1. Introduction

The analysis of satellite images has great impacts on several areas of life such as urban planning, nature monitoring, agriculture, change detection, military applications. The traditional roaming field-work of biological surveys and ecological monitoring can be efficiently changed by visual evaluation of airborne or satellite images. In this case the visual observer has to evaluate the image pixels (or blocks of pixels) and recognize the different objects such as buildings, trees, fields, water, etc. This human based classification requires some professional expertise but can also be solved by machine vision techniques if multispectral information is utilized. Airborne images are also available only for some given locations while almost the whole Earth is covered by satellite images freely available. In our research we try to substitute an existing manual method, used for the estimation of urbanization, using only visual photographic satellite images and marginal manual work.

The effect or urbanization can be observed by several natural phenomena. Liker et al uses data records of more than 10 years to investigate the change of weight, size, and condition of birds along the urbanization gradients. They observed house sparrows but other living beings or other natural or artificial phenomena can be the target of research of environmentalist or other researchers. In the birds from areas of different urbanization are compared considering the relation between their condition and competitive behaviour. In the urbanization of a region is estimated with the help of the ratio of buildings, vegetation and roads

This Project Report describes the Estimation of Urbanisation of an Area Using Image Segmentation Technique with briefly presenting its input and output functionalities. This would give an overview to the client about the development of an area and also give a detail specification for the developer.

Urbanisation means an increase in the proportion of people living in urban areas compared to rural areas. An urban area is a built-up area such as a town or city. A rural area is an area of countryside. It refers to the population shift from rural to urban areas, "the gradual increase in the proportion of people living in urban areas", and the ways in which each society adapts to the change. It is predominantly the process by which towns and cities are formed and become larger as more people begin living and working in central areas. Previous literature measures the extent of urban areas using household-survey-based socio-economic data, night-time lights, and mobile-phone records which requires some professional expertise for estimation.

Almost whole earth is covered by satellite images freely available. Our purpose is to develop the application to estimate the urban area with an algorithm used for the automatic classification of satellite images. In our project we will classify Built-Up (BU) and Non Built-Up Area (NBU), and use some techniques for vegetation extraction and building detection, which will result in the urbanization of an area.

The analysis of satellite image has great impact on several areas of life such as urban planning, nature monitoring, agriculture, change detection, military application.

2. Objectives

- Classification of Built-Up and Non Built-Up areas based Image Segmentation Technique.
- Extraction of vegetation from aerial image using Image Segmentation and Clustering Technique.
- Extraction of building from high resolution satellite image using various Detection and Transformation Technique.
- Graphical representation of Urbanization of an area.

3. Software Requirements Specification

3.1 Overview

This section deals with the overall description about the product while describing the product perspective, functional and data requirements, input and output data, general constraints and assumptions of the application briefly. Section 3 gives the detailed description about the functional and non-functional requirements of the application.

3.2 Overall Description

3.2.1 Product Perspective

The System is intended to substitute the time consuming and exhausting manual work with an Application to estimate the urban area with an algorithm used for the automatic classification of satellite images. The application will classify Built-Up (BU) and Non Built-Up Area (NBU), and use some techniques for vegetation extraction and building detection, which will result in the estimation of urbanization of an area. While our approach has ecological motivations it can be used for other surveys such as change detection, Deforestation, may help government to know, which part of the country they should take care more for the development in terms of infrastructure as the Budget of government is fixed.

3.2.2 Methodology

The application includes pre-processing of Aerial Image and followed by various image segmentation techniques. After pre-processing vegetation extraction using Normalized Difference Vegetation Index (NDVI). Then building extraction is done using edge and corner detection and Hough transformation. Then classify the different parts of image into Built-Up & Non Built-Up Area. Then clustering is done for image enhancement using K-Nearest Neighbour Clustering. At last we will represent the estimation of vegetation and building in terms of graphs.

Each step is further described below in detail: -

Vegetation Extraction: - A basic way to extract vegetation from remotely sensed data such as satellite or aerial imagery is to calculate the Normalized Difference Vegetation Index (NDVI) followed by thresholding the NDVI. Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1); however, no green leaves gives a value close to zero. A zero means no vegetation and close to +1 (0.8 – 0.9) indicates the highest possible density of green leaves.

Building Extraction: - In automated analysis of digital images, a sub problem often arises of detecting simple shapes, such as straight lines, circles or ellipses. In many cases an edge detector can be used as a pre-processing stage to obtain image points or image pixels that are on the desired curve in the image space.

Due to imperfections in either the image data or the edge detector, however, there may be missing points or pixels on the desired curves as well as spatial deviations between the ideal line/circle/ellipse and the noisy edge points as they are obtained from the edge detector. For these reasons, it is often non-trivial to group the extracted edge features to an appropriate set of lines, circles or ellipses. The purpose of the Hough transform is to address this problem by making it possible to perform groupings of edge points into object candidates by performing an explicit voting procedure over a set of parameterized image object.

The Hough transformation is a feature extraction technique used in image analysis, computer vision, and digital image processing. The purpose of the technique is to find imperfect instances of objects within a certain class of shapes by a voting procedure. This voting procedure is carried out in a parameter space, from which object candidates are obtained as local maxima in a so-called accumulator space that is explicitly constructed by the algorithm for computing the Hough transform.

