

A Comparative Study on Object Segregation in Satellite Images using PSO and K-Means

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ABSTRACT

“Object Segregation in Satellite Images” deals with the aerial and satellite images to calculate the open space area. They are complex to analyze high resolution satellite image. The satellite captures the entire image including the open space, buildings, cars, peoples, etc. This automatic extraction algorithm uses some filters and segmentations and grouping is applying on satellite images. The result images are used to calculate the total available open space area and the built up area. This paper deals with the segregation of aerial and satellite images to manipulate the objects in open space area object segregation is necessary for remote sensing applications. The remote sensing is used for manipulate the area of the land mass according to time. Satellite image can be segregated in respected time interval for measuring the area land mass. In this paper a comparison study has been made between various algorithms like Particle Swarm Optimization (PSO), K-Means Clustering Algorithm,

Keywords

Satellite images, Filtration, Segmentation, Particle Swarm Optimization, Image Segmentation, K means

1. INTRODUCTION

Extraction of objects from satellite images is a very important part of GIS features such as GIS updating, geo-referencing and geo spatial data integration [1].

Satellite imagery is widely popular and provides a snapshot of an area. The objects in the satellite image are obscured and not clear. These satellite images are extracted from Geo Satellite. The objects in the environment are seen mainly from an oblique Perspective. Objects that are remotely sensed are often imaged from above and the sensors used in the imaging process may be recording electromagnetic signatures that are outside human vision [2].

Natural or man-made objects are extracted from Google earth for many applications, e.g... Military, map publishing, transportation, car navigation, etc. Automatic natural objects (road, building, forest, water body etc.) extractions are a challenging problem, and no existing software is able to perform the task reliably. Since manual extraction of natural objects from imagery is very time consuming, automatic method has the

potential to improve the speed and utility for military and civil application [3].

2. ALGORITHMS COMPARED

In this paper a study is made between the following algorithms which can be applied for segregation of objects is being compared for their effectiveness.

1. Particle Swarm Optimization (PSO)
2. K-Means Clustering

2.1 PARTICLE SWARM OPTIMIZATION (PSO)

Particle Swarm Optimization (PSO) is a population based stochastic optimization technique. Stochastic Optimization (SO) methods are optimization methods that generate and use random variables. For stochastic problems, the random variables appear in the formulation of the optimization problem itself, which involve random objective functions or random constraints, for example. Stochastic optimization methods also include methods with random iterates.

2.2 K-Means Clustering

K-Means clustering is a method of cluster analysis which aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean. This results into a partitioning of the data space into Voronoi cells. The most common algorithm uses an iterative refinement technique. Due to its ubiquity it is often called the k -means algorithm; it is also referred to as Lloyd's algorithm, particularly in the computer science community.

3. ALGORITHM DESCRIPTION

3.1 PARTICLE SWARM OPTIMIZATION

In PSO, the potential solutions called particles fly through the problem space by following the current optimum particles. Each particle keeps track of its coordinates in the problem space which are associated with the best solution (fitness) it has achieved so far. (The fitness value is also stored.) This value is called *pbest*. Another "best" value that is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the neighbors of the particle. This location is called *lbest*. When a particle takes all the population as its topological

neighbors, the best value is a global best and is called *gbest*. The particle swarm optimization concept consists of changing the velocity of each particle toward to its *pbest* and *lbest* locations.

The algorithm is based on global threshold (average) using PSO. To obtain the desired results, the histograms of several of the scenes in the database containing Objects, were analyzed. From the analysis, the histogram is divided in five main regions in the basis of unsupervised learning. Computing the Threshold *t* using PSO the threshold values are evaluated and ten agents are created which scan their respective regions assigned to them from the image. Every agent scans the image row wise to find local best values for each row and eventually evaluates its global best for the assigned region. Among these regional global bests the agents select the most suitable candidate solution by communicating with each other. This is known as the Threshold value or the Global best.

3.1.1 PROCEDURE

The process of extracting objects comprises of following steps:

1. **Preprocessing:** Removing unwanted noise from the image.
2. **Selection** : The particular feature which best describes the object.
3. **Decision** : Choice of suitable fitness function for Comparing the image patterns with the target patterns.
4. **Assessing** : The accuracy of Object Extraction

3.1.2 PSEUDO CODE

```

Iteration =100
Particle= 10
While fitness value= threshold value
  For each iteration
    For each particle in the swarm
      Initialize each particle randomly respective regions
      If particle finds best local best value (best object)
        Then update particle position and velocity
      Else
        Not updated
      End for
    Find best global best particle (fitness function)
  End for
End while
End Program Loop

```

3.2 K-Means Clustering

K-Means algorithm starts with some clusters of pixels in the feature space, each of them defined by its center. The first step consists in allocating each pixel to the nearest cluster. In the second step the new centres are computed with the new clusters. These two steps are repeated until convergence. The basic step of k-means clustering is simple. In the beginning determine number of clusters *K* and assume the centroid or center of these clusters. Take any random objects as the initial centroids or the first *K* objects in sequence can also serve as the initial centroids.

