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## INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/16075  
DOI URL: <http://dx.doi.org/10.21474/IJAR01/16075>



### RESEARCH ARTICLE

#### DETECTION AND EXTRACTION OF VEGETATION AREA FROM SATELLITE IMAGES

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#### Manuscript Info

##### Manuscript History

Received: 25 November 2022  
Final Accepted: 27 December 2022  
Published: January 2023

##### Key words:-

Tree Crown Detection, Vegetation,  
Satellite Images, NDVI, Segmentation

#### Abstract

The overall growth of the population and continuing migration to urban increases the demand to meet sustainability in the city. Further, urbanization increases the development of buildings and reduces vegetation. This study focuses on detection and extraction of vegetation in urban using image processing from high resolution satellite images. Here, in this paper four steps are used to detect the tree crown, Detection of the Vegetation area and masking of the Non-vegetation area, the clustering of the input image, The GLCM of Texture analysis algorithm is used to find the hard and smooth surface of the vegetation area in the image. Finally, vegetation area is extracted by using a region-based segmentation process.

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#### Introduction:-

Study of urban vegetation area plays an important role in city development. Detection of vegetation is an imperative and challenging task that involves a substantial investment in time and resources. The traditional method involves manually counting the trees which is time consuming and expensive. However, high resolution satellite images will have more information to find the tree crown in the forest area and in an urban area <sup>[1]</sup>. Also, remote sensing is helpful in providing the different types of algorithm and technique to detect vegetation area.

Detection and extraction of urban city vegetation is an interesting topics for the researches. Because vegetation plays an important role in nature it prevents the obliteration and afford living quarters to ecosystem <sup>[2]</sup>. Trees release the fresh oxygen gas in the large quantity and decrease the quantity of carbon dioxide gas presenting in the atmosphere. Vegetation which indirectly controlling the temperature of Earth surface and weather conditions. However, now a days the amount of vegetation area decreases because of growth of the city like industrialization, Modernization and Urbanization. Decrease in vegetation area which lied to increase in the natural ruins like global warming, hole in ozone layer, acid rain, floods, earth quake and volcanic eruption <sup>[3]</sup>. Hence, this work explains the detection and extraction of trees in selected or particular land using the image processing algorithms.

Bangalore was once called the garden city of India, now it is regarded as Silicon Valley of India. This metropolis contain huge amount of lake like Kalkere lake, Ulsoor lake, Hebbal lake etc., Green forest like Bandipur National Forest, hills like Nandi Hills and garden like Cubbon park and Lalbagh. Here, in this work the image of Peenya and Nagarabavi which is a small part of Bangalore in Karnataka, India is taken as the study area to analyse the vegetation.

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The study of tree extraction have attracted many researchers to identify and detect the individual tree crown automatically or semi-automatic combined with other methods to improve the performance. Remote sensing finds an important role in individual tree detection, combination of remote sensing and local maxima filtering to improve the accuracy of detection [4]. Geometrical optical (GO) model integrated with marked point process and template matching that can simulate angular disparities of remote sensing gestures from the surface of earth with the stochastic process of selecting the size and number with marked point process and template matching have achieved the performance of 82% [5].

Supervised and unsupervised methods in deep learning is an emerging field used in remote sensing applications. Detection of tree in urban rely on identification and extraction of individual tree crown from images. However, there are less research in unsupervised tree detection in RGB images [6]. There are considerable research in object detection using deep learning, which is the emerging field used in wide variety of applications to detect, recognize and analyze objects. In particular mask region based convolutional neural network can automate the detection of tree crown [7]. The main challenge in deep learning is the requirement of large data to train, integration of deep learning with instance segmentation reduce the data sets for training and automate the delineation of tree crowns [8].

Aerial images is another source which covers a large search area and enables the detection of structure of the forest based on tree using the high special resolution images acquired using UAV. The canopy height model. UAV photogrammetric point clouds was adopted to define and detect the trees in the woods [9]. Principal Components Analysis (PCA) is used to get the proper image of single band. Principal Component Analysis is utilized to convert a group of images addicted to a new group of images with a slight correlation among them. The most variance appearance in the first component and each consecutive component contain very less variance than the lastly presented components [10].

**PaperOutline:**

The rest of the paper is summarized as follows, section 2 gives the brief description of the method adopted to detect and extract the tree crown in the urban area, which follows the illustration of experimental results in section 3. Finally, section 4 concludes the proposed vegetation area detection.

