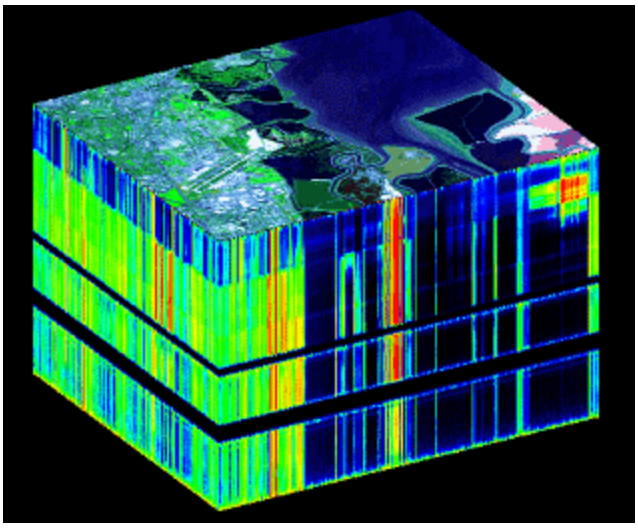
CSI Remote Sensing – Hyperspectral Imaging Provides "DNA" for Geospatial Information

Introduction

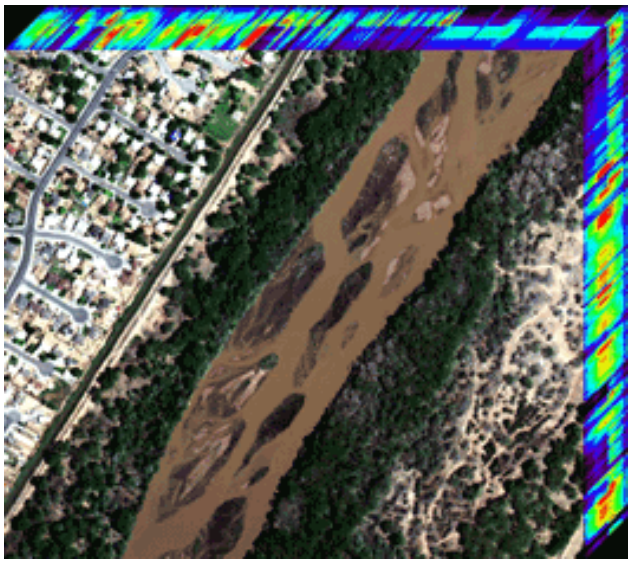
The crime scene investigation (CSI) television programs have popularized how fingerprints and DNA can be used to solve crimes. The remote sensing industry has its own technology to detect and discriminate unique characteristics of materials and features. Airborne hyperspectral imaging (HSI) provides the capability to detect and discriminate unique characteristics of materials and features, much like DNA is used in crime scene investigations.



Hyperspectral imagery data cube enables automated classification of features, including delineation of land water interface, vegetation associations and dominant vegetation.

The Technology

Hyperspectral imaging extends remote sensing and image processing beyond the traditional capabilities of multispectral satellite and airborne remote sensing. Hyperspectral sensors collect reflected and radiant energy data from the Ultraviolet and Infrared, as well as the familiar Visible portions of the electromagnetic spectrum where a variety of statistical and mathematical algorithms are applied to automate the image interpretation and feature identification process



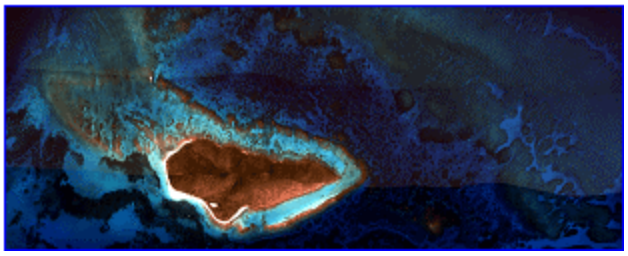
Hyperspectral refers to any data source that includes ten or more bands of spectral data and the bandwidth of the data collected is typically in the range from one to fifteen nanometers (a nanometer is one-billionth of a meter). In contrast, multispectral data typically consist of three to seven bands of data, with bandwidths ranging from 50-120 nanometers. This higher spectral resolution enables quantification and analysis of the interaction of surface materials and features with light and radiant (heat) energy, and is based on concepts of energy reflectance, absorption and emissivity resulting from feature composition and atmospheric condition.

Hyperspectral sensors measure the intensity of reflected solar energy across a continuous span of wavelengths–from shortwave infrared light to visible light and visible near-infrared light. Image measurements are made at many narrow contiguous wavelength bands–resulting in a complete spectrum for each pixel. The spectral resolution derived from HSI, for example when looking at vegetation, provides the ability to determine whether a "patch" is dominated by one species (homogeneous) or many species are intermixed (heterogeneous); the morphology of the feature (e.g. size, growth form); phenology (e.g. deciduous or coniferous, annual or perennial); and, number of features (e.g. dense or sparse).

