



## RESEARCH ARTICLE

## Hybrid Multi-Core Algorithm Based Image Segmentation for Plant Disease Identification using Mobile Application

\*Vignesh Janarthanan<sup>1</sup>, Venkata Reddy Medikonda<sup>2</sup>

<sup>1</sup>Professor, Department of Computer Science and Engineering, Sreyas Institute of Engineering and Technology, Bandlaguda, Hyderabad, India.

<sup>2</sup>Associate Professor, Department of Computer Science and Engineering, Sreyas Institute of Engineering and Technology, Bandlaguda, Hyderabad, India.

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### ABSTRACT

Agriculture is the backbone of Indian economy. Right around 70% individuals rely on it and shares major part of the Gross Domestic Product (GDP). Diseases in yields, is generally identified by the symptoms on the leaves which affects both quality and quantity of farming items. Impression of human eye is less grounded, to watch minute variations in the tainted portion of leaf. In this paper, we propose an Android application for naturally recognizing and ordering plant leaf infections. The project enables the users to identify plant leaf infections based on photographs of the plant leaves taken with a mobile phone. This mode of approach is expected to upgrade the efficiency of harvests. It incorporates a few stages viz. image acquisition through mobile camera, image pre-processing to improve the quality of picture using smoothing filter, segmentation of image using hybrid multi-core algorithm, feature extraction using colour co-occurrence and classification of diseases using Baye's classifier. The research results indicated a better accuracy rate of 97.42% in detecting and classifying diseases.

**Keywords:** Android application, Smoothing filter, Hybrid multi-core algorithm, Colour co-occurrence, Baye's classification.

### 1. INTRODUCTION

Plants play an imperative part in the ecosystem. The quantity of plant species is evaluated to be around 400,000 however there still exist numerous species which are yet obscure. Plant diseases identification is an essential and challenging task. With the fast advancement of information technologies, many works have been committed to apply the technologies of image processing for recognizing plant diseases. Since leaves are the primary organ that first shows the symptoms of infection, the leaf shape and shading gives profitable data about plant diseases. This research portrays the identification and classification of leaf diseases through image processing associated with mobile technology.

The naked eye perception of specialists is the primary approach adopted in practice for discovery and distinguishing proof of plant infections. Be that as it may, this requires consistent checking of specialists which may be restrictively costly in extensive ranches. In some developing nations, agriculturists may need to go long distances to contact specialists. This makes agriculture specialists excessively costly and tedious and additionally farmers are unaware of non-local infections. Automatic recognition of plant infection is an essential research theme as it demonstrates benefits in observing extensive fields of harvests, and along with these automatically identifies the infection from the symptoms that show up on the plant leaves. This empowers machine vision that is to give

\*Corresponding author. Tel.: +919550402068

Email address: [vigneshj2004@gmail.com](mailto:vigneshj2004@gmail.com) (V.Janarthanan)

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picture based automatic inspection, handle control and robot guidance. Comparatively, visual recognizable proof is labour intensive and less precise [1, 2].

Plant disease identification by visual methods is a more laborious task and in the meantime, less precise and should be possible just in constrained ranges. However if automatic identification procedure is utilized it will take less endeavours, less time and turn out to be more exact. Fungi are the most widely recognized parasites bringing about plant diseases. Most are minute (little and must be seen with the guide of a microscope) plants that feast upon living green plants or on dead natural material. When they attack living plants, diseases break out. Fungi usually produce spores which, when conveyed to a plant, can start an infection. These spores might be conveyed from plant to plant by wind, water, insects and equipment. All together for fungus spores to start new diseases; sufficient dampness and the correct air temperature are required. A plant wound can some times act as an entry path for the fungus. Fungus diseases are regular and common in wet, humid seasons. In plant leaves, some general diseases seen are leaf spots and leaf blights, rusts, downy mildew and powdery mildew, viral and bacterial diseases. Image processing is utilized for identifying a wide range of diseases and to decide the distinction in the shade of the affected zone.

Image segmentation is the process of dividing a computerized image into various portions (sets of pixels, otherwise called super-pixels). The objective of segmentation is to rearrange as well as change the portrayal of an image into something that is more significant and easier to analyse. Image segmentation is ordinarily used to locate objects and boundaries (lines, curves, etc.) in images. All the more correctly, image segmentation is the way toward allocating a label to each pixel in an image to such an extent that pixels with a similar label share certain attributes. The consequence of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extricated from the image. Each of the pixels in an area is comparable regarding some characteristic or computed property, for example, colour, intensity, or texture. Adjacent regions are significantly different with respect to the same

characteristic. There are currently many different ways of performing image segmentation, ranging from the simple thresholding method to advanced colour image segmentation methods. In this research we use hybrid multi-core algorithm for image segmentation.

