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# Grading of Arecanut Using Machine Learning Techniques

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**ABSTRACT**
Arecanut is a commercial crop that grows well in areas with a lot of rain. Arecanuts have economic, cultural, and therapeutic value, and are classified into many varieties depending on the region where they are grown and consumed. An effort at grading Arecanut is discussed here. This method extracts features using a global textural characteristic called Local Binary Pattern. The Support Vector Machine classifier is used to grade Arecanut. Finally, measurements such as accuracy and precision are used to assess the grading system's performance.

**Keywords:** Arecanut grading, Image processing, Local ternary pattern, Support vector machine

## I. INTRODUCTION

India is the world's greatest producer of Arecanuts, with Karnataka being the most productive state. As a high- value commercial crop, it makes a substantial contribution to the national economy in terms of livelihood, employment, and revenue. Arecanut grading is an important part of the marketing process. It allows for the classification of produce into several homogeneous categories based on features.

Arecanut forms an essential requisite for several religious and social ceremonies and its use dates back to Vedic period with high antiquities. It has a vital role in the preparation of medicines in the field of ayurveda and veterinary. Nowadays we can see the usage of arecanut in areca tea.

Different types of processed Arecanut are available in the market, depending on where they are grown. The Arecanut will be blanched, boiled, and dried for 3 to 4 days after harvesting before going through the grading process. Arecanut grading is currently done based on market need. Arecanuts are initially classified into different varieties in the market, depending on their ripeness and the use for which they are used. For this project, five types of Arecanuts were considered: Biligotu, Chali, Koka, Kempugotu and Rashi, all of which are native to Karnataka's Malnad region.

Bharadwaj N K, et al. [1] proposed the methodology of block wise LBP approach and the samples are segmented using Otsu's thresholding technique and necessary pre-processing is done. S Siddesha and S K Niranjan, et al. [2] proposed the method where the images segmented using K-means clustering method and color feature is extracted using color histogram and color moments techniques. Pushparani M.K, et al. [3] proposed the computer vision based efficient grading system for boiled Arecanuts. S Siddesha, et al. [4] proposed three methods: segmentation, feature extraction and classification of arecanuts. Kuo-Yi

Huang [5] proposes an application of neural networks and image processing techniques for detecting and classifying the quality of arecanut. Tong Liu et al. [6] proposed an automatic classification method based on computer vision to solve the problem of betel nuts' misclassification by manual ways. Ajit Danti and Suresha, et al. [7] proposed a novel method for classification of Arecanut into two classes based on color. The proposed method has three steps. They are Segmentation, Masking, and classification. Ajit Danti and Suresha, et al. [8] proposed the method for classification of Arecanut based on texture features. Classification is done using Mean around features, gray level co-occurrence matrix (GLCM) features and combined (Mean around-GLCM) features. Meghana R and Ramya D Shetty, et al. [9] proposed the method for feature extraction and classification of the image is Inception version 3 to extract the image features and classify the image accordingly.

## II. METHODS AND MATERIAL

Figure 1 depicts the many procedures taken in the study, including the Block wise LBP technique for feature extraction and the Support Vector Machine (SVM) for Arecanut classification. Image Acquisition, Pre- processing, segmentation, feature extraction, and classification are some of the procedures involved. The following subsections explain the various stages of the system model.

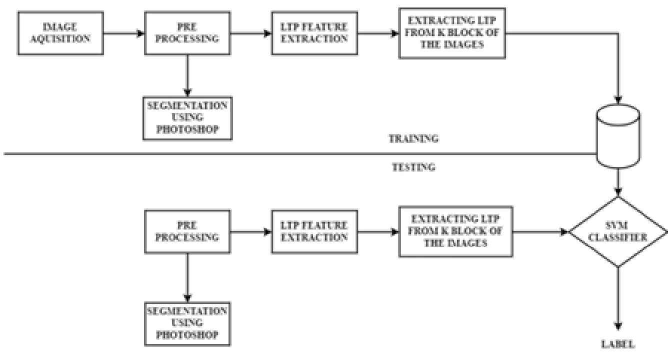



Figure 1: Architecture of the system model

### A. Image Acquisition

Images of areca nuts are being acquired using a smart phone while visiting several arecanut plantations for the project's execution. This collection contains images of several grades of arecanuts.