**Methodology:-**

The steps used to detect and extract the vegetation area is represented in block diagram form and is given in figure 1. It consists of four steps namely, Pre-processing, Clustering, Segmentation and Feature Extraction each step is explained in detail below.

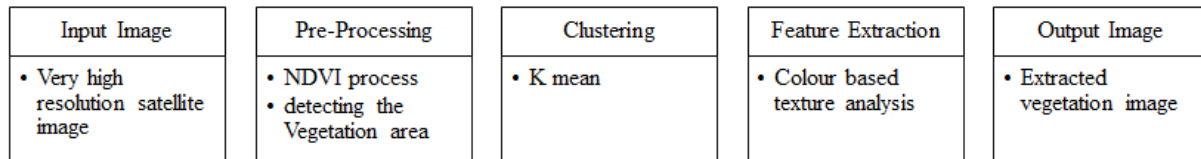


Fig. 1:- Steps to detect the vegetation area.

**Pre-Processing:**

The high resolution satellite image contains errors associated with geometry values of image pixels and brightness. These errors are exacted using proper mathematical models which are either statistical or definite models. However, image pre-processing is the initial lower stage of operation of the abstraction of the image. Here, high resolution satellite image is taken as an input image and is resized to 512 x 512 image size. After resizing the NDVI (Normalized Difference Vegetation Index) is applied to get the vegetation area. Now, this NDVI image is subjected to further process.

**NDVI and SI spectral indices:**

The NDVI is the ratio of difference between NIR (Near-Infrared) band and red band (R) and sum of these two bands.

$$NDVI = \frac{NIR - RED}{NIR + RED} \tag{1}$$

The NIR and RED are values of pixels. Where RED and NIR represents visible red band and near-infrared band respectively. The algorithm of NDVI take the assistance of datum that green vegetation reflects lesser visible light and more near infrared. However, less or sparse green vegetation area indicate a larger part of visible and fewer near-infrared. The NDVI joins these reflectance description in a ratio so it's an index associated to capacity of photosynthetic. Collection of values achieved is among -1 and +1. Only +ve values correspond to vegetation area; larger the index, larger the content of chlorophyll target [12].

### K-Means clustering:

K-mean algorithm classifies input points into k initial groups, either using random data or some experiential information. Then, it computes centroid or mean point of every group. A new partition will be built by connecting every point with the closer centroid. Further, the centroids are again evaluated for novel clusters, and the steps has to be repeated till it converge. The following steps explains the k means clustering.

- i. To form K clustering nodes, firstly at random spaces consider 'k' centroids
- ii. From centroid to every node point, calculate the Euclidian distance to generate 'k' initial clusters.

The difficult lies here is to get k- clusters from the nodes by searching k-centroids using least difference clustering.

The k centroids  $\{m_j\}$   $k, j = 1$  in  $R^d$  such that,

$$\left(\frac{1}{n}\right) \times \sum \left( \min d^2 (X_i, m_j) \right), \text{ for } i = 1 \text{ to } n, \quad (2)$$

Where  $(X_i, m_j)$  indicates Euclidean distance among  $X_i$  and  $m_j$ . However the points  $\{j\}$   $k_i = 1$  are called as cluster means or centroids of cluster

- iii. Again calculate the position of centroids at every cluster and find the position changes from the earlier one.
- iv. If in case the position is changed in any one of the centroid then repeat step 2, otherwise complete the cluster and progression in clustering ends by the nodes of cluster into l cluster number. The clustering algorithm is given below

#### Algorithm: K-mean Clustering

<p>Step 1: Start  Step 2: Initialize cluster Centre  Step 3: Attribute the each data point in the closest cluster  Step 4: Set location of each cluster to the mean of all points of data belonging to that cluster  Step 5: Repeat steps 2-3 until union  Step 6: Stop</p>
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### Segmentation:

Suppose various tree species are position near to each other, the difference within a tree crown of the tree is less than dissimilarity between various trees. Here, in this work region growing method of segmentation is used to identify the tree crown [11]. The challenge in region growing relies on proper selection of seed points. However, the criteria required for proper selection of seed point is

- 1) Seed pixel should contain higher similarity to its neighbours.
- 2) To create a region, minimum of one seed should be produced from every predicted region.
- 3) If dissimilar in the Seeds regions should be disconnected.

The following procedure is adopted for calculating the similarity of a pixel to its neighbors.

