

# Calculation of Area and Perimeter of Guntur and Byadagi Chilli Images- A Fourier Transformation



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**Abstract**— Automation can significantly profit agricultural science by aiding in quality grading of agricultural produce. Dry Red Chilli is one major agricultural exports of India. Automated procedures can help in assessing the quality of various fruits and vegetables. The primary selling point of Chillies is their sensory qualities-visual appearance and odour. Chilli is sorted based on size and shape, and it is usually performed manually, is time-consuming and inconsistent. The current research proposes the use of a Fourier Transform based algorithm to assess the area and perimeter of the chillies. This algorithm can be used in a Computer Vision system to sort the chillies based on the Morphological Characteristics.

**Keywords** : Red Chilli; Fourier Transforms; Binarisation; Flood-fill.

## I. INTRODUCTION

Red Chilli (*Capsicum annum L.*) is a commonly used commodity in subtropical and tropical cooking, mainly owing to its nutritional significance [1]. Red chillies are used to add flavour to food and also for various medicinal purposes.

In India, the complete area under red chilli cultivation is 792,000 hectares. India adds one-fourth of dry chilli production worldwide and has a 22% share of total spice export basket. [2]

Fourier transform relates to frequency domain depiction as well as mathematical operations associating frequency domain representation to a time function. A time function's Fourier transformation is itself a complex-evaluated

frequency function whose size (modulus) depicts the amount of that frequency present in the original function, and whose meaning is the inverse phase of the basic sinusoid in that frequency. The Fourier transform is not limited to time functions but is commonly called the time domain as the original function domain.

## II. MATERIALS AND METHODS

The Images were acquired using the Cost-Effective Test Bed for a Computer Vision System [3]. The methodology of the study is shown in Fig. 1. Table I describes the various materials and methods used in the study.

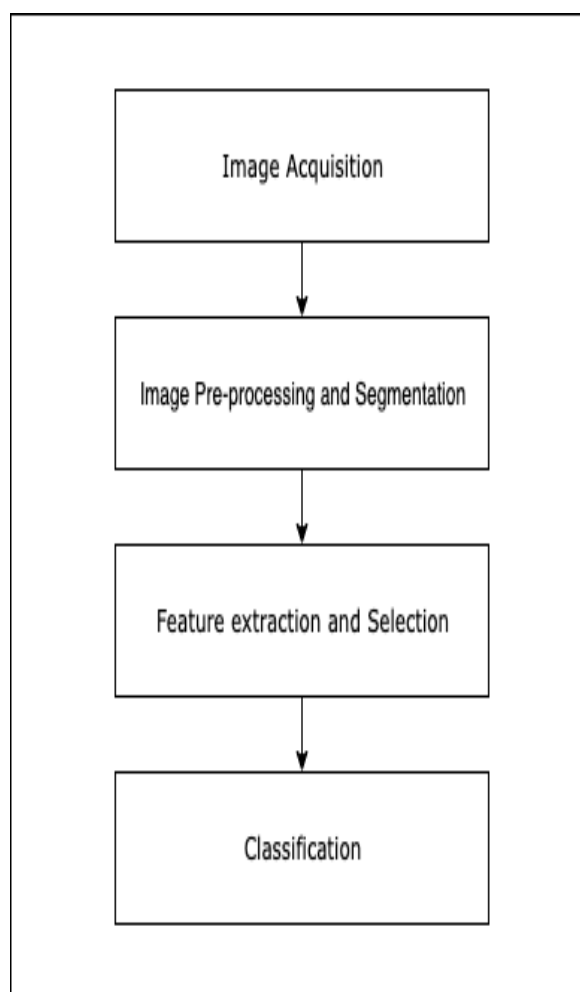


Fig.1 Methodology of the study

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Table 1:Materials and Methods

