Tree Delineation and Tree Parameters Estimation in Satellite Images

Yalavarthi Sai Eswari
Department of Computer science and technology
V R Siddhartha engineering college, Vijayawada, A.P, India

B.L.N.Phaneendra Kumar
Department of Computer science and technology
V R Siddhartha engineering college, Vijayawada, A.P, India

Abstract- Advanced data mining technologies along with the large quantities of Remotely Sensed Imagery, provide a data mining opportunity with high potential for useful results. Extracting interesting patterns and rules from data sets composed of images and associated ground data are typically used in order to detect the distribution of vegetation, soil classes, built-up areas, roads and water bodies such as rivers, lakes etc. The availability of new high spatial resolution satellite sensors permits people having large amounts of detailed digital imaging of rural environment. In this paper an approach towards the automatic segmentation of the satellite image into distinct regions and further to extract tree count from the vegetative area is presented. Counting trees in specific geographical areas is a very complicated process. Now a days manual counting is done by the forest department, both in agricultural as well as forest regions. Image segmentation is a very important technique in image processing. However, it is a very difficult task and there is no single unified approach for all types of images In this paper, image processing techniques have been employed for automatic segmentation of the satellite image and extraction of the trees from the segmented image.

Keywords –Spatial resolution, Vegetation.

I. INTRODUCTION

Trees are an important component of the natural landscape because of their prevention of erosion and the provision of a weather-sheltered ecosystem in and under their foliage. They also play an important role in producing oxygen and reducing carbon dioxide in the atmosphere, as well as moderating ground temperatures. They are also elements in landscaping and agriculture, both for their aesthetic appeal and their orchard crops (such as apples). Wood from trees is a building material, as well as a primary energy source in many developing countries.

Segmentation of satellite image is an essential application in field of multimedia data mining. Data available through high spatial resolution satellite sensors are difficult to manipulate using traditional digital image investigation methods, hence new algorithms are required to exploit these new data. There is a huge amount of data available in the satellite images and we require efficient models to extract information such as, the presence of buildings, cultivatable land, forest regions, barren land etc. Further more, in the cultivatable land it is very essential to know the type of soil, so as to be able to get better crops. The group of pixels contained in each region provides a good statistical sampling of data values for the multispectral feature values. The present approach is intensity based. Dealing with high dimensionality is highly complex, so dimensionality reduction techniques like Principle Component Analysis (PCA) are used. There are two reasons for keeping dimensionality small, measurement cost and accuracy, but reduction leads to loss in the discrimination power between classes. The counting of trees is a classic forestry application in remote sensing data.

The very valuable livestock fodder produced by Trees can be a matter of life and death in semi-arid or mountainous areas. Trees contribute to check wind and water erosion, improve soil fertility, facilitate the percolation of rainwater and guarantee long-term crop production. Trees also often have symbolic and, in some cases, religious value. They mark boundaries and indicate ownership, border property and decorate living quarters.

In arid landscapes they serve as landmarks, looming on the distant horizon and acting as beacons for nomadic peoples. This long list, to which wood as a source of fuel or building materials, wooden handles for tools, and wood for furniture should be added, gives some indication of the range of current and potential goods and services offered by trees. Some trees are tapped for their sap in the form of resin, latex and gum arabic, others provide essential oils.

Figure1: Original Image

Modern forest management requires that forest resources be efficiently managed, not only for timber production, but also for such purposes as maintaining biodiversity and meeting wildlife, environmental, and recreational needs.

Accordingly, there is an increasing need for detailed knowledge of forest stands, which are the basic units for forest management. In-evitably, stand measurement It involves the measurement of individual trees within the stand. The traditional method for deriving stand information is to utilize sampling designs with transects, random or systematically selected plots, so that the final stand parameters can be derived based on statistical ex-trapolation methods.

