Software Requirements Specification

For

Estimation Of Urbanization Of An Area

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01. Introduction

1.1 Purpose

This document 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.

1.2 Problem Description

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.

1.3 Objectives

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

1.4 Overview

Section 2 here 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.

02. Overall Description

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.

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-Nearest Neighbour 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.

Data Flow Diagrams:-

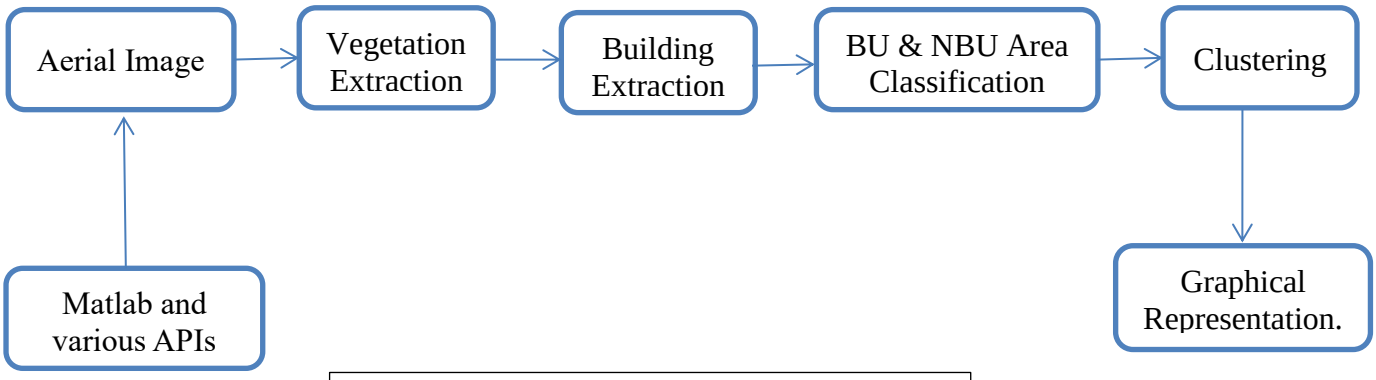

Fig 1.1 Flowchart of Working of Application.

