fruits and vegetables is of great interest for a wide and ever increasing range of applications in the food industry, including sorting, personalized nutrition , quality inspection ,and pricing. However, due to the similarity of the classes in both shape and color and the large intra- class variation of shape and color for some classes (e.g. apples), the task is considered as difficult and models are often still not accurate enough or impose too many constraints on how the data must be recorded with limited relevance for real world use cases. A computer vision system for automatic pricing of fruits and vegetables in grocery stores proposed by used a combination of pre trained image feature extractors and weight information for classification. While the data collection is close to the real use case, the achieved average accuracy is not sufficient to let the system operate on its own.

The aim of this paper [13] is authors have proposed approaches for fruit picking using computer vision. Have used Genetic Algorithm optimized support vector machine. It is prepared to classify fruit types such as apples , leaves and branches from an apple tree. Such techniques are useful during post-harvest of the crop to identify the fruit count

The aim of this paper [14] is the use of computer vision techniques in post-harvest processing of agricultural products has increased considerably in recent years due to their non-destructive and rapid monitoring abilities. Image processing, combined with pattern recognition, has been applied in fruit sorting and classification. In this study, a Bag-of-Feature (BOF) model is used for the classification of 20 sweet and bitter almond varieties.

The aim of this paper [15] is having a system that classifies different types of fruits and identifies the quality of fruits will be of a value in various areas especially in an area of mass production of fruits' products. This paper presents a novel system that differentiates between four fruits types and identifies the decayed ones from the fresh. The algorithms used are based on the colour and the texture features of the fruits' images. The algorithms extract the RGB values and the first statistical order and second statistical of the Gray Level Co-occurrence Matrix (GLCM) values. To segregate between the fruits' types, Fine, Medium, Coarse, Cosine, Cubic, and Weighted K-Nearest Neighbours algorithms are applied

The aim of this paper [16] manual fruit grading by visual inspection is labor intensive, time consuming and suffers from the problem of inconsistency in judgment by different persons. Currently, cheap labor is mostly unavailable in many country orchards and fruit farms. There is a need for an automatic fruit classification machine replacing the expensive human labor with the real-time smart fruit quality classification system. However, it is very difficult to determine the quality classification of a variety of fruits using the non destructive technology in real time. There are many factors that need to be considered in fruit grading. Appearance features including size, weight, volume, shape, colour, and outside defects are very important factors for fruit quality grading. Internal flavour factors such as sweetness, bitterness, acidity, saltiness, and moisture and texture of fruit such as hardness, crispness and nutrients also seriously affect fruit grading

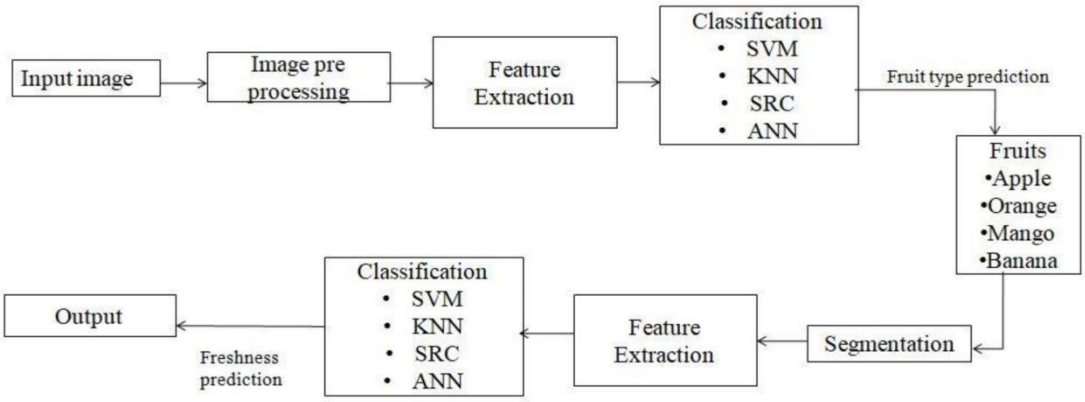
The aim of this paper [17] automation in agriculture comes into play to increase productivity, quality and economic growth of the country. Fruit grading is an important process for producers which affects the fruits quality evaluation and export market. Although the grading and sorting can be done by the human, but it is slow, labor Intensive, error prone and tedious. Hence, there is a need of an intelligent fruit grading system. In recent years, researchers had developed numerous algorithms for fruit sorting using computer vision. Colour, textural and morphological features are the most commonly used to identify the diseases, maturity and class of the fruits. Subsequently, these features are used to train soft computing technique network. In this paper, use of image processing in agriculture has been reviewed so as to provide an insight to the use of vision based systems highlighting their advantages and disadvantages.

