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# IDENTIFICATION OF RIPE AND UNRIPE CITRUS FRUITS USING ARTIFICIAL NEURAL NETWORK

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**ABSTRACT**--Agriculture has a major role in the economic development of our country. Productive growth and high yield production of fruits is essential and required for the agricultural industry. Application of image processing has helped agriculture to improve yield estimation, disease detection, fruit sorting, irrigation and maturity grading. Image processing techniques can be used to reduce the time consumption and has made it cost efficient. In this paper, we have provided a survey to address these challenges using image processing techniques.

**KEYWORDS**--Image Acquisition, Smart Farming, Maturity grading

## 1. INTRODUCTION

India's 70% of the population depends on agriculture. Agriculture has a major benefaction towards economic development by providing food and raw material to non- agricultural sectors. Agriculture needs a lot of man work. It consumes a lot of time for the farmers for manual sorting and examining of fruits from harvest till its growth period. Manual sorting doesn't give adequate results everytime, so it needs an efficient smart farming techniques which can used to get better yield and growth with less human efforts. The quality and quantity of agricultural products has significantly reduced due to plant diseases[1]. These diseases can be detected using image processing techniques.

Image processing is a form of signal processing where the image is given as an input; photographs or frames of video and the output obtained will be image parameters or an image. The image processing techniques and algorithms are successfully implemented in many fields like satellite, medical researches and so on. Since agriculture, being the basic need of mankind, we use image processing techniques to do crop detection and analysis, maturity grading, disease detection and sort them accordingly.

## 2. IMAGE PROCESSING TECHNIQUES

### *A. Image Acquisition*

This is the initial process in which the original image is converted into digital format. This process will support pre- processing methods like scaling. It supports enhancement techniques

### *B. Image Pre-processing*

This method basically process the raw image at the early stage. The manipulation and the analysis of the image is done in order to improve the quality of the image by reducing noise reduction , resizing of the image , contrast stretching, sharpening, magnifying and histogram modification.

### *C. Image Segmentation*

It's the process of subdividing the whole image into specific objects[2]. Image segmentation algorithms works on two basic properties of intensities such as similarities and discontinuity. Methods used in this category are image thresholding, region growing , region splitting and merging. It is generally used to identify objects lines and curves. The output of this process will be of segments that will hold the entire image or the set of outlines which are extracted from the image.



The various applications of image segmentation are content based retrieval, object detection, machine vision, medical field, recognition tasks, and traffic control systems and so on.

#### *D. Feature Extraction*

It is the process by which certain features of an image are represented and detected for future processing. The representation can be pictorial or non-pictorial when extracted is used as an input to classification techniques and pattern recognition that classifies, labels or recognizes the content of the image[3]. Parameters like colour, texture, morphology, edges can be used to give a better result when applied to an image. Feature extraction reduces the resources that are required to define a large set of data.

#### *E. Classification*

There are various classifiers in image processing to support precision, accuracy, consistency of the data compared with image samples[4]. Decision tree algorithms, artificial neural networks, KNN, Back propagation algorithm, Bayes algorithm. Support vector machine algorithms.

### **3. LITERATURE SURVEY**

#### **A.MATURITY GRADING**

##### *A. Colour Image segmentation for fruit ripeness determination*

In this paper they have used different techniques to check the rate of ripeness for different fruits and vegetables. The various techniques used are histogram matching, clustering algorithm based on segmentation, relative value of parameter based segmentation and image segmentation. The clustering algorithms used for segmentation are k means, fuzzy c means and GK-B[5]. The process uses colour image as input and they have set some threshold values. Then by comparing the input data images with those threshold values they have found the maturity level of a vegetable or fruit. It was concluded that histogram matching techniques provide better results as it increases global contrast of the image so that intensities can be distributed better. Since clustering algorithm and histogram matching needs colour space transform but parameter based segmentation doesn't use so even this is considered to be an effective technique.