Considering 3 x 3 neighborhood the standard deviations of  $Y$ ,  $C_b$  and  $C_r$  elements are evaluated by using equation (3)

$$\sqrt{\frac{1}{9} \sum_{i=1}^9 (x_i - \bar{x})^2} \quad (3)$$

In equation 3 ' $\bar{x}$ ' can be  $Y$ ,  $C_b$ , or  $C_r$ ; the mean value  $\bar{x} = \frac{1}{9} \sum_{i=1}^9 x_i$ .

The total standard deviation is given in equation 4

$$\sigma = \sigma_y + \sigma_{C_b} + \sigma_{C_r} \quad (4)$$

Normalizing the standard deviation to [0, 1] by

$$\sigma_N = \frac{\sigma}{\sigma_{max}} \quad (5)$$

Where  $\sigma_{max}$  indicates the maximum standard deviation in image, further the similarity between the neighboring pixels is defined by  $H=1-\sigma_N$

The condition for seed pixel selection based on similarity is given below.

- a. Firstly, the value of the seed pixel should be greater than the threshold, secondly the relative Euclidian distance (in terms of  $YC_bC_r$ ) of a pixel to its eight neighbours is calculated using equation 6

$$d_i = \frac{\sqrt{(Y - Y_i)^2 + (C_b - C_{b_i})^2 + (C_r - C_{r_i})^2}}{\sqrt{Y^2 + C_b^2 + C_r^2}} \quad (6)$$

Through experiments, it is observed that the performance of relative Euclidean distance is better than normal Euclidean distance. Also, the distance of every pixel with its neighbors is evaluated using equation 7

$$d_{max} = \max_{i=1}^8 (d_i) \quad (7)$$

- b. A candidate seed pixel should contain more relative Euclidean distance to its 8 neighbours lesser than a value of threshold. Further, a pixel is categorised as seed pixel only if it satisfies the above mentioned conditions. However, otsu's technique is used to select the value of threshold robotically for condition 1. The maximum discrimination criterion  $\frac{\sigma_b^2}{\sigma_w^2}$  is used to determine the threshold value. Here,  $\sigma_b^2$  represents between class variance

and  $\sigma_w^2$  indicates within class variance. For 2<sup>nd</sup> condition, the threshold value of 0.05 is chosen based on experiments. Every seed pixels of associated component is considered as single seed. Hence, the seeds produced may be single region or one pixel with some pixels. 1<sup>st</sup>Condition verifies whether seed pixel contain higher similarity to its neighbours. 2<sup>nd</sup>condition ensures the selected seed pixel is not the boundary pixel [2].

**Feature extraction by GLCM:**

Every tree has its unique texture features, Texture is one of the most important feature of the trees. Here, in this work Gray Level Co-occurrence Matrix algorithm is used to extract the features from input images. The algebraic relation of Co-occurrence matrix is given by,

$$C_{\Delta_x, \Delta_y}(i, j) = \sum_{p=1}^n \sum_{q=1}^m \begin{cases} 1, & \text{if } I(p, q) = i \text{ and } I(p + \Delta_x, q + \Delta_y) = j \\ 0, & \text{otherwise} \end{cases} \quad (8)$$

The Co-occurrence matrix is defined by C, ( $\delta_x, \delta_y$ )

Where,  $\delta_x$  and  $\delta_y$  indicates the parameterized offset of input image  $m \times n$ . The equation related to frequency is given by 8

$$\begin{aligned} P(i, j, d, \theta) &= \{ (x, y), (x + D_x, y + D_y) | f(x, y) = i, \\ &= \{ (x, y), (x + D_x, y + D_y) | f(x, y) = i, f(x + D_x, y + D_y) = j \} \end{aligned} \quad (9)$$

Where  $P(i, j, d, \theta)$  denotes frequency at the position  $(x + D_x, y + D_y)$ .

$i$  and  $j$  are intensity levels with distance  $d$  from pixel at location  $(x, y)$ . Further,  $\theta$  is taken in all four directions  $0^\circ, 45^\circ, 90^\circ, 135^\circ$ . Normalization has to be achieved on  $P(i, j, d, \theta)$  once certain direction is attained by GLCM. Normalization of  $P(i, j, d, \theta)$  is given by,

If  $\theta$  is  $0^\circ$ , R is considered as  $(M-1) \times N$  (10)

If  $\theta$  is  $90^\circ$ , R is considered as  $M \times (N-1)$  (11)

If  $\theta$  is  $45^\circ$ , R is considered as  $(M-1) \times (N-1)$  (12)

### Experimental Results

The proposed technique is validated by considering high resolution satellite image of Nagarbhavi and Peenya, which is a small part of Bangalore the capital city of Karnataka, India. By subjecting the high resolution satellite images as an input the simulation results obtained is presented in this section. Some part of input image is cropped and taken for further process, the input image and cropped image is given in Figure 2 and figure 3 respectively.