By utilizing remote sensing data, we can reduce the amount of field sampling; hence, information gath-ering becomes more cost-effective. Segmentation of satellite image is an essential application in field of multimedia data mining. Data available through high spatial resolution satellite sensors are difficult to maniplateusing traditional digital image investigation methods,hence new techniques are essential to extract data such as presence of buildings, forest land, and borren land etc.. in that particular image.

Raster data with an object-based image analysis (OBIA) of a canopy height model (CHM). Procedure is based on segment the imagery into meaningful objects through the use of spectral and spatial context[14].

A wide variety of tree crown detection and delineation algorithms based on high spatial resolution optical imagery have been developed over the last decade. These algorithms can be grouped into two general categories in terms of their primary objective: individual tree detection and tree crown delineation.

Tree detection con-siders those processes that deal with finding tree tops or locating trees, while tree crown delineation refers to automated drawing of tree crown outlines. In this paper, we derive individual tree-crown boundaries and treetop locations under a unified framework. We applied a two-stage approach with edge detection followed by marker-controlled watershed segmentation. A Laplacian of Gaussian edge detection method at the smallest effective scale was em-ployed to mask out the background. This approach uses data from Lidar[8].

Automatic extraction & characterization of vegetation structures in high density urban areas. Urban vegetation structures are extracted from high resolution images and Digital Elevation Model's. In this method, at first identify all vegetation areas in the urban environment using spectral indices. Then they proceed to finer level of analysis of those vegetation areas, by performing the texture analysis, to differentiate lawns and trees. Trees are characterized by a higher gray level variance on the DEM , they obtain an indicator which allows us to separate lawns from tree crowns. Tree tops are detected by searching local maxima on a fixed window size in the DEM. Starting from tree tops, tree crown borders are obtained by a region growing approach based on geometric criteria's of the trees[16].

Procedure is based on Variable window filteringAn eight-connectivity scheme was used to label the remaining tree objects in the edge map. Subsequently, treetops are modeled based on both radiometry and geometry. More specifically, treetops are as-sumed to be represented by local radiation maxima and also to be located near the center of the tree-crown. As a result, a marker image was created from the derived treetop to guide a watershed segmentation to further differentiate touching and clumping trees and to produce a segmented image comprised of individual tree crowns.

This is a Region based approach and Depends on Multiple scale edge segments.Laplace operator can be used to detect parts of the tree crowns. A region growing algorithm can then be used with the tree tops (maxima spectral response) as seeds and light intensity as growing function right up to the pre-calculated boundaries[13].These methods are more robust for detecting trees which are partly in shadow. However preprocessing is also needed to avoid detecting light patches in lower density areas[14].

Background: Review of tree crown detection and delineation methods

Overview

The display of a greyscale high resolution image of a moderate density forested area as a three-dimensional surface has a spatial structure resembling a mountainous region (Wulder et al. 2000) with high reflectance pixels as mountains and low reflectance pixels as valleys. In particular, for trees with conical structure, bright peaks in the image correspond to the tree tops because of the higher level of solar illumination. On vertical images, such tree crowns exhibit circular shape and the tree top is associated with the pixels in the centre of the tree crown. This reflectance and spatial pattern is an underlying assumption in most tree detection and delineation methods. The three methods explored in this article utilize these charac-teristics from different perspectives.

Reflectance decreases towards the crown boundaries; darker pixels surrounding the bright crown correspond to shading from neighbouring tree crowns or are caused by bidirectional reflectance effects.

Figure2: Image Aquasition

On vertical images, such tree crowns exhibit circular shape and the tree top is associated with the pixels in the centre of the tree crown. This reflectance and spatial pattern is an underlying assumption in most tree detection and delineation methods. The three methods explored in this article utilize these charac-teristics from different perspectives.

The valley-following algorithm detects local minima to form valleys and considers a circular tree crown shape by following crown boundaries; watershed segmentation generates tree tops based on local max-ima and applies a morphological watershed segmentation algorithm to delineate crown boundaries; the region growing algorithm utilizes both local maxima and local minima, but does not take crown shape into consideration. These algorithms were selected because they are representative of the methods commonly presented in the literature. A description of these algorithms is provided in the remainder of this section.