##### *B. Using machine learning techniques for evaluating ripeness of a tomato*

In this article multi class classification approach for tomato ripeness measurement has been used. Tomato ripeness stages are been classified using colour features. Approaches like PCA is used in addition to SVM and LDA segmentation algorithm[6]. Principal component analysis (PCA) is a statistical technique used in compression for aa dimensionality by avoiding duplicate information and converting sample features space to feature sub-space. Around 250 datasets were used for the experiment for training and testing. Training datasets were divided into 5 classes showing different stages of tomato ripeness. The figure shows the different classifications made. They considered three scenarios as stated:

Scenario I: one against one multiclass SVMs system using 10-fold cross validation.

Scenario II: one against all multiclass SVMs system using 10-fold cross validation.

Scenario III: LDA system using 10-fold cross validation.

It was found that the highest ripeness accuracies were achieved in first scenario and second scenario ie 90.80% and 84.80% respectively and 84% using third scenario. So it was concluded that OAO multi-class SVMs method was better than other SVMs and LDA approaches. Also the limitations was accuracy depending on the size of the datasets. In there future work they will be

classifying the objects based on size, colour and texture and also will be using the machine learning techniques.

*C. Colour recognition algorithm using neural network model determining the ripeness of banana.*

RGB image was taken as input of the resolution 320X240 pixels. Image was captured in four different positions and it was resized and rescaled using a heuristic methods. The main three stages used in the process were preprocessing, feature extraction and ripening classification. For the ripening classification artificial neural networks were used. 100 samples of ripe and 116 samples of unripe bananas were taken. The results were saved in excel file and data will be sorted randomly and was used to train the network as input[7]. The network architecture contained 1 output layer 9 input neurons, 45 hidden neurons and one output layer with one output neuron. For the ripe fruit output was 1 and for unripe was zero or near zero. 60% of samples were used for training and 100% for testing. The experiment results shows that the ripeness recognition rate was 96%. It can be applied in future to increase the effectiveness for cashiers and customers for determining the prices of fruits instead of the weighing method and this will save time.

*D. Non-destructive watermelon ripeness determination using image processing and artificial neural networks*

This paper work is to measure the ripeness and the quality of the watermelon. Using digital camera the watermelon's skin will be captured through a digital camera and the image will be filtered using some image processing techniques. This paper also presents a non-destructive technique to identify the maturity[8]. Artificial neural network is been used to determine the quality of the watermelon. ANN was used to detect the complex trends and extract patterns.

YCbCr was used for image representation and processing. Y contains luminance information and Cb and Cr stores chrominance information. 90 samples were taken, 45 samples were taken for training, 30 for training and 15 for validation. In the pre-processing step the RGB image is converted into YCbCr and the data was stored in database then it was used for pattern recognition. Y component was eliminated and CbCr colour feature was extracted. From the result it was concluded that the best hidden unit with higher accuracy was at 32 hidden units and also the highest accuracy was found to be 86.51% and the error percentage was found to be 0.29 to 1.07 percents.

## B. DISEASES DETECTION

### *A. Plant disease detection using image processing*

Image processing is used for plant disease detection as it makes monitoring easy and saves time. Image processing techniques like image acquisition, image pre-processing, image segmentation, feature extraction and image classification are applied to the leave images and the diseases are detected effectively. Boundary and spot detection algorithm is used for segmentation. The object classification is done by K-means clustering[9]. The binary images are created from gray-level images when threshold is applied. The R, G AND B components can be extracted from the images and Otsu's method is used to calculate the threshold. Then features like Texture, Color, morphology and edges can be extracted to detect the plant disease. Among the other features morphology gives better results. Neural network is used to classify the training database images once after the feature extraction is done. ANN consists neurons as feature vectors where back propagation algorithm and Multiclass Support vector machines are used for plant disease detection efficiently.

### *B. Fruit disease detection using color , texture analysis and ANN*

Effective growth and improved yield is so essential and needed as the Agricultural industry is in great demand. In this paper efficient smart farming technique is used to replace manual sorting as it takes more time and does not give significant results. Open CV library is put in for implementation.

