Extracting Clutter Information from Landsat 8 Multispectral Imagery

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Introduction

When conducting a spectrum engineering study, it is common to perform a propagation simulation using digital terrain and clutter models. It is also common to display the simulation results of digital map imagery. High fidelity map imagery is now widely available to the public thanks to the competitive efforts between Google, Microsoft, Nokia, Apple and others. There are very few places in the world where one cannot find high resolution aerial, satellite imagery or detailed street maps. Additionally, free global terrain data is also easily accessible on the internet. The SRTM v.4 and ASTER projects have produced a contiguous medium resolution surface model of most of the planet. On the contrary, access to a good quality worldwide baseline for clutter data is still nonexistent. In a radio frequency propagation analysis, a clutter model provides information about the static morphological conditions above the terrain. Common clutter categories can include urban, suburban, open water and vegetation. Attaching measurement derived statistics and associating these values with a clutter model is a common methodology used for tuning propagation models.

In order to find higher fidelity terrain and clutter data one has to search on an individual basis from national or local resources. The USGS provides a free, contiguous clutter resource for most of the United States (except northern Alaska) known as the National Land Cover Dataset (NLCD-2006) product. In Europe, the Corine Land Cover product provides contiguous clutter information for the entire continent.

The recently launched Landsat 8 satellite provides a source of information that, with the proper tools, can allow one to extract the digital information necessary for generating quality clutter data for anywhere on the planet. This paper describes some of the principle techniques used to extract the relevant classes of clutter information from Landsat 8 multispectral imagery.

Source Data

Landsat 7 provided an enormous amount of satellite photography that were used to create 30 meter resolution images of the entire planet. Because the Landsat 7 satellite captured photographs at multiple frequencies, digital signatures of various layers of land cover information could be identified and extracted from this multispectral imagery in a semi-automatic manner. Unfortunately, a sensor failure in 2003 made the new Landsat 7 images too difficult to use for the purposes of clutter extraction.

The Landsat 8 satellite was launched earlier this year providing yet another opportunity to acquire better data on land use and cover. The satellite orbits in 99 minutes and covers the entire earth in 16 days. Imagery data from the Landsat 8 photographs have been produced since April 11, 2013. The instrumentation used to take the satellite photographs have been upgraded from Landsat 7 and the results are stunning. Landsat 8 photographs provide 12 bit layers ranging from blue to infrared, as well as thermal images. The USGS website at ***http://earthexplorer.usgs.gov/*** provides public access to Landsat 8 products.

A full scene takes about 1 GB of disk space and covers an area of about 170 x 183 kilometers at 30m resolution. Each scene is composed of multiple imagery layers taken at various frequencies. The layers are 16-bit GeoTIFF files, and can be imported using ATDI's GIS management platform, ICS Map Server, through a dedicated Import L8 menu option. The layers are already projected to a UTM grid.

Upon importing the individual imagery layers, a user may extract clutter classes by converting the original layers into the following indexes:

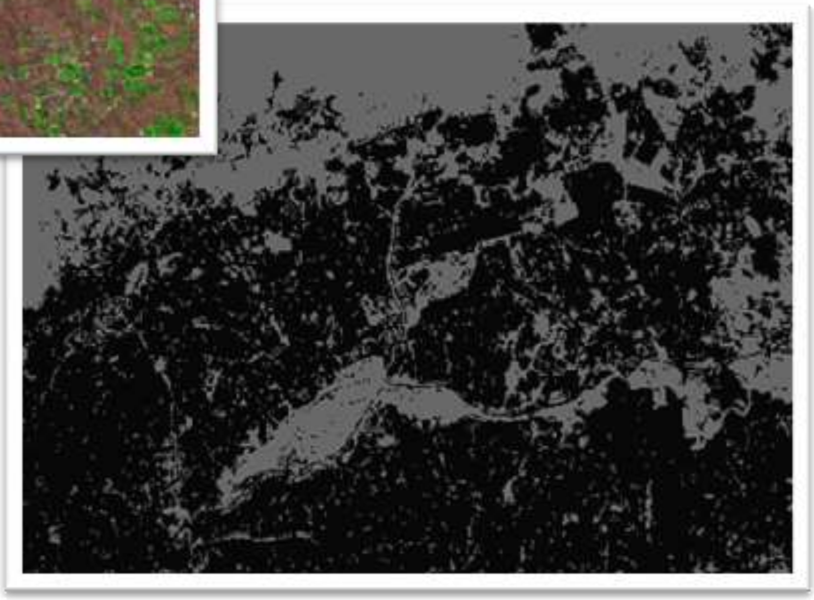
Vegetation: A very classic and well documented method for extracting vegetation is the calculation of the Normalized Difference Vegetation Index (NDVI). This index calculates the difference in reflection from the red and the near infrared channels (NDVI = (L5-L4) / (L5+L4)). The result is directly proportional to the density of the vegetation.

