



OBJECT-BASED IMAGE ANALYSIS AND LIDAR

NEW GENERATION OF IMAGE ANALYSIS SOFTWARE SUPPORTS THE ANALYSIS OF LARGE VOLUMES OF HIGH RESOLUTION IMAGE DATA FROM DIFFERENT SOURCES

The output data from aerial and satellite remote sensing technologies has become increasingly precise and detailed, making it possible to deliver high-quality maps and models of much larger areas of land. Light Detection and Ranging (LiDAR) can deliver precise estimations of an object's three-dimensional properties over a broad range of scales. However, the manual analysis of LiDAR data sets can be a labor-intensive and expensive exercise. Employing automated image analysis software enables geospatial organizations to process high volumes of data objectively and rapidly.

Definiens was the first company to introduce object-based image analysis (OBIA) to the earth sciences market in the early part of the decade. In contrast to traditional, pixel-based methods, Definiens employs a context-based approach, segmenting and classifying images by looking at them in context and making inferences. Definiens utilizes sample objects to identify similar objects, or extracts objects defined by specific characteristics, such as color, shape, texture and local context.

eCognition 8 is the latest iteration of the company's object-based image analysis software for earth sciences. Released in November 2009, *eCognition 8* incorporates a number of features that are new to image analysis, including the automated classification and segmentation of LiDAR point clouds.

While LiDAR data previously required processing before commencing image analysis, with *eCognition 8* users are able to input LiDAR datasets in their native format. Additionally, the software can fuse LiDAR data with other available data, such as aerial photography, satellite imagery and GIS layers. By applying



Figure 1. Airborne photography, LiDAR data and GIS vector information is fused to generate impervious surface maps on a cadastral level]

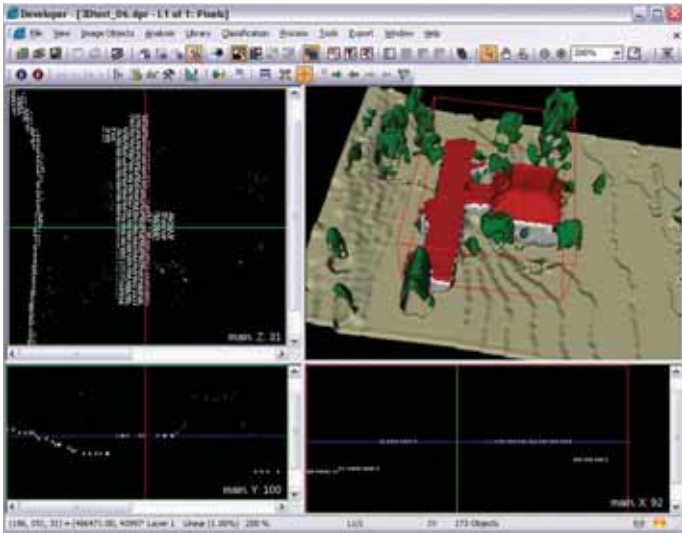


Figure 2. 3D segmentation and classification of LiDAR data with eCognition Developer 8

object-based image analysis (OBIA) principles to LiDAR data, users can efficiently manage complex projects.

eCognition on LiDAR Data

In the loading process, LiDAR data is rasterized rapidly to render an initial overview. Filtering and rasterizing of the point cloud within a project opens up a wide variety of applications, including feature extraction from LiDAR data and fusion with optical data. This approach gives eCognition 8 the power to segment and extract 3D information from LiDAR data sets.

The following case studies outline how eCognition has been successfully utilized to analyze data sets from different sources, including LiDAR data, in urban planning and land cover projects.

Assessing Urban Tree Canopy for Greener Cities

An increasing number of urban planners and local authorities want to improve air quality, reduce energy consumption and ease storm water flows in their cities. A sufficient number of healthy trees is essential to achieving these ambitious goals.

Researchers at the University of Vermont, working in conjunction with the U.S. Forestry Service, utilized eCognition to develop an application that assesses and quantifies urban tree canopies (UTC). By integrating data from aerial photos, LiDAR and taxation maps, the application determines the tree canopy coverage in urban areas, quantifying how much tree cover is on public land and how much is on private land. Major U.S. cities already use this information to accurately quantify the amount of potential additional tree canopy.