### B. Image Pre-processing

Various pre-processing operations, such as image scaling and grey scale conversion, are carried out at this step. To ensure uniformity in the dimensions of the photos, change all Arecanut images of dimension M*N to m*n during image resizing. Because the dataset contains numerous images of varying sizes during the image acquisition stage, it is always recommended to use uniform datasets for improved accuracy.

A non-linear digital filtering technique called the median filter is used to eliminate noise from a picture or signal. The median filter's fundamental principle is to go over the signal entry by entry, replacing each one with the median of the entries next to it. The "window" is a pattern of neighbours that slides over the entire signal, entry by entry.

To boost contrast in photographs, histogram equalisation, a computer image processing technique, is used. It does so by effectively spreading out the most common intensity values, i.e., expanding out the image's intensity range. To improve contrast, histogram equalisation is utilised. Contrast does not have to be increased all of the time in this. In rare circumstances, histogram equalisation may be detrimental. The contrast is reduced in those circumstances.

The purpose of picture normalising is to adjust the range of pixel intensity values. Normalization is a procedure in image processing that alters the range of pixel intensity values. For example, images with low contrast due to glare can be used. Normalization is also known as histogram stretching or contrast stretching. Then, transform RGB photos to their grayscale equivalents, which aids in the extraction of texture information from the images.

### C. Segmentation

Image segmentation is a way of breaking down a digital image into various subgroups called Image segments in order to reduce the image's complexity and make future processing or analysis easier. In simple terms, segmentation is the process of assigning labels to pixels. To segment the arecanut images, we used the Adobe Photoshop tool. The image is selected and segmented from the background using the Object selection tool.

### D. Feature Extraction

We retrieved textural features, using Local Binary Pattern, from the Arecanut datasets in this stage. The Local Binary Pattern is obtained as a whole in order to achieve precision. Then, in an image of dimension K*K, the LBP of the image is produced in segments using a variable number of blocks by varying the K value. Each block's LBP is obtained separately, and then the associated LBPs are concatenated at the end.

#### Local Binary Pattern

Local Binary Pattern (LBP)[1] is a basic yet effective texture operator that labels pixels in an image by thresholding each pixel's vicinity and treating the result as a binary number. Each neighbour pixel is compared to the centre pixel, and those whose intensities surpass the centre pixels are marked as 1, while those whose intensities do not exceed the centre pixels are marked as

0. This yields a simple circular point feature made up entirely of binary bits.

#### Local Ternary Pattern

Local ternary patterns (LTP) are an extension of Local binary patterns (LBP). Unlike LBP, it does not threshold the pixels into 0 and 1, rather it uses a threshold constant to threshold pixels into three values. Considering k as the threshold constant, c as the value of the centre pixel, a neighbouring pixel p, the result of threshold is:

$1, \quad if\ p > c + k$

$\{0, \quad if\ p > c - k\ and\ p < c + k$

$-1, \quad if\ p < c - k$

In this way, each thresholded pixel has one of the three values. Neighbouring pixels are combined after thresholding into a ternary pattern. Computing a histogram of these ternary values will result in a large range, so the ternary pattern is split into two binary patterns. Histograms are concatenated to generate a descriptor double the size of LBP.