II. ALGORITHMS STUDIED

Valley-following: The valley-following algorithm was originally developed by Gougeon (1995) for automated delineation of trees in mature coniferous forest plantations in Canada using multispectral electro-optical imaging sensor (MEIS)-II imagery with 31 cm GSD. A threshold was first applied to mask out non-forest areas. Within the forested area, instead of searching for local maxima as tree tops, the valley-following algorithm finds local minima as valley bottoms. Valleys are followed by searching for pixels that are in between pixels with higher values. Gougeon (1995) then used a five-level rule-based program to complete the delineation. The lower level rules deal with following the convex tree crown by defining the crown boundary; higher levels considered some exceptions such as branches that stick out, which cause indentations in the crown boundary, or indicate

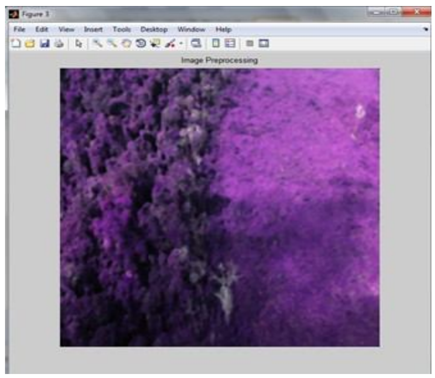


Figure3: Preprocessing

separation of two crowns. Gougeon (1995) reported 7.7% error in overall tree count; however, the presence of commission and omission errors meant around 81% of recognized trees exactly matching the reference. Lower spatial resolution imagery caused decrease in the total tree count accuracy.

Region Growing:
The first step in region growing is to select a set of seed points. Seed point selection is based on some user criterion (for example, pixels in a certain grayscale range, pixels evenly spaced on a grid, etc.). The initial region begins as the exact location of these seeds.

The regions are then grown from these seed points to adjacent points depending on a region membership criterion. The criterion could be, for example, pixel intensity, grayscaletexture, or color.

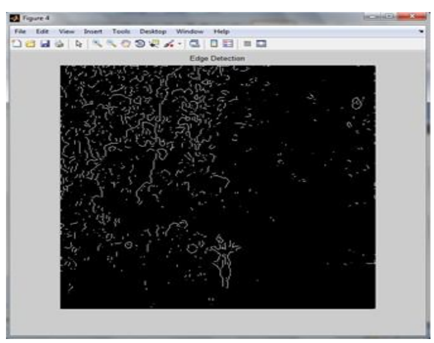


Figure4: Edge Detection

Since the regions are grown on the basis of the criterion, the image information itself is important. For example, if the criterion were a pixel intensity threshold value, knowledge of the histogram of the image would be of use, as one could use it to determine a suitable threshold value for the region membership criterion.

There is a very simple example followed below. Here we use 4-connected neighbourhood to grow from the seed points. We can also choose 8-connected neighborhood for our pixels adjacent relationship. And the criteria we make here is the same pixel value. That is, we keep examining the adjacent pixels of seed points. If they have the same intensity value with the seed points, we classify them into the seed points. It is an iterated process until there are no change in two successive iterative stages. Of course, we can make other criteria, but the main goal is to classify the similarity of the image into regions.

Watershed Segmentation**:**

The main goal of watershed segmentation algorithm is to find the “watershed lines” in an image in order to separate the distinct regions. To imagine the pixel values of an image is a 3D topographic chart, where x and y denote the coordinate of plane, and z denotes the pixel value. The algorithm starts to pour water in the topographic chart from the lowest basin to the highest peak. In the process, we may detect some peaks disjoined the catchment basins, called as “dam”.

