

Framework for Tree Crown Delineation from Panchromatic Images

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Abstract

In this paper we developed a Framework for Delineation of Trees to discover the tree of urban areas. Individual tree crown extraction is important for urban forest inventory. Earlier some research studies were done which primarily deal with particular tree crown or tree species detection. These methods not found the solution for distinguishing trees from their shadows. In our framework we used methods which extract texture-based features from panchromatic images. In the proposed methodology first the input image will undergo with pre-processing where unnecessary distortions like shadows and dark spots etc. were suppressed and then image quality is used by applying enhancement techniques. Output image is segmented to detect boundaries and objects from the image. Finally a framework is developed for delineation of trees. The proposed framework process with shadows of trees and identify the tree effectively from a satellite image.

Keywords: Intelligent Systems, Training Systems, Panchromatic images, Green ICT, Delineation, Histogram equalization,xture Feature.

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1. Introduction

The tree crown extraction and delineation has used for counting or delineating tree crowns and their size respectively [10]. Moreover, the techniques related to this topic, enhance the calculation of boundaries of interest for plantation directories such as forest standard limitations, tree species composition. Remaining parameters, such as height and size of tree crown can also be easily delineated. While most of the existing studies only concentrated on tree crown delineation, and existing authors used regular algorithms [11, 12] in image processing. In the same time period, grey scale analysis was applied on high resolution satellite imagery and to estimate tree crown area and the

template matching techniques were introduced for extraction of tree crown delineation of the given model.

Different tree crown detection and delineation algorithms have been developed over the past decade. Based on the objectives and parameters, these crown detection algorithms are clustered into two categories: Tree crown detection and Tree crown delineation. Tree crown extraction is defined as those techniques that deal with finding tree tops or locating trees, while tree crown delineation refers to automated drawing tree crown outliers. While they are theoretically separated, these two categories often associated in the literature.

The delineation is considered to be as same to tree extraction, i.e., independent trees were detected and extracted once the tree crowns were delineated. Since it is challenging to separate detection from delineation, while the

algorithms studied in this topic have the particular motive of delineating tree crowns, they are referred to as “detection and delineation” techniques in general. In appropriate, for trees with cone shaped structure, in the image correspond to the tree crowns due to the fact of the higher stage of solar illumination. Reflectance decreases toward the crown boundaries; darker pixels surrounding the brilliant crown correspond to shading from neighboring tree crowns or from directional reflectance effects. This pattern is extremely used in most tree crown extraction and delineation methods.

1.1. Motivation

Now days, the deforestation makes a lot of changes in environmental system that causes the environmental pollution [14]. Our methodology was motivated to resolve the environmental pollution. Deforestation reduces the number of trees in nature. Our methodology makes an efficient method for delineation of trees effectively. It is necessary to know that urban development is increasing quickly [1]. Urban tree cover improvement will facilitate to mitigate a number of the harmful effects of a more and more developed landscape by providing several of the system services that forests would have provided. whereas some communities have instituted good growth methods, that facilitate to mitigate populated area, fewer still have developed land cover methods like the enumeration of trees, and delineation of trees to assist mitigate the environmental effects of new urban areas. Delineation of trees will play a very important role in decreasing our impact on the surroundings.

1.2. Problem Statement

The data that is used for the analysis of detailed tree crowns is provided by the Cartosat-2 satellite imagery. Individual tree crown extraction has significant role in identifying the forests in urban areas [8]. . The technique of Delineation for trees is adopted to identify the trees of urban areas. In the past research most of the researchers made studies that deal with particular tree crown or tree species detection only. No attempts are made for detecting major tree species of urban area collectively from visually distinguishable satellite images [9]. Differentiating trees from their shadows is one more major problem in estimation of tree count. All these problems are addressed in our paper and we developed a framework that differentiates the trees from their shadows in identifying the trees effectively from a satellite image.

2. Literature Review

Bhavana, B. L., N et.al, [1] projected a technique title as a tree crown detection and extraction from high-resolution satellite images in a geographical area. They made investigations to extracts the urban vegetation indexes. For their research the authors took the Bangalore city color composite image as input. To find the trees and grasslands

they used texture Analysis algorithms. To detect the tree crowns from satellite images, the developed approach is utilized. The quality and accuracy of detected trees is high with the proposed methodology.