The aim of this paper [18]a method for grading fruits **a**nd vegetables by means of using RGB-D (RGB and depth) images and convolutional neural network (CNN). Here, focus on grading according to the size of objects. First, the method. Transforms positions of pixels in RGB image so that the centre of the object in 3D space is placed at the position equidistant from the focal point by means of using the corresponding depth image. Then, with the transformed RGB images involving equidistant objects, the method uses CNN for learning to classify the objects or fruits and vegetables in the images for grading according to the size, where the CNN is structured for achieving both size sensitivity for grading and shift invariance for reducing position error involved in images. The convolutional neural network consisting of a convolutional layer and a max pooling layer, fruit size detecting and grading system based on image processing. After capturing the fruit side view image, some fruit characters is extracted by using detecting algorithms. According to these characters, grading is realized. This embedded grading system has the advantage of high accuracy of grading, high speed and low cost. It will have a good prospect of application in fruit quality detecting and grading areas.

The aim of this paper [19]the hardware board contains eight modules: CMOS camera module, power management module, USB interface module, clock module, Ethernet module, serial module, TFT display module and memory module the hardware board resource .The capturing part contains two lights sources, one CMOS camera and one conveyor belt. The CMOS camera is used to perform fruit image capture. The camera type is OV9650, which is supported by the processor interface, so the camera can easily connect to the main board. And its capturing speed is 30fps and resolution is more than 130W pixels. In order to avoid shadow, two annular lights are used to supply well- distributed light. The black background colour in image is easier to extract the fruit edge characters later. So the background is set black in whole process of image capture. The system power supply is 3.3V and the depth of the touch screen and is the man-machine interface for operation.

The aim of this paper [20]the conventional post-harvesting process of horticultural fruit and vegetables is exorbitant and highly subjective which susceptible to errors. This process is extremely unreliable in terms of accuracy, throughput, speed and cost. An automated fruit grading approach is desirable to reduce the manual efforts and increase the efficiency. In this paper, developing a computer vision based an image acquisition and classification system for fruit grading. This system is divided into three modules image pre-processing, image segmentation and Classifier. In the first phase, we are extracting the image features such as image quality, area, perimeter, mean, variance, colour, intensity.

IV. IMPLEMENTATION



K-nearest neighbour(k-NN)

K-nearest neighbour is used for classification and regression. k-nearest neighbour is a statistical classifier that targets the samples measured by Euclidean distance to measure the distance between input data and trained data. It assigns data to the most expressed category within its closest k-neighbours. A support vector machine is a supervised machine learning algorithm. It is used for classification of linear and non-linear data. The classifier uses kernel function that non-linearly maps input field to multidimensional field. There are two key parameters to be optimized they are epsilon and gamma. The epsilon indicates the miss prediction tolerance of training data, gamma govern the shape of hyper plane. The values of gamma and epsilon of linear kernel function were organized using cross-validation.

Support Vector Machine(SVM)

A support vector machine is a supervised machine learning algorithm. It is used for classification of linear and nonlinear data. The classifier uses kernel function that non-linearly maps input field to multidimensional field. There are two key parameters to be optimized they are epsilon and gamma. The epsilon indicates the miss prediction tolerance of training data, gamma govern the shape of hyper plane. The values of gamma and epsilon of linear kernel function were organized using cross-validation.

Sparse Representative Classifier(SRC)

A sparse representative classifier that sparsely represents the face image by a subset of training data. The classifier can directly assign a class label to a test sample based on a training samples from various classes.

Algorithm

1. A dictionary D = [D1, D2, D3… DC] € Rmxn for c classes are formed from training samples.
2. Initialize test sample y € Rmand optional error tolerance € > 0.
3. Normalize the values of the dictionary.
4. Solve minimization problem

   Min ||x|| y=Dx
5. Compute the residuals ri(y)=|| y−Dεix||
6. The test sample class is determined by

   identity (y)= min r(y)

Artificial Neural Network(ANN)

An artificial neural network is a scientific structure that processes instructions through connected neurons through the modifiable threshold, weights and transfer function . It has the best decision making capability for classification of organic products where the size and shape. The output of neurons is a function of the weighted sum of the inputs and a bias. The function of the neural network is simply the calculation of the outputs of all the neurons. ANN has the capability to store information on the entire network.

Evaluation

In order to establish and prevent the prediction results and over-fitting of the models, the sample set was partitioned into two independent pieces: 80% for training and 20% for cross validation. The calibration model for the quality parameters were developed using k-NN, SVM, SRC, and ANN from the training samples.

$$\text{Accuracy}(\%) = \frac{TP + TN}{TP+TN+FP+FN} \times 100\% \quad (8)$$

$$\text{Sensitivity}(\%) = \frac{TP}{TP+FN} \times 100\% \quad (9)$$

$$\text{Specificity}(\%) = \frac{TN}{TN+FP} \times 100\% \quad (10)$$

RESULTS AND DISCUSSION

Results of Descriptive Statics of Study Variables

This work, fully automatic and grading of multiple fruits are proposed. In this project, images of different fruits are given as and their input their various feature are extracted based on which we rank them as rank1, rank2, and defected one. The system also intent to predict the ripeness of fruits purchased and evaluate the quality of the fruits more precisely. The system also expect to optimise the projects output to a mobile applications thereby alerting the users. The system attain better classification and fruit detection with maximum accuracy and enhance the production yield.

