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An Open Source Image Segmentation Tool for Remote Sensing Images

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ABSTRACT

There is a growing interest in open source alternatives to expensive commercial packages for extracting information from remotely sensed images. The benefits of open source software go beyond cost savings on software licenses. For researchers, open source software provides the ability to explore existing algorithms as well as provide access to latest algorithms, by looking at the source code and making changes as required. Image Segmentation is a process of partitioning an image into homogenous non-overlapping regions of related content. The segmentation algorithms are based on two basic properties: discontinuity and similarity. An attempt is made here to develop an open source tool for image segmentation using python. The Python language is particularly beneficial in allowing the system to be expanded as there are a large number of Python libraries already available. It also provides good interoperability with other programming languages allowing existing code to be incorporated as part of the workflow.

The tool is based on pull down menu driven graphical user interface. The tool provides basic file operations, filtering, segmentation, morphological operations and feature extraction routines. Laplacian edge detection, Gaussian smoothing, Canny, Gabor and Hough transform form a part of the filtering based segmentation. Erosion, Dilation, Opening and Closing are implemented under morphology. Segmentation menu includes Thresholding, Region Growing and Watershed segmentation techniques and work flow for road and building detection is implemented as feature extraction. The tool is particularly useful for feature extraction. One of the key advantages of the system proposed is that its modular nature allows other packages and routines to be incorporated alongside and to build new algorithms on top of the existing framework.

INTRODUCTION

Image segmentation is an important and challenging process of image processing. It is a technique which is used to partition an image into meaningful parts having similar features and properties. The main aim of segmentation is simplification i.e. representing an image into meaningful recognizable parts. The algorithms for segmentation are based on either satisfying homogeneity property over a large region or detecting abrupt change in image intensity or other feature within a small neighborhood. The first approach extracts the regions as a whole over which some measure shows the presence of homogeneity in feature value, while the second one detects the borders between two regions and is commonly known as edge detection. Objects thus created by image segmentation are the subdivisions of an image into separate regions. These objects form the basis of object-oriented image analysis where the smallest units are segments or image objects, and not single pixels. Advantages of object-oriented analysis are meaningful statistic and texture calculation, an increased uncorrelated feature space using shape (e.g. length, number of edges, etc.) and topological features (neighbour, super-object, etc.), This relation improves the value of the final classification and cannot be fulfilled by common, pixel-based approaches.

Traditional pixel-based classification approaches barely suffice the requirement of accurate and detailed land-cover classification (Blaschke et.al 2011, Mallinis et.al 2008, Zhou et.al 2009 due to not accounting for meaningful image objects at different scales and resulting in the “salt and pepper” effect/noise (speckles) (Li et al. 2014 , Blaschke et.al, 2010, Li et al. 2012. To address the challenges of classifying high-resolution remote sensing imagery, researchers are switching from traditional pixel-based methods to alternative approaches in image processing, namely the Object-Based Imagery Analysis (OBIA) [Blaschke et.al 2011 & Blaschke et.al 2012. The OBIA approach, advancing in its image segmentation, groups pixels into image objects as its basic unit to avoid or minimize “noise” within ground objects. In addition, it integrates characteristics within the spectral domain of the high-resolution imagery (Kumar et al 2014, Arvor et. Al 2013).

Python is a high-level, interpreted and general-purpose dynamic programming language that focuses on code readability. The syntax in Python helps the programmers to do coding in fewer steps as compared to Java or C++. The language founded in the year 1991 by the developer Guido Van Rossum has the programming easy and fun to do. The Python is widely used in bigger organizations because of its multiple programming paradigms. They usually involve imperative and object-oriented functional programming. It has a comprehensive and large standard library that has automatic memory management and dynamic features.

Since last two decades, processing power of affordable computers allows image processing and image segmentation. Therefore, these methods become applicable for operational remote sensing image analysis. An open source tool is developed using python for all functionalities of image segmentation. The algorithms for image segmentation in this paper are evaluated on a data set of Remote Sensing Images. The tool is tested on three cases general photographic images of objects, remote sensing images from two high resolution satellite sensors.