<b>Chilli Type</b>	Byadagi and Guntur (Sanam) (Fig. 2)
<b>Proportion of Chilli used</b>	1.0 kg of dry chilli of each type
<b>Image Acquisition</b>	Using Digital Camera and the set up as proposed in our previous work-A Cost-Effective Test Bed for a Computer Vision System [4]
<b>Image Processing Tool Used</b>	MATLAB 2016 b
<b>Manual Measurement</b>	Graphical Method was used for manual area calculation of Chilli as shown in Fig. 3. [5]
<b>Morphological characteristics Considered for the study</b>	Length(L): The longest dimension of dry red chilli(cms) Girth(G): The distance around dry red chilli.(cms) Area(A): $A=L * G$ (cms) Perimeter(P): $P=2*(L+G)$ (cms).
<b>Units: cms</b>	
<b>Exclusions: Pods</b>	
<b>Error Calculation</b>	Difference between the Manual measurement and Fourier-based approach

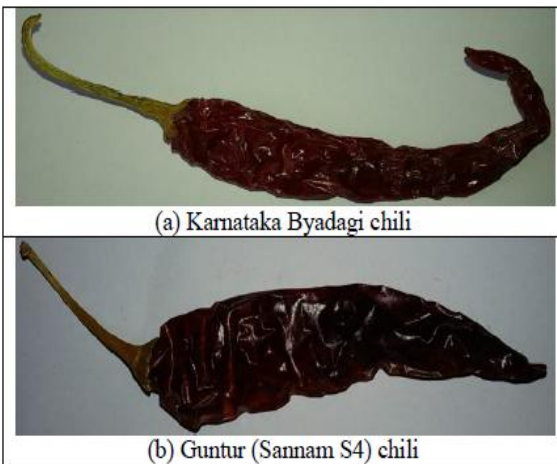


Fig.2 Image samples of dry chilli variety used in the experiment.

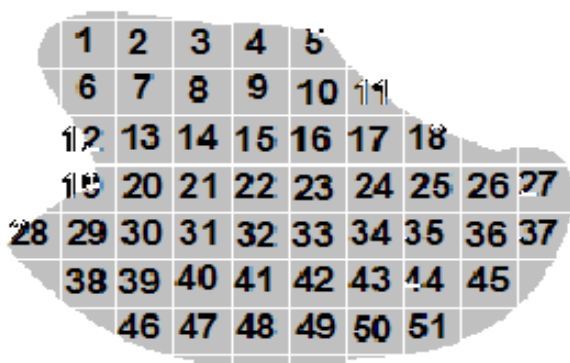


Fig.3 Manual Graphical Method of Area Calculation of Chilli

III. ALGORITHM

It was observed during the study that the removal of the high-frequency components removed the variation in shades of colours and only maintained the basic shapes of the objects. Further, it was observed that using a low pass filter enabled in the extraction of the shape of objects within the image. On following a trial and error approach, the ideal filter parameters for our defined experimental conditions were obtained. The basic shape came under low-frequency components and the detailing and other contours come under high frequency. In this case, r matrix was taken for the Fourier analysis. Fourier retained the primary colour red from the background, and the displayed the chilli as black as the colour of the chilli is closer to a darker shade of red.

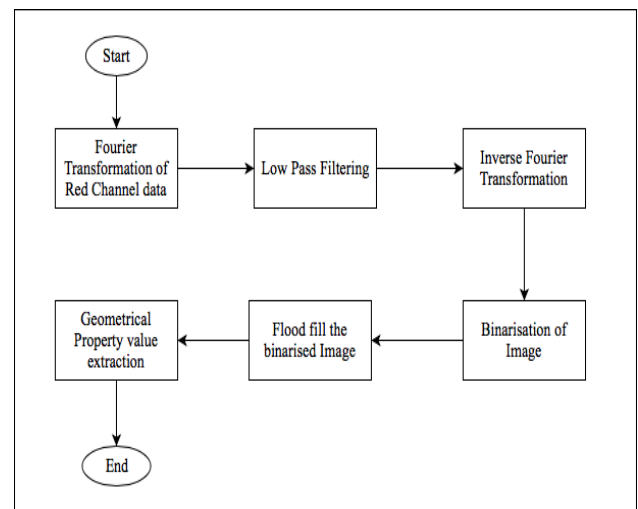


Fig 4. Flowchart for Fourier based feature extraction

Fig. 4 shows the Flowchart for Fourier based Feature extraction.