Before describing the steps of watershed, we previously define some parameters. Let M1, M2, …, MR sets denoting the coordinates in the regional minima of an image g(x, y), where g(x, y) is the pixel value of coordinate (x, y). Denote C(Mi) as the coordinates in the catchment basin associated with regional minimum Mi . Finally, let T[n] be the set of coordinates (s, t) for which g(s, t) < n.

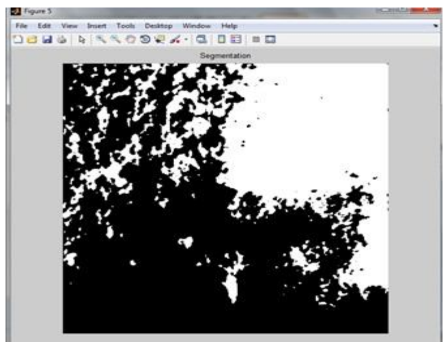


Figure5: Segmented Image

Wang et al. (2004) adopted a marker-controlled watershed segmentation method to delineate tree crowns in a mature white spruce stand using Compact Airborne Spectral Imager (CASI) imagery with 60 cm GSD.

Tree crown objects were first extracted using a Laplacian of Gaussian edge detection operator. This operator differentiated tree crown areas from the most significant background (shaded area), and further segmentation was used to separate individual trees from neighbouring trees. Within each object, tree tops were determined using the intersection of local maxima in the grey-level image, which represent high reflectance, and the local maxima in a geodesic distance image, which represent the centre of tree crowns based on the assumption of circular tree crowns. With the tree tops used as markers, Wang et al. (2004) applied marker-controlled watershed segmentation to determine the geodesic influence zone of each marker. The boundary of each influence zone was considered as defining a tree crown boundary.

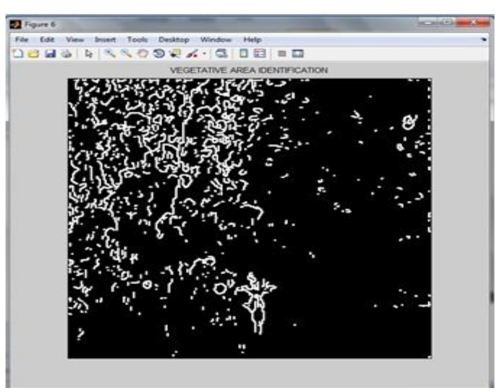


Figure6: Vegetative Area Identification

The algorithm implemented by Wang et al. (2004) identified 1122 trees in the study area compared to 957 manually delineated trees. The results were also evaluated using pixel-based accuracy assess-ment with 75.6% of total pixels (crown or non-crown) correctly corresponding to manual delineation results.

III. ARCHITECTURE AND MODELLING

Many times vegetation parameters on large scale often required by the government agencies for detecting the vegetated area. Mainly this is possible based on the limited area where it have limited field work.

Edge Detection:

Tree crown, understory vegetation, and bare soil comprise the major portion of the forest image. This gives rise to the first step, which is to separate trees from their background. Multi-spectral images provide more information for use in the sepa-ration procedure and in some sense can help compensate for coarse spatial resolution (Pollock, 1996). However, current edge-detection methods can be applied only to a single-band image.

Therefore, we used Principal Components Analysis (PCA) to obtain a suitable single-band image for our study. PCA transforms a set of images into a new set of images (compo-nents) with as little correlation between components as possi-ble. The first component contains the most variance, and each subsequent component contains less variance than the previ-ous component (Ricotta *et al.*, 1999). Therefore, we selected the first principal component as our single-band image for edge-detection processing.

Architecture for Segmentation:

The entire flow of segmentation process as follows: It starts with data obtained from original image. In the next stage Images are pre-processed to reduce the noise and enhance the clarity. Third stage is region of interest like vegetated or borren land etc… what ever area we select the particular area. Last stage is if further noise is there then eliminate that noise and then finally original area is restored.