Wen, Dawei, et.al, [2] presented a paper in 2017 to classify urban trees from a high resolution satellite images. In this work the authors developed a new framework with three levels for semantic classification of trees. This classification classifies the urban trees into park, road side tress and residential–institutional trees. VHR remote sensing imagery is used for this. The positive point with the proposed method is, in order to assist with good environment protection and provide viable development guidance for urban planners, where as the downside it is difficult to meet the needs of environmental issues. It is complicated to create dataset of trees of urban area from satellite image, as result this approach is little difficult to implement.

Zhen, Zhen. et.al [3] developed a tool for assessment of accuracy of individual tree crown delineation. In their work the authors presented a procedure for assessment of accuracy of individual tree crown enumeration. They also presented procedure for crown detection and crown enumeration. Accuracy assessment could be a major factor of ITCD, that makes it additional economical and convenient to assess ITCD results than victimization standard commercial software system.

Chao-Cheng Wu., et.al [4] introduced a technique titled “least square fitting of Pollock model for tree extraction and crown delineation”. During this study, the authors presented an algorithm for tree detection and crown delineation. They used a repetitive least-squares fitting algorithm to make a Pollock model best for tree detection and crown delineation. They took high resolution satellite images as input for this research. The planned rule provides an answer to avoid difficulties to find the most effective set of parameters for every tree crown. The experimental results shows that the proposed technique gives considerable improvement in the detection rate with reduced computing time.

Baoxin Hu., [5] presented a research paper titled “Improving Individual Tree Delineation using Multiple-Wavelength Lidar Data” in 2016. They used multi-wavelength lidar information to enhance the improvement in individual tree crown delineation. The data employed in this study were obtained by an instrument with 3 completely different wavelengths: 500 nanometers, 1024 nanometers, and 1540 nanometers. Individual tree crowns function is the essential unit for several helpful activities like species identification, gap analysis, and volume estimation.

Linda Gulbe., [6] proposed a method for calculation and enumeration of tree crowns. In this paper, they present a new methodology for tree crown enumeration. High resolution data methods generally classified to three groups of fusion level: fusion at measurement level, at feature level and at decision level. Delineation algorithm used the in this methodology. It consists of two substeps: setting boundary points by inspecting transects and performing the algorithm that grows in the region.

Xiaojing Huang, et.al [7] proposed a method title as tree crown extraction and enumeration using optical satellite imagery. In this article, using image processing segmentation, they implemented a methodology to recognize individual trees through tree top identification, tree height and crown border delineation from satellite imagery. Using structure filter and increasing region technique, the tree crowns are smoothed. Finally, the crowns of the spherical tree are rebuilt. The method has been expanded across a wide region and has proved effective and reliable in delineating tree crowns.

3. Methodology

The process for extraction and enumeration of trees is as in methodology diagram is shown in Figure 1.

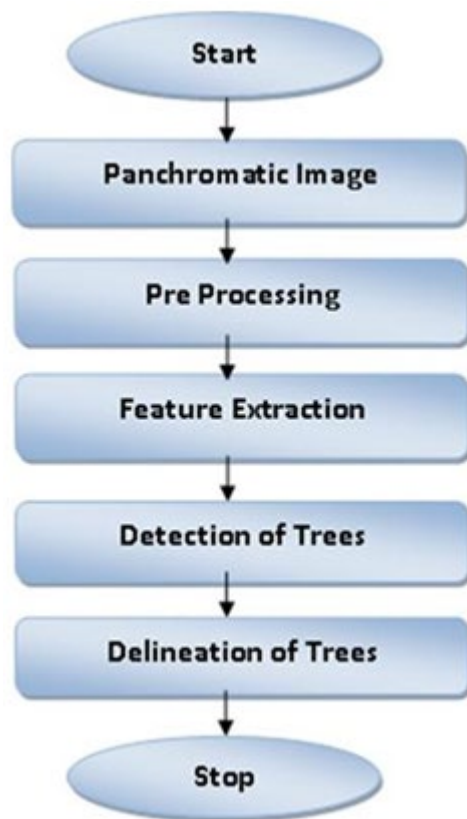


Figure 1. Overview of Proposed Methodology

The Proposed methodology consists of three phases for solving drawbacks of existing system, they are

- Panchromatic image or Data set Collection
- Pre processing
- Texture feature extraction
- Detection of Trees
- Delineation of Trees

3.1. Panchromatic Image / Data set

For experiment we used data set provided by NRSC Hyderabad, consisting of about 100 panchromatic images taken from a Cartosat-2 satellite. The image is of size 500×500 and of the file format .tif. In the proposed strategy, we used input images from the Chittoor and Chhattisgarh states in India taken from Cartosat-2 satellite information. A Sample panchromatic image is shown in Figure 2. By using ERDAS imagine software version 2015, we create our data set which is Cartosat-2 satellite data [13].