Water: The Normalized Difference Water Index (NDWI) calculates the difference between the green layer and the near infrared layer.

Urban: The basic index for urban extraction uses the near infrared and infrared layers. In this case, supervised extraction is required and refined indexes are often used as well as logical operations between the indexes to remove mixed classes, like water or bare earth.

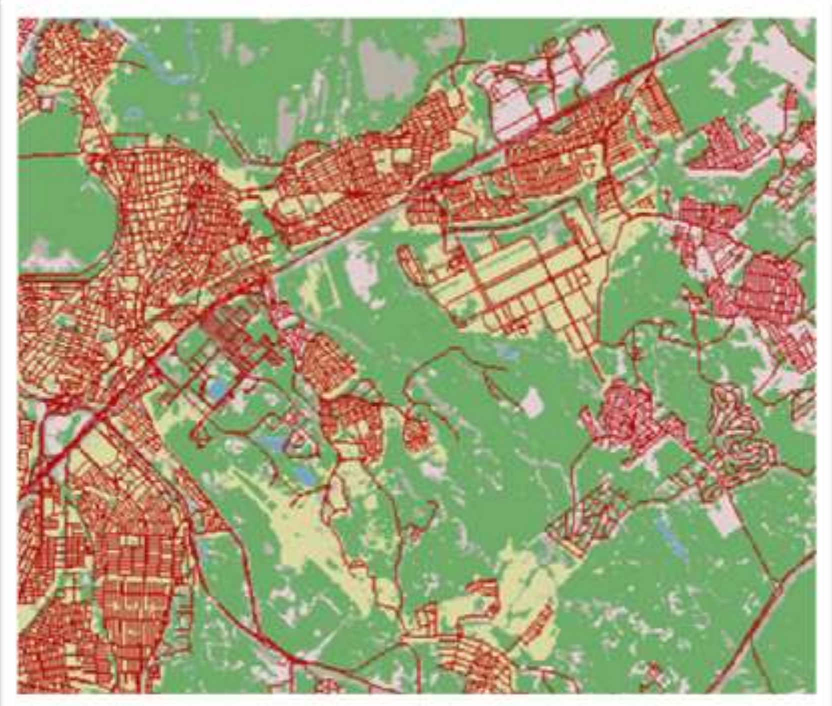
Landsat 8 Imagery

Urban extraction (in black)



This semi-automatic approach for clutter extraction can be used to replace classic manual clutter extraction techniques. Semi-automatic extraction of clutter from Landsat 8 multispectral imagery produces very detailed urban clutter models. Differentiating between different classes of urban clutter is still operator driven (supervised), and uses traditional fill techniques on clusters of urban areas.

Finally, road vectors can be inserted into the clutter model in the case the user needs to distinguish propagation simulation results on and off the roads and streets. A global source of these vectors is OpenStreetMap.



Final Clutter layer with roads inserted

Final Clutter – Sao Paulo, Brazil

Production of a clutter model generated from satellite multispectral photography is possible wherever low cloud coverage satellite imagery, such as those produced by Landsat 8, is available. This public resource of information allows for the creation of a medium resolution dataset with homogeneous high quality clutter for anywhere in the world.