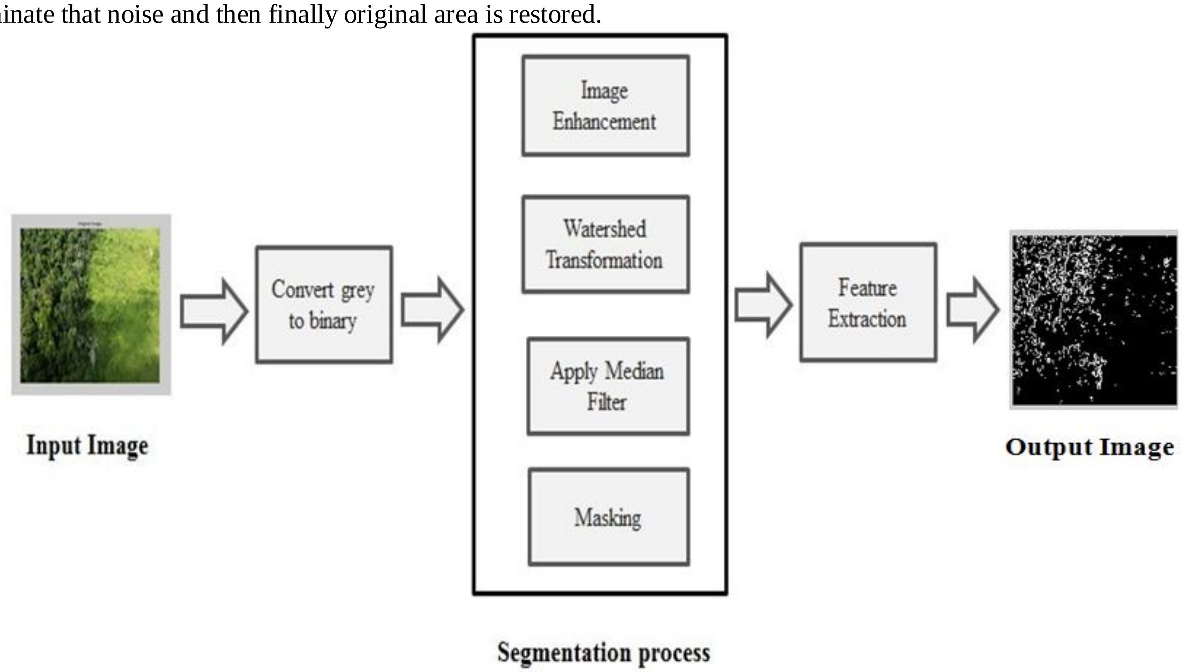


Figure7: Flow diagram for tree detection

Architecture for Tree Counting:

Image repository is the one in which rgb image is restored. Maximum images are all are in the raw form so that we reduce the noise is the difficult task. It is difficult to interpret the images in the raw form. Thus, to produce the reliable form we need to preprocess them. Median filter is used to preprocess the image. It is best filter among all. Median filter is also called as order statistics filter.Median filter best used for detecting the outliers of the image without reducing the sharpness of the image. Feature extraction mainly used for R dimensions of the RGB matrix is extracted and stored.

Image segmentation is adopted for digital image processing in the field of computer vision. This involves partitioning the image into homogenous and separated regions. Crown counting is a very tedious and inaccurate process. Much depends on the quality of the image data, the physiognomy of the stand, and the most accurate counts can be obtained in boreal forests, open grown woodlands and recently thinned plantations.

