Fruit Grading for Pomegranates: An Overview

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***Abstract*— More often the external look of the fruit decides the quality of that fruit. The fruit with bright colour, good texture and shape is often very firstly chosen by the costumer. Fruits with such features are said to be high quality fruits. High quality fruits can be exported to other countries and generates a good income. Although fruits can be qualified or graded by manually but it is inefficient and time consuming. Automated grading system not only speeds up the time of the process but also minimizes errors. Machine vision techniques are another way to automate the fruit grading. This paper discusses the fruit grading of pomegranates.**

Keywords*— Pomegranates; fruit grading; support vector machine; classifiers;

I. INTRODUCTION

In day today life humans are finding for good quality products whether it is agricultural product or animal product or any electronic device or any kind of material. Good quality bares higher price in the market. In agricultural field maintaining good quality is a difficult task. Agriculture is a traditional occupation of India. India is second leading cultivator of fruits. Most of the cities in Karnataka especially in Bijapur-Bagalkot districts many farmers grow fruits like pomegranate, mango, chickoo, guava, grapes, etc., and send to Bangalore for further exportation. Whole world is racing towards profit- money making policy. Quality fruits offer more profit for farmers. Hence fruit quality inspection is the most important task in post-harvesting stages before sending them to market to fetch higher price. Quality inspection of fruits if done by humans is time consuming, inefficient also costlier Hence automated quality inspection of fruits is cost effective, efficient and speeds the work.

Pomegranate: Pomegranate, botanical name 'Punica Granatum', is considered to be the "fruit of paradise" and is one of the key fruit crops of dry region. For centuries, a pomegranate is considered as a jewel of fruits. The fruit is colorful, juicy with sweet acidic grains called 'Arils'. Pomegranate juice is a polyphenol-rich with high antioxidant capacity. A number of varieties of pomegranates are cultivated and are distinguished by shape of the fruit, color and thickness of the peel, taste and colour of the aril. In India pomegranate was formerly grown in kitchen gardens but viable plantations have come up in recent years. Although, the fruit is grown all over India, it is commercially cultivated only in Maharashtra and North Karnataka. There are different varieties in the fruit mainly there are: Ganesh, Bhagwa, Araktha, Sindoor, Mrudula and Jyoti are shown in Fig. 1.

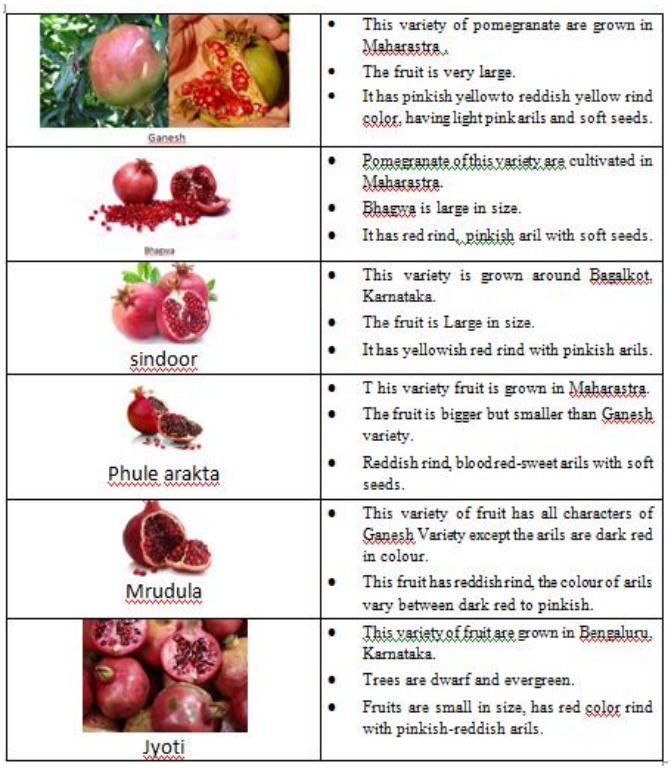

Fig.1: Varieties of pomegranates

With the topical improvements in dry land horticulture, the pomegranate is being cultivated and exported in large quantity. Recently The Hindu daily dated 23rd Nov 2017 reported that Pomegranates exports to European countries reached at least one ton a day from Bangalore, Karnataka. The consumer value of pomegranate is truly realized due to its latent health benefits based on a significant body of medical research carried with authentic pomegranate juice. Pomegranate is a non climacteric fruit which means it cannot be picked before the fruit is ripened completely. Hence post harvesting work that is grading and marketing is an important task for farmers.

