Multi-Sensor Data Fusion Provides the Means to Extract True Value From Remote Sensing Data

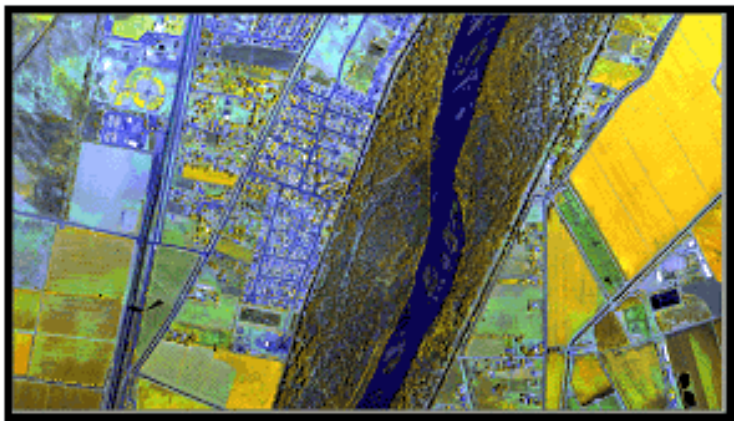
Current developments in the integration of multiple digital data sets such as hyperspectral imaging, color digital orthophotos and airborne LIDAR data are generating 3-D geospatial information that, previously, has been unattainable.

Color IR digital imagery fused with LIDAR data for the development of an intelligent 3D Urban/Natural Database

The fusion of geospatial data from different sources allows the creation of thematic data layers and structural features for urban and natural environments that can be critical elements of a geospatial database. These elements include: building footprints, height and structural characteristics; feature composition and material maps; vegetation type, height and density; and, natural and cultural land-use and cover information, providing a powerful toolkit to enable intelligent data analysis.

This "Intelligent Data" is not derived from new, better or faster equipment, but rather from the ability to work with the various types of data simultaneously, fuse the data and extract information not previously accessible.

At the forefront of fusion of geospatial data from different sources is Spectrum Mapping, LLC located in Denver, Colorado. Spectrum developed a process to fuse data from various sensors such as LIDAR, hyperspectral, and multi-spectral digital cameras to create "Intelligent Data." This process of sensor fusion is called Spectral Imagery LIDAR Composite (SILC) which facilitates feature extraction for LIDAR mapping projects where multispectral and hyperspectral pixels are associated with individual X,Y,Z values to discriminate between roads, buildings, trees, water and other features.



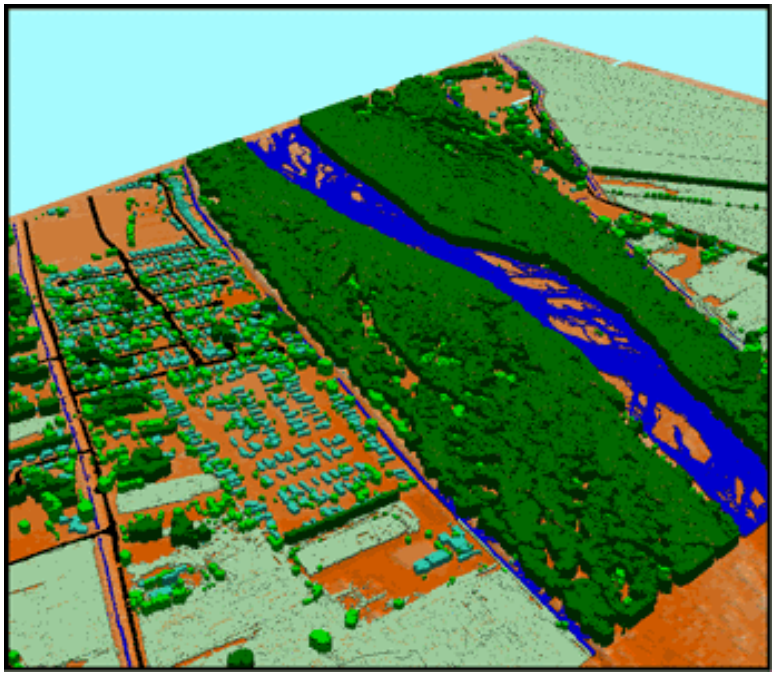
Hyperspectral imagery feature attributes using spectral analysis techniques