CHARACTERISTICS OF TOOL

The tool is based on Graphical user interface (GUI) and does not require any specific computer knowledge to use it. The tools hardware and software requirements are very less. It occupies very less space and the python and its libraries being open sourced as easily be accessed. The tool is a culmination of all the image pre-processing and feature extraction techniques which can be easily accessed. This tool acts as an "image viewer" which allows the image to be edited using filters, morphological operators and saved. The tool has been developed to detect the road networks and the buildings present in the given image. This tool also enables the user to segment the similar regions in the image for further analysis. It facilitates the user to extract the foreground from the image, detect the objects present in the image.

The GUI is menu driven (Figure1) with the following options available to the user. They are:

Filters: Laplacian edge detector, Gaussian Smoothing Filter, Canny edge detector, Gabor Filter and Hough Line Transform

Morphological Operators: Erosion, Dilation, Opening, Closing.

Segmentation Techniques: Thresholding, Region Growing, Watershed

Feature Detection: Foreground extraction, Corner Detection, Rural Road Detection, Urban Road Detection, Building Detection

The sample output of segmentation is illustrated in Figure 2

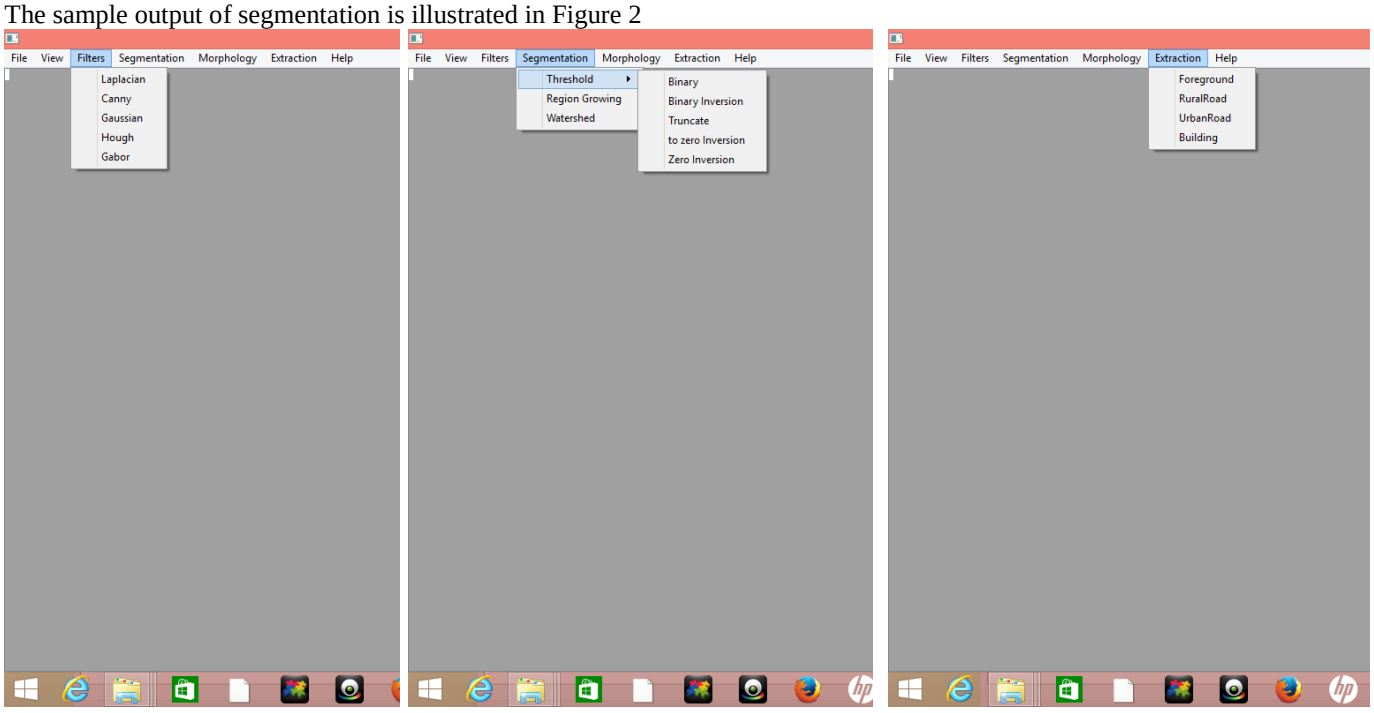

Figure 1 GUI Tool layout with a) Filters menu b) Segmentation menu and c) Extraction menu

