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# Segmentation of Arecanut Bunches using YCgCr Color Model

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***Abstract*—Arecanut is profit-oriented crop of south India. In the market maturity level decides the price of Arecanut. To enhance the profitability identifying maturity level of Arecanut before harvesting is indispensable. Farmer need expertise to determine maturity level otherwise they get less profit for their crops. In recent times Computer Vision and Image Processing techniques are used in Precision Agriculture to identify the matured fruits and vegetables before harvesting. This paper proposes YCgCr color model to automatically segment the Arecanut bunch from a given image. Further, the segmented image could be used to determine Arecanut maturity level. Experiments were conducted to evaluate the efficacy of the segmentation method and found that the average Volumetric Overlap Error (VOE) is - 0.30 and Dice Similarity Coefficient (DSC) is 0.81.**

***Index Terms*—ripeness, harvesting, segmentation, erosion, closing, Arecanut bunches and YCgCr.**

## 1. Introduction

Arecanut is the dried seed of the palm tree. In India Arecanut plays a prominent role in the religious, social, culture functions and in economic life of the people. Approximately 4.73 lakh hectares (HA) of land has been utilized for Arecanut cultivation with the production of 7.06 lakh tons. Majority of Arecanut grows in the states of Karnataka and Kerala [1].

Arecanut is one of the major commercial crop of south India. Apart from chewing purpose, it is used as ingredients in making areca tea, soaps, diabetes formulations, tooth powder, pan masala, gutka, soft drinks, wines and ayurvedic medicine [1].

Figure 1, enumerate different parts of Arecanut plant. It grows to maximum height of 30 to 40 feet depending up on it's varieties and maximum round bark of stem is 15 to 20 cm. Nut bearing starts after five years of planting. The process of matured Arecanut begins with inflorescence which is a spadix surrounded by one or more spathes that become woody at maturity of Arecanut bunch. Spadix includes both male and female flowers. Male flowers begin to be waste inflorescence and female flowers become Arecanuts. The spadix takes 6 months to become Arecanut. Each Arecanut plant grows one spadix every month and it is purely depends on strength of the plant. In each plant at least 5-6 spadix would mature in to Arecanut bunches. One hectare of land may accommodate 1200 plants or less depending upon the distance in between individual plants. To harvest the nuts Farmers uses traditional method of sampling a nut from bunches and cracking it by the teeth to hear the cracking sound of the nut to determine the maturity level for a harvest. Repeating this process for all the bunches is time consuming task. Hence, the Farmer tends to co-relate one bunch maturity level to all other bunches leading to harvesting less matured or over matured bunches.

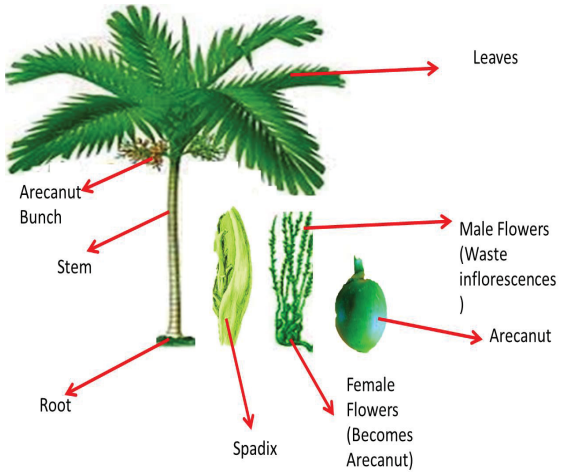


Figure 1. Parts of Arecanut Plant

Harvesting immature Arecanut bunches is a huge loss to Farmer as price for those nuts is less in the market. Figure 2, shows Api, Bette, Mine and Gotu which are different stages of Arecanut with respect to the maturity levels of Arecanut. These stages would decide the price of Arecanut in the market. As maturity level increases, the cost of Arecanut decreases. The graph is drawn based on daily price statistics from 01 to 30 April 2019 of Arecanut market MAMCOS (Malnad Areca Marketing Co-operative Society Ltd., Shivamogga) in Karnataka [2].