1. Fourier Transformation of Red Channel Data

2. Low Pass Filtering

2.1 Logical filter generation

$$\alpha(x,y) = \begin{cases} 1, & f(x,y) \leq r \\ 0, & \text{otherwise} \end{cases}$$

$$f(x,y) = \sqrt{\left(x - \frac{X}{2}\right)^2 + \left(\frac{Y}{2} - y\right)^2}$$

Where,

x is Row Index

y is Column Index

X is Total Rows

Y is Total Columns

r is the low pass filter value determined based on lighting and other conditions.

2.2 Filtering

$$DFT'(x,y) = \begin{cases} DFT(x,y), & L(x,y) = 1 \\ 0, & \text{otherwise} \end{cases}$$

(one to one multiplication of L DFT)

Where,

L is Logical Filter Matrix  
DFT is Fourier Transformed Image Matrix

3. Inverse Fourier Transformation

4. Binarisation of Image:

Otsu's thresholding technique was used for automatic threshold determination by maximizing inter class variance and minimizing the intra class variance within the processed image.

4.1 Nobuyuki Otsu's Method [6]

The algorithm exhaustively searches for the threshold that minimizes the intra-class variance, defined as a weighted sum of variances of the two classes:

$$\sigma_w^2(t) = \omega_0(t)\sigma_0^2(t) + \omega_1(t)\sigma_1^2(t)$$

$$\omega_0(t) = \sum_{i=0}^{t-1} p(i)$$

$$\omega_1(t) = \sum_{i=t}^{L-1} p(i)$$

$$\sigma_b^2(t) = \sigma^2 - \sigma_w^2(t) = \omega_0(\mu_0 - \mu_T)^2 + \omega_1(\mu_1 - \mu_T)^2$$

$$= \omega_0(t)\omega_1(t)[\mu_0(t) - \mu_1(t)]^2$$

$$\mu_0(t) = \frac{\sum_{i=0}^{t-1} ip(i)}{\omega_0(t)}$$

$$\mu_1(t) = \frac{\sum_{i=t}^{L-1} ip(i)}{\omega_1(t)}$$

$$\mu_T = \sum_{i=0}^{L-1} ip(i)$$

$$\omega_0\mu_0 + \omega_1\mu_1 = \mu_T$$

$$\omega_0 + \omega_1 = 1$$

Where,

$\omega_0$  and  $\omega_1$  are the probabilities of the two classes

T is the threshold which separates the two classes

$\sigma_0^2$  and  $\sigma_1^2$  are the variances of the two classes

L is the number of bins of the image histogram

$\omega_0(t)$  and  $\omega_1(t)$  are the class probabilities of the two classes

$\mu_0(t)$  and  $\mu_1(t)$  are the class means of the two classes

5. Flood-filling the Binarised Image

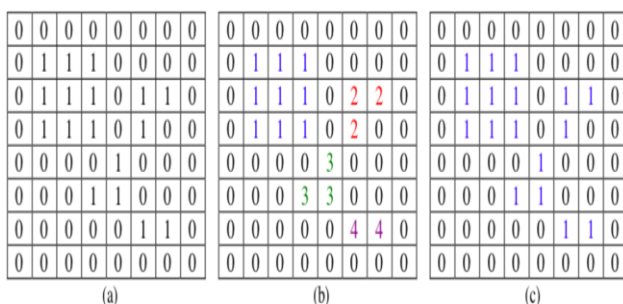


Fig.5 (a) Matrix of sub-image (b) Matrix obtained using 4-connectivity (c) Matrix obtained using 8-connectivity [7]