II. AUTOMATED FRUIT GRADING

Fruit grading is done with the expectation of cost effective, accurate and fast determination of fruit quality in post harvesting stage. Computer vision and image processing techniques now days are being popular in the fruit industry, especially in the areas of sorting, grading of fresh fruits, detection of defects such as dark spots, cracks and bruises on fresh fruits, plants, leaves and seeds, etc. Thus fruits produced in the garden are sorted according to quality and maturity level

and then transported to different standard markets at different distances.

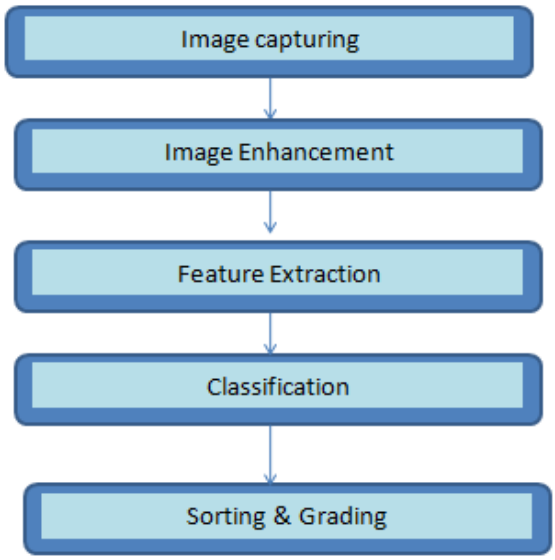

Fig. 2: Basic steps of fruit grading.

The basic steps of fruit grading are image acquisition, preprocessing, feature extraction, classification and grading as shown in Figure. 2

1. *Image acquisition*: Images are captured using CCD camera, USB camera or by using real time X-ray System.

2. *Image Preprocessing:* Images captured are usually not directly suitable for feature extraction and classification because of noise, camera resolution and lighting variations or weather conditions. Hence they need to be preprocessed to enhance the image. There are different techniques used for image enhancement. Mainly,

   a) *Contrast stretching*: image is converted into gray scale image to extract the unusual feature on the fruit such as dark spots.

   b) *Histogram modification*: Histogram has a lot of importance in image enhancement. It reflects the characteristics of image. By modifying the histogram, image characteristics can be modified. One such example is Histogram Equalization. Histogram equalization is a nonlinear stretch that redistributes pixel values so that there is approximately the same number of pixels with each value within a range. The result approximates a flat histogram. Therefore, contrast is increased at the peaks and lessened at the tails.

3. *Feature extraction*: From the preprocessed image features are extracted. Features may be based on color, morphologcal and texture information of the fruit. Shape and size are the morphological features that describe appearance of the object. The area and perimeter are mainly used one. The area and perimeter are scalar measure where area is the actual number of pixels in the region and perimeter is the distance around the boundary of the region. Shape features are measured by using these scalar quantities for e.g., roundness ($4\pi \times$ Area/Perimeter) and compactness (Perimeter/Area)[1].

4. *Classification and Analysis*: with the boon of machine vision classification goes easy. There are different classifiers used such as Support vector machine(SVM), Fuzzy logic, Artificial Neural Network(ANN) to classify the fruit. Based on classifier result fruits are graded.

   a) Support Vector Machine: Support vector machines are supervised machine learning algorithm that analyze data used for classification. It is a binary classifier. That is, in a given set of training examples, each marked as belonging to one or the other of two categories. An SVM training algorithm builds a model that assigns new examples to one category or the other.