Built-Up & Non Built-Up Area Classification: - After Vegetation and Building Extraction we classify which region of image comes under the Built-Up & Non Built-Up Area and how much area they acquire in image in terms of percentage.

K Mean Clustering: - The goal of this clustering method is to simply separate the data based on the assumed similarities between various classes. Thus, the classes can be differentiated from one another by searching for similarities between the data provided. A distance is assigned between all points in a dataset. Distance is defined as the Euclidean distance between two points or:

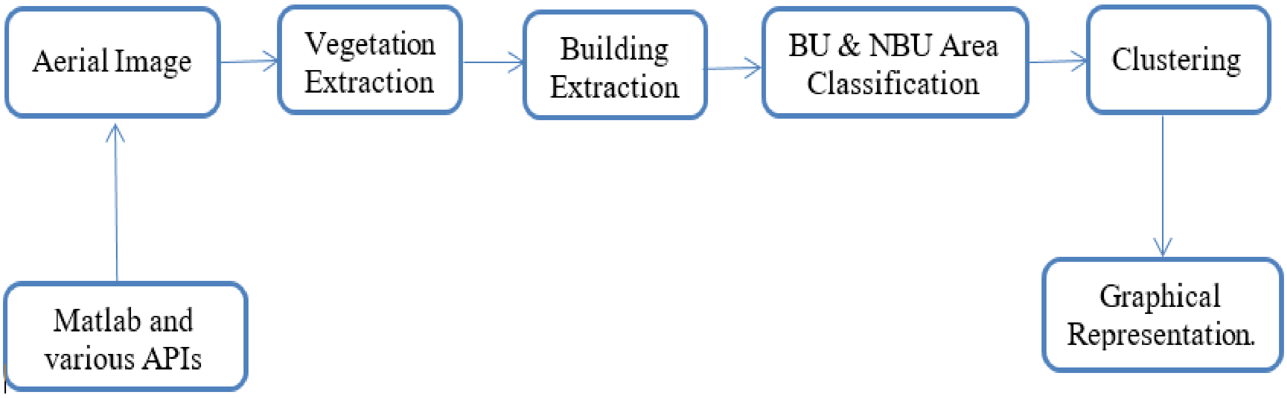
$$d = \sqrt{\sum_{i=0}^{i=n} (x_i - y_i)^2}$$

From these distances, a distance matrix is constructed between all possible pairings of points (x, y).Each data point within the data set has a class label in the set, C = { C1, C2 , ... , Cn }.

The data points', k-closest neighbours (k being the number of neighbours) are then found by analysing the distance matrix. The k-closest data points are then analysed to determine which class label is the most common among the set. The most common class label is then assigned to the data point being analysed.

Graphical Representation: - At last we will graphically represent the estimation of vegetation and building in terms of percentage using various libraries of python like matplotlib, numpy etc and Matlab.

Work Flow Diagram:-



3.3 Functional Requirements

The main purpose of this project is to provide a better and automatic approach for estimation of urbanization of an area. The following functions are provided through an API.

3.3.1 Pre-processing and Extraction

In pre-pre-processing and extraction, samples of aerial images are processed using various image segmentation technique of classify them into BU and NBU area and clustering for image enhancement?

And it involves

- Sample processing
- Feature extraction
- BU and NBU area classification.
- Image Enhancement.

3.3.2 Verification

In verification, one or more samples of aerial images from different geographical location are processed and store the results, and then matched against a manual estimation of urbanization of these image. The result will either have less or more classification error rate. If it is less then application works properly otherwise it require modification.

It involves:-

- Comparison of the automatic estimation vs manual estimation of urbanization.
- A verification decision based on classification error rate.

3.3.3 Representation

Graphically represent the estimation of vegetation and building in terms of percentage.

3.4 Non-Functional Requirements

3.4.1 Input

Inputs are the aerial or satellite image of different geographical region like developed and undeveloped area.

3.4.2 Output

We are expecting the following outcomes:

- Classification of BU and NBU areas.
- Estimation of Urbanization
- Visualization of development of an area graphically.

3.5 General Constraints, Assumptions, Dependencies, Guidelines

3.5.1 Software Constraints

- Windows XP, Windows 7, 8.
- Mat lab, matplotlib and python libraries.

3.5.2 Hardware Constraints

- Minimum of 10GB space of hard disk.
- Minimum of 1024MB RAM

3.5.3 Guidelines

- Code is kept clean and simple for future upgrades and maintenance.

3.5.4 Assumptions

User will provide aerial or satellite image with a preferable quality.

3.6 Other Non-Functional Requirements

3.6.1 Reliability

The application should classify the portion of images as BU and NBU area with very less Classification Error Rate.

3.6.2 Performance

The application should generate the output very fast means doing very fast computational work and consuming less resources.

4. Software Design Specification

4.1 Overview

- Various modules or phases of the Estimation of urbanization of an area and their relationships:-
  The Estimation of urbanization of an area is implemented in the form of various phases. The following section defines these phases.

- Flow diagrams containing decision policies:-
  Flow diagram and state diagram clears the picture of the control flow and the relationships between various phases and states.

- Detailed descriptions of various phases:-
  These phases consists of various states and algorithms. The next section describes in detail various inputs, outputs and functioning of these states and algorithms.