To maximize profitability of the crop, Farmer needs to know maturity level of Arecanut before harvesting. There is a need of Technological help in order to enable Farmers to automatically

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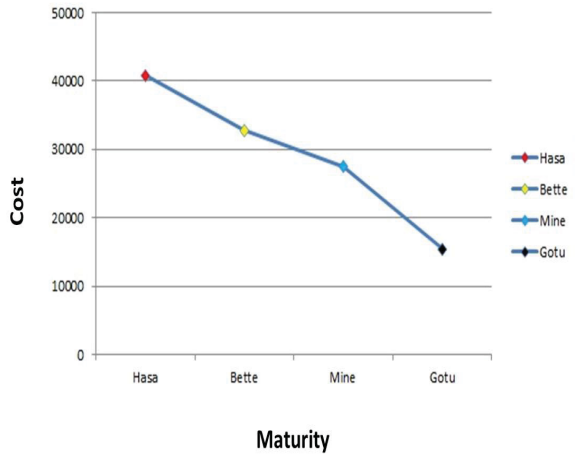


Figure 2. Analysis of Maturity level

determine maturity level of bunches to secure the profitability.

In precision agriculture, Image processing and computer vision techniques grown rapidly and applied on various agricultural products. Anuja Bhargava et.al [3], described a detailed summary on various techniques to classify fruits and vegetables quality by considering features as color, shape, texture and size.

Van Huy Pham et.al [4], a method was presented for detection of deficiency in orange fruits. Further, segmentation techniques are used for detection of defects in orange fruits. To classify defects orange fruits the authors have used graph based and k-means clustering techniques. Mosbah El Sghair et.al [5], proposed an algorithm to detect plant diseases. To segment the area of interest CIELAB, HSI ( Hue Saturation Intensity) and YCbCr color models are used. Ajit Danti and suresha [6], presented a method to classify two category of raw Arecanut. Raw Arecanut are classified using the variation of RGB components with upper and lower limits based on red and green color as dominant color. Siddesha et.al [7], proposed segmentation of Arecanut bunch using Thresholding, K-means clustering, Fuzzy C means, Fast Fuzzy C Means clustering, watershed and Maximum similarity based Region Merging (MSRM) segmentation techniques. RGB color model was used. Dhanesha R. et.al [8], presented a approach to segment an Arecanut bunches using active contour method. The VOE (Volumetric Overlap Error) and DSC (Dice Similarity Coefficient) metrics are used to evaluate the segmentation results.

From the survey, it is observed that different color models and thresholding techniques were used to segment region of interest. To segment Arecanut bunches thresholding and active contour methods were used. In this work YCgCr color model is used to segment the Arecanut bunches before harvesting. The proposed model could be applied to automatically determine the maturity level of Arecanut bunches.

### 1.1. RGB to YCgCr color model

The name YCgCr color model is a variation of YCbCr color model. In YCbCr the Cb chrominance is used whereas in YCgCr the Cg chrominance is used. To get Cg the green channel of RGB color model is subtracted from luminance (Y). When dealing with natural images which contain more Green and Red component compare to Blue component. Hence it is intuitive to use YCgCr color model to segment Arecanut bunches.

Equations (1) to (4) gives the conversion of RGB color model to YCgCr color model.

$$Y = 16 + 65.481 * C1 + 128.553 * C2 + 24.966 * C3 \quad (1)$$

$$Cg = 128 - 81.055 * C1 + 112 * C2 - 30.915 * C3 \quad (2)$$

$$Cr = 128 + 112 * C1 - 93.768 * C2 - 18.214 * C3 \quad (3)$$

$$YCgCr = Y + Cg + Cr \quad (4)$$

where C1, C2 and C3 are Red, Green and Blue color components respectively.

To classify any agriculture products automatically, segmentation plays very important role to determine the ROI in the given image. Further, the segmentation method must be evaluated against ground truth images using performance metrics.

### 1.2. Segmentation performance metrics

Ground truth images are used to verify the results of segmentation process. Different metrics are used to measure the accuracy of segmentation. The most commonly used statistical measures are Volumetric Overlap Error (VOE) and Dice Similarity Coefficient (DSC). Considering S as segmented region using proposed method and G as the ground truth image, the VOE and DSC are calculated based on their definitions. Volumetric Overlap Error is the ratio of the amount of pixels within the intersection of segmented region and also the ground truth, and variety of pixels within the union of segmented region and the ground truth. Good segmentation should have values close to 0 and the increase in the score shows the discrepancies in the segmented image. The VOE is computed by applying Equation (5)