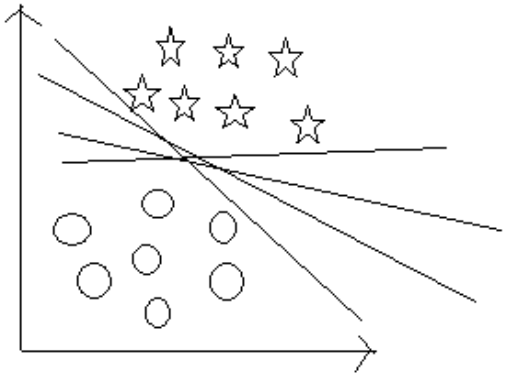

Fig..3: Classification method of SVM

The fig. 3 shows an example of classifying two groups with different possibility with separation lines.

b) Fuzzy Logic: Fuzzy logic is a multi-valued logic in which the result lies between 0 and 1. Fuzzy logic is used where ambiguity exists in the social judgment. Fuzzy logic system is a non-linear mapping of a input dataset to a output dataset as shown in fig. 4.

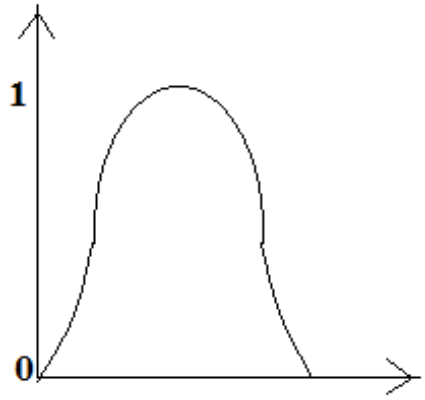

Fig. 4: Non- linear mapping of fuzzy system

The fuzzy logic system consists of four parts: Fuzzifier, Rules, Inference engine, and defuzzifier as shown in fig. 5.

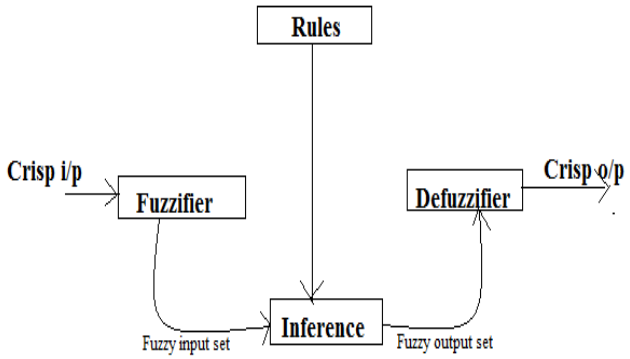

Fig. 5: Fuzzy logic system

In step 1, a crisp input data are collected and converted to a fuzzy set using fuzzy linguistic variables, fuzzy linguistic terms and membership functions. This step is called as fuzzification. In step 2, an inference (decision making) is made based on a set of rules. Lastly, the resulting fuzzy output is mapped to a crisp output using the membership functions, in the defuzzification step.

c) *Artificial Neural Networks*: Artificial neural network algorithms are designed by the inspiration of biological neural networks. These are weighted directed graph in which artificial neurons are nodes and directed edges are the connections between the neuron inputs and neuron outputs, with some weights. A typical artificial neural network contains three main layers: Input layer, hidden layer and output layer as shown in fig. 6.

Input Layer: The nodes in input layer receive input from outside world from which the network learn and recognize about and process.

Hidden Layer: These nodes are in between input layer and output layer. They transform the input unit into something and transfers to output unit.

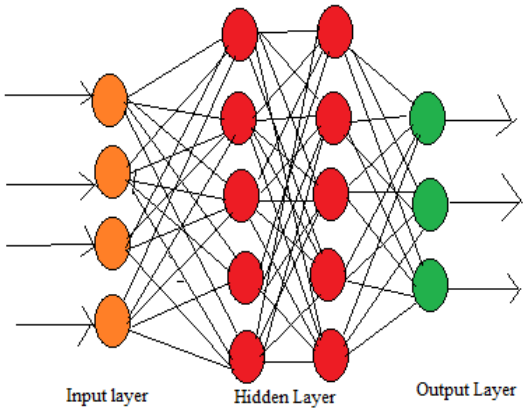

Fig. 6: Artificial Neural Network

Output Layer: This layer responds to the data about how it has learned any task.