- Existing algorithm used:-
  Various existing algorithm and procedures of Building extraction, vegetation extraction and classify urbanization are used in implementation in Project.

4.2 Scope of the Development Project

1. To estimate of urbanization of area:
   - Extraction of vegetation from high resolution satellite image
   - Extraction of building from high resolution satellite image.
   - Classification of Built and Non Built-up area .

2. Graphical representation of .urbanization of an area.

4.3 Abbreviations

The abbreviations used in the document are listed below:-

- KNN – K Nearest Neighbors.
- NDVI – Normalized Difference Vegetation Index.
- RGB – Red Green Blue
- IGV – Internal Gray Variance

4.4 Overview of System:-

The System Overview Are given below:-

4.4.1 Vegetation Extraction

For extracting vegetation from remotely sensed data such as satellite or aerial imagery is to calculate the Normalized Difference Vegetation Index (NDVI) followed by thresholding the NDVI. Calculations of NDVI for a given pixel always result in a number that ranges from -1 to +1. However, no green leaves gives a value close to zero. A zero NDVI means no vegetation and NDVI close to +1 (0.8 – 0.9) indicates the highest possible density of green leaves.

4.4.2 Building Extraction

First the Vegetation Extracted image is converted into RGB to Gray form. Then image is enhanced and at last thresholding is done based on IGV extraction and Binarization. The output of this module provide a well formed structured image of detected building.

4.4.3 K Mean Clustering

The goal of this clustering method is to simply separate the data based on the assumed similarities between various classes and Graphical representation of urbanized Area.

4.5 Detail Descriptions

4.5.1 Vegetation Extraction:-

Identification	Vegetation Extraction (forms first phase of the Urbanization)
Type	A Module
Purpose	This Module mainly focus on strategy to Detect the Vegetation from a aerial or geoTaged image. For pre-processing the following Techniques are used- • More Green coloured region absorbs red colour and reflecting the much near infrared light.

	• Less green coloured region reflects red colour and less near infrared light. • NDVI is calculated on a per-pixel basis as the normalized difference between the red and near infrared bands from an image. At the end Segmentation is used to provide a well differentiated image of vegetated image or non-vegetated image.
Function	For extracting vegetation from remotely sensed data such as satellite or aerial imagery is to calculate the Normalized Difference Vegetation Index (NDVI) followed by thresholding the NDVI. Calculations of NDVI for a given pixel always result in a number that ranges from -1 to +1. However, no green leaves gives a value close to zero. A zero NDVI means no vegetation and NDVI close to +1 (0.8 – 0.9) indicates the highest possible density of green leaves.
Dependencies	The input image which we taken must be in ".tif" or ".tiff" image format and images must contains geoTags. Considering the ideal situation where the green colored region is indication for vegetation and while other colored region as non-vegetated region.
Processing	Predefined functions in Matlab are used for pre-processing step (geotiffread, geotiffread, info.GeoTIFFTags.GeoKeyDirectoryTag etc.). And then NDVI method is for vegetation calculation and at last Segmentation technique will divide the region into vegetated area and non-vegetated area.
Data	A single storage file is used which will having enhanced and pre-processed image of input image and this image is proceed further to the next module for segmentation and finally the last image will be the vegetation extracted image which is further proceeded for building extraction.

4.5.2 Building Detection:-

Identification	Building Detection(forms second phase of the Urbanization)
Type	A Module
Purpose	This Module mainly focus on strategy to Detect the Building from a vegetation extracted image. For pre-processing the following Techniques are used- • IGV Extraction for shadow removal process.

	• Canny Operation for Edge Detection. • Filling of Small patches. At the end Segmentation is used to provide a well formed Structure of detected building.
Function	First the Vegetation Extracted image is converted into RGB to Gray form. Then image is enhanced and at last thresholding is done based on IGV extraction and Binarization. The output of this module provide a well formed structured image of detected building.
Dependencies	Considering the ideal situation where the shape of each building is either a rectangular or a square. For Storage, a text file is used to store the corner point of each building. The Thresholding is depend on the image pixel size , if it's too large then it takes many iteration to process the image and if it's too small then it is difficult to analyze the edges of building.
Processing	Predefined functions in Matlab are used for pre-processing step (binarization, rgb2gray, bwconncomp, etc.). And then Algorithm is design to filling the small patches and at last Segmentation technique will divide the structure into building detected area and non-detected area.
Data	A single storage file is used which will having all the four pixel point of each detected building and this file is proceed forward to the next module for calculating the area and finalize the percentage of Urbanization.