Given an initial set of *k* means $m_1^{(1)}, \dots, m_k^{(1)}$ (see below), the algorithm proceeds by alternating between two steps:

Assignment step: Assign each observation to the cluster with the closest mean (i.e. partition the observations according to the Voronoi diagram generated by the means).

Update step: Calculate the new means to be the centroid of the observations in the cluster.

3.2 .1 PROCEDURE

1. Select *K* points as the initial centroids.
2. Repeat
3. From *K* cluster by assigning all points to closest centroids.
 - 1) Determine the centroid coordinate.
 - 2) Determine the distance of each Object to the centroids.
 - 3) Group the object based on minimum distance.
4. Recomputed the centroid of each cluster.
5. Until the centroids don't change.

The vector **m** contains a reference to the sample mean of each cluster. **x** refers to each of our examples, and **b** contains our "estimated [class] labels"

3.2.2 PSEUDO CODE

1. Initialize m_i , $i = 1, \dots, k$, for example, to *k* random x^t
2. Repeat
3. For all x^t in *X*

$$b_i^t \leftarrow 1 \text{ if } \|x^t - m_i\| = \min_j \|x^t - m_j\|$$

$$b_i^t \leftarrow 0 \text{ otherwise}$$
4. For all m_i , $i = 1, \dots, k$

$$m_i \leftarrow \text{sum over } t (b_i^t x^t) / \text{sum over } t (b_i^t)$$
5. Until m_i converge.

4. SEGREGATION METHODOLOGY

Object Segregation in satellite images includes many implementation phase for segregating object from satellite image. They are:

- 1) Gray Scale Conversion
- 2) Edge Detection
- 3) Filtering
- 4) Segmentation

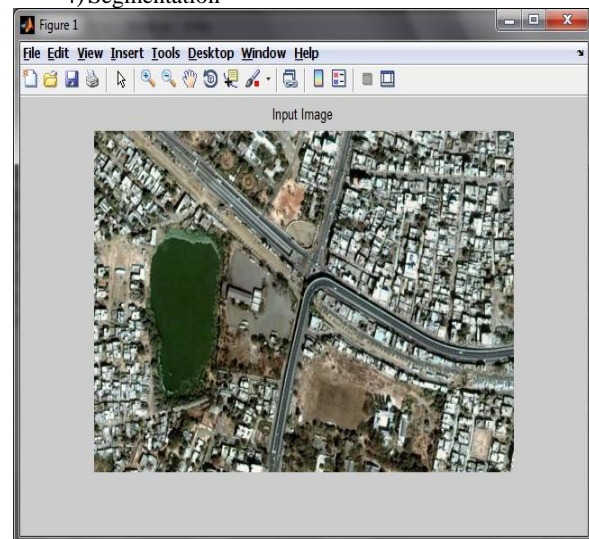


Fig.4.1: Original Satellite Image

4.1 Gray Scale Conversions

Any Satellite image is selected as input (Figure 1). Gray scale images are distinct from one-bit bi-tonal black-and-white images, which in the context of computer imaging are images with only the two colours, black, and white (also called bi-level or binary images). Greyscale images have many shades of gray in between. Gray scale images are also called monochromatic, denoting the absence of any chromatic variation. Gray scale images are often the result of measuring the intensity of light at each pixel in a single band of the electromagnetic spectrum (e.g. infrared, visible light, ultraviolet, etc.), and in such cases they are monochromatic proper when only a given frequency is captured. But also they can be synthesized from a full colour image; see the section about converting to gray scale.(Figure 2)