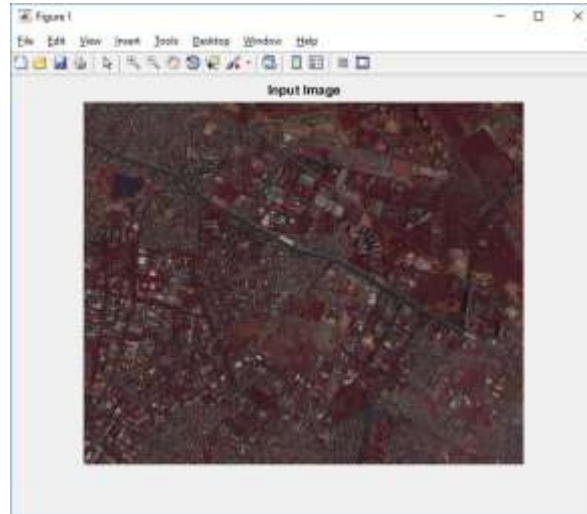


Fig2:-Input Image.

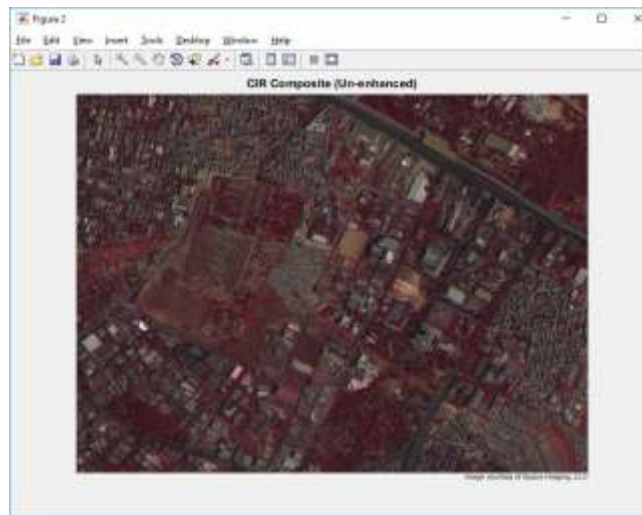


Fig3:- Cropped Image.

The cropped image is pre-processed by using the NDVI. The CIR composite image with de-correlation stretch obtained is given in Figure 4. Which is an image of RGB which consist of the false colour. The image appeared in NIR band is indicated by red colour and red band by green colour, the green colour is indicated by blue colour. Water bodies features which are presented in the CIR images which appear like very dark (river) and the area appears red in colour (parks and trees).

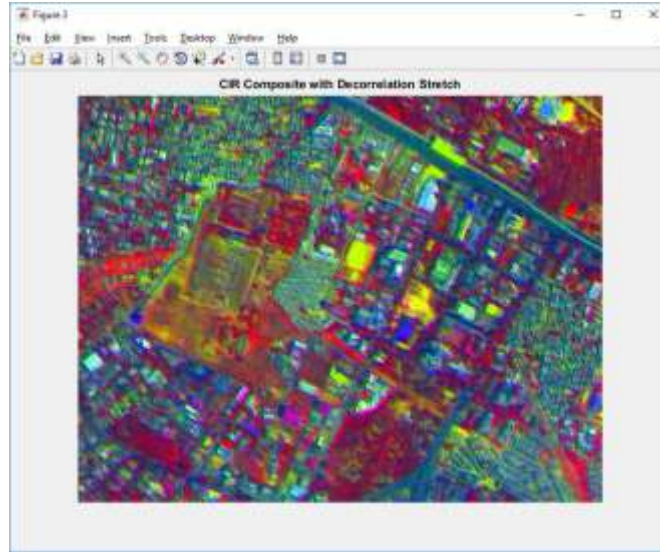


Fig 4:-CIR Composite Image.

