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An Analysis of Segmentation Techniques to Identify Herbal Leaves from Complex Background

I.Kiruba Raji[a] , K.K.Thyagharajan[b *]

[a] Asst.Prof, RMD Engineering College, Anna University, Chennai-601206,INDIA

[b]Professor & Dean(Academic), RMD Engineering College, Anna University, Chennai-601206,INDIA

Abstract

Herbal leaves are used widely in local medication. But now a day, an ordinary person has little knowledge about those herbs and he may not identify such herbals easily. As a first step of computer based recognition of herbs, an analysis has been made to identify the best method for segmenting leaves object from its background. This type of segmentation is a preprocessing step required in identification of species of leaves or plants. Several methods are available for detecting the objects based on global and local features of an image. In this paper we are examining various object detection techniques for segmenting leaves based on color, shape and texture. Features like local adaptive mean color, evidence based color model, color histogram techniques are used. Boundary structure model is used to detect the leaves based on boundary descriptors of an image and Chan-Vese algorithm is used to segment the leaves from complex background. To extract leaves from texture background, edge focusing algorithm is used. From our experimentation analysis, shape is the powerful characteristics of segmenting leaf images and Chan-Vese algorithm provides better results compared to other techniques without affecting the leaf colors, texture etc.

Keywords: Segmentation; Color; texture; Shape; Image Feature

Corresponding author: * kkthyagharajan@yahoo.com

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I. Introduction

Identification and classification of leaves of various plants was done manually over many decades. But it was very complex process because many of the leaves have similar morphological characters such as shape, color and texture [1]. We need novel methods of image processing to overcome such problems when automatic identification of leaves is to be introduced. A simple and effective recognition scheme is to represent and match images based on color histograms. Texture gives us information about the spatial arrangement of color or intensities in an image or selected region of an image. Texture can be outlines as the spatial pattern formed by the surface characteristics of an object that manifests itself as color or grayscale variations in the image. Texture analysis is done in a spatial or the frequency domain. Gray level co-occurrence, Markov random fields and Gabor filters are used to recognize textures. Marko and LBP operator methods can tolerate against illumination changes [8]. Minu and Thyagharajan [11] combine dominant color descriptor, color layout descriptor and edge histogram descriptor to classify flower images using SVM classifier. They have also suggested a method named hidden value learned K-mean algorithm[12] to identify the prevalent or dominant color in a flower image and also proposed a new method based on gray level co-occurrence matrix (GLCM) in their paper[13] to recognize the texture of flower images.

Shape is the most distinctive individual characteristic of an object. Shape is analyzed either on region or on boundary. Region based approach uses moment descriptors like Zernike or Legendary moments. Boundary based system utilizes the contour of objects based on Fourier descriptors, curvature scale space methods or deformable templates. Belongie identified shapes are denoted as a set of points sampled from shape contours [2].

This paper is organized as follows. In section 2, various color based object detection techniques are explained. In section 3, texture based detection techniques are examined. In section 4, shape based techniques are introduced. In section 5, some of the techniques applied to the leaf images and the results are analyzed.

2. Color based object detection techniques

The color histogram represents the distribution of colors in an image [10]. A histogram of an image is produced first by the discrietization of the colors in the image into number of bins and counting the number of image pixels in each bin. After computing histogram value in order to obtain illumination changes, the RGB color image is normalized. But color histogram technique provides classification inaccuracy because same color information is shared by all objects of an image, we cannot differentiate components of an image separately. To avoid these problems global and local adaptive mean color models are introduced [3].

Guilliaume cerutti et al [3] have used L*a*b color space which is perceptually different from regular RGB color manifestation and intersects well the chrominance information from the luminance. The color distribution of L*a*b forms a straight continuous cylinder. But other color spaces such as HSL, RGB produce curved cylinders. This algorithm initially selects the smaller region in L*a*b color space after it considers the same axis for the whole leaf. This color segmentation considers leaf pixel which is not close to the initial region of leaf image and it discriminates the leaf of interest from other leaves of similar color in the background.

The color of a leaf may vary due to climate changes, reflection, venation and shadows. A global linear regression model considers these changes also as a color and makes difficult to differentiate a foreground and background of a leaf object. To avoid such confusion, local adaptive mean color model computes the mean value of the neighborhood around the pixel. Then this mean value is updated through the entire leaf image. This process is repeated for all neighborhood regions. But finding the color transition between the leaf and background image is difficult and because in many cases large part of the background pixel values are close to the values of the pixels in the object.