In our research image processing data are stored in a database server. A database server is the key in solving the issues of data administration. In general, a server dependably deals with a lot of information in a multi-client condition so that numerous clients can simultaneously get the similar information. This is refined while delivering high performance. The details of the leaf diseases are stored in the database. When we process the image we can get the details of the infected leaf and solution to healing.

Some advantages of hybrid multi-core algorithm are

- Extensive number of factors can be processed in the meantime.
- It can advance factors with exceedingly complex cost surfaces.
- Gives various ideal arrangements, not a solitary arrangement.
- Hybrid multi-core algorithm upgrades both factors productively, consistent or discrete.
- It looks from a substantial testing of the cost surface.

## 2. LITERATURE REVIEW

A vast amount of literature can be found in the classification methods that can be utilized for detecting plant leaf diseases.

In [3] Support Vector Machine (SVM) classifier was used. This classifier involved long training time. In SVM it was also difficult to understand the learned function (weights). The large number of support vectors used from the training set to perform classification task also adds to the disadvantage.

In [4] hybrid multi-core algorithm was used for the segmentation process and was found to be an efficient method. For the filtering process bilateral filter was used. In the proposed methodology we use smoothing filter as it is more accurate than bilateral filter as bilateral filter involves longer steps to filter the image and in the final step can result in the deletion of some wanted portion of the infected leaf.

K-Nearest Neighbour (KNN) algorithm [5] is a slow learner, to the extent that if there is a large number of data to classify, it is very sensitive to the presence of irrelevant parameters. In the proposed methodology hybrid multi-core algorithm is used where the user can get instant results and can handle large amount of data.

In [6] hybrid clustering algorithm is used and for using this algorithm highly configured computers are needed which are highly unaffordable for normal farmers. For our proposed methodology, only a minimum quality camera of 5 mega pixel attached to a smart mobile phone is needed. When compared to high configuration computers smart mobile phone is very cheaper.

Hybrid techniques [7] for medical image segmentation is an advanced methodology mostly used in medical fields such as in x-ray machines, MRI scans, etc. but the disadvantage is that this technique need to be used as embedded software and these machines are very costly compared to our proposed methodology.

[8] talks about the pipe line and its behaviours using sand fill method. These methods are suitable for hard object leaves. Moreover these methods are not suitable for large quantity specimens.

As indicated by [9] histogram coordination can be utilized to recognize the plant diseases. Along the lines of the leaves, histogram coordination was done within the premises of edge identification procedure and colour feature extraction. Layers division method was utilized which incorporated the preparation of these samples by isolating the layers of RGB picture into red, green, and blue layers and edge discovery system which recognized the edges of the layered pictures.

In [10] author discusses about intra voxel analysis in image processing. These techniques mostly find their application in scanning processes for medical purposes. This process needs large amount of space and the detection accuracy was found to be lower than the proposed method.

[11] presents the triangle threshold and basic edge techniques. These strategies are utilized to lesion locale zone and fragment the leaf range separately. In a conclusive stride, order of the disease is finished by ascertaining the remainder of leaf zone and injury range. As indicated by the examination done, the given

strategy is quick and exact for ascertaining leaf disease seriousness and leaf zone count is finished by utilizing limit division.

A strategy for early and precise plant disease detection, utilizing counterfeit neural system and assorted picture handling strategies was discussed. As the proposed approach depends on counterfeit neural classifier for characterization and Gabor filter for highlight extraction, it gave better outcomes with an acknowledgment rate of up to 90%. Classifier characterizes distinctive plant diseases and utilizes the mix of surfaces, shading and components to perceive those diseases [12-14].

In [15] rice seedlings contaminated with unhealthy phenotypes were discussed. SVM classifier was utilized to screen unhealthy seedlings. Hereditary calculation was actualized for highlight extraction. The proposed approach recognized, tainted and healthy seedlings with an exactness of 87.9% and a positive prescient estimation of 91.8%.

[16] discussed automatic plant disease determination for early infection side effects. However, this proposition was tried just on wheat trim in various seasons. The obtained results uncovered AuC (Area under the Receiver Operating Characteristic–ROC–Curve) measurements, higher than 0.80 for all the broken down maladies on the pilot tests under genuine conditions.

[17] presented image processing techniques to identify and classify fungal disease symptoms which affects different agriculture/horticulture crops. Automated decision support system for taking strategic decision on the agricultural production and protection research was discussed. Since fungi are the main disease causing organism, focus has been done on the early detection of fungal disease based on the symptoms. The proposed system detected only fungal diseases. Accuracy of detecting other diseases was very low.