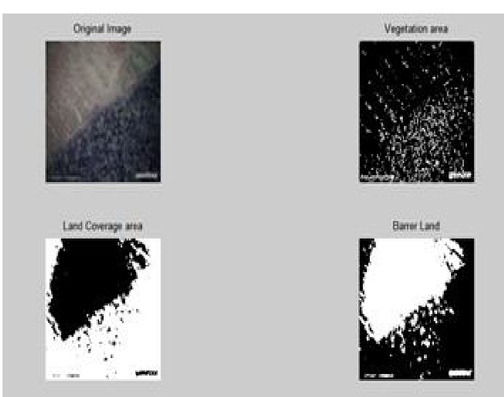
Tree counting can be done based on following steps:

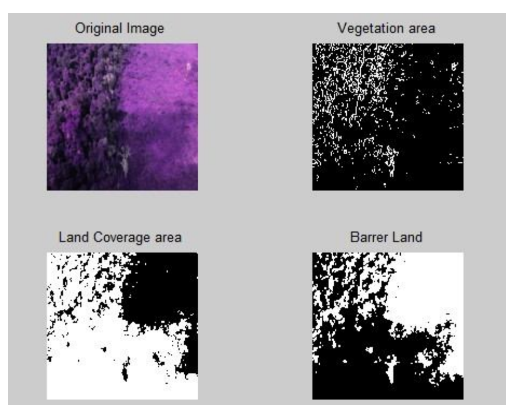
1. Select Segemented vegetation region
2. Mark foreground objects
3. Apply morphological opening and closing
4. Threshold Opening and closing by reconstruction
5. Apply watershed transform
6. Get boundaries and then count number of trees.

The counting of trees becomes extremely difficult when the satellite image is of low resolution. because of two major difficulties. First, intensity changes can occur over a wide range of scales. For example, at finer scales all branches in a tree-crown image are visible. Thus branches account for most of the changes in intensity. At a coarser scale, a tree crown may merge with it

3D-based methods have been applied by fewer researchers in comparison to other types of methods. Sheng *et al.* (2001) employed model-based image matching to obtain an improved tree-crown surface reconstruction. They utilized a parametric tree-crown surface model that takes into consideration crown shape, illumination, and a sensor model. As a further im-provement, Gong *et al.* (2002) developed an interactive tree interpreter to generate the tree model providing the means for semiautomatic tree-crown segmentation. To fully automate this method, however, a necessary step is to automatically determine the treetop locations separately on the left and right epipolar images.

IV. RESULTS





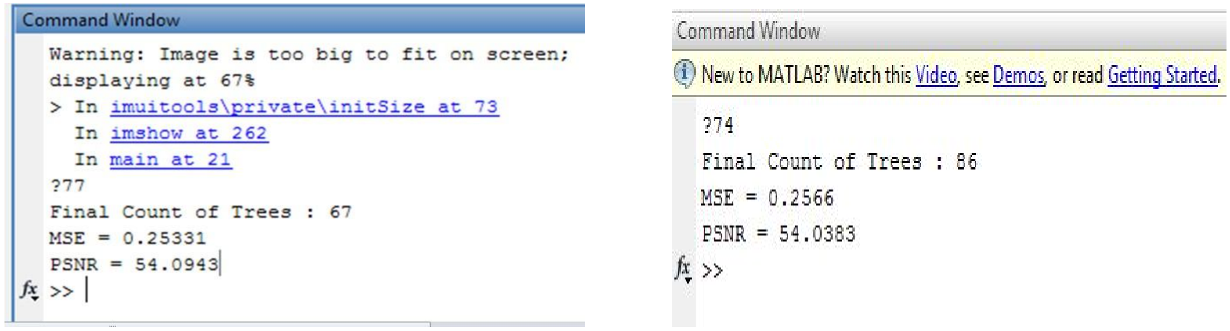


Figure9: Final Result

By using the image segmentation process image has to be divide into different regions. Based on that we select one region where it having the trees. In this tree counting process input image is retrived from segmentation technique. Other regions are cultivated land, buildings, borren land etc.. Ignore all those and then processed out. Baseed on the threshold value we divide the different regions. Applying the median filter it removes the noise. Image enhancement technique mainly used to separate out the foreground and background portions.

If this image segmented then it goes to the postprocessing technique. In that mainly region growing and region masking are used. Region growing is used to fill the holes and removes the gaps in between them. Where as region masking helps gray level image into binary image. Final image is retrived. Apllying the basic steps to find the number of trees in that segmented image.