For example:

| | | |
|---|---|---|
| 27 | 33 | 24 |
| 26 | **30** | 30 |
| 28 | 36 | 34 |

**Example image**

| | | |
|---|---|---|
| -1 | 1 | -1 |
| -1 | | 0 |
| -1 | 1 | 1 |

**Local ternary pattern**

| | | |
|---|---|---|
| 0 | 1 | 0 |
| 0 | | 0 |
| 0 | 1 | 1 |

**Upper pattern**

| | | |
|---|---|---|
| 8 | 4 | 2 |
| 16 | | 1 |
| 32 | 64 | 128 |

**Binary weights**

| | | |
|---|---|---|
| | | |
| | 196 | |
| | | |

**LTP value**

| | | |
|---|---|---|
| 1 | 0 | 1 |
| 1 | | 0 |
| 1 | 0 | 0 |

**Lower pattern**

| | | |
|---|---|---|
| 8 | 4 | 2 |
| 16 | | 1 |
| 32 | 64 | 128 |

**Binary weights**

| | | |
|---|---|---|
| | | |
| | 58 | |
| | | |

**LTP value**

Figure 2: Local ternary pattern

### E. Classification

Image classification is the process of labelling an image using a pre-determined set of categories.

SVM is a supervised machine learning technique that can be used to solve problems in classification and regression. It is, however, mostly employed to solve categorization difficulties. A Support Vector Machine (SVM) is a discriminative classifier with a separating hyperplane as its formal definition. This hyperplane is a line that divides a plane into two halves in two-dimensional space, with each class on either side. SVM attempts to discover an ideal separating hyperplane across numerous classes in order to solve the classification problem. Support vectors are the training cases that are placed on the edge of the class descriptor, and any other cases are deleted. The SVM algorithm aims to optimise the margin between positive and negative classes around a hyperplane.

## III. RESULTS AND DISCUSSION

### A. Image Acquisition:

We investigated five different sorts of arecanut photos at first. Figure 4.1 depicts the five types of arecanuts: Biligotu, Chali, Koka, Kempugotu, and Rashi.

i) Biligotu ii) Chali iii) Koka

iv) Kempugotu v) Rashi

Figure 3: Types of Arecanut

### B. Image Pre-processing

We have performed different pre-processing tasks, namely, image resizing and greyscale conversion. In Image resizing, converted all the images of Arecanut of dimension M*N to m*n i.e., 3000* 3000 to maintain uniformity in the dimensions of the images as shown in fig.,4.

Figure 4: Resized Image of size 3000*3000

The median filter, a non-linear digital filtering technique is applied which is often used to remove noise from an image or signal. It is shown in fig.,5.

Figure 5: After applying median filter

Histogram Equalization, a computer image processing technique is performed to improve contrast in images as shown in the fig.,6.

Figure 6: After applying Histogram Equalization

Then the normalization of images is done to change the range of pixel intensity values as shown in the fig.,7.

Figure 7: After applying normalization

Then, converting RGB images into its equivalent greyscale images as this conversion helps in extracting the texture features from the images as shown in the fig.,8.

Figure 8: After converting RGB images into its equivalent greyscale images

### C. Segmentation

Arecanut images are segmented using photoshop and the result is as shown in figure 4.6.

Figure 9: Segmented Image

### D. Feature Extraction

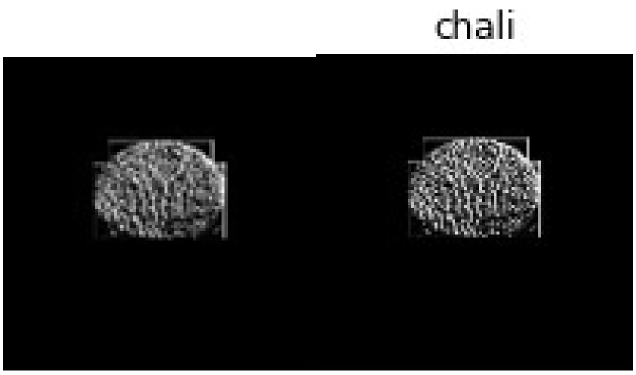
In this step, from the Arecanut datasets we have extracted texture feature viz. Local Ternary Pattern from the images. It is shown in the figure 10.

Figure 10: Image after applying LTP

The data is split into two categories: training data and testing data. Training data is used to train the model whereas testing data is used to test the trained model.