Fig 2.1: (a)input Image (b) local adaptive mean color image

When we are applying global and local adaptive mean color linear regression model, we cannot separate the foreground and background of an Image. In global linear regression model it considers [3] similar color for all leaves. The local adaptive mean color method uses eight neighborhood pixel values to estimate the mean value. To overcome these drawbacks of global and local adaptive mean color mode and for achieving better results with color images, K-means clustering algorithm is used. The following figure shows the result of this algorithm

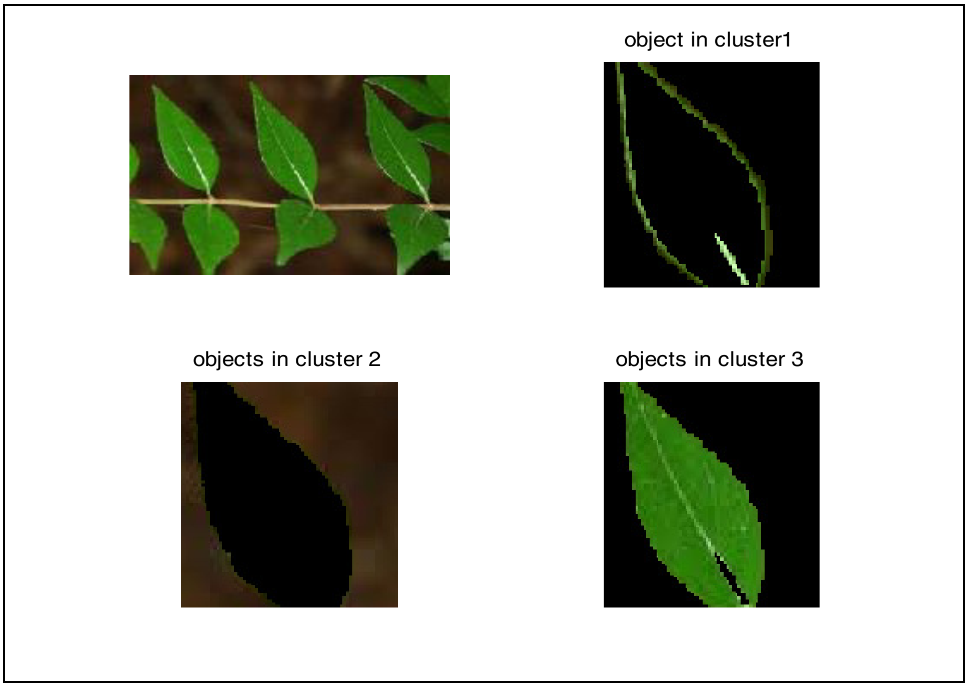


Fig 2.2 Result of K-means Clustering Method

3. Texture based segmentation

Edges detect and characterize significant intensity changes in an image[8] and it can be applied to find out the edge contour of an object. An edge focusing algorithm detects smallest scale space image recursively and returns the result to a specified array.

Fig 3.1: (a) Input Image (b) After edge detection

4. **Shape based Leaf detection technique**

Shape is commonly defined in terms of the set of contours that describe the boundary of an object. Shape can be very useful to detect clutter images[4]. Shape is the important characteristics for identifying the family of leaf. Botanist usually identifies species of leaves based on the botanical name but others can't identify the species by botanical name. They can be identified based on the basic shapes introduced in Fig 4.1.