Digital panchromatic representational process of the surface is additionally made by some fashionable satellites, like fast Bird, Cartosat and IKONOS. This representational Process is very helpful, because it is usually of a way higher resolution than the multispectral representational process from constant satellite. For instance, the short Bird satellite produces panchromatic representational process having a component reminiscent of a district 0.6 m × 0.6 m (2 linear unit × two ft), whereas the multispectral pixels represent a district of 2.4 m × 2.4 m (8 linear unit × eight ft). Low Earth orbit satellites are usually military reconnaissance satellites capable of picking up tanks 160 km above Earth. They orbit the earth very fast, usually taking 90 minutes to finish one orbit.



Figure 2. Sample panchromatic image [13]

3.1.1. Cartosat-2 Satellite Data

In this research, Cartosat High Resolution Satellite Images are used for detecting and enumerating the no of trees available in the selected area of region. There is exists different types of satellite data from different types satellite.

The Indian Earth Observation Pro-gram has successfully introduced a series of Indian remote sensing satellites with coarse, medium and high resolution sensors over the previous three decades. The Cartosat-2 satellite has been introduced by ISRO since 2005 as the second domestic mapping satellite to provide data with a resolution of quite a

meter. Cartosat-2 may be a sophisticated remote sensing satellite capable of delivering scenic spot images and the Cartosat-2 satellite information requirements are listed in Table 1.

Cartosat-2 is an advanced satellite for remote sensing capable of offering scene-specific spot representation. The satellite's panchromatic camera will provide representational process with a spatial resolution of more than one meter and a 9.5 km swath.

Cartosat-2 uses several new techniques such as two single camera axis mirrors, carbon material reinforced plastic mainly based electro-optic design, and lightweight, huge size mirrors, data compression, sophisticated solid-state recorder, high-torque reaction wheels, and superior star sensors, spaced imaging or any direction.

Table 1. Stipulation of Cartosat-2 Satellite Data

Category	Remote Sensing
Curve	630.6 km 7008.745 km
Formal large axis	7008.745 km
Appeal	97.914 degrees
correct time	9:30 A.M
Repetitive	310 days
persistent	4/5 days

3.2. Pre processing

In this stage, the input pictures will be pre-processed to suppress undesirable distortions such as shadows and dark spots etc. and to improve image quality and image enhancement and segmentation techniques will be used in this stage to remove undesirable distortions such as shadows and dark spots etc. Preprocessing does not improve the content of picture data. After the improvement process has been completed, the specified improved picture will extract texture characteristics. These texture features are used for segmentation of texture, dividing the picture into a collection of disjoint areas based on texture so that each region is homogeneous to certain texture characteristics. For instance, object recognition, segmentation findings can be implemented for further image processing and analysis. The results of the segmentation can be implemented in order to further detect trees and to delineate trees. The required texture features are ASM, Contrast, Correlation, Entropy, Sum of Squares, Sum average, Sum variance, Sum Entropy, Difference of variance, Difference of Entropy, Information Measures of correlation, Maximum correlation coefficients.

If pre-processing pursuits to correct some degradation in the image, the nature of a priori records is important:

- The first group of strategies uses no information about the nature of the degradation; only very widely wide-spread houses of the degradation are assumed.

- A second group assumes understanding about the residences of the image acquisition device, and the prerequisites beneath which the photo used to be obtained. The nature of the noise is sometimes known.
- A third method uses understanding about objects that are searched for in the image, which may additionally simplify the pre-processing very considerably. If information about objects is now not accessible in improve it can be estimated in the course of the processing.

3.2.1. Image Enhancement

Image enhancement may be a technique that is widely employed in special effects. This procedure is conducted to alter the satellite image's brightness, contrast, or gray level distribution. The objective of image enhancement is to improve the interpretability or perception of the information for human spectators within the picture or to generate "better" feedback for various automatic image processing methods. This module discusses the construct of image enhancement, their approaches, and completely different techniques [15,16].