Flood fill Algorithm is helps an algorithm that determines the region linked to a specified node in a multi-dimensional array. The binary image was further enhanced using flood Filling. The approach relied on was the 8 connectivity (Pixels are connected if their edges or corners touch. Two adjoining pixels are part of the same object if they are both on and are connected along the horizontal, vertical, or diagonal direction.) since the results obtained with a lesser value for connectivity were not satisfactory. Fig. 5. (a), (b) and (c) shows the working of Flood-fill Algorithm. [8]

6. Geometrical Property Value Extraction

The area of an object O,  $A_o$ , is defined as the number of pixels in O.

$$A_o = | \{p(x,y) | p(x,y) \in O\} |$$

Where,

p is the pixel matrix (x,y) p to be replaced with beta symbol

O is the set of binary pixels contained within the Object

$A_o$  is the area of the Object O

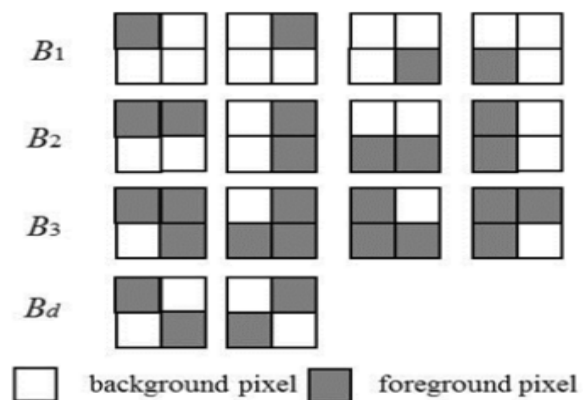


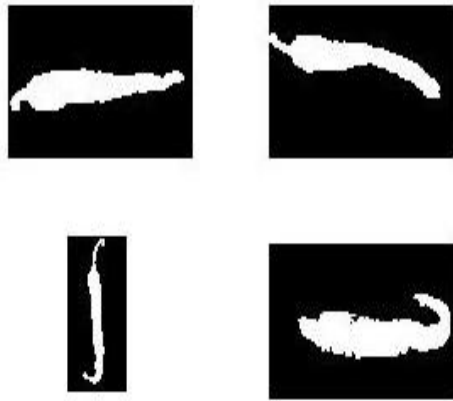
Fig.6 Patterns for calculating perimeter [9]

The perimeter of O, P, can be calculated by the numbers of patterns  $B_1, B_2, B_3,$  and  $B_d$  shown in Fig. 6 in the object O. Let  $N_i$  be the numbers of  $B_i$ , then, P can also be calculated as follows [9], where  $K_1 = 1/\sqrt{2}, K_2 = 1, K_3 = 1/\sqrt{2},$  and  $K_d = \sqrt{2},$  respectively.

IV. RESULT AND DISCUSSION



Fig.7 Binary image of the Guntur Chillies extracted from the RGB image using Fourier (Algorithm 2)



**Fig.8 Binary image of the Byadagi Chillies extracted from the RGB image using Fourier (Algorithm 2)**

Fig. 7 shows the Binary image of the Guntur Chillies extracted from the RGB image using Fourier (Algorithm 2) and Fig. 8 shows the Binary image of the Byadagi Chillies extracted from the RGB image using Fourier (Algorithm 2).

The Algorithm developed calculated the Area with an accuracy of 64.16%.

## V. CONCLUSION

The Fourier Transformation based Algorithm presented in this paper used the RGB Model to which the Discrete Fourier Transform was applied. The algorithm achieved an accuracy of 64.16%. The limitation of the study is that the threshold values must be calculated again if the lighting condition changes or the variety of Chilli changes. The parameters extracted included the area and perimeter of the chilli. The error percentages between the extracted and manually measured values were 35.84% which is reasonably okay. Further, the features extracted can be used for automated classification of the Chillies based on the morphological features using techniques like Self Organising Maps. These can be used to develop a Computer Vision system for automated Chilli Sorting.

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