The University of Vermont utilizes color infrared (CIR) aerial imagery acquired at a resolution of 1m for reference purposes. The application completes all feature-extraction and morphological operations on a digital surface model (DSM) of LiDAR data acquired at a high-resolu-

tion. In this normalized DSM, each pixel represents the relative height of features, and the LiDAR data is corrected relative to the terrain. The application analyzes the LiDAR point cloud to distinguish a minimum height threshold, classifying features above the height threshold as "trees." Once areas of interest are classified based on the height threshold, these features are extracted from the image and border areas are smoothed. When this process is completed for an entire urban area, an accurate quantification of the urban tree canopy is obtained for the purpose of planning healthier and more sustainable urban environments.

Mapping Impervious Surfaces to Better Manage Storm Water and Control Erosion

Accurate impervious surface maps are becoming increasingly important for developing plans for a wide range of projects such as watershed protection, storm water management, erosion control and water quality protection. Lagan Spatial, a Definiens partner based in Sydney, Australia, has utilized eCognition to develop an application that allows local Australian governments to quickly segment and classify aerial photos in combination with LiDAR to quantify impervious surfaces. Following the success of their pilot program at a Sydney council, Lagan Spatial is convinced that automated land mapping is essential to establishing accurate pervious and impervious land cover.

Utilizing eCognition, impervious surface mapping is completed by integrating all available data, including CIR or RGB airborne photography, LiDAR elevation data and existing GIS layers, such as cadastral plot data and road networks. The data is automatically segmented into similar regions based on spectral and spatial homogeneity. By aggregating pixels into image objects, the data can be further analyzed

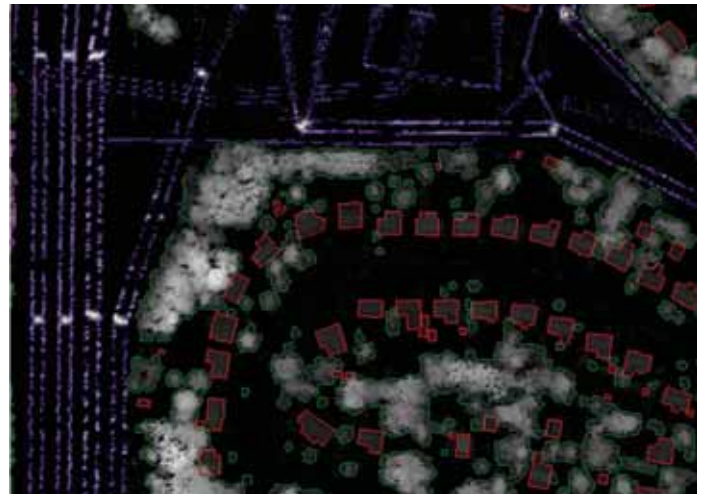


Figure 3. UTC land cover results overlaid on LiDAR data



Figure 4. UTC land cover results overlaid on imagery



Figure 5. upper left: RGB; upper right: nDSM; lower left: basic land cover; lower right: generalized results

based on additional factors, such as texture, shape and contextual information. Once features are identified, they can be extracted into standard GIS data formats such as ESRI shape files for further analysis in GIS and CAD platforms.

Analyzing Land Use and Land Cover to Improve Urban Living

The Department of Surveying and Geo Information of the State Government of Lower Austria (GEOinfo) is currently developing a land-

use and land-cover model of more than 20,000 km² of territory, encompassing bodies of water, forests, urban and rural areas. Utilizing eCognition 8, the department developed a software application to detect and quantify changes in forests, buildings, field and water areas from LiDAR data and orthophotos.

The ground resolution was 12.5cm to 15cm. A normalized digital surface model (DSM) was generated from the airborne LiDAR data. During the segmentation phase, a tiling and stitching technique was applied. This ensures that images of all possible sizes can be processed. The area was segmented into 2000 x 2000 pixel tiles, each representing 1km x 1.25km of territory. Within each tile segment, the software automatically classified elevated objects and distinguished buildings, trees and scrub from among this set of elevated objects. Results were then stitched together and border effects were removed. The application enabled the generalization of building outlines, producing clearer, more intuitive results and facilitating simpler map construction.

The software application supports urban planning initiatives and - as part of a European Union higher-traffic network project - the development of sound-wave propagation models of traffic noise.

Conclusion

Advances in optical sensor technologies and aerial LiDAR are producing increasingly high-quality data that is used by geospatial organizations to map vast areas of land. Software developers are challenged to create tools that can realize the full potential of this data. With its eCognition software, Definiens enables rapid and objective analysis of imaging data from all remote sensing acquisition modalities for large-scale land-use modeling. The latest developments in automated image analysis technology allow organizations to engage in novel and ambitious projects, from the development of UTC coverage models to the creation of maps which can identify optimal rooftop orientations for solar panel installations.

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