K-means clustering methodology is used in image segmentation[10]. Images are classified and mapped to their respective diseases on the basis of four parameters such as color, texture, structure and morphology of the whole fruit. Two image databases are put to use in this system a) implementation of query images b) trained infected images that are already stored. Artificial Neural Network (ANN) algorithm is used for classifying the diseases and pattern matching. This technique reduces the effort of humans and gives 90% accurate results. The main objective is to increase the values of automated fruit disease detection. The future work is to suggest proper treatments accordingly once the disease is detected.

#### *C. Machine Vision Based Automatic Fruit Grading System using Fuzzy Algorithm*

Chandra Sekhar Nandi proposed a machine vision based method for automatic fruit grading system. Mango is used in the study. This computer vision based fruit grading system can reduce time consumption and labor work which can be used to maintain consistency and accuracy[11]. The system gathers video images from the CCD cameras that are placed on top of the conveyor belt, then the image is processed to collect several features which are quick to maturity quality. The fruits are sorted into different grades using the Fuzzy rule based algorithm. The major drawback is the automated technique fails to figure out the maturity level of the mangoes when their surfaces are contaminated with black patches and scratches.

#### *D. Adapted approach for fruit disease identification using images*

Fruit diseases causes greater problem in production and economic losses in agricultural industry. It is composed of the following steps; in the first step K-means image segmentation technique is applied for the defect segmentation[12]. In the second one some features are extracted from the segmented image and are categorised using Multi-class Support Vector Machine. Apple is considered as a test case and the disease such as apple botch, apple rot and apple scab are evaluated. Diseased apple classification is achieved in both color spaces; RGB AND HSV. The accuracy of classification for the proposed work is 93% when CLBP (Completed Local Binary Pattern) feature is applied. More than one feature can be fused and considered to improve the output as the future work.

#### *E. Bacterial blight disease detection using Multiclass Vector Machine*

The domain expertise mainly observes the fruits by the naked eye but the process is tedious and high in charges. There is a necessity of automatic fruit disease detection. The bacterial blight is the wide occurrence disease in the fruit pomegranate. This disease basically affects the leaf, stem and fruit[13]. The image segmentation technique is used to partitioning the whole image using the K-means clustering. The features of the image is extracted using Color coherence vector, Histogram, Local binary patterns, complete binary patterns. The disease of the fruit is detected by the Multiclass Support Vector Machine. The two image database is constructed for the specific training and testing. The image processing techniques involves the preprocessing approach which resizing the image 300X300. The CCV feature vectors used for the feature extraction. The boundary extraction has done by Erosion operation is to get the image boundary by subtract the eroded image from original image. The classification of the diseased fruit has done by SVM.

#### *F. Fungal disease detection on fruit crops*

In earlier the fungal disease detection has done by the visual symptoms. The fungus infection is mainly targets a mango and pomegranate fruits. The powdery mildew and downey mildew are the basic fungus infection[14]. The infected images are gathered and ordered according to the disease severity resulted into slightly affected, fairly affected, highly affected and normal. The statistical feature is extracted from the loaded image samples using Gray Level Co-occurrence Matrix (GLCM), Gray Level Run Length Matrix (GLRLM). The Nearest Neighbor (NN) classifier uses the Euclidean distance based on the disease severity.

### *G. Plant leaf disease*

In plants some common diseases are brown shades and yellow shades. The image processing methods used for the measuring of the affected part of the leaves. The image segmentation process used to separate or remove the infected part of the sample leaf[15]. This process ranges from the threshold image to the advanced color image process. The agricultural plant leaf detection has done by the vision based detection algorithm comprises the green pixel masking and the another method called color co-occurrence method. K-means clustering algorithm associated with the Artificial Neural Network used for the automatic detection of leaf disease.

### *H. Fungal disease detection on commercial crops*

The fungal infections mainly occurs on chilli and sugarcane crops for commercial. The feature is mainly extracted using (DWT) and the obtained features are reduced by using Principal Component Analysis. The feature which is reduced taken as input for the further classification and specific testing performed on the input samples[14]. The Probabilistic Neural Network (PNN) is mainly used for classification purpose.