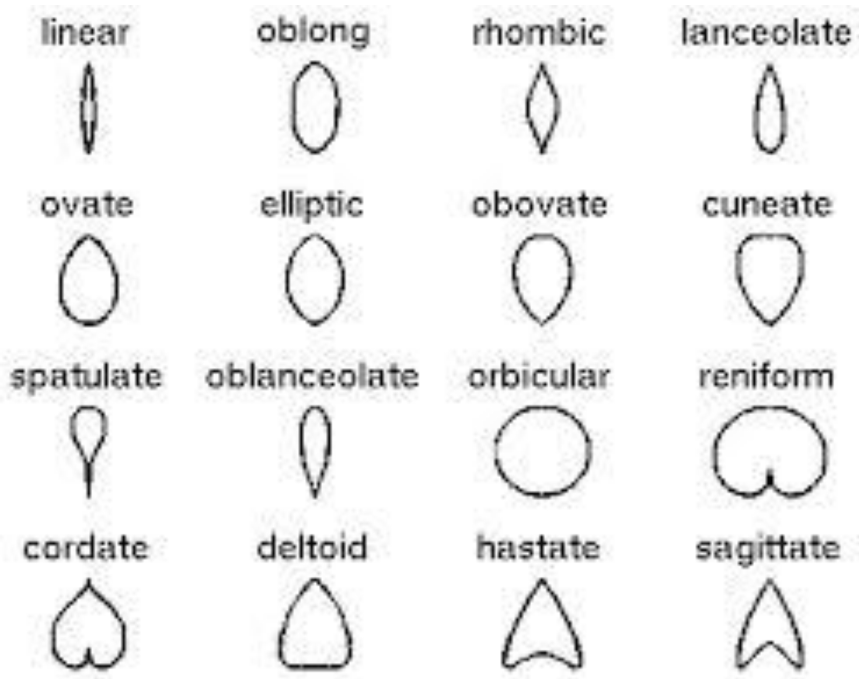


Fig 4.1: Shapes of leaf

The classification of species of leaves based on arrangement of leaf, margin of leaf, leaf base and tip, leaf vein and shape of leaf. Table 4.1 shows some of the species based on the shape.

Table 4.1: Species of Leaves

S.No	Name of Leaf Species	Basic Characteristics of Leaf Species
1.	Alliaceae onion Family	Biennial herbs, Narrow base Leaf Ex:Onion,Garlic
2	Amaranthaceae s. lat. AMARANTH B FAMILY	Ovate Shape leaf Ex:beet,spinach
3	Amaryllidaceae AMARYLLIS FAMILY	Linear Shape leaf Ex:Spider lilly,Swamp Lilly
4	Anacardiaceae CASHEW FAMILY	Pinnate Shape Leaves Ex:Mango
5.	Apiaceae s. lat. D CARROT and GINSENG FAMILY	Lobed Shape Leaf Ex:Cumin,fennel
6.	Asphodelaceae ALOE FAMILY	Linear Shape Leaf Ex:Aloe
7.	Brassicaceae s. str. MUSTARD FAMILY	Lobed Shape Leaf Ex:Cabbage
8.	Boraginaceae s. str. BORAGE A FAMILY	Simple Leaf Ex: Pulmonaria
9.	Cucurbitaceae CUCUMBER A FAMILY	Lobed Ex:Watermelon
10.	Cyperaceae C SEDGE FAMILY	Linear Leaf Ex:Sedge

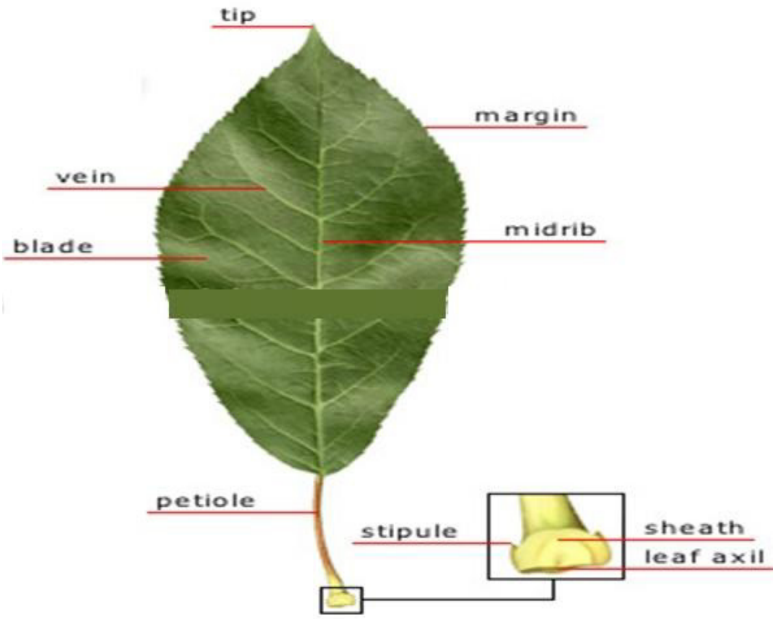


Fig 4.2: parts of leaves

For extracting shapes from leaves, Yunyung Nam[14] used, edge detection methods for identifying contours of images. Z.Husin[15] used thresholding methods to identify the shapes. But these techniques we are applying only for gray level images. But for real time images Active contour model of Chan-Vese algorithm gives better result compared to other basic methods.