Limitations of existing work:

- Low accuracy in detection.
- More optimization is needed.
- Database extension is needed.
- Need to cover more diseases.
- Misclassification of diseases.

The advantages of our proposal methodology are as follows:

- It provides instant results.

- The recognition exactness is upgraded with proposed algorithm.
- Only with the help of mobile phone camera disease can be detected.
- Fully automated process.
- User friendly.

### 3. PROPOSED METHODOLOGY

Mobile camera is utilized to take images of leafs of various types, and afterward these images are used to distinguish the affected area in leaves. Different types of image processing techniques are applied on them, to process those images for getting distinctive and valuable components required for the purpose of investigation in the later stages. In this proposed system, the application encourages the user to give the picture of the leaf as the input. The framework applies algorithm to infer fundamental parameters identified with the properties of the leaf. It then compares these parameters and the ones stored against a leaf section in the database. On fruitful match of the disease, the application shows information related to that specific disease to the client for his review. Moreover, the framework additionally encourages the client to report false reports produced by the application in order to sharpen its outcomes in future. Figure 1 illustrates the step by step procedure for the proposed image segmentation and recognition process:



Figure 1.Steps of proposed methodology

- Image acquisition is the very first step; open the image processing application and capture the image of the infected leaf with the help of a mobile phone (smart phone) as shown in figure 2 with a minimum specification of 5 megapixel camera and process the image.
- Pre-process the input image to enhance the nature of picture and to expel the undesired distortion from the picture. Processing of the leaf picture is performed to get the clear picture area and after that picture smoothing is finished utilizing the smoothing filter. To build the complexity, image enhancement is also done.

Let  $(x_i, Y_i); x_1 < x_2 < \dots < x_n, i \in z$  be a sequence of observations, modelled by the relation  $Y_i=f(x_i)$ . The smoothing filter estimate  $\hat{f}$  of the function  $f$  is defined to be the minimizer (over the class of twice differentiable functions) of

$$\sum_{i=1}^n (Y_i - \hat{f}(x_i))^2 + \lambda \int_{x_1}^{x_n} \hat{f}''(x)^2 dx.$$

where  $\lambda \geq 0$  is a smoothing parameter.



Figure 2.Snap of the plant leaf with disease in mobile

- Next colour of the leaf is absorbed and pixel intensity of green colour is filtered out. Mostly green colour pixel is the non-infected part of the leaf. In the algorithm threshold value for green pixel is set to zero.
- The infected segment inside the image is filtered out and the non-infected segment is removed.
- The valuable portions to classify the leaf infections are acquired. The components are segmented using hybrid multi-core algorithm. The hybrid multi-core algorithm is a standout amongst the most referenced thresholding techniques to fragment pictures via consequently choosing threshold esteems from the histogram of the picture.

Assume that  $\{P_i\}_{i=0}^{L-1}$  are the probabilities of the gray-scale image, where L is the range of intensity levels. The probabilities of background ( $P_B$ ) and the probabilities of object ( $P_O$ ) of the image with a threshold (t) are as follows:

$$P_B(t) = \sum_{i=0}^t p_i$$

$$P_O(t) = 1 - P_B = \sum_{i=t+1}^{L-1} p_i.$$

The mean related with the background and the object can be further computed utilizing the following equations:

$$\mu_B(t) = \sum_{i=0}^t \frac{i \cdot P_i}{P_B(t)},$$

$$\mu_O(t) = \sum_{i=t+1}^{L-1} \frac{i \cdot P_i}{P_O(t)}.$$

By using values of mean, we can compute variance as follows:

$$\sigma_B(t) = \sum_{i=0}^t (i - \mu_B)^2 \cdot \frac{P_i}{P_B(t)},$$

$$\sigma_O(t) = \sum_{i=t+1}^{L-1} (i - \mu_O)^2 \cdot \frac{P_i}{P_O(t)}.$$

The between-class variance ( $\sigma_{\text{between-class}}(t)$ ) which is the weighted variance of the cluster means around the overall mean is defined as follows:

$\sigma_{\text{between-class}}(t) = P_B(\mu_B(t) - \mu)^2 + P_O(\mu_O(t) - \mu)^2$ , where  $\mu = \sum_{i=0}^{L-1} i \cdot P_i$  is the global mean of the image. Furthermore, the within-class variance ( $\sigma_{\text{within-class}}(t)$ ) can be expressed as follows:

$$\sigma_{\text{within-class}}(t) = P_B(t) \times \sigma_B(t) + P_O(t) \times \sigma_O(t).$$

Finally, the optimal threshold value,  $t_{\text{opt}}$  can be determined by maximizing the between-class variance or equivalently minimizing the with-class variance as follows:

$$t_{\text{opt}} = \underset{1 \leq i \leq L-1}{\text{arg max}} (\sigma_{\text{between-class}}(t)),$$

$$= \underset{1 \leq i \leq L-1}{\text{arg min}} (\sigma_{\text{within-class}}(t)),$$

- Next the components are utilized using colour co-occurrence methodology.