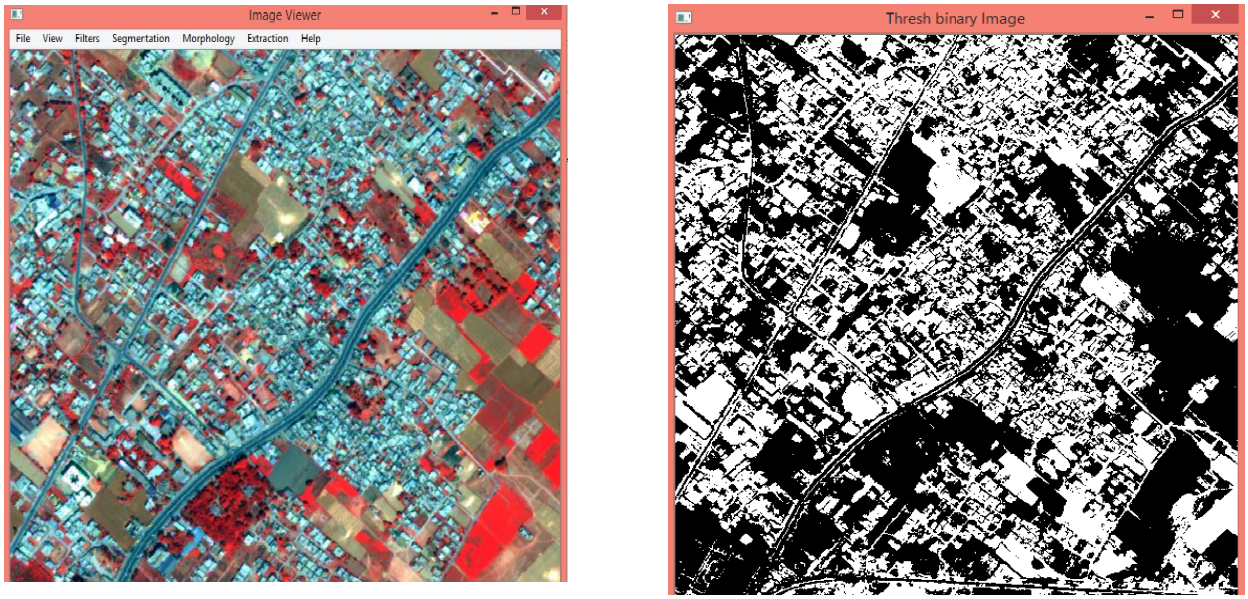

Figure 2: (a) High Resolution Image and (b) Segmentation results

CONCLUSION AND RECOMMENDATION

The division of an image into meaningful structures, image segmentation, is often an essential step in image analysis, object representation, visualization, and many other image processing tasks. Perfect image segmentation that is each pixel is assigned to the correct object segment– is a goal that cannot usually be achieved. Indeed, because of the way a digital image is acquired, this may be impossible, since a pixel may straddle the "real" boundary of objects such that it partially belongs to two (or even more) objects. Perfect image segmentation is also often not reached because of the occurrence of *oversegmentation*. In the first case, pixels belonging to the same object are classified as belonging to different segments. A single object may be represented by two or more segments. In the latter case, the opposite happens: pixels belonging to different objects are classified as belonging to the same object. The paper presents the first version of the tools which is under beta testing. All of the libraries are accessed through Python, allowing processing chains to be easily build and applied to very large datasets. Through Python, a large number of third party libraries are also available, which can easily be incorporated due to the open and modular nature of the system.

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