In color infrared (CIR) composite image the features surface have become more apparent and it appear like more colorful image. Since, the differences in spectral crossways the scene had been inflated and increased in contrast. Moreover, the image emergence is because of the presence of content like chlorophyll-rich, healthy, vegetation has a higher reflectance in near infrared. Due to mapping near infrared band into channel in composite as red band, any area with higher vegetation are a mass looks which display the red color. Figure 5 and 6. Depicts the visible band image and near infrared band (NIR) respectively.

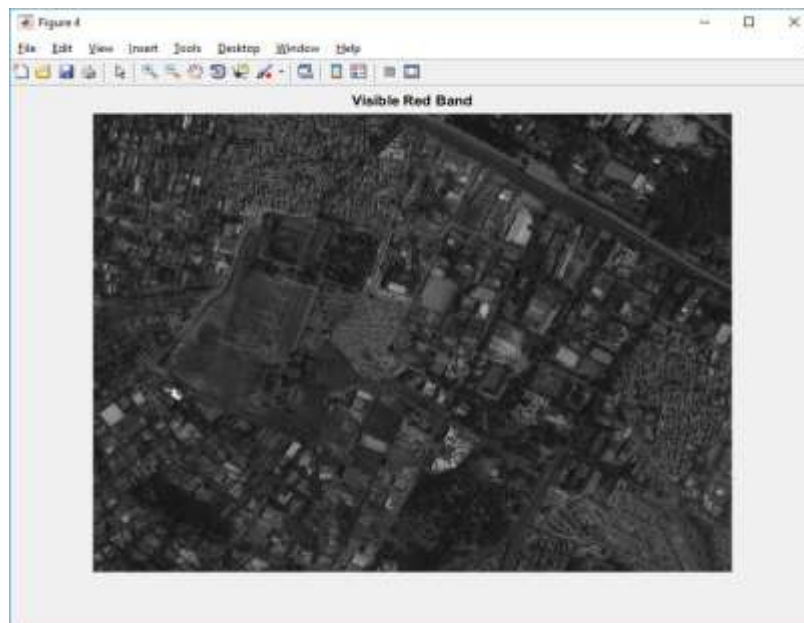


Fig 5:- Visible Red Band.

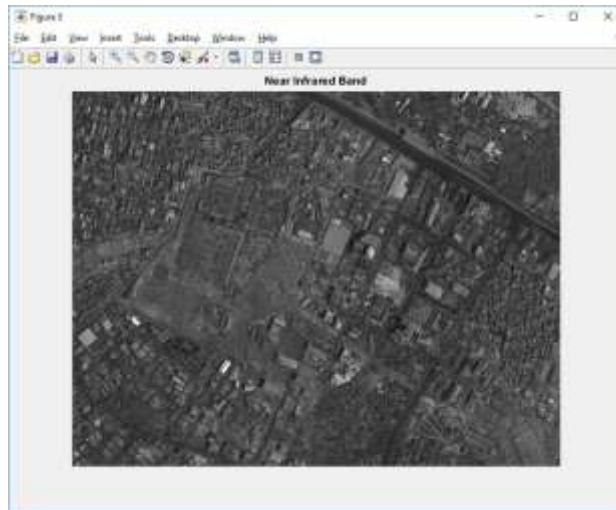


Fig 6:- Near Infra-Red Band.

After pre-processing the resultant image is NDVI image. Threshold value is applied to NDVI image to divide vegetation area from the image which is given in figure 7 and 8.

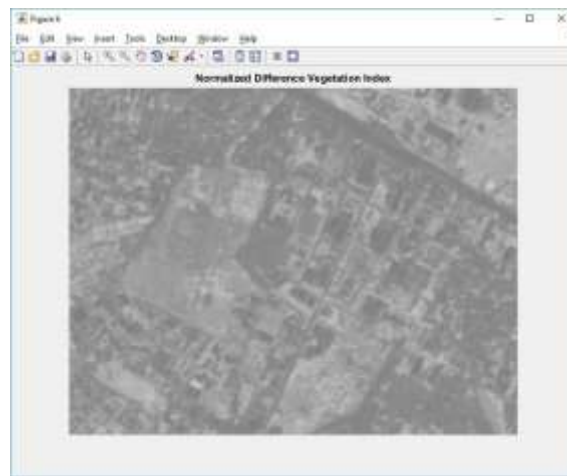


Fig.7:- NDVI Image.