III. LITERATURE SURVEY

Title : A Neural Network Assisted Machine Vision System for Sorting Pomegranate Fruits[2].
Author: Arun Kumar R, Vijay S Rajpurohit, Nargund V B
Publication year: 2017 IEEE
Method: The image dataset of pomegranate fruits are obtained from a local fruit market. Images are then preprocessed and then fed to a feature extraction module. The extracted features are of twofold: spatial domain features and wavelet features. The process of sorting is then carried out by Artificial Neural Network (ANN) training and results are analyzed. There are few limitations of the work. The author have considered large number of features, all those are not used in sorting process.

Title: Image Processing Approach for Grading And Identification Of Diseases On Pomegranate Fruit:An Overview[3].
Author: D. S. Gaikwad , K. J. Karande
Publication year: 2016 IJCSIT
Method: The author collected images from National Research Centre on Pomegranate in Solapur, Maharashtra, India. These images are further pre-processed like filtering and segmentation. Then in the feature extraction texture and colour feature are extracted. Further extracted features are fed as input to the classifier to classify the fruits.

Title: Pomegranate Fruit Separation Using MATLAB Based on Size[4].
Author: Nikhil Kailas Kumbhar, Vaibhav Shrimant Pawar, Omkar Pandurang Kumbhar, Pankaj Suresh Kadu.
Publication year: 2017 IJRITCC.
Method: In this paper the author has collected images of real time fruit. Then in the pre processing, fruit image in converted into gray scale image to separate the foreground objects from background objects extract the features. Based on size parameter, fruits are classified as good and bad fruit. The size of the fruit is computed by identifying edges. There are different techniques for edge detection: Sobel, Canny and Prewitt. The author used canny edge detection technique to determine the edge and K-means clustering algorithm to

calculate area of fruit. Depending upon size fruits are separated.

Title: A Hybrid Intelligent System For Automated Pomegranate Disease Detection And Grading[5].
Author: Sannakki S.S., Rajpurohit V.S., Nargund V. B., Arun Kumar R. and Yallur P.S.
Publication year: 2011 IJMI
Method: In this paper, an automated system for the disease detection and grading in pomegranate plant is proposed. The system encompasses various image processing and soft computing techniques such as SVM and Fuzzy Logic. The methodology begins with image acquisition. Captured images are enhanced and segmented with appropriate algorithms. Further, feature extraction is carried out and selected features are used as input to the disease classifier which appropriately identifies and grades the disease.

Title: Classifications of Citrus Fruit Using Image Processing - GLCM Parameters[6].
Author: Chandan Kumar, Siddharth Chauhan, R.Narmadha Alia and Harika Mounica gurram.
Publication year: 2015, IEEE ICCSP conference.
Method: The author has proposed a model for the sorting of citrus fruits like lemon, sweet lime, and orange by capturing single view if the fruit. Since orange is a non-climacteric fruit based on color the fruits were categorized into different classes. Later based on grey level co-occurrence matrix parameters like contrast, energy, correlation, homogeneity. The test image samples were compared with trained image sample and the dissimilarity value was obtained. Based on the result of the comparison of dissimilarity value and threshold value classification is done as good fruit and bad fruit.

Title: Quality Analysis of Pomegranate by Non-Destructive Soft X-Ray Method[7].
Author: Payel G and Sunil CK.
Publication year: 2014 JFPT
Method: X-ray examination is non-destructive imaging of internal features of a sample which detects internal defects. The author has used soft X-ray machine in IICPT to capture the fruit image. The images acquired are processed further by MATLAB 2010b. In image processing using MATLAB images are first converted into gray scale image to count number of black pixels which represents non defected parts. Increase the contrast of the image. Adaptive thresholding is used to convert the image into binary image. Blob Analysis block is used to calculate the centroid, label matrix, and blob count to get total area of fruit as well defected area of fruit. Later image is converted back to RGB to show defected regions clearly. Colour-map shows the density variation in the fruits from which fruits are categorised into diseased fruit and good fruit.

IV. CONCLUSION

Machine vision and image processing techniques yield non-destructive and accurate results in fruit grading process. There are different techniques used for sorting and grading of fruits such as fuzzy logic, artificial neural networks, and support vector machine. Each has its own advantages and disadvantages depending upon features used.

In future work implementation of hand held automated grading system can be done with higher accuracy.

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