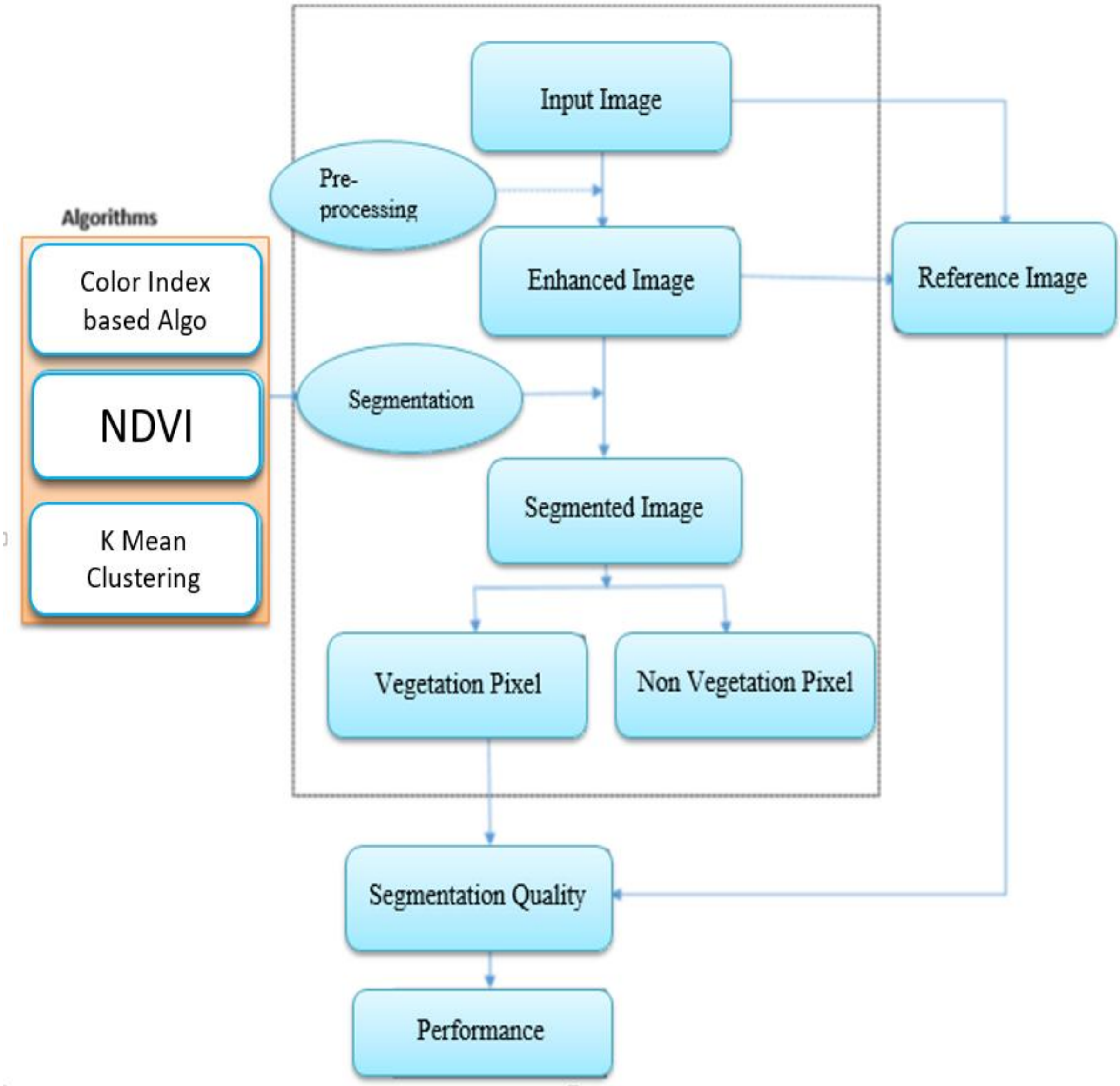
4.5.3 K Mean Clustering:-

Identification	K-Mean Clustering
Type	A Module
Purpose	This is last phase of System. This module mainly focus on strategy to classify the area and Graphical representation of urbanized Area. For classification of urban area, it is using K-mean algorithm.
Function	The goal of this clustering method is to simply separate the data based on the assumed similarities various classes. A distance is assigned between all points in a dataset. Distance is defined as the Euclidean distance between two points. The data points K-mean are then found by analyzing the distance matrix. The K-Nearest data point are then analyzed to determine which class label is the most common among