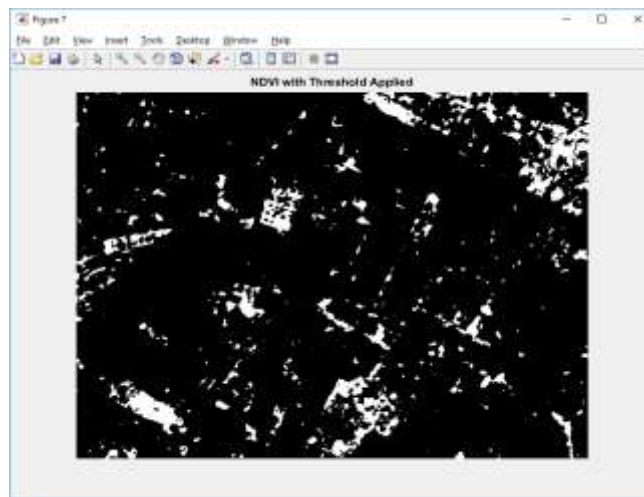
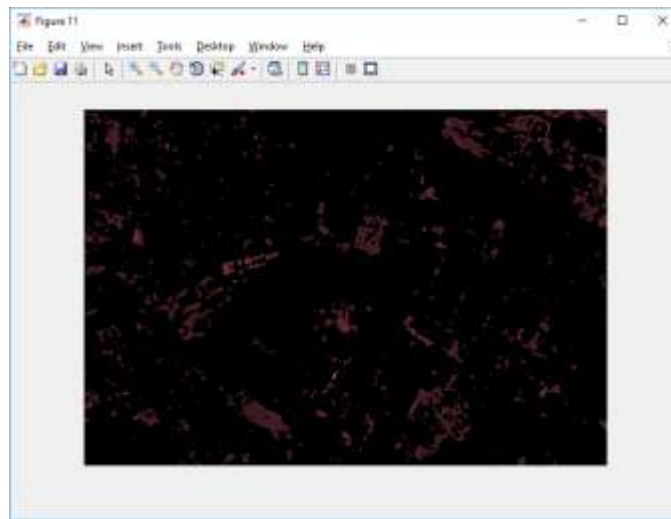


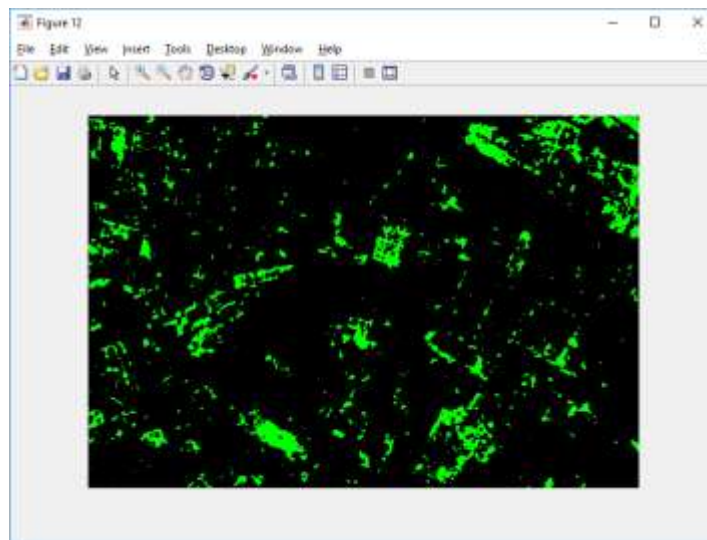
Fig. 8:- NDVI with threshold.

The next stage is to cluster the image. K-Mean clustering is used in this work. Color based region growing technique is adopted to extract the regions of similar color. Once the regions are identified the detected trees are given in figure 9.



**Fig 9:-**Detected trees.

Finally using the GLCM (Gray Level Co-occurrence Matrix) features are extracted and is given in figure 10.



**Fig 10:-**Vegetation Extracted Output Image.

### **Conclusion:-**

Detection and extraction of vegetation in urban area is presented in this work. To demonstrate the performance of the work, the paper focused on detection and extraction of tree crown in an urban environment. The vegetation area in Nagharbhavi and peenya which is a small part of Bangalore the capital city of Karnataka, India is extracted from high resolution satellite imagery. In first phase pre-processing technique that is NDVI is used to detection of vegetation area. Secondly, the clustering formation is done and then colour based region growing technique of segmentation is used. Finally, by using texture analysis the tree crowns are extracted. The experimental results demonstrates that the proposed method detects and extracts the tree crown efficiently.

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