It indicates enhancing the visibility of any part or function of the picture that suppresses information in various components or choices. Data extraction techniques facilitate to induce the applied mathematics data concerning any specific feature or portion of the image. Currently, daily Image enhancement is applied within the field of medical imaging, analysis of satellite image, etc. The satellite image having insufficient data or having a lot of further data that is unwanted. It should scale back the background level by exploitation the enhancement technique and eliminate by exploitation some filtering techniques. Even filtering techniques area unit a vicinity of image enhancement techniques. These techniques area unit mentioned intimately and illustrated during this module. Image sweetening algorithms area unit applied.

To enhance the appearance of a picture for visual assessment by humans [3]. The main goal of picture enhancement is to alter an image's attribute to make it suitable for a specified job and a chosen viewer. Throughout this technique, one or many picture region unit characteristics have altered. This method is widely applied to geology images and accustomed to building it easier for visual interpretation and earth science understanding. The block diagram of enhancement process is shown in Figure 3.

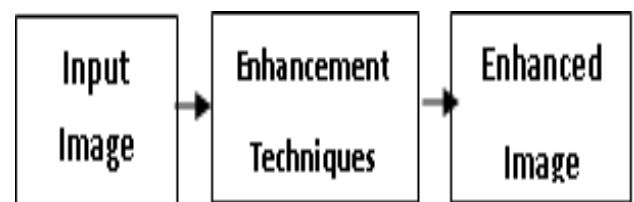


Figure 3. Enhancement Process

Most GIS and image processing software can find the most prevalent kinds of picture improvement instruments.

- Contrast Enhancement:
- Linear Stretch
- Histogram Equalization
- Density Slicing
- Edge Enhancement

Image Reduction strategies enable the analyst to attain a regional viewpoint of the remotely sensed data. The laptop display screen can't display the entire image on the display screen except decreasing the visual illustration of the image. It is in many instances regarded as zoom out. Image magnification is very useful strategies when the evaluation is attempting to reap the element information about the spectral reflectance or emittance traits of an incredibly small geographic location of hobby and it is also used to match the display scale of every other image. It is regularly regarded as zoom out.

Non-linear enhancements linear enhancements Image Enhancement Applied to greater effectively show or record the photograph statistics for subsequent visual interpretation. Two Image enhancements are designed exclusively to improve the image's appearance to assist in visual interpretation and evaluation. Examples of improvement characteristics include distinguishing stretching to increase the tonal difference between a range of scene characteristics and spatial filtering to decorate or suppress particular spatial patterns in a picture.

The key to enhancing perception differentiation is to apprehend the concept of a histogram of a picture. A histogram is a graphical illustration of a picture's brightness values. The values of brightness (i.e. 0-255) are displayed next to the graph's x-axis. The incidence frequency of each of these values in the picture is displayed on the y-axis. This involves the identification of reduction and top boundaries from the histogram and the use of a severe shift to extend this variety to fill the complete variety.

This enhances the image's differentiation with light-toned regions performing darker and lighter regions, making visual interpretation much simpler. This picture illustrates the make bigger in distinction in a picture earlier than (left) and after (right) Linear distinction stretch.

A. Image Enhancement Methods

There are some enhancements methods are used or applied in our proposed methodology. And we choose an algorithm which is best of among all, they are

- Contrast limited adaptive Histogram Equalization
- Contrast Enhancement
- Linear Contrast Enhancement
- Non-Linear Contrast Enhancement
→ Histogram Equalization

Our proposed methodology uses nonlinear enhancement technique. There are three types of nonlinear enhancement techniques

- Histogram Equalizations
- Adaptive Histogram Equalization
- Homomorphism Filter

B. Histogram Equalization

It is another non-linear distinction enhancement technique. It is one of the most useful strategies for nonlinear contrast enhancement. It generally will increase the world contrast of satellite images. It creates an output version of satellite for image which maximizes the distinction of the information via making use of a nonlinear contrast stretch that redistributes pixel values so that there is about the same range of pixels with every cost within a range. When the histogram values of the satellite for image are equalized, all pixel values of the picture are redistributed.

Histogram equalization can additionally separate pixels into distinct. The total variety of pixels is divided by using a variety of bins, equalling the variety of pixels per bin, as proven in the following equation-1.

$$A = \frac{T}{N} \tag{1}$$

Where,

N= number of bins.

T= total number of pixels in the image.

A= equalized number of pixels per bin.

C. Adaptive Histogram Equalization

In Adaptive histogram equalization the satellite image divides into several rectangular domains, compute an equalizing histogram and modify levels. This method enhances the contrast of images by transforming the values in the intensity image. Contrast is increased at the most populated range of brightness values of the histogram.

