Expanding The Vision

Hyperspectral Imaging

By Kendalle Crawley

Project Description

- This project will explore the expanding remote sensing technology, hyperspectral imaging, in an artistic context in order to see things that are not visible to the naked eye.
- Reexamination of art, generated from an internal composition instead of exterior.
- Looking at a work of art through a hyperspectral image, viewers will gain a new perspective by seeing something they are normally unable to see.
- Every realistic from of art, from still lifes and portraiture to landscapes can be viewed as a hyperspectral image.

Background Information

- Hyperspectral imaging, also known as imaging spectrometry, is a concept in the world of remote sensing.
- The first Remote Earth sensing satellite to use spectral imaging was LANDSAT
- The original version of LANDSAT employed just four wavelength data points (WDP) using bandpass filters.
- Later bandpass filters were replaced with imaging spectrometers that used diffraction gratings to deliver thousands of WDP. This new technology was referred to as Hyperspectral imaging.
- Hyperspecral imaging concerns itself with the measurement, analysis and interpretation of spectra presented by objects, or conditions in a field of view.

Hyperspectral Imaging

- Hyperspectral imaging collects and processes information from across the electromagnetic spectrum.
- This technique of dividing images into bands can be extended beyond what is visible to the human eye.
- HIS utilizes wavelength composition of the electromagnetic radiation.
- The wavelengths of interest for HSI range from the low end of the visible spectrum (violet) through the high end of the visible spectrum (red), through near-infrared (NIR), short-wave infrared (SWIR) and mid-wave infrared (MWIR) to long-wave infrared (LWIR).