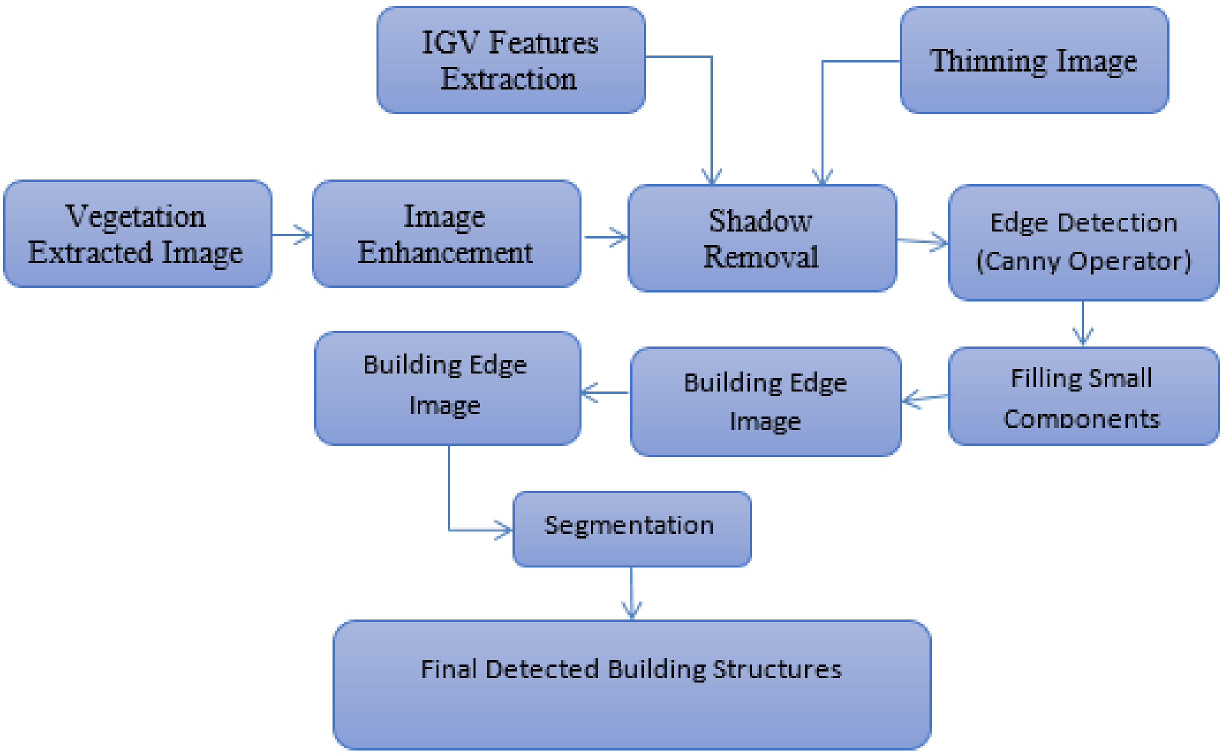
	the set. And at the last the last, graphical representation of estimated of vegetation and building in term of percentage.
Dependencies	Considering the idea situation where data set of color will be only in three type, first color for vegetation, second color for building and third color for background.
Processing	In Matlab, the K-mean algorithm is using to cluster the vegetation & building extracted image. Then get the dataset of color and classify it. After classification of data set, it matches to training data to estimate the Urbanization of area. And Then using python libraries, Graphical representation of urbanized area.
Data	A single storage file which is vegetation and building extracted is used for clustering and get data set the data set of color. The data set of color is used in graphical representation of estimated of urban area.