The best enhancement technique will be taken in our proposed methodology from these are all enhancement algorithms respectively. In enhancement process we use combination two methods for better performance of getting an image. They are Histogram equalization plus Binary Thresholding.

Algorithm: Histogram equalization + Binary Thresholding.

Input: Original Cartosat-2 Satellite Image.

Output: An image with Histogram Equalization + Binary Thresholding.

Pseudo Code:

1. Start
2. Read Satellite Image.
3. Split the image into tiles (based on the dimension of the Image) and Convert the input image into a gray image.
4. Find occurrence frequency for each pixel value i.e. an Image histogram (values for any gray scale image are in the Range [0, 255]).
5. Calculate all pixel values cumulative frequency.
6. The cumulative frequencies are divided by the total number of pixels and multiplied by the maximum pixel value in the image.

7. Apply Binary Thresholding for an image histogram in segmentation phase texture features are extracted using enhanced image and then image segmentation methods are applied for required enhanced image.
8. Repeat steps 2 to 7.
9. Stop

3.3. Texture Feature Extraction

The function is described as one or more measurements, each of which indicates the quantifiable property of an object and is calculated to quantify some of the important properties of the object. All characteristics can be grossly categorized into low-level and high-level characteristics.

These texture characteristics are used for segmentation of texture, dividing the picture into a collection of disjoint areas based on texture so that each region is homogeneous to certain characteristics of texture. For further image processing and evaluation, such as object recognition, the findings of segmentation can be implemented.

Segmentation results can be implemented to further trees identification and trees elicitation, respectively, trees delineation. The texture characteristics needed are ASM, Contrast, Correlation, Entropy, Sum of Squares, Sum Average, Sum variance, Sum Entropy, Variance Difference, Entropy Difference, Correlation Information Measures, and Maximum Correlation Coefficients.

The Gray-Level Co-occurrence Matrix for feature extraction appears to be a standard statistical method. The GLCM is a tabulation of how particular combos of gray pixel concentrations should appear in a picture on a regular basis. The aim is to assign one of a set of recognized texture classes to an unknown pattern image. Scalar numbers, discrete histograms or empirical distributions can be textured facets.

They mean the images' textural properties, such as spatial composition, contrast, roughness, orientation, etc., and have a positive correlation with the required output. Extraction of features is the technique of obtaining a picture's higher-level documents such as color, shape and texture. The texture is a main component of visible perception of human beings

Texture features are used to classification of enhanced image in our methodology they are [2]

- Correlation
- Contrast
- Angular Second Moment Feature (ASM)
- Sum of squares: variance
- Sum average
- Sum entropy
- Sum variance
- Inverse difference moment
- Difference variance
- Entropy
- Difference entropy
- Information measures of correlation
- Maximal correlation coefficient

These features all used in identifying objects or regions of an image. This set of parameters enables one to identify parameters of the texture.

Correlation:
$$\frac{\sum_{i=1}^{Ng} \sum_{j=1}^{Ng} (i-\mu i)Pd(i,j)}{\sigma i \sigma j}$$

Contrast:
$$\sum_{n=0}^{Ng-1} n^2 \sum_{|i-1|} Pd(i,j)$$

ASM:
$$\sum_i \sum_j \{P(i,j)\}^2$$

Sum of squares: variance:
$$\sum_i \sum_j (i - \mu)^2 P(i,j)$$

Sum average:
$$\sum_{i=1}^{2Ng} i Px + y(i)$$

Sum of entropy:
$$-\sum_{i=2}^{2Ng} Px + y(i) \log\{Px + y(i)\}$$

Sum variance:
$$\sum_{i=2}^{2Ng} (i - fg)^2 Px + y(i)$$

Inverse difference moment:
$$\sum_i \sum_j \frac{1}{1+(i-j)^2} P(i,j)$$

Difference of variance: variance of $Px - y$

Entropy:
$$\sum_{i=1}^{Ng} \sum_{j=1}^{Ng} Pd(i,j) \log(Pd(i,j))$$

Difference of entropy:
$$-\sum_{i=0}^{Ng-1} Px - y(i) \log\{Px - y(i)\}$$

Information measures of correlation:
$$\frac{HXY - HXY1}{\max(HX, HY)}$$

Maximal correlation coefficient: (second largest high

variance Q^2 where $Q(i, j) = \sum_k \frac{P(i,j)P(j,k)}{Px(i)Py(k)}$

3.4. Detection of Trees

A common bottleneck for GIS applications is the huge amount of data that you want to process. The bottleneck is largely substantial when involving monitored education. Training a pixel-level classifier in our strategy needs guidance to create ground-truth tree masks. If it takes a massive proportion of the data to train a discriminative classifier, it will be prohibitively expensive to use the manual work required to process the entire globe.