Implementation And Performance Analysis:

The two algorithms one is segmentation and another is counting of trees in a vegetated area is done using the matlab. The performance is done by computing the accuracy of counting. Intensity values causes some variation in accuracy.The accuracy of segmented image is shown below fig.

The efficiency increases as distance between the tree s increases. This algorithm for detecting the tree is generic and it can be used to identify different objects by making minor changes in template generation. The average accuracy obtained is 87% and the graphical representation is as shown below.

V. CONCLUSION

Tree counting in a specific geographical area is a complicated process. With evolution of satellite images it is made easy. Tree Counting implemented using morphological opening and closing does not yield good result. So, Tree Counting by morphological opening and closing by reconstruction and watershed transform to delineate overlapping tree crowns is implemented.

REFERNCES

[1]. Patrick Gonzalez, Rashid Hassan, Petro Lakyda, Ian McCallum, Sten Nilsson, Juan Pulhin, Bernardt van Rosenburg, and Bob Scholes: Forest and Wood land Systems (Chapter 21).

[2]. FAO Corporate Document Repository “Global Forest Resource Assessment 2000” produced by Forestry Department (Chapter 4: Trees Outside Forest).

[3]. Forestry Department, Food and Agriculture Organization of the United Nations “TOF: Towards Rural and Urban Integrated Resources Management” by Forest Conservation, Research and Education Service.

[4]. Mapping of TOF by Subhash Ashutosh, Deputy Director, Forest Survey of India, Dehradun.

[5]. TOF Resource Study and Management: Assessment Methodologies and Institutional Approaches in India by Chinmaya S. Rathore and Ram Prasad, Indian Institute of Forest Management Bhopal, India.

[6]. Field Work Report “Developing a New Rapid Biodiversity Assessment System: A Tool for Inventory and Conservation” by Carlos E Gonzalez founded by Rufford Small Grant in 2004/2005.

[7]. Inventory Methods for Forests and TOF using Remote Sensing: A Literature Review by Eija Soini.

[8]. Forestry Department, Food and Agriculture Organization of the United Nations “TOF: Towards Rural and Urban Integrated Resources Management” by Forest Conservation, Research and Education Service.

[9]. Mapping of TOF by Subhash Ashutosh, Deputy Director, Forest Survey of India, Dehradun.

[10]. TOF Resource Study and Management: Assessment Methodologies and Institutional Approaches in India by Chinmaya S. Rathore and Ram Prasad, Indian Institute of Forest Management Bhopal, India.

[11]. Field Work Report “Developing a New Rapid Biodiversity Assessment System: A Tool for Inventory and Conservation” by Carlos E Gonzalez founded by Rufford Small Grant in 2004/2005.

[12]. Inventory Methods for Forests and TOF using Remote Sensing: A Literature Review by Eija Soini.

[13]. M.Katoh: Comparison of high resolution IKONOS images to interpret individual trees, I. For. Res., Vo1.84 N0.4, pp.221-230, 2M) 2.

[14]. Brandtberg, T. (1998). Algorithms for structure- and contour-based treespecies classification using digital image analysis. In D. A. Hill, &D. G. Leckie (Eds.), Proceedings of the International Forum on AutomatedInterpretation of High Spatial Resolution Digital Imagery forForestry (pp. 199 – 207). Victoria, BC: Canadian Forest Service, PacificForestry Centre.

[15]. Popescu, S.C.; Wynne, R.H. Seeing the trees in the forest: using lidar and multispectral data fusion with local filtering and variable window size for estimating tree height. *Photogramm. Eng.Remote Sensing* **2004**

[16]. CorinaIovan, Didier Boldo and Matthieu cord, Automatic extraction of urban vegetation structures from highresolution imagery and digital elevation model in institute of geographic national laboratoire, 1-4244-07125/07/$20.00©2007IEEE