For feature extraction the method utilized is colour co-occurrence. It is the methodology in which both the surface and colour of a picture are considered, to arrive at the unique features, which demonstrates the picture.

Over the conventional gray-scale portrayal, in the visible light range, the utilization of colour picture features gives an extra component to picture characteristic. There are three mathematical procedures in the colour co-occurrence method. First, conversion of the RGB pictures of leaves is forced into HIS colour space portrayal. After completion of this procedure, to produce a colour co-occurrence framework, every pixel map is utilized, which comes about into three colour co-occurrence grids, one for each of H, S and I.

Features such as texture features, which incorporate local homogeneity, contrast, cluster shade, energy, and cluster prominence are computed for the H picture as shown below.

$$\text{CONTRAST} = \sum_{i,j=0}^{N-1} (i, j)^2 C(i, j)$$

$$\text{Energy} = \sum_{i,j=0}^{N-1} C(i, j)^2$$

$$\text{Local Homogeneity} = \sum_{i,j=0}^{N-1} C(i, j) / (1 + (i - j)^2)$$

$$\text{Entropy} = - \sum_{i,j=0}^{N-1} C(i, j) \log C(i, j)$$

- Classification of disease

For the classification of diseases, first the Minimum Distance Criterion (MDC) and then Baye's classification are used and both accuracy are compared for better results.



Baye's Theorem:

There are two probability types in Baye's theorem. They are

1. Posterior Probability [P (H/X)].
2. Prior Probability [P(H)].

where X is data tuple and H is some hypothesis. According to Bayes' theorem,

$$P(H/X) = P(X/H) P(H)/P(X)$$

It is a classification technique based on Baye's Theorem with an assumption of independence among predictors. In simple terms, a Baye's classifier assumes that the presence of a particular feature in an image is unrelated to the presence of any other feature. For example, an image of apple is considered if it is red, round, and about 3 inches in size. Even if these features depend on each other or upon the existence of the other features, all of these properties independently contribute to the probability that this image is an apple and that is known as Baye's classification.

The gain is calculated as follows:

$$\text{Gain (\%)} = \frac{\text{number of correct classification}}{\text{Total no of test images}} * 100$$

#### 4. RESULTS

All research is performed on mobile platform. Some plant leaves like, potato and tomato leaves with bacterial infection, mango and banana leaves with sunburn diseases, guava and palm leaf with fungal diseases, papaya and avocado leaf with scorch diseases are taken as samples. Figure 3 shows the input image and segmented image of various disease affected leaves. Segmented image is utilized for further feature extraction and classification of leaf diseases. Figure 4 shows the input images of potato and tomato leaves with bacterial diseases and output image shows the classification of the diseases using Baye's classification. Other plant diseases are also classified in the same manner as shown in figures 5 to 7.

The co-occurrence is figured after mapping the R, G, B components of the info picture to the thresholded pictures. The co-occurrence highlights for the leaves are separated and compared with the corresponding component values that are stored in the database.