Fig 4.3(a).Input Image **(b).Contour of Image after applying basic contour detection technique**

Active contour models otherwise called as snakes, are autonomous and self adapting in their linear search for minimal energy state. They can be used to track dynamic objects in temporal as well as spatial dimensions. It is used to obtain a complete and accurate outline of an object. In general active contour model has several problems such as,

- Several snakes require an initially unknown number of Contours.

- Different types of snakes will need different initialization condition
- It is needed to split up the snakes when they approach contours.

To avoid such problems, level set approach was introduced. Initially the level set approach was applied to whole regions rather than edges. So contours are represented implicitly. Here we apply Chan-Vese active contour for whole region of images rather than edges.

Chan-Vese active contour [6] is a powerful and flexible method which is able to segment many types of images. This model is based on an energy minimization problem, which can be reformulated using the level set formulation to solve this problem. Most of the level set formulation methods are based on first order and second order partial differential equations of the curvature models [9, 6]. Figure 4.4 (a) is obtained by applying image cropping method to extract a single leaf from the bunches of leaves and Figure 4.4.(b) is obtained after applying Chan-Vese Segmentation algorithm on the cropped image.

(a).Cropped Image (b) Segmented Image

Fig.4.4: Chan-Vese Algorithm Applied to a Single Leaf

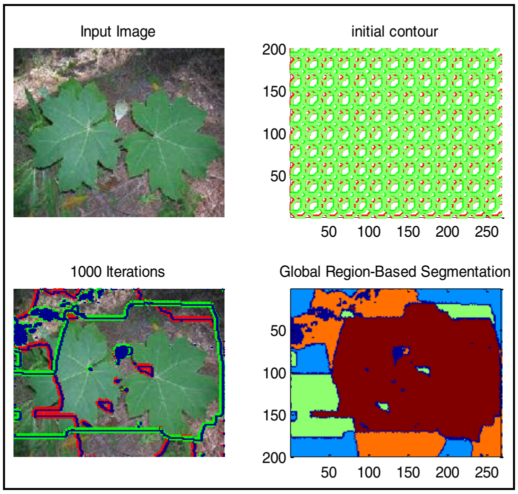


Fig 4.5 Chan-Vese for whole Image

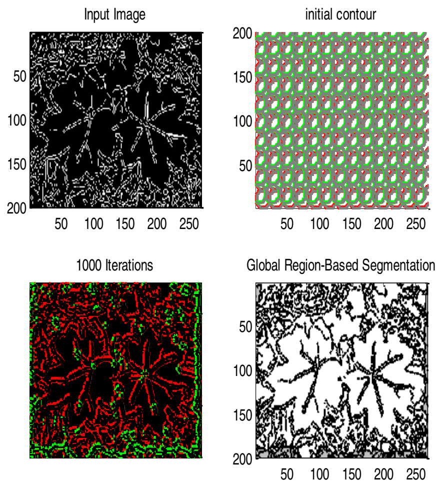


Fig 4.6 Chan-Vese for thin edges

Figure 4.5 shows the result of Chan-Vese algorithm applied to entire image that has many leaves. It works well for large images, but it takes more time for execution because the number of iterations is more. It works well for thin edges also. Figure4.6 shows the result of thin edges. After identifying edges ,this algorithm is used to remove some unwanted edges from both foreground as well as background. From our observation, Chan vese algorithm works well for thin edges, and it gives the results for whole region. But execution time is more when we are applying for large images.

We consider another method called Distance Regularized active contour model [16] which regularizes the level set formulation. There is no need of reinitialization of level set formulation. In chan –Vese algorithm we need to reinitialize the levelset formulation to its distance function because conventional level set formulation leads to numerical errors. So it takes more number of times to complete the process. So time complexity is more. But in DRLS there is no need of reinitializing level set formulation because it depends on the gradient flow that minimizes the energy. So it reduces the computational cost. It works for complex topology. From our observation it applies only for small images and it takes less time compared to Chan-Vese algorithm even though the number of iterations is more. But it provides lesser information about contour of images.