"By using imagery acquired simultaneously with the surface data, each surface point possesses an accurate spectral signature assigned to its location, allowing accurate classification of features using conventional remote sensing techniques," explains Don Wicks, president of Spectrum Mapping. "Through the element of color, SILC data allows urban terrain, forested terrain, agricultural lands, mountains, cliffs, ravines, and wetlands to be classified, providing vastly improved bare-earth surfaces and feature extraction."

Multi-Sensor Data Fusion Uses

Spectrum applies this sensor fusion process for the development of Intelligent 3-D Urban/Natural Geospatial Databases for mapping and simulation purposes. By collecting all three datasets simultaneously with their own plane, multispectral digital camera, LIDAR, and 63-band Hyperspectral sensors, they use the data fusion approach to generate a rich, geospatial feature database.

LIDAR and hyperspectral derived classifications in shape file format



3D perspective view of LIDAR and hyperspectral derived classifications.

LIDAR serves as the terrain data and (X,Y,Z) feature source information for most of the 3-D objects contained in the terrain database. This includes: a bare-earth surface and contours; building footprints and height; height and structure of vegetation and tree cover; roads; and, localized planimetrics and infrastructure. All features are extracted as LIDAR point data and then transformed into their appropriate terrain formats (GeoTiff, polygon, point, line shape files). The 0.5-ft to 1.0-ft resolution Color / CIR Digital Orthophotography serves as the geo-coordinate base for the terrain database, due to its highly accurate geopositional characteristics, and is used as the base (RGB) layer for the visualization model.

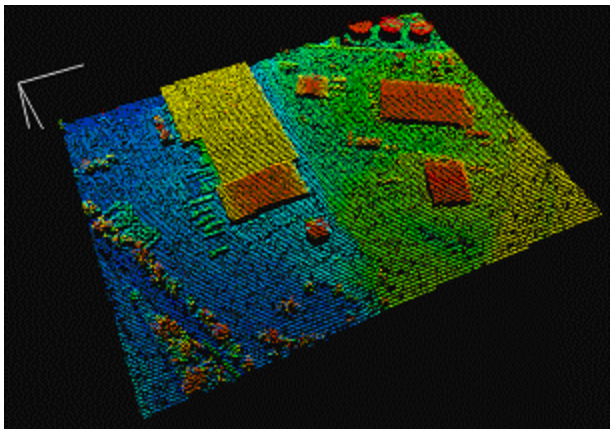
The hyperspectral imagery is used for feature attribution using automated spectral analysis techniques. All hyperspectral pixels are geo-located to their corresponding LIDAR point data, giving each point an identifiable material class to be used in the visualization construction process. The hyperspectral data is also used to generate an overall land cover map, which provides feature class names and material class attributes for all surface features contained within the project area. Extracted features included: roof and building composition; road composition; tree species and health; wetlands; and agricultural classes.

Spectrum also provides the necessary toolsets required to take all source information from its 2-D feature profile to an importable 3-D object. All derived surface features are attributed

appropriately to generate usable 3-D objects. The urban database contains real world 3-D objects, projected in a real-world coordinate system.