4.6 Data Flow Diagram :-

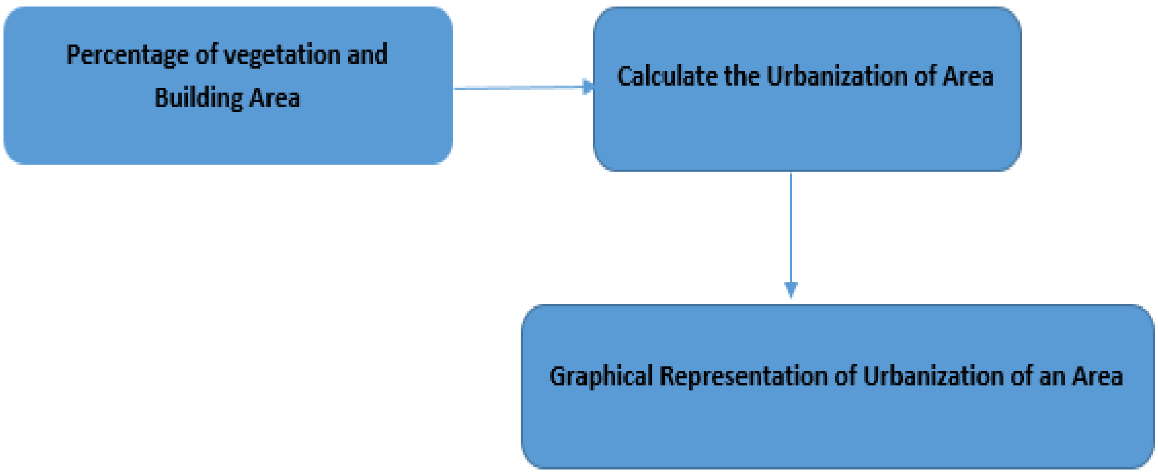
4.6.1 Vegetation Extraction:-



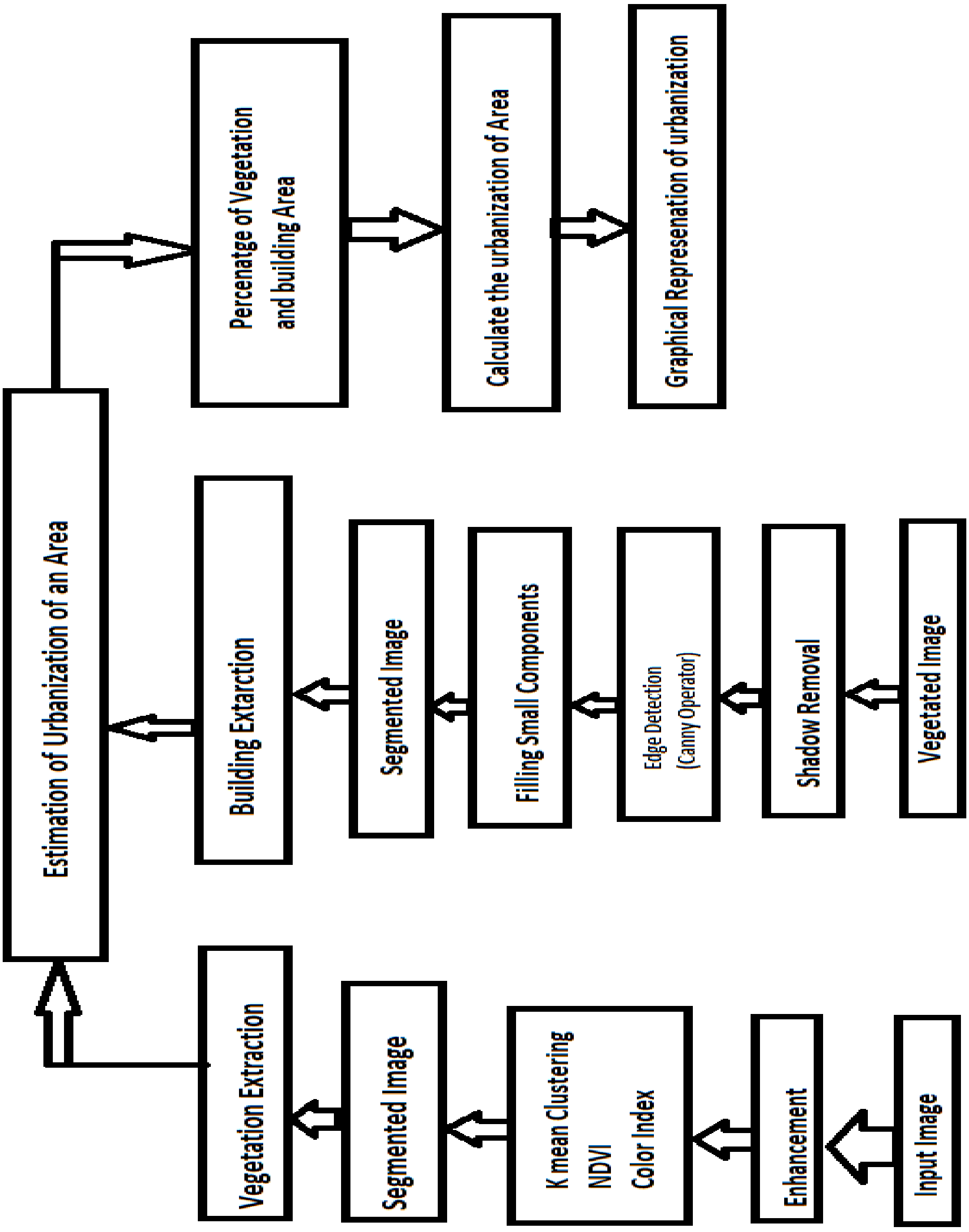
4.6.2 Building Extraction:-



4.6.3 Graphical Representation:-



4.7 Structure Diagram



5. Implementation (Algorithm, Input, Output) :-

5.1 Algorithm for Vegetation Extraction

1. Select an aerial image from the Dataset.
2. Pre-processing of image and making it enhanced image.
3. Using Normalized Difference Vegetation Index and Image Segmentation for Vegetation Extraction
4. Calculate the NDVI value of every pixel of an image.
5. If NDVI value nearly equal to one then label this pixel to vegeted pixel otherwise non-vegeted pixel.
6. Convert Image from RGB Color Space to L*a*b* Color Space
7. The L*a*b* space consists of a luminosity layer 'L*', chromaticity-layer 'a*' and 'b*'.
8. All of the color information is in the 'a*' and 'b*' layers.
9. Classify the colors in a*b* colorspace .
10. Since the image has 3 colors create 3 clusters.
11. Measure the distance using Euclidean Distance Metric.
12. Label every pixel in the image using results from K means.
13. Create a blank cell array to store the results of clustering.
14. Display the contents of the cluster and Segmentation.
15. Calculate the Vegetated pixel and percentage of vegetation in an image.
16. Image is now passed for building extraction.

5.2 Algorithm for K Mean Algorithm

1. Load the image to be segmented.

2. Apply partial contrast stretching. Initialize number of cluster, *k*.

3. Use equation (1) to calculate the potential for every pixel value of the image.

4. Find maximum potential in step 3 and set that point be first center cluster and its corresponding potential as maximum potential.