In this chapter, we discuss the scalability of classification of texture-level and advocate techniques for selecting mannequin and training facts in order to reduce the percentage of facts used for training while at the same time achieving true looking precision.

Take the classification of the tree, for instance, if a geographical region includes a lake, but none of the opinions of the lake appear in the training data, then the classifier is likely to perform badly on the lake because it looks more similar to tremendous samples (trees) than adverse ones (ground, houses, etc.).

On the other side, if we amplify the geographical location to big land coverage, the range of geographical characteristics (e.g., soil, grass, trees, houses, lakes, etc.) will develop at a decreasing pace owing to the reality that

the total amount of geographical characteristics in the site is very limited as opposed to the region.

Algorithm: Histogram equalization + Binary Thresholding + Canny Edge detection

Input: Enhanced Image.

Output: An image with Histogram Equalization + Binary Thresholding + Canny Edge Detection.

Pseudo Code:

Step1: Start

Step 2: Read Satellite Image.

Step 3: Divide the picture into tiles (depending on the picture aspect) and convert the picture input into a gray picture.

Step 4: Find occurrence frequency for each pixel value i.e. an Image histogram (values for any gray scale image are in the Range [0, 255]).

Step 5: Calculate all pixel values cumulative frequency.

Step 6: The cumulative frequencies are divided by the total pixel number and multiplied by the image's maximum pixel value.

Step 7: Apply Binary Thresholding for an image histogram.

Step 8: Repeat steps 2 to 7 until the number of the trees was acquired.

Step 9: Stop

3.4. Delineation of Trees

In this, the total number of trees was calculated, after completing the detection and elicitation of trees respectively. In this, the suggested methodology for improving the method of enumerating urban area trees and extracting easy texture characteristics from panchromatic picture.

Evaluation of the delineation of trees will be performed after the classification of textures feature classification. Whatever an algorithm used in our suggested methodology assumes a connection occurs between tree crown number and. The texture characteristics of an input respectively.

Identification and delineation of individual tree crowns is useful for estimating tree crown size, crown closure, and facilitates classification of textures features. In addition, such methods improve the derivation of interest parameters for urban inventories such as limits, etc. Other parameters, such as tree crown characteristics and dimensions, can also be obtained readily. In the same time span, the distance measure algorithm was used to assess the tree crown of individual trees on greater resolution imagery. Finally, a framework for the delineation of trees will be built effectively after delineation of trees.

4. Results and Analysis

In the tree delineation methodology, 1 meter Resolution Cartosat-2 models of distinct sample dimensions and places are used and percentage deviation is calculated and tabulated for all sample images as shown in Table 2. Our suggested algorithms are therefore appropriate for the identification

and delineation of trees as they are tested and validated on the information set above. In this phase, we are considering an input image from Chittoor region and image processing methods are applied to an input image respectively [13]. After completing the framework for delineation of trees, we are successfully enumerates the total number of trees of urban area respectively.



Figure 4. Input Image of Chittoor region [13].

The Figure 4 describes input image of Cartosat-2 satellite data in our methodology. The picture input includes a resolution of One meter and height and width of 500 * 500 respectively. This image input will perform the enhancement process.

4.1. Enhancement- Pre processing- Histogram Equalization

Image enhancement is a fundamental and crucial image processing technique used to improve a picture's structural appearance without losing data in a digital image. When noise and other artifacts are handled in an image, the process is completed in Figure 5. In this step, histogram equalization algorithm was used.



Figure 5. Enhanced Image.



Figure 6. Tree Detection.

4.2. Extraction of Trees- Histogram Equalization + Binary Thresholding + Canny Edge Detection.

Image segmentation is a crucial image processing technique used to detect boundaries or edges of an image as shown in Figure 6. It follows two principles: the first is to separate the image into distinct components and to reliably extract the components to be analyzed and the second is to depict changes in the picture.

4.3. Delineation of Trees

In Figure 7, it shows the extracted trees of input image. The extracted trees are used to calculate the total number of trees, tree crown size and height.