$$VOE = (|S \cap G|/|S \cup G|) - 1. \quad (5)$$

Dice Similarity Coefficient (DSC) gives the measure of the segmentation of pixels of the region of interest. Good segmentation should have values close to 1 and the score near to zero shows the discrepancies in the segmented image. DSC is obtained by using Equation (6)

$$DSC = 2|S \cap G|/(|S| + |G|). \quad (6)$$

In this work, VOE and DSC segmentation metrics are used to measure the accuracy of the segmentation. Segmentation of Arecanut bunches is done through various steps. The YCgCr color model is used for segmentation of bunches of natural Arecanut images. Methodology section describes the details of how Arecanut bunches are segmented.

## 2. Methodology

Given an image finding out ROI is not trivial but it requires several steps and methods of image processing. The following subsections illustrates the process.

## 2.1. Database preparation

Database consisting of 1000 images of Arecanut bunches which includes 350 immature, 450 matured and 200 over-matured bunches.

To acquire these images a mobile phone and a selfie stick were used. The mobile phone is OPPO F3 make with Android operating system, Octa core processor, 4GB RAM fitted with 16 megapixels rear camera. The selfie stick had folded length 5.31496 inches and extended length 28.7 inches . Figure 3 shows the setup adopted to photograph the Arecanut bunches from each plant.

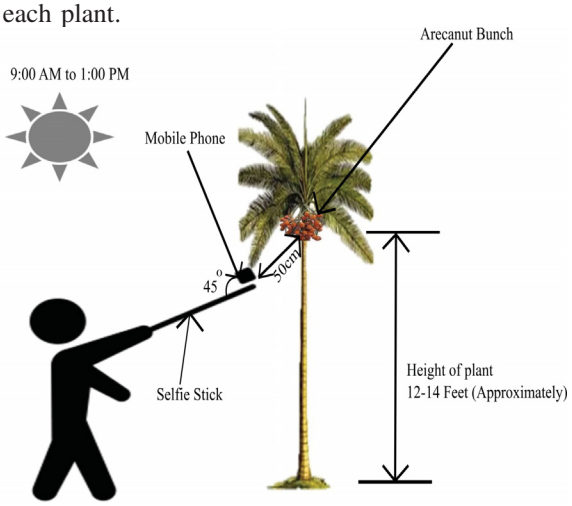


Figure 3. Apparatus used to photograph Arecanut bunches

Images are captured between 9 AM to 1 PM as relating to normal harvesting time of the farmer. A 50 cm approximate distance was maintained between the extended selfie-stick and Arecanut bunches. The mobile phone was fixed to selfie-stick holder which was at 45°orientation. The age of plant selected to capture images was between 7-9 years and height of plant was around 12-14 feet. An expertise was available to identify the maturity levels of Arecanut bunches. All images are stored in jpeg format.

## 2.2. Work Flow

In this work 500 images from the 1000 images database were chosen (designated as db1). The db1 consists of 120 immature, 280 matured and 100 over-matured Arecanut bunches images. The corresponding ground truth image database (designated as db2) containing only Arecanut bunches was prepared to evaluate the YCgCr color model for segmentation. Open source Adobe photoshop 7.0 the professional image-editing standard licensed under Adobe Systems was used to remove uninterested regions from the images.

To segment an Arecanut bunch, images are read from db1 and resized to 256 X 256 pixels. Red, Green and Blue components are extracted from resized image and Y, Cg and Cr channels are computed using Equations (1) to (3). YCgCr image is reconstructed by Equation (4). YCgCr image is converted to binary image using Equation (7).

$$Bin(x,y) = \begin{cases} 1, & \text{if } 120 < YCgCr(x,y) < 200. \\ 0, & \text{otherwise} \end{cases} \quad (7)$$

where,

Values 0 and 1 represents black and white pixels respectively. x, y represents row and column respectively.

Bin(x,y) image further processed using morphological operation erosion followed by closing. Erosion is performed by using kernel size 1 X 1 size and 4-neighborhood connectivity to remove outlier pixels. Further, closing operation is performed considering kernel with radius 30 and 4-neighborhood connectivity. Closing operation is performed to fill the gaps in the image. Finally the segmented image is obtained by masking the original RGB image by processed Binary image. The efficiency of the segmentation process is evaluated using corresponding image in db2. Experiments were conducted using MATLAB R2018b version and the results are discussed below.

