# Extraction of Satellite Image using Particle Swarm Optimization

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## Abstract

Of all tasks in photogrammetry the extraction of cartographic features is the most time consuming.  Fully automatic acquisition of features like roads and buildings, however, appears to be very difficult. The extraction of cartographic features form digital satellite imagery requires interpretation of this imagery. The knowledge one needs about the topographic objects and their appearances in satellite images in order to recognize these objects and extract the relevant object outlines is difficult to model and to implement in computer algorithms. This paper introduces Particle Swarm Optimization  based method of object extraction from Google Earth image (satellite image). This paper deals with the land cover mapping by using swarm computing techniques. The motivation of this paper is to explore the improved swarm computing algorithms for the satellite image object extraction.

**KEYWORDS** - Objects extraction,  Google Earth image, Unsupervised Learning PSO algorithm

## 1. INTRODUCTION

Natural or man-made objects extracted from Google earth has been used for many different purpose, 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 have the potential to improve the speed and utility for military and civil application and are therefore highly desirable. Google Earth is a virtual globe, map and geographic information program that were originally called Earth Viewer. Google Earth provides satellite images of any area. In this paper, Google earth's image is used for implementation of extraction natural or man-made object from satellite image.Simultaneously there is a new wide range of computational algorithms that have emerged from the behaviour of social insects. Social insects are usually characterized by their self organization and with the minimum communication or the absence of it. Every social insect individually is self-autonomous. They can obtain information about environment and interact with the remote insects or environment indirectly, by stigmergy. All these features characterize Swarm Intelligence . We can found these features in nature such as ant colonies, bird flocking, animal herding, fish schooling etc. The two most widely used swarm intelligence algorithms are Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO).

We are presenting here the usage of PSO (Particle Swarm Optimization) algorithms applied to Google earth's image for the extraction of natural or man-made object. The activities for the development of this paper are organized in four sections.

In section 1, a high- resolution satellite image (Google earth), including scenes of highways, forest, buildings, were formed and how particle swarm optimization, unsupervised learning technique are used. In section 2, using the collected image form section 1, PSO algorithm to detect and extract the natural or man-made objects was developed.In section 3, algorithms to detect, extract and classify natural or man-made objects (road, building, forest, barren land etc.) were implemented.In section 4, the feasibility of using this image and the results are presented.

## 2. SECTION 1: USAGE OF IMAGE FROM GOOGLE EARTH AND APPLICATION OF PARTICLE SWARM OPTIMIZATION AND UNSUPERVISED LEARNING

### Google Earth

Google Earth is used to get number of satellite images. Google Earth is a virtual globe, map and geographic information program that was originally called Earth Viewer, and was created by Keyhole, Inc, a company acquired by Google. To collect image from Google Earth and implementing PSO algorithm for extracted natural or man-made object from satellite image (Google Earth). Google Earth displays satellite images of varying resolution of the Earth's surface, allowing users to visually see things like cities and houses etc. The degree of resolution available is based somewhat on the points of interest and popularity, but most land (except for some islands) is covered in at least 15 meters of resolution.

A few Google Earth images :

 A)
 B)

**Figure 1.** Enlarge Google earth images (A,B)

**Particle Swarm Optimization**

Particle swarm optimization (PSO) is a swarm intelligence based algorithm to find a solution to an optimization problem in a search space, or model and predict social behavior in the presence of objectives.

Particle swarm optimization is a stochastic, population-based computer algorithm for problem solving. It is a kind of swarm intelligence that is based on social-psychological principles and provides insights into social behavior, as well as contributing to engineering applications. The particle swarm optimization algorithm was first described in 1995 by James Kennedy and Russell C. Eberhart. The techniques have evolved greatly since then, and the original version of the algorithm is barely recognizable in current ones.

Social influence and social learning enable a person to maintain cognitive consistency. People solve problems by talking with other people about them, and as they interact their beliefs, attitudes, and behaviors change; the changes could typically be depicted as the individuals moving toward one another in a socio-cognitive space.

The particle swarm simulates this kind of social optimization. A problem is given, and some way to evaluate a proposed solution to it exists in the form of a fitness function (4).

The swarm is typically modeled by particles in multidimensional space that have a position and a velocity. These particles fly through hyperspace and have two essential reasoning capabilities: their memory of their own best position and knowledge of the global or their neighborhood's best. So a particle has the following information to make a suitable change in its position and velocity:

a. A global best that is known to all and immediately updated when a new best position is found by any particle in the swarm.
b. Neighborhood best that the particle obtains by communicating with a subset of the swarm.
c. The local best, which is the best solution that the particle has seen.