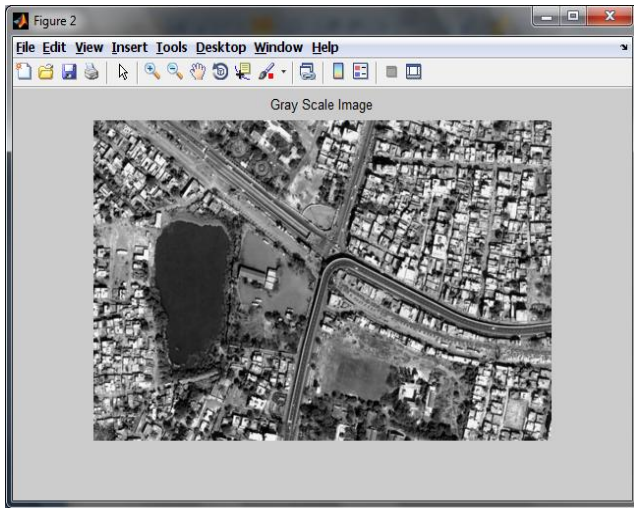


Fig.4.2:Image after Gray Scale Conversion

4.2 Edge Detection

The Canny method finds edges by looking for local maxima of the gradient of Image(Figure 3). The gradient is calculated using the derivative of a Gaussian filter. The method uses two thresholds, to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges. This method is therefore less likely than the others to be fooled by noise, and more likely to detect true weak edges. "Optimal" edge detector means:

- Good detection – the algorithm should mark as many real edges in the image as possible.
- Good localization – edges marked should be as close as possible to the edge in the real image.
- Minimal response – a given edge in the image should only be marked once, and where possible, image noise should not create false edges.

4.3 Filtering

Median filtering is similar to using an averaging filter, in that each output pixel is set to an average of the pixel values in the neighbourhood of the corresponding input pixel. However, with median filtering, the value of an output pixel is determined by the median of the neighbourhood pixels, rather than the mean.

The median is much less sensitive than the mean to extreme values (called outliers). Median filtering is therefore better able to remove these outliers without reducing the sharpness of the image.

The second stage also serves an important purpose to fill the big gaps for open space extracted in stage one. Under some severe noise, part of the area may be disqualified as valid open space region and hence missed in stage one, leaving some major gaps in open space area edges. With the additional spectrum information, these missed areas can be easily identified to complete the open space area extraction.(Figure 4)

Therefore, the two stage process eliminates the need to assume or guess the colour spectrum of open space and allow them to extract much more complete.

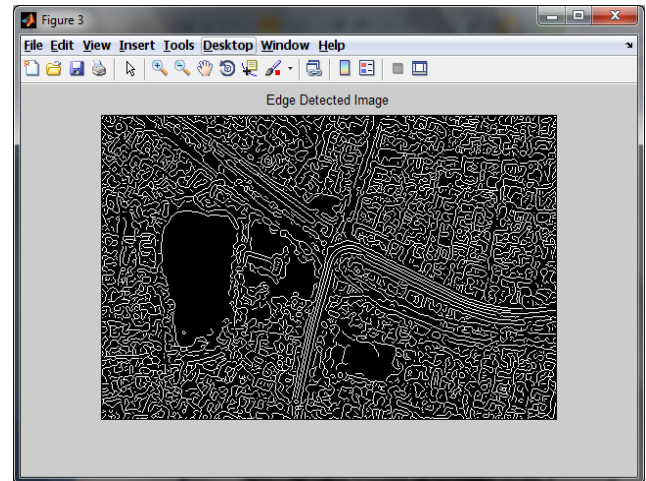


Fig 4.3:Image after Edge Detection

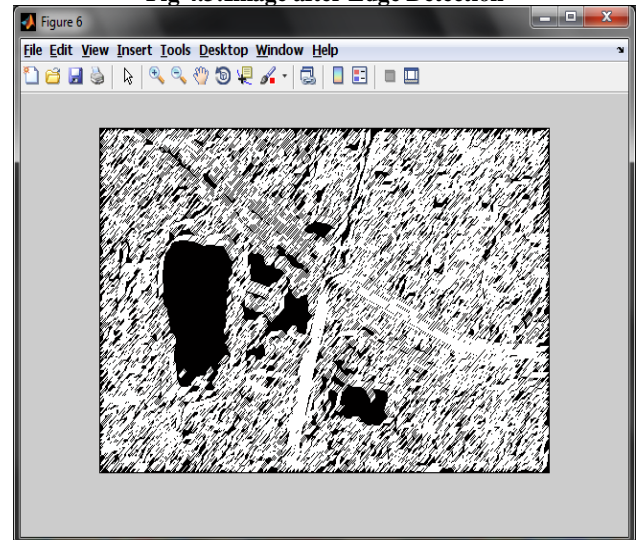


Fig 4.4: Image After Filtering

4.4 Segmentation

Segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of Segmentation is to simplify and/or change the representation of an image into something that is more

meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. Image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. According to various algorithms the image is segmented and displayed.