Applications

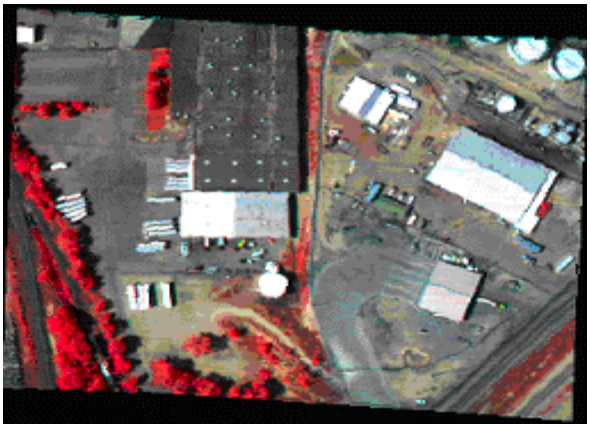
This "Intelligent Data" can be a valuable tool to support a myriad of industries and applications such as the pipeline industry's efforts to identify geohazards that could endanger the pipeline structure and its surrounding environment and community.



LIDAR Point Data

Spectrum's "Intelligent Data" could be useful in emergency response and mitigation providing an accurate representation of the terrain, features, hazards and obstructions - allowing the identification of High Consequence Areas (HCA) such as buildings over four stories in height, hospitals, schools, apartment buildings, office buildings - areas which would have difficult response or evacuation conditions.

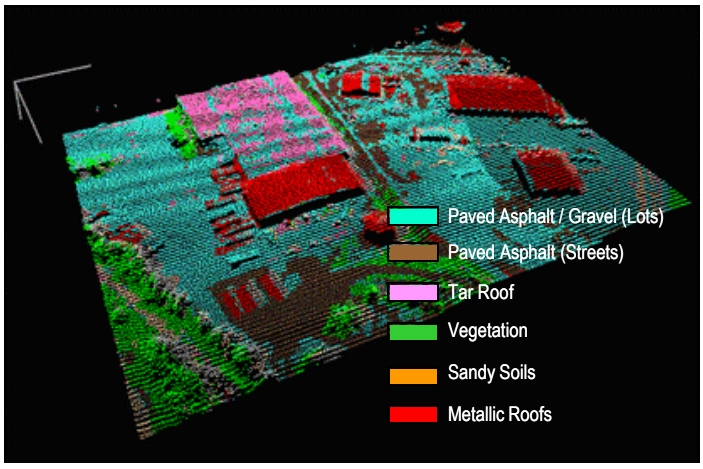
The higher vertical accuracy of the LIDAR data provides a bare-earth model for profile of the pipeline and the surrounding terrain, which is necessary for construction approvals, pipe replacement, and pre-construction engineering. The ability to generate one and two foot contours for site mapping for plant construction, analysis for risk assessment and steep slope evaluation is another benefit.



Hyperspectral Image

The data fusion would be ideal for flood mapping (before and after) by accurately mapping the flood plains and identifying structures that are in the flood plain. This data can be used in modeling the extent of flooding using storm surge modeling.

Another application would be mapping of surface contamination from non-point source as well point source pollution. The "Intelligent" data can be used to identify potential areas of contamination using a combination of elevation and slope from LIDAR data, a landuse/landcover map from multi-spectral and hyperspectral imagery, and identify damaged vegetation areas due to contamination using hyperspectral data.



SILC'd Hyperspectral Data with Materials Classifications

Also, mapping Tamarisk, an invasive plant species, along streams is another potential application where the DEM

from LIDAR can be used to identify areas close to streams and combination of hyperspectral and multispectral imagery can be used to identify Tamarisk.

Summary

The operational benefits and applications of multi-sensor fusion are just becoming apparent. The convergence of high-powered geospatial analysis and 3-D visualization with the fusion of multiple sensors such as LIDAR, aerial and hyperspectral imagery is meeting the compelling need for true geospatial intelligence from remote sensing data.

About Spectrum Mapping:

Spectrum Mapping, LLC is a full-service mapping, software development, and GIS company with six offices located throughout the United States and Canada. Spectrum's full-service mapping core competencies are in the fields of Photogrammetry; Remote Sensing Services (LIDAR, multispectral, hyperspectral and digital imaging); Digital Camera Development and Sales; and Software Development.

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