5. Use equation (2) to update the potential value of other remaining pixels based on the first cluster center.

6. Again find the maximum potential in the step 4 and let that point be second point.

7. Continue the process until it finds the *k* number of cluster.

8. Used *k* centre as initial centre in the *k*-means clustering algorithm.

9. Find the Euclidean distance of each centroid from every pixel of the image using the relation (3).

10. Assign the pixel with minimum distance with respect to centroid to its respective cluster of the centroid.

11. Recalculate the new center location by using the equation (4).

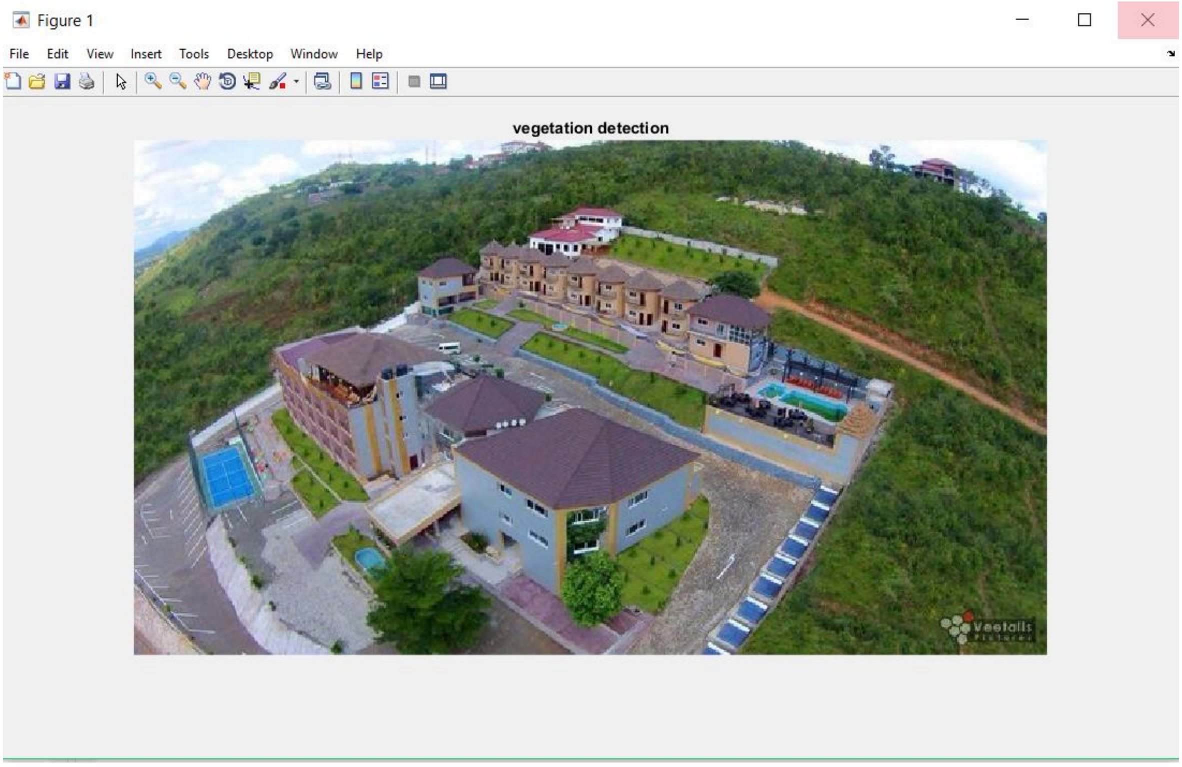
12. Repeat the steps 10–12, until it satisfies the tolerance or error value.

13. Reshape the cluster into image.

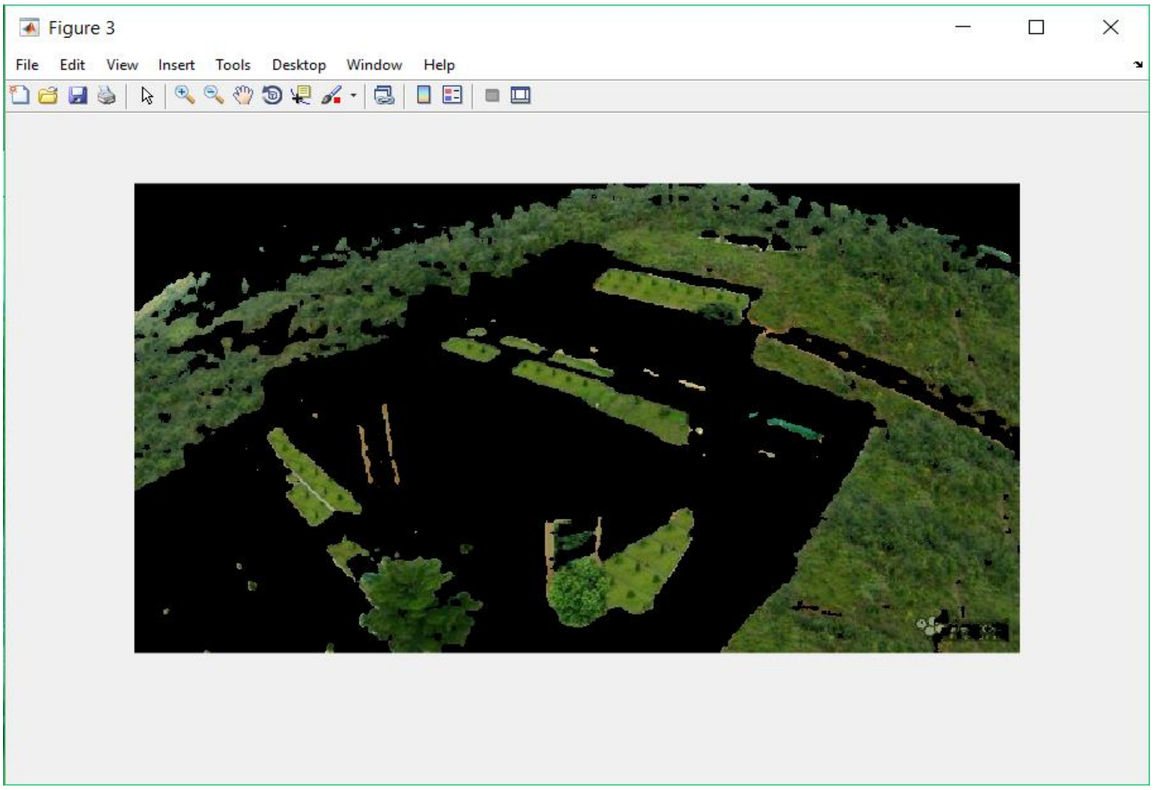
14. Median filter is applied to the segmented image to remove any unwanted noise or region.