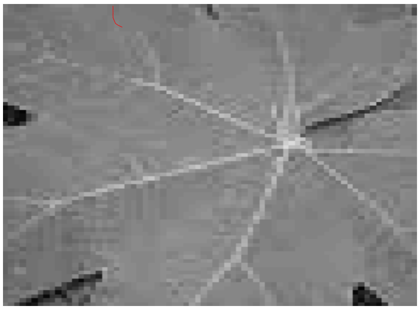
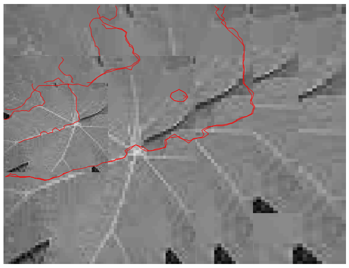
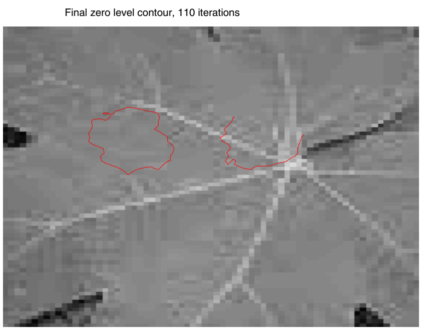


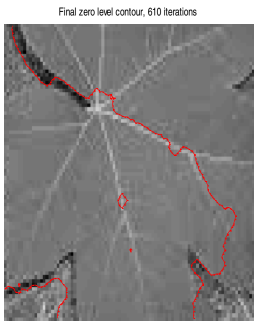
Fig 4.6 (a).Input Image



(b)Contour obtained in 210 iterations



© Contour obtained in 110 iterations



(d) Contour obtained in 640 iterations

Fig. 4.6. Contour Detection with Distance Regularized active Contour Model

5.Conclusion

Rand index is a statistical parameter used to evaluate the segmentation results of various segmentation algorithms. It takes the value in between 0 and 1. The value of rand Index 0 indicates that the segmentation result is poor. From the graph shown in fig. 5.1, Chan Vese algorithm gives high rand index value compared to global linear regression, local adaptive mean color and Kmeans clustering as well as edge focusing algorithm and Distance Regularized Level set function. So Chan Vese algorithm gives better results for both bunches of leaves as well as single leaf. In feature extraction methods, various scale invariant techniques are used to identify the similarity between leaf images. So shapes of leaves are very useful to identifying the species of leaf family.

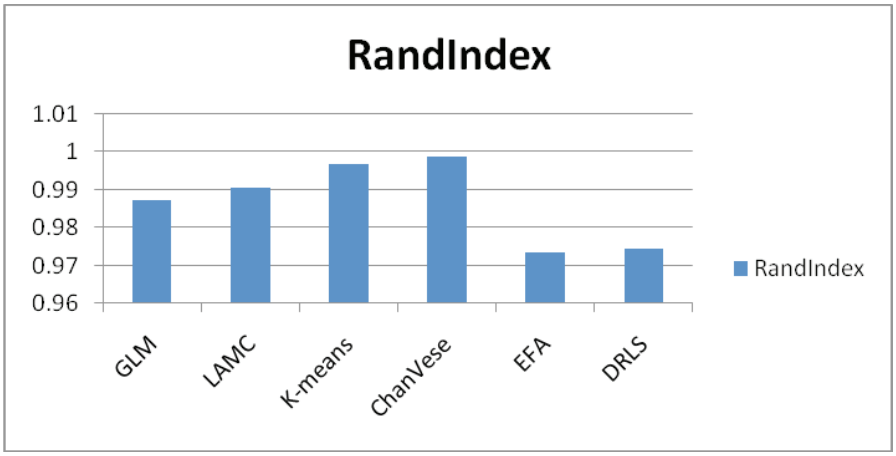


Fig5.1: Analysis of different Segmentation algorithms based on Rand Index

In future after identifying the shapes of leaves, some of the shape representation techniques may be introduced for identifying the similarity of shapes. With these shapes, analyzing leaf vein, margins and tip and base of leaves will also be considered because families of leaves include the characteristics of vein, base and tips.

References

1. James S.Cope, David Corney Jhonathan Y.Clark,"Plant Species identification using digital morphometrics:A review",Expert system with its applications, 39(2012),7562-7573.

2.S.Belongie,Jitendra Malik and Jan Puzhicha,"Shape matching and object recognition using shape contexts", IEEE transactions on Pattern Analysis and machine intelligence,vol24,nov29,APR 2002

3.Guilliaume cerutti, Laure Togune,"Understanding leaves in natural images-A model based approach for tree spices identification","Computer vision and Image Understanding",2013,pp:1482-1501.