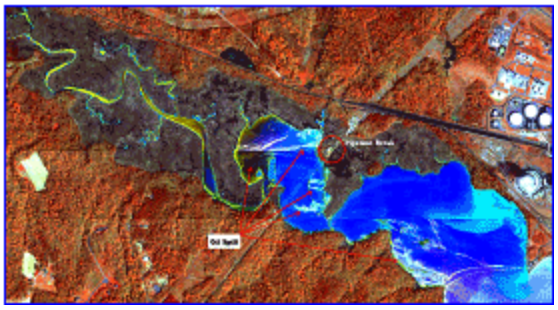
HSI Applications

There are numerous real-world applications that benefit from HSI data, such as:

- Materials mapping (e.g. sand, clay, gravel, asphalt, vegetation, and water)
- Land Use/Land Cover Classification
- Pervious/Impervious Surface Mapping
- Identification of geologic materials
- Detecting and identifying indicators of water quality (e.g. turbidity, chlorophyll, organic and inorganic pollutants)
- Vegetation type mapping, both terrestrial and aquatic
- Vegetation health and vigor
- Insect pest infestations of forests and crops
- Coral reef detection and condition

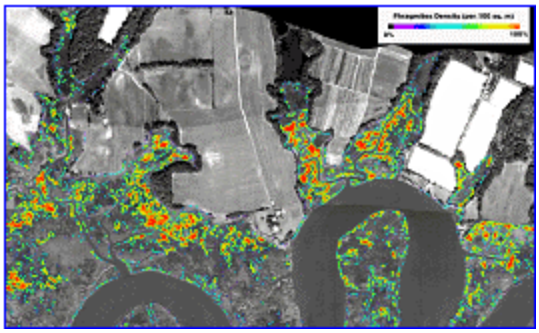


Coral reef mapping



Oil and toxic spill detection

For example, coastal managers can use hyperspectral remote sensing data to determine the effects of tide restriction on marsh habitat and help prepare for future restoration and preservation projects. Scientists from the Meadowlands Environmental Research Institute and Rutgers University compared habitat heterogeneity in tide-restricted areas and tide-open areas using hyperspectral remote sensing. Hyperspectral imagery from the Airborne Imaging Spectroradiometer for Applications (AISA) instrument was used to create a thematic map of marsh surface types in the New Jersey Meadowlands.



Noxious plant control

They found a significant difference in landscape heterogeneity between tide-open and tide-restricted marsh areas. Tide-open sites displayed a greater number of patch types and a more even distribution than tide-restricted sites. Results from this project revealed the potential for using hyperspectral imagery on its own to identify marsh features that are ecologically significant.

Spectrum HSI Capabilties

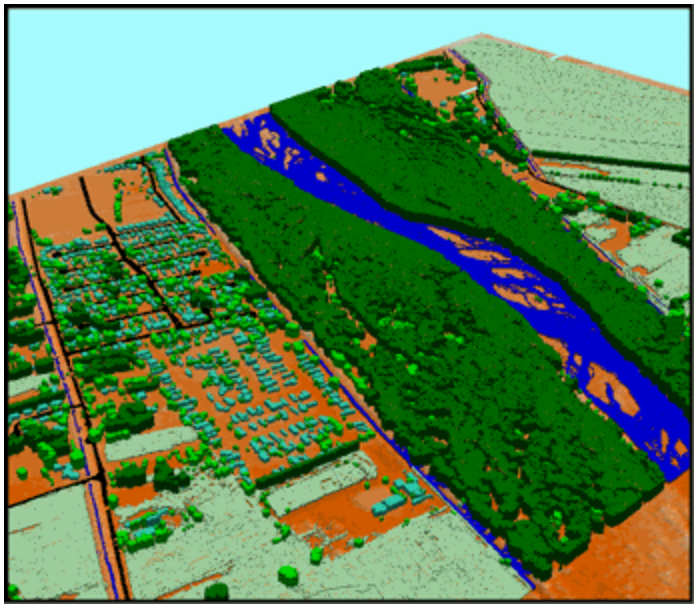
Since much of the work in the hyperspectral imaging area has been done in the research and academic realms, there are very few commercial sources of hyperspectral data and, more importantly, the capability to perform the

Forestry applications

processing and interpretation of hyperspectral data.

Spectrum Mapping, Denver, Colorado, is unique in the remote sensing/mapping industry in that they have their own hyperspectral sensor, planes and other instruments such as multi spectral and LIDAR sensors. Spectrum has the ability to acquire geospatial information with multiple sensors, fusing data from these sources and extracting meaningful "Intelligent Data."

Spectrum is integrating high resolution HSI, digital orthophotos and airborne LIDAR data to derive thematic data layers and structural features in urban and natural environments. By collecting all three datasets simultaneously with their own plane, mulitispectral digital camera, LIDAR, and Hyperspectral sensors, they use a data fusion approach for the development of Intelligent 3-D Urban/Natural Geospatial Databases for GIS, mapping and simulation purposes.



3D Perspective View of LIDAR and Hyperspectral derived Land Cover Classes

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 include: roof and building composition; road composition; tree species and health; wetlands; and agricultural classes.

The future trend in the remote sensing industry is the fusion of geospatial data from hyperspectral and other sensors which allows the creation of thematic data layers and structural features for urban and natural environments that can be critical elements of any geospatial database, providing a powerful toolkit that may not solve crimes, but enables intelligent data analysis.

About Spectrum Mapping, LLC:

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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