Vegetation Extraction

INPUT IMAGE



OUTPUT IMAGE



5.3 Algorithm for Building Detection

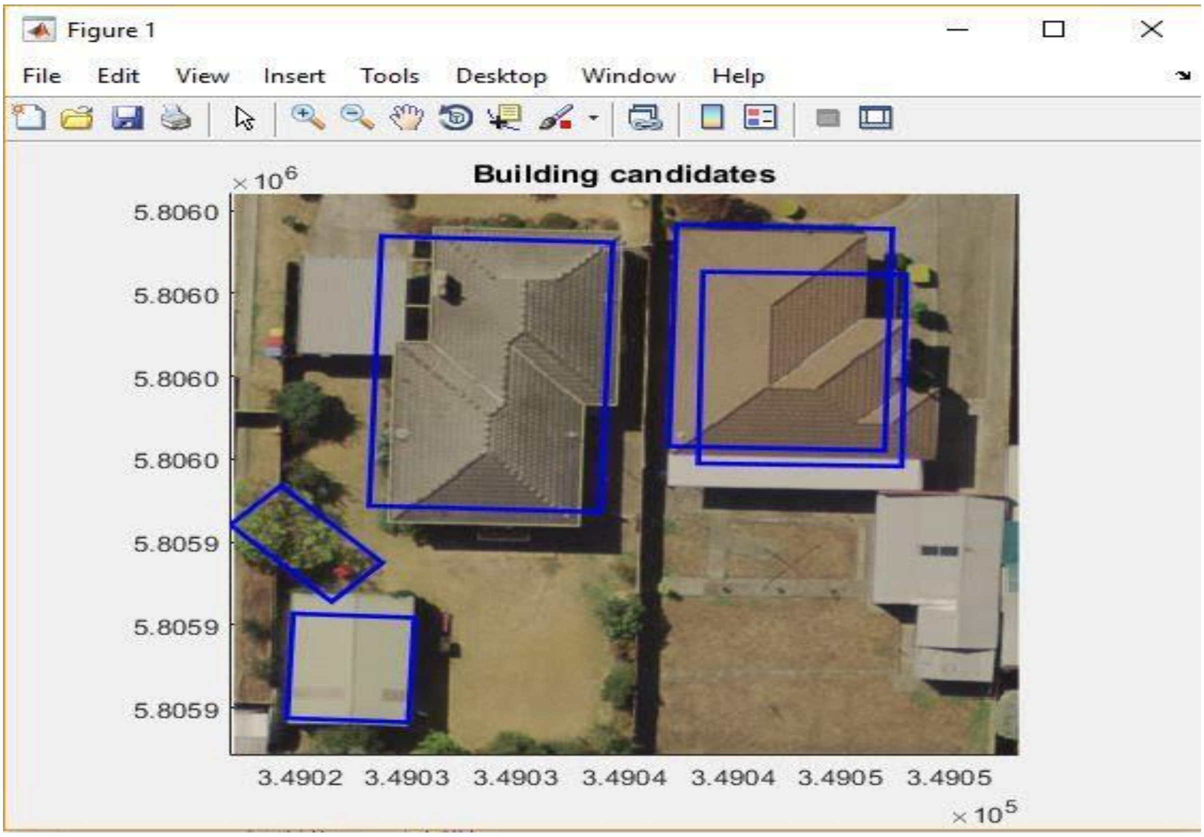
We will proceed further to find the edges of building via a function named as building_detection -

1. INPUTFILE_name-- input image file name including path. The file format is geotiff and must contain geodata information itself
2. Lidar file -- input LIDAR file name including path. The data format is X Y Z in each line.
3. Light Detection and Ranging (LIDAR) is active remote sensing which uses laser lights to strike features and record the reflected pulses to generate the 3D model of objects. Nowadays LIDAR data is widely used in different field. But the problem is, it is expensive and there are only few websites that provide access to download the data for free. Free LIDAR data are mostly from the United States area.
4. Entropy flag-- turn this flag on (1) if the scene has green coloured building roofs; 0 otherwise; default 0, but we are still working on it for better results.
5. Adjustment flag-- turn this flag on (1) if you want to adjust the mask lines with the image lines; 0 otherwise; default 1.
6. For the detection of edge points the Canny detector was used with different settings.
7. Now with the help of Harris edge detection the Corners were detected.
8. Generate building masks: applies a height threshold to divide point cloud into ground and non-ground points. These two sets of points are used to generate two building masks namely primary and secondary building mask.
9. Line extraction: extracts lines around buildings from the primary building mask.
10. At last finalize the result in candidate file contains the Corner pixel of (x1,y1),(x2,y2),(x3,y3)and (x4,y4).

Building Extraction

INPUT IMAGE

OUTPUT IMAGE



6 Work to be accomplish further

1. Calculation of vegetated pixel & non-vegetated pixel and percentage of vegetation in an image.
2. Calculation of percentage of Building in an image.
3. Estimation of Urbanisation and Graphical Representation of Built-Up and Non-Build-Up Area.

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