**Unsupervised Learning**

In unsupervised learning, all the observations are assumed to be caused by latent variables, that is, the observations are assumed to be at the end of the causal chain. In practice, models for supervised learning often leave the probability for inputs undefined. This model is not needed as long as the inputs are available, but if some of the input values are missing, it is not possible to infer anything about the outputs. If the inputs are also modeled, then missing inputs cause no problem since they can be considered latent variables as in unsupervised learning.

In unsupervised learning, the learning can proceed hierarchically from the observations into ever more abstract levels of representation. Each additional hierarchy needs to learn only one step and therefore the learning time increases (approximately) linearly in the number of levels in the model hierarchy.

# 3. SECTION 2: DEVELOPMENT OF PSO ALGORITHM TO DETECT AND EXTRACT NATURAL AND MAN MADE OBJECTS

**Natural or man-made object Extraction.**

Object extraction of image procedures is to automatically categorize all pixels in an image into roads, forest, barren land, water bodies and settlements. In this paper we extract the objects from the images using PSO algorithm. To do this, appropriate threshold values have to be computed, and then segmentation is performed. To compute the appropriate threshold values several problems had to be analyzed.  In this phase, an algorithm for the extraction of objects from Google earth's image was developed. This test image is presented various conditions under which the performance of our algorithm was evaluated. In the following section the proposed algorithm is described.

**The Algorithm: Detection of Objects**

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, we divided the histogram in five main regions in the basis of Unsupervised learning. Figure drawn below shows these regions. Region I start from the lowest intensity values to half of the midway of average intensity. For most of the cases, the intensity values on this region cover water bodies. Region II covers intensities that go from approximately half of the midway of the average intensity to midway of average intensity, and typically covers trees. Region III goes from midway of average intensity, to average intensity and covers bright gray objects such as highways. Region IV goes approximately from average intensity to midway of highest intensity and generally covers bright objects like buildings, road dividers, etc. Region V goes approximately from midway of highest intensity to highest intensity and generally covers barren land(6).
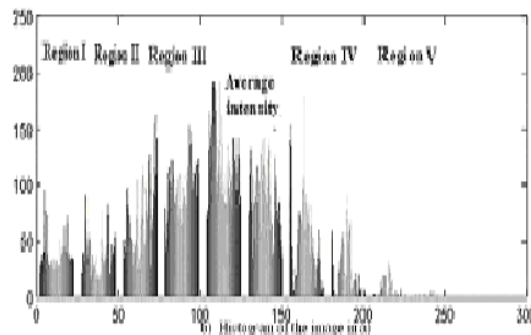


**Figure 2:** Google's Earth Image



**Figure 3**: Histogram of the Image (2)

### Morphological Operations

Morphology is a technique of image processing based on shapes. The value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbours. By choosing the size and shape of the neighbourhood, you can construct a morphological operation that is sensitive to specific shapes in the input image.

## 4. SECTION 3: IMPLEMENTATION OF ALGORITHMS TO GET THE DESIRED RESULT

### Computing the Threshold T using PSO

To evaluate the threshold values, we created ten agents 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.

**Pseudo code for Object Extraction**

The process comprises of following steps:

1. Preprocessing: e.g. Atmospheric, correction, noise suppression, band ration, principal component analysis etc.
2. Selection of the particular feature which best describes the object.
3. Decision: Choice of suitable fitness function for comparing the image patterns with   the target patterns.
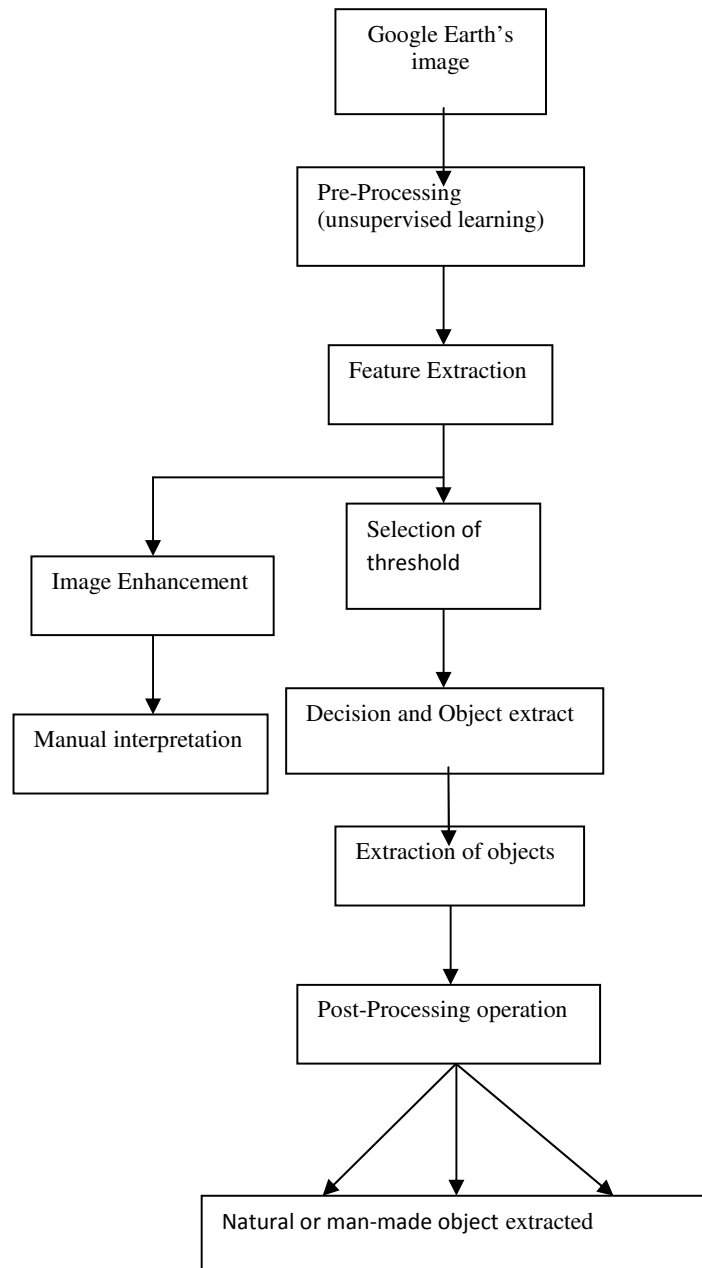4.  Assessing the accuracy of the object extraction

```
                    ┌─────────────────┐
                    │ Google Earth's  │
                    │     image       │
                    └────────┬────────┘
                             │
                    ┌────────▼────────┐
                    │ Pre-Processing  │
                    │(unsupervised learning)│
                    └────────┬────────┘
                             │
                    ┌────────▼────────┐
                    │ Feature Extraction │
                    └────────┬────────┘
            ┌────────────────┤
            │                │
   ┌────────▼────────┐  ┌────▼──────────┐
   │                 │  │ Selection of  │
   │Image Enhancement│  │  threshold    │
   └────────┬────────┘  └────┬──────────┘
            │                │
   ┌────────▼────────┐  ┌────▼──────────────────┐
   │Manual interpretation│ │Decision and Object extract│
   └─────────────────┘  └────┬──────────────────┘
                             │
                    ┌────────▼────────┐
                    │Extraction of objects│
                    └────────┬────────┘
                             │
                    ┌────────▼────────┐
                    │Post-Processing operation│
                    └────────┬────────┘
                     ┌───────┼───────┐
              ┌──────▼───────▼───────▼──────┐
              │Natural or man-made object extracted│
              └────────────────────────────┘
```

**Figure 4:** Flowchart for feature extraction

```
Main Program
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
```

**Pseudo code:** Implementation of algorithm

## 5. SECTION 4: RESULTS

Figure 5 shows natural or man-made objects which we extract from Google earth image.
To extract Water, Barren land, Road, Settlement, Tree etc. objects in the image   which are following:
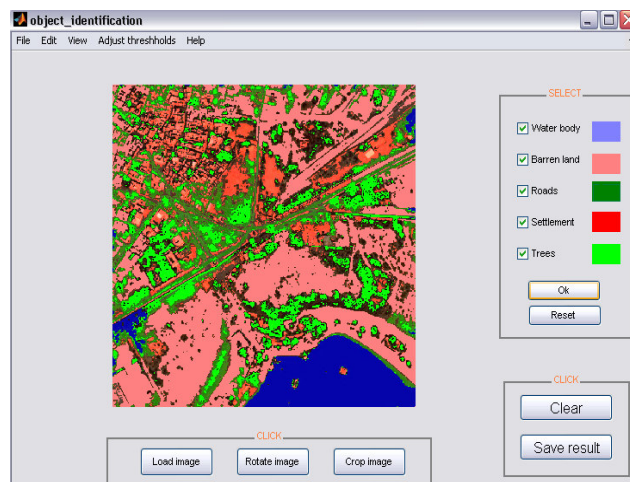


**Figure 5:** Natural or Man-made Object Extraction image.

## 6.  CONCLUSION

In this paper, a new approach for natural or man-made object extraction in urban areas from high resolution satellite image (Google Earth) is proposed. By combining the spectral information and shape measures we may to find natural objects from the image.  These objects may further be used for urban planning, ground water estimation, GIS mapping etc. The experimental results on

real Google Earth imagery demonstrate that it is an effective way to detect objects by learning from object's features. It is fully depend on unsupervised earning. The results prove that proposed approach effectively extracts the major objects from the Google Earth's image.

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