## **4. IMPLEMENTATION**

In our project we have taken orange citrus. Orange also called as sweet orange, which is one of the most commonly used and highly cultivated citrus product all over the world. 70% of the world's citrus production is considered to be sweet orange. They are widely used in commercial fields like for juice preparation, orange oils, marmalades consisting jam and jelly, fruit butter and candies. Alongside food industries, sweet oranges are also used in medical industries for preparing medicines that contains protopection, bioflavonoids and inositol. In 2018 around 49.3 million metric tons of sweet oranges were produced. The following algorithm has been proposed to identify the ripe and unripe fruit in the citrus fruit.

Step 1: start

Step 2: Collect the datasets consisting of images in jpeg or png format

Step 3: read the image using imread() command.

Step 4: Improve the image quality by preprocessing techniques like denoising the image, resizing the digital image.

Step 5: use Imresize(I,[256X256]) to obtain the standard size.

Step 6: RGB channel splitting

$R = I(:, :, 1)$

$G = I(:, :, 2)$

$B = I(:, :, 3)$

Step 7: Estimate colour features

Find mean value

$Mean_r = \text{mean}[\text{mean}(R)]$

$Mean_g = \text{mean}[\text{mean}(G)]$

$Mean_b = \text{mean}[\text{mean}(B)]$

$Co = [mr \ mg \ mb]$

Step 8: Artificial neural network

Dataset of 400 images (200 ripe images and 200 unripe images)

Step 9: the obtained parameters are accuracy, average precision and average sensitivity.

Step 10: End

Transportation of these fruits from different places contains ripe, unripe and infected fruits so manual labour for this sorting is a tedious work and also gives inefficient results. Therefore there is a need to differentiate the conditions of these oranges. With the origination of digital image processing and computer vision techniques the efforts of the researches have helped in discriminating the various vegetables and fruits. Several techniques were put forth to differentiate or classify and recognize fruit or vegetable images. (Search for references) The paper provides classification method of three orange citrus conditions i.e. unripe, ripe and infected orange detection. The feature is been extracted from the citrus image using RGB colour space. BIC is used to extract visual features of the citrus fruit. The comparison between the three algorithms are demonstrated. The software MATLAB 2016 is used to extract the features in image processing. Some applications has been demonstrated on Naïve Bayes, Neural Network and Decision tree classification.

## 5. REQUIREMENTS AND METHODS

### A. Orange Samples and requirements

A sample of 350 RGB colour images of orange citrus of 1024 x 768-pixel resolution on black background were captured and stored in JPG format. It includes ripe, unripe and infected/rotten oranges.

### B. Segmentation

It is the second process used to divide the digital image into objects. The basic thresholding methods are applied to the image that produces the resultant of image partitioning. It reduces the complexity of the image representation. Watershed method is applied to achieve efficient results by image intensity, thresholding, region processing, discontinuity detection of the citrus fruit.



**Fig.1: Identification of Unripe Orange**

### C. Feature Extraction

The significant parameter to classify the orange condition is the surface colour. It will detect the faults, freshness and the maturity section of the citrus. The average values for the Red  $\mu_r$  component, Blue component  $\mu_b$ , Green component  $\mu_g$ . To separate the image components and to calculate the logarithmic distance (dLog) an extracting the mean grey value of the fruit have been done by BIC and CBIR (content based image retrieval).



**Fig. 2: Identification of Ripe Orange**

## 6. CONCLUSION

In this present work we conclude that the effective growth and improved yield is so essential and needed as the Agricultural industry is in great demand so efficient smart farming technique is used to replace manual sorting to reduce more time and does not give significant results. Artificial Neural Network (ANN) algorithm is used for classifying the diseases and pattern matching. This technique reduces the effort of humans and can give 90% accurate results. The future work is to suggest proper treatments accordingly once the disease is detected.

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