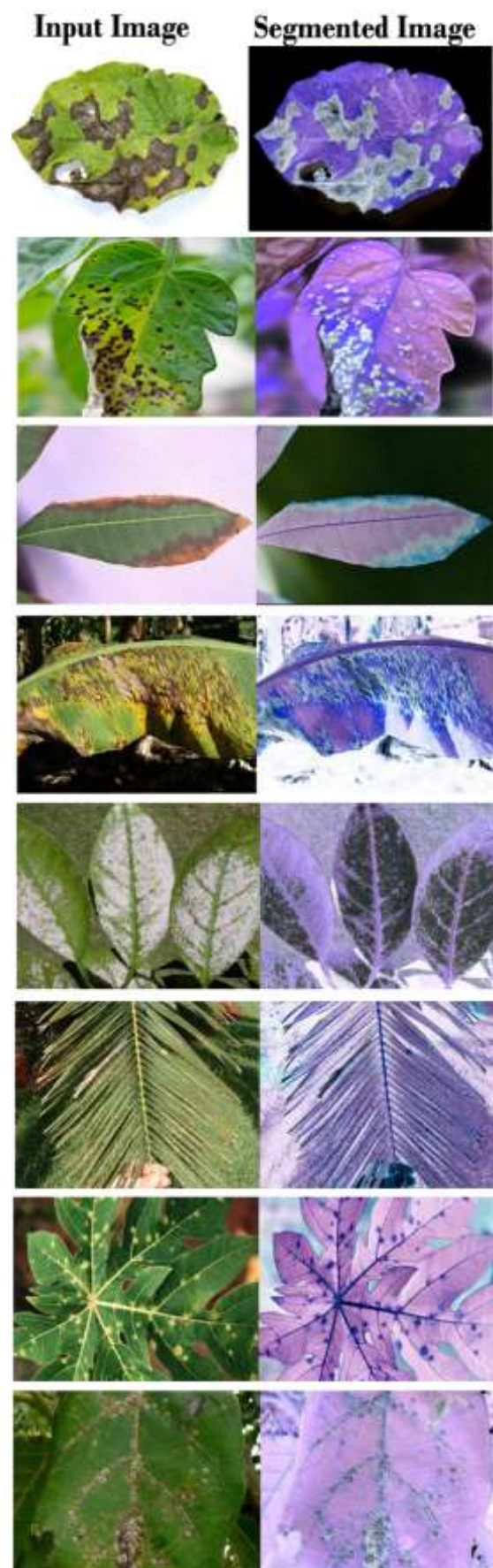


Figure 3.Segmented Image



Figure 4. Input and output image of potato and tomato leaves and output disease is bacterial disease



Figure 6. Input and output image of guava and palm leaves and output disease is fungal disease



Figure 5. Input and output image of mango and banana leaves and output is sunburn disease



Figure 7. Input and output image of papaya and avocado leaves and output disease is scorch disease



The arrangement is first tested utilizing the Minimum Distance Criterion (MDC) with K-Mean Clustering and shows its effectiveness with an exactness of 88.85%. The exactness is enhanced to 94.74% by the proposed algorithm. The second classification is finished utilizing Baye's classifier and demonstrates its effectiveness with a precision of 97.42%. Hence the accuracy is enhanced to 97.42% by Baye's classifier with the proposed algorithm. The preparation and the testing sets for each kind of leaf alongside their detection exactness is shown in table A1 and figure 8. From the results it can be concluded that the detection exactness is upgraded by Baye's classifier with the proposed algorithm. Moreover the research result will be available to the user instantly as shown in figure 9 after the image is uploaded for the process.

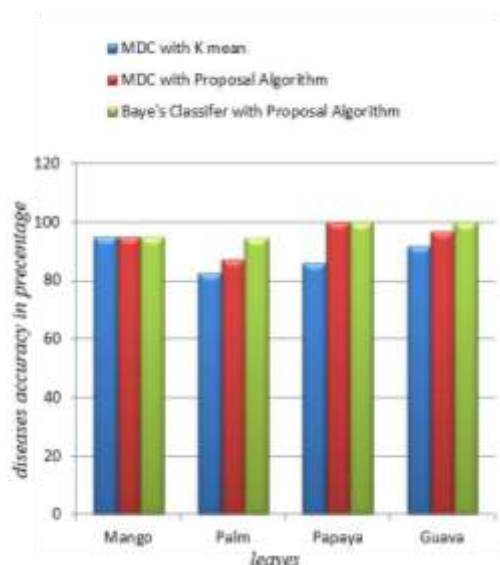


Figure 8.Comparison graph

## 5. CONCLUSION

In this paper a mobile application for detecting the plant disease based on image processing has been explained. Potato, tomato, mango, banana, guava, palm, papaya and avocado are some of those eight species on which proposed algorithm is tested. Commendable accuracy of result and disease can be identified in the early stage. Anyone with little knowledge about agriculture and agricultural products can use this application. The technique will be of more help for people who has home garden as they can easily find their plant disease and necessary remedies through their mobile phones. Moreover for using this application, the user has to perform

only two steps viz capturing the infected leaf and next uploading it through this application. It will automatically detect the disease and display the result instantly. The other processes are done in the database server. The extension of this work will focus on developing algorithms in order to increase the recognition rate of classification process.



Figure 9.Instant result

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## APPENDIX

Table A1.Comparison results

Samples leaves	Number of samples tested	Classification accuracy		
		MDC with K mean	MDC with proposed algorithm	Baye's classifier with proposed algorithm
Mango	10	95.00	95.00	95.00
Palm	10	82.50	87.23	94.66
Papaya	10	86.00	100	100
Guava	10	91.90	96.74	100
Average accuracy		88.85	94.74	97.42