4.Alexander Toshev,Ben Taskar,"Shape based Object detection via Boundary Structure Segmentation",International Journal of Computer vision,2012,pp:123-146.

5.Chao Hung,F.Meng,"Bird breed classification and annotation using saliency based graphical model",Journal of Vis.Commun.Image .R ,2014,pp:1299-1307.

6.Rami Cohen,"Chan Vese Algorithm",Introduction to medical imaging,2010.

7.Ardeshir,"On Edge Focusing",Image and vision Computing,1994.

8.Maro,Mattai,"A texture based method for moeling the background and detecting moving objects", IEEE transaction on Pattern Analysis and machine intelligence-vol 28(4),Apr 2006.

9.Mahimood R.Glozarian, Jinhai Cai,Ross, Frick, Stan Miklavic ”Segmentation of cereal Plant Images using level set methods-A comparative study,”

10.H.Kebapchi,B.Yanikoglu, ”Plant Image Retrieval using color,Shape,Texture”, The computer Journal,

11. Minu R I, Thyagarajan K K (2013) "A Novel Approach to Build Image Ontology Using Texton", Advances in Intelligent Systems and Computing, Vol. 182, 2103, pp. 333 – 339, Springer Berlin Heidelberg,.

12.Minu R I, Thyagharajan K K, (2011), 'Automatic Image Classification Using SVM Classifier', CiiT International Journal of Data Mining and Knowledge Engineering, Vol. 3, No. 9, pp. 559 – 564,.

13.Nagarajan G, Thyagharajan K K (2012) "A Machine Learning Technique for Semantic Search Engine", Procedia Engineering, Elsevier **ONLINE** Journal, Vol. 38, pp. 2164-2171, **.**

14.Yunyoung Nam,Eenjun Hwang,Dongyoon Kim, "A Similarity –based leaf Image retrieval scheme :Joining Shape and venation feature", Journal of Computer vision and Image Understanding, pp:245-259.

15. Z.Husin,A.Y.M. Shakaff,"Embedded portable device for herb leaves recognition using image processing techniques and neural network algorithm",Computers and Electronics in agriculture (2012),pp18-29.

16.Chemung Li,Cheyuang Xu, "Distance Regularized level set Evolution and its applications to Image Segmentation", IEEE transaction on Image Processing, Vol 19(12),December 2010.

Authors biodata

I.Kiruba Raji received her B.E degree in Computer Science and Engineering from P.S.N.A College of Engineering and Technology. Madurai Kamaraj University ,India and received her M.E degree in Computer and Communication Engineering from Anna University. Currently She is doing her Ph.D at Anna University. She has published four papers in national conference.
E-mail:kiruba_251@yahoo.co.in

K.K. Thyagharajan received his B.Eng. degree in Electrical and Electronics Engineering from PSG College of Technology, Madras University, India and received his M.Eng. degree in Applied Electronics from Coimbatore Institute of Technology, India in 1988. He also possesses a Post Graduate Diploma in Computer Applications from Bharathiar University, India. He obtained his Ph.D. degree in Information and Communication Engineering from College of Engineering Guindy, Anna University, India. He is in teaching profession for around three decades and served at various levels including Principal, Professor and Dean at various Engineering Colleges. He has written 5 books in Computing including "Flash MX 2004" published by McGraw Hill (India), which has been recommended as text and reference book by universities. He is a grant recipient of Tamil Nadu State Council for Science and Technology. He has been invited as chairperson and delivered special lectures in many National and International conferences and workshops. He is reviewer and editorial board member for many International Journals and Conferences. He is a recognized supervisor for Ph.D candidates and Master students at Anna University. He has published more than 90 papers in National & International Journals and Conferences. His research interests include Computer Vision, Semantic Web, Image & Video Processing, Multimedia Streaming and e-learning. He is a life member of ISTE, CSI INDIA and also senior member and invited member in many professional associations. He has been recognized by

Marquis Who's Who in the World for his contribution to the technical society and his biography has been published in its 25th Anniversary Edition.

Personal Web Site: http://tansitresearch.com
Official Web Site: http://www.rmd.ac.in/deanacademic.html

E-mail: kkthyagharajan@yahoo.com , kkthyagharajan@gmail.com