Phase I: Detection of Fruit Type

The results proposed in this phase are a system that analyzes four different types of fruits namely apple, avocado, banana, and orange With the information given in the previous section, in the pursuit of fruit detection, we have inspected geometrical features (12 features) with k-NN, SRC, ANN, and SVM are used for classification. Table 4 represents the performance of fruit detection. The maximum accuracy 77.24% (k-NN), 82.75% (SRC), 88.27% (ANN), and96.55% (SVM) for k = 10 is achieved by the system.

Among various works established in the last years for fruit grading, some of them gain attention as summarized in Table 6. Comparative analysis of the proposed system with other existing techniques shows improved and better accuracy with four different fruit images. Hence, our approach contributes to improved recognition with cascaded features and a the available system. The system performance will be improved by taking more combinations of features.

Phase II: Grading (Rank1/Rank2/Defected) of Fruit Type

The results proposed in this phase are a system that analyzes among Rank 1, Rank 2, and defected ones different types of fruits as shown in Fig. 8. With the information given in the previous section, in the pursuit of fruit detection, we have inspected statistical, textural, and geometrical features with k-NN, SRC, ANN, and SVM used for classification. Table 5 represents the performance of fruit detection. The maximum accuracy of 77.24% (k-NN), 82.75% (SRC), 88.27%, (ANN)

V. CONCLUSION

We have urged during this paper that fully automatic and grading of multiple fruits are proposed. In this project, images of different fruits are given as and their input their various feature are extracted based on which we rank them as rank1, rank2, and defected one. The system also intent to predict the ripeness of fruits purchased and evaluate the quality of the fruits more precisely. The system also expect to optimise the projects output to a mobile applications thereby alerting the users. The system attain better classification and fruit detection with maximum accuracy and enhance the production yield.

VI. ACKNOWLEDGMENT

We utilize this opportunity to convey our gratitude towards all those who have helped us directly or indirectly for the completion of our work. We deeply and wholeheartedly thank Dr. Sreeraj R - HOD, Computer Science and Engineering for his extreme valuable advice and encouragement. We especially thankful to our guide and supervisor Mr. Sreejith PS -Assistant Professor ,Computer Science and Engineering for giving valuable suggestions and critical inputs in the preparation of this paper. We would like to extend our sincere gratitude to all faculty of Computer Science and Engineering department for the support and suggestions that helped us in the development of our work to what it is now. We thank our parents and friends for the mental support provided during the course of our work at the times when our energies were the lowest.

VII. REFERENCES

[1] BasavarajTigadi, Bhavana Sharma" BANANA PLANT DISEASE DETECTION AND GRADING USING IMAGE PROCESSING " Research Article Volume 6 Issue No. 6 DOI 10.4010/2016.1565 ISSN 2321 3361 © 2016 IJESC

[2] S. Naik and B. Patel, "MACHINE VISION BASED FRUIT CLASSIFICATION AND GRADING - A REVIEW,"

International Journal of Computer Applications(0975-8887), vol. 170 No.9, pp. 22–34, July 2017.

[3] Ann Nosseir, SeifEldin ,Ashraf Ahmed, "AUTOMATIC CLASSIFICATION FOR FRUITS TYPES AND IDENTIFICATION OF ROTTEN ONES USING K-NN AND SVM", iJOE – Vol. 15, No. 03, 2019

[4] J. Gill, A. Girdhar, and T. Singh, "A HYBRID INTELLIGENT SYSTEM FOR FRUIT GRADING AND SORTING,"

International Journal of Computer Science and Engineering(IJCSE), vol.9 No.05, pp. 257-265, may 2017.

[5]J. Wang, T. Li, X. Luo, Y.-Q. Shi, and S. K. Jha, 'IDENTIFYING COMPUTER GENERATED IMAGES BASED ON QUATERNION CENTRAL MOMENTS IN COLOR QUATERNION WAVELET DOMAIN', *IEEE Trans. Circuits Syst. Video Technol.*, vol. 29, no. 9, pp. 2775–2785, 2019, doi: 10.1109/TCSVT.2018.2867786.

[6] Shweta R. Astonkar, Dr. V. K. Shandilya" DETECTION AND ANALYSIS OF PLANT DISEASES USING IMAGE PROCESSING TECHNIQUE " International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 04 | Apr-2018

[7]. NasirahmadiAbozar, MiraeiAshtiani, Seyed-Hassan , "BAG-OF-FEATURE MODEL FOR SWEET AND BITTER ALMOND CLASSIFICATION , BIOSYSTEMS ENGINEERING" , volume 156 (2017) .

[8]Y. Tao, J. Zhou, "AUTOMATIC APPLE RECOGNITION BASED ON THE FUSION OF COLOR AND 3D FEATURE FOR ROBOTIC FRUIT PICKING", Computers and electronics in agriculture 142 (2017)

[9]Anonymous (2014) Commission regulation (ec) no 85/2014 of 15 January 2014 on marketing standards for apples. Off. J. Eur. Union L 13, 3–18.

[10] Jong H. Shin, "DIGITAL IMAGE PROCESSING", Hanbit Academy, 2015 S. Oh," COMPUTER VISION", , Hanbit Academy, 2014