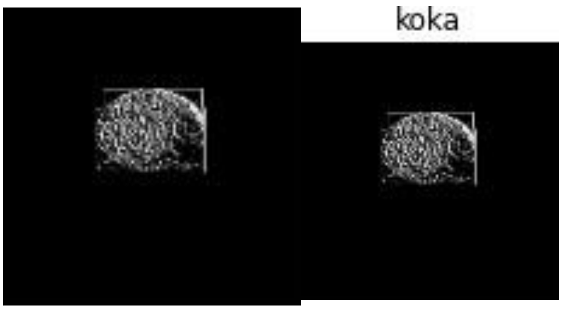
### E. Classification

Case 1: Correct identification




(a)Input data (b) correctly identified SVM output

Case 2: Wrong identification




(a) Input data (b) wrongly identified SVM output

In case 1, for given input type rashi the output is correctly identified as type rashi. In case 2 for given input type rashi the output is wrongly identified as type koka.

**Comparison between LBP and LTP:**

LBP are sensitive to noise as well as illumination changes; LTP is an extension of LBP and are robust to noise but not to illumination changes. LBP has two kinds of pixel values – central pixel value and neighboring pixel value whereas LTP has three kinds of pixel values – a threshold constant along with the central pixel value and neighboring pixel values. LBP holds threshold pixel values as 0 and 1; whereas LTP holds threshold pixel values as 0,1 and -1. Computing a histogram of these ternary values will result in a large range, so the ternary pattern is split into two binary patterns.

After applying SVM for LBP applied images we got the following result as shown in Table 1.

Table 1: accuracy achieved for LBP Feature extraction.

| Arecanut Classes | precision | recall | F1-score | support |
|---|---|---|---|---|
| 0 | 0.53 | 0.77 | 0.62 | 26 |
| 1 | 0.72 | 0.72 | 0.73 | 40 |
| 2 | 0.81 | 0.97 | 0.88 | 30 |
| 3 | 0.90 | 0.53 | 0.67 | 34 |
| 4 | 1.00 | 0.88 | 0.94 | 34 |
| Accuracy | | | 0.77 | 164 |

| | | | | |
|---|---|---|---|---|
| Macro average | 0.79 | 0.77 | 0.77 | 164 |
| Weighted average | 0.80 | 0.77 | 0.77 | 164 |

After applying SVM for LTP applied images we got the following result as shown in Table 2.

Table 2: accuracy achieved for LTP Feature extraction.

| Arecanut Classes | precision | recall | F1-score | support |
|---|---|---|---|---|
| 0 | 0.65 | 0.92 | 0.76 | 26 |
| 1 | 0.88 | 0.55 | 0.68 | 40 |
| 2 | 0.85 | 0.93 | 0.89 | 30 |
| 3 | 0.69 | 0.74 | 0.71 | 34 |
| 4 | 0.91 | 0.88 | 0.90 | 34 |
| Accuracy | | | 0.79 | 164 |
| Macro average | 0.80 | 0.80 | 0.79 | 164 |
| Weighted average | 0.81 | 0.79 | 0.78 | 164 |

We have achieved 77% of accuracy for LBP Feature Extraction and 79% of accuracy for LTP Feature Extraction.

## IV. CONCLUSION

We conducted our project in four stages - Image Acquisition, image pre-processing, Segmentation, feature extraction and Classification. Collected over 1000 Arecanut images of five different types namely Bili gotu, Chali, Kempu gotu, Koka and Rashi.These raw images were pre-processed using Median filter, Histogram equalization and Normalization and then these RGB images were converted into gray scale images. These gray scale images were segmented using Adobe photoshop where foreground is separated from the background. Local binary pattern and Local ternary patterns are applied on the segmented images to extract the features of Arecanut images. LTP which is the extension of LBP is used for better accuracy scores. The various combinations of Test and Training tests are considered for image classification. Finally, SVM classifier is applied for the extracted features of Arecanut images where 77% accuracy is obtained for LBP technique and 79% accuracy is obtained for LTP technique. From this the LTP technique is the better approach for extracting the features than the LBP technique.

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