Vegetation Extraction

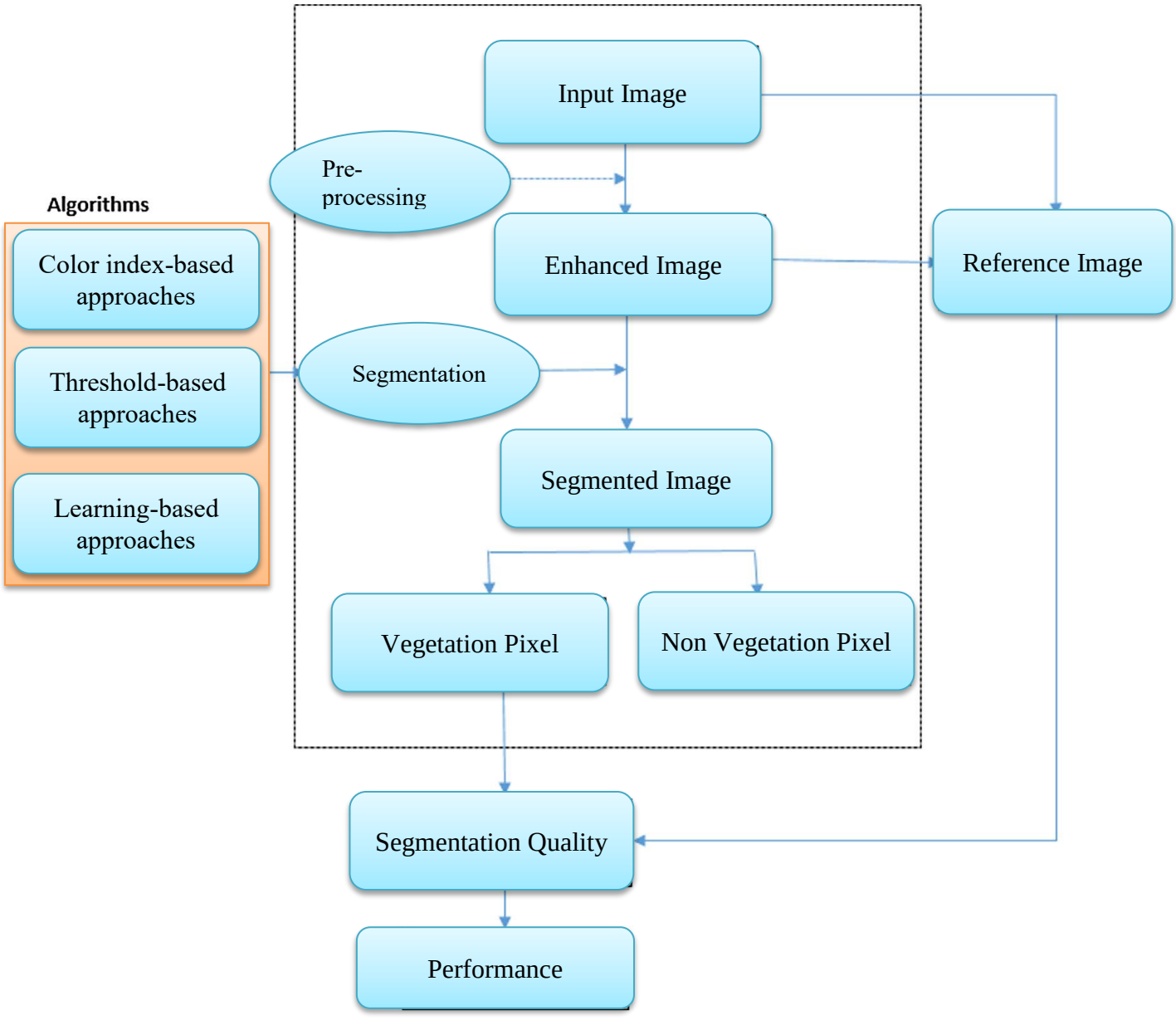

Fig 1.2 Flowchart of vegetation Extraction

Building Extraction and KNN Clustering

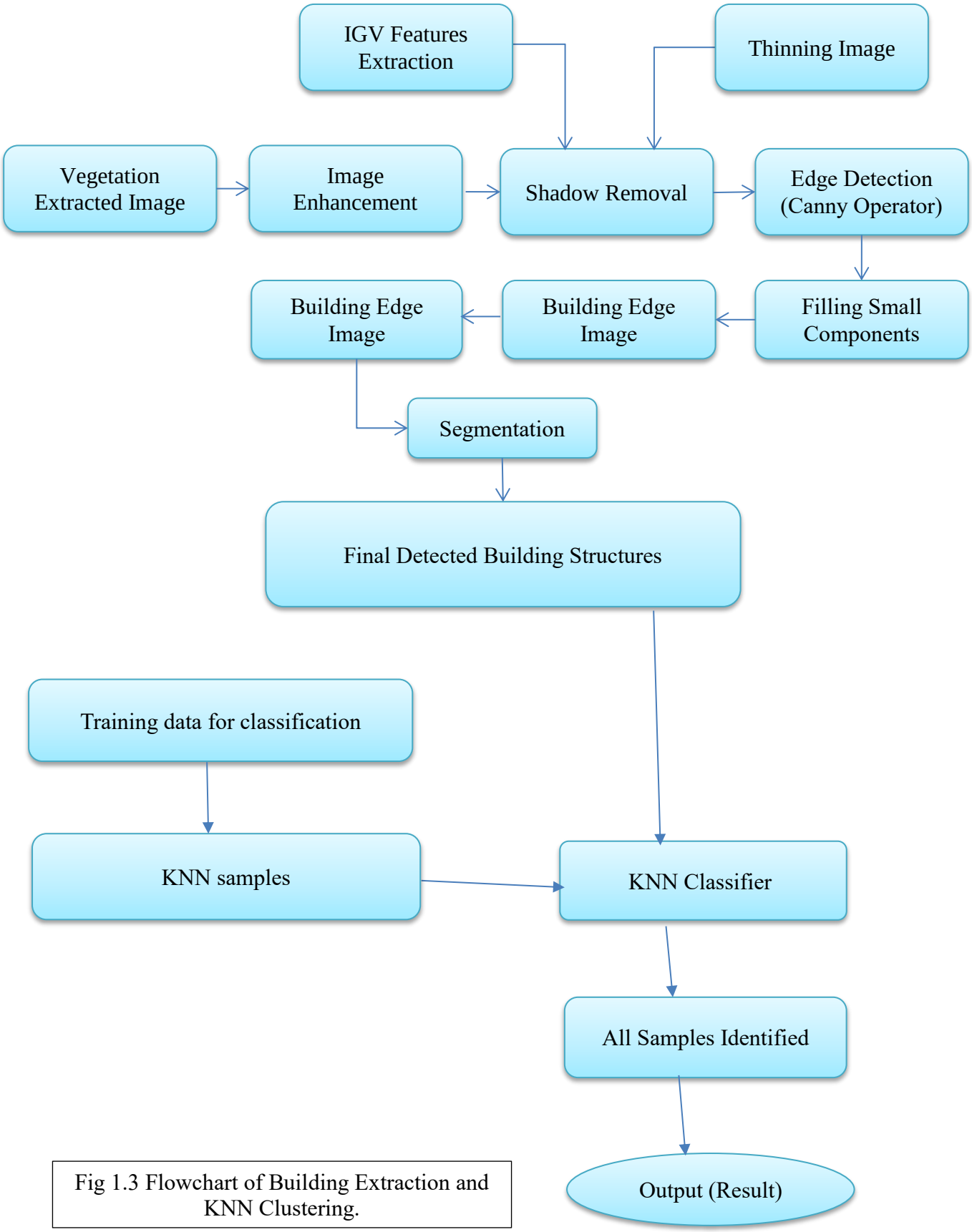

Fig 1.3 Flowchart of Building Extraction and KNN Clustering.

2.3 Overview of Non-Functional Requirements

2.3.1 Input

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

2.3.2 Output

We are expecting the following outcomes:

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

2.4 General Constraints, Assumptions, Dependencies, Guidelines

2.4.1 Software Constraints

- Windows XP, Windows 7, 8.
- Mat lab, python.

2.4.2 Hardware Constraints

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

2.4.3 Guidelines

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

2.4.4 Assumptions

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

03. Specific Requirements

3.1 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.

3.1.1 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.

3.1.2 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.

3.1.3 Representation

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

3.2 Other Non-Functional Requirements

3.2.1 Reliability

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

3.3.2 Performance

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

04. References

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