## 3. Results and Discussions

Experiments were carried out on db1 500 images using the process explained above. For illustration purpose, 4 images intermediate results of segmentation is discussed as follows. Figure 4(a) shows the input images (immature, matured and over-matured Arecanut bunches) are RBG image and appropriate YCgCr converted images (Figure 4(b). The YCgCr image is used to segment Arecanut bunch.

(a) (b)

Figure 4. Conversion of RGB image to YCgCr image.(a) Input image(RGB image) (b) YCgCr Image

Figure 5(a), shows input image of immature (Image 1), matured (Image 2) and over-matured (Image 3) Arecanut bunches.

After applying proposed segmentation method result is obtained as shown in Figure 5(b). To compute performance of segmentation obtained result image is compared with Ground truth image (Figure 5(c)).

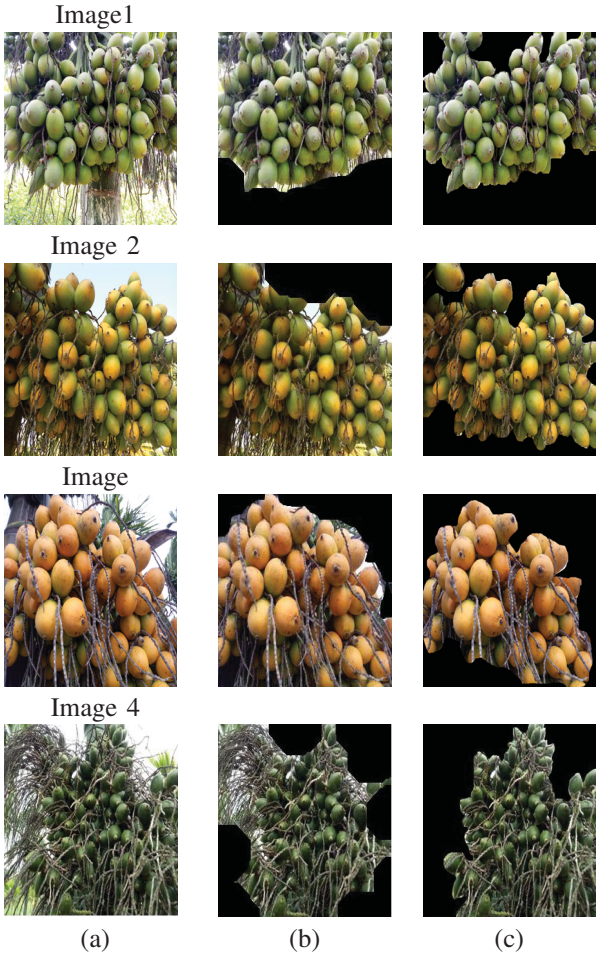


Figure 5. Segmentation of immature, matured and over-matured Arecanut bunch.(a) Input image (b) Segmented image (c)Ground truth image

The corresponding images from db2 was used and value of VOE and DSC is computed shown in Table 1, for immature, matured and over-matured Arecanut bunches. Figure 5, for Image 4 it shows that input image (Figure5(a)) is not segmented (Figure 5(b)) properly compare to ground truth image (Figure 5(c)). The value of VOE and DSC in Table 1 for Image 4 shows low performance, because input image contains more waste inflorescence. In this work removing of inflorescence was not considered.

TABLE 1. EVALUATION OF SEGMENTATION USING PERFORMANCE METRICS

| Input Images | VOE | DSC |
|---|---|---|
| Image 1 | -0.2556 | 0.8535 |
| Image 2 | -0.2217 | 0.8734 |
| Image 3 | -0.1770 | 0.9029 |
| Image 4 | -0.3698 | 0.7731 |

Similarly, for all 500 images VOE and DSC were calculated and found that the mean value of VOE and DSC is -0.3004 and 0.8096 respectively.

## 4. Conclusions

In this paper, Segmentation of Arecanut bunches is presented using YCgCr color model. Database of 1000 images and corresponding ground truth database was created using mobile phone camera. No efforts were made to remove the effect of scale, illumination and inflorescence in the database and also in the experiments. The segmentation methods should be robust to handle these variations. Experimental results show that, the proposed method segments Arecanut bunches from associate input image with the accuracy of 80% . The proposed technique performance could be improved in the future by removing the inflorescence (male flowers).

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