5. EXPERIMENTAL RESULTS

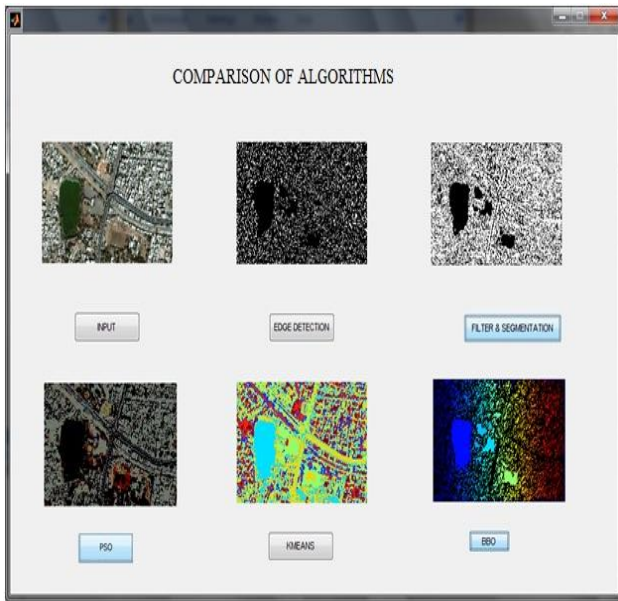


Fig 4.5: Implementation – Screen Shot of Main Menu using MATLAB7.0

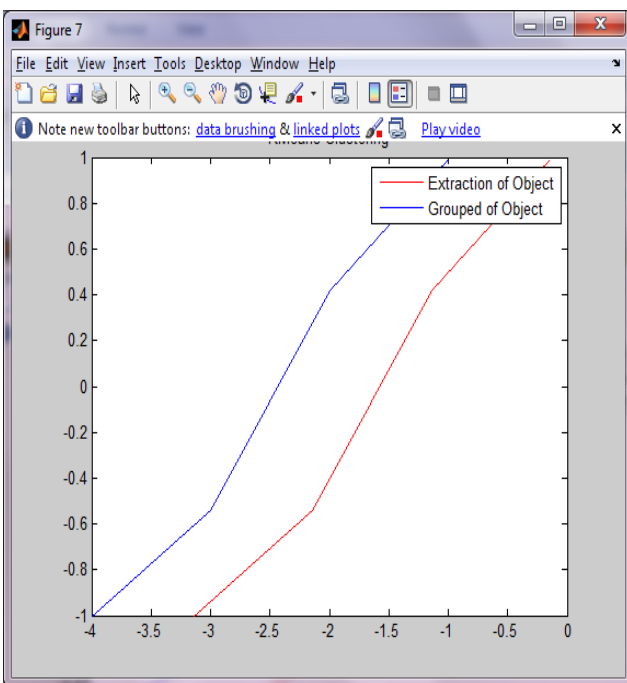


Fig.4.6.Segregation of Objects through PSO.

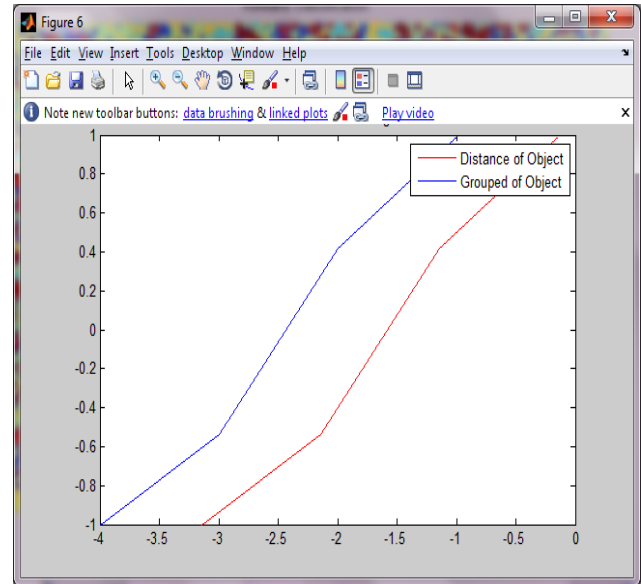


Fig.4.7. Segregation of Objects through k-means.

5. CONCLUSION

This paper develops a new approach for natural or man-made object extraction in urban areas from high resolution satellite image is proposed. By combining the spectral information and shape measures natural objects are identified from the image. The experimental results on image demonstrate that it is an effective way to detect objects by learning from object's features. It is fully dependent on unsupervised learning. The results prove that proposed approach effectively extracts the major objects from the image.

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