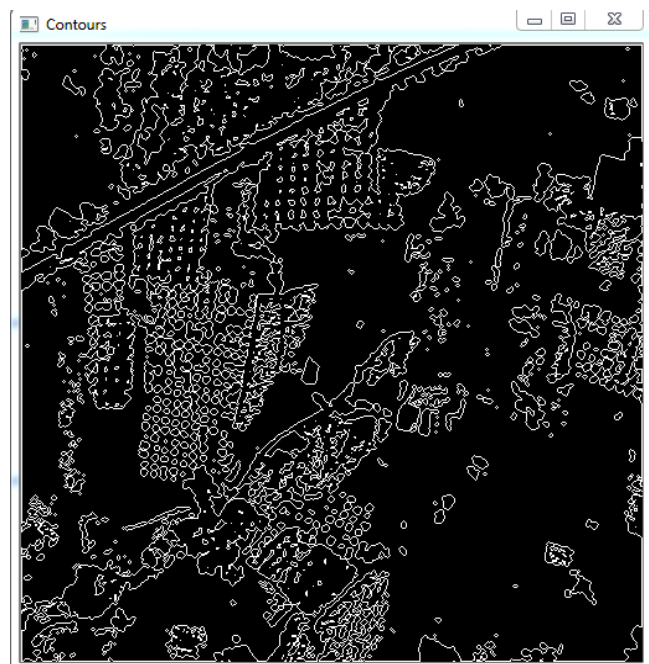


Figure 7. Delineation of Trees.

4.4. Counting Total Number of Trees

The Table 2 consists of different parameters they are, 1m resolution Cartosat-2 image, Size of the input image, Original tree count, proposed tree count, existing tree count, accuracy of proposed tree count, respectively. The values in the proposed tree count column outcome of our proposed method (delineation of trees). Existing tree count specifies the count of the trees, when we are using existing algorithms like CLAHE, Contrast enhancement. But, in our proposed methodology we use new algorithms they are, Histogram equalization + Binary and Histogram equalization + Binary Thresholding + Canny Edge detection Thresholding. When compared to existing tree count and proposed tree count, we observe a difference in accuracy of two phases. Finally, proposed algorithms presents considerable improvement in accuracy compared to existing algorithms.

Table 2. Performance Accuracy Measurement.

Carto sat-2 Image 1m Resolution	Size of the Input Image	Original Tree count (Manual)	Proposed Tree Count	Existing Tree Count	Accuracy of Proposed Tree Count %
test1.tif	500x500	425	418	394	98
test2.tif	500x500	600	574	532	95
test3.tif	500x500	175	168	152	96
test4.tif	500x500	421	412	402	94
test5.tif	500x500	517	502	494	95.25
test6.tif	500x500	310	294	260	94.8
test7.tif	500x500	240	215	200	94
test8.tif	500x500	331	315	302	96.32
test9.tif	500x500	392	375	320	97.15
test10.tif	500x500	412	404	380	95
test11.tif	500x500	273	268	248	98.23
test12.tif	500x500	312	307	280	97.45
test13.tif	500x500	439	419	373	96
test14.tif	500x500	623	618	589	98.26
test15.tif	500x500	451	429	415	95.12
test16.tif	500x500	541	517	426	95.56
test17.tif	500x500	1148	1130	1024	99.12
test18.tif	500x500	2019	1996	1935	98.86
test19.tif	500x500	1632	1612	1599	98.77
test20.tif	500x500	1123	1104	1098	98.63
test21.tif	500x500	1064	1047	1025	96.25
test22.tif	500x500	1132	1115	1110	97.46
test23.tif	500x500	1637	1620	1598	98.65
test24.tif	500x500	242	225	198	97.51
test25.tif	500x500	231	217	182	97.66
test26.tif	500x500	375	366	340	98.26
test27.tif	500x500	456	445	421	95.12
test28.tif	500x500	428	418	382	95.56
test29.tif	500x500	874	868	820	99.12
test30.tif	500x500	526	515	498	98.86
test31.tif	500x500	584	573	515	98.77
test32.tif	500x500	245	238	217	98.63
test33.tif	500x500	258	242	222	96.03
test34.tif	500x500	624	617	594	98.87
test35.tif	500x500	248	237	215	95.56

test36.tif	500x500	2468	2447	2436	99.14
test37.tif	500x500	647	633	612	97.83
test38.tif	500x500	894	887	216	95.25
test39.tif	500x500	512	498	452	94.8
test40.tif	500x500	248	240	218	94
test41.tif	500x500	248	232	217	96.32
test42.tif	500x500	278	267	237	97.15
test43.tif	500x500	854	237	218	95
test44.tif	500x500	897	866	825	98.23
test45.tif	500x500	817	804	784	97.45
test46.tif	500x500	647	636	601	96
test47.tif	500x500	578	566	506	95.25
test48.tif	500x500	598	582	545	94.8
test49.tif	500x500	684	672	641	94
test50.tif	500x500	597	587	542	96.32
test51.tif	500x500	524	515	485	97.15
test52.tif	500x500	556	542	512	95
test53.tif	500x500	554	547	510	98.23
test54.tif	500x500	278	264	224	97.45
test55.tif	500x500	984	977	936	96
test56.tif	500x500	267	256	216	98.26
test57.tif	500x500	634	615	602	95.12
test58.tif	500x500	688	674	632	95.56
test59.tif	500x500	2124	2105	1085	99.12
test60.tif	500x500	1784	1764	1732	98.86
test61.tif	500x500	1742	1737	1714	98.77
test62.tif	500x500	248	238	212	98.63
test63.tif	500x500	146	140	125	96.25
test64.tif	500x500	158	152	124	97.46
test65.tif	500x500	167	159	135	98.65
test66.tif	500x500	647	639	615	97.51
test67.tif	500x500	652	644	616	97.66
test68.tif	500x500	712	707	682	98.26
test69.tif	500x500	1485	1478	1436	95.12
test70.tif	500x500	1654	1640	1612	95.56
test71.tif	500x500	1785	1775	1724	98.23
test72.tif	500x500	1689	1678	1624	97.45
test73.tif	500x500	1634	1624	1601	96
test74.tif	500x500	1549	1529	1504	98.26
test75.tif	500x500	635	618	582	95.12
test76.tif	500x500	2456	2452	2405	95.56
test77.tif	500x500	891	887	815	99.12
test78.tif	500x500	1264	1260	1245	98.86
test79.tif	500x500	1348	1338	1312	98.77
test80.tif	500x500	1249	1239	1214	96.03
test81.tif	500x500	1235	1228	1210	98.87
test82.tif	500x500	1248	1235	1214	95.56
test83.tif	500x500	1278	1270	1245	99.14
test84.tif	500x500	1354	1350	1312	97.83
test85.tif	500x500	1785	1775	1740	95.25
test86.tif	500x500	1085	1078	1012	94.8
test87.tif	500x500	1604	1590	1527	94
test88.tif	500x500	1356	1352	1312	99.70
test89.tif	500x500	1450	1442	1416	99.45
test90.tif	500x500	1603	1598	1535	99.64
test91.tif	500x500	1403	1398	1326	99.87
test92.tif	500x500	1302	1294	1264	98.96
test93.tif	500x500	1204	1185	1123	98.35
test94.tif	500x500	1058	1042	1012	97.36
test95.tif	500x500	1080	1078	1025	98.45
test96.tif	500x500	1608	1602	1598	99.62
test97.tif	500x500	1204	1200	1156	99.66
test98.tif	500x500	1048	1036	1012	98.85
test99.tif	500x500	1263	1258	1238	99.26
test100.tif	500x500	1270	1255	1212	98.81

5. Conclusions and Future Scope

An intelligent system for delineation of trees was developed in this paper. Firstly, the framework takes the input as an image which is captured from satellite; it may take different resolutions like 1m, 2.5m, 30m etc.. Among all resolutions, we take 1 meter resolution in our framework for analysis. The Input satellite image is undergone with some pre-processing and image enhancement process to improve the quality of the image. In this framework histogram equalization algorithm was used for enhancing the image. For better analysis of result, segmentation is performed i.e. here; in our framework segmentation is nothing but tree detection phase with active contour model and detection of tree crowns is generated using thresholding, canny edge detection method respectively. Counting number of trees or tree crowns depends on the pixels by using Thresholding technique. For experiments are done on 100 panchromatic images taken from a Cartosat-2 satellite of the file format .tif, provided by National Remote Sensing Centre (NRSC), Hyderabad. The results show that the proposed framework is giving better results with an average accuracy of 97%. As a future scope, Texture feature are used for classification of image data into more readily interpretable information which we use in image retrieval medical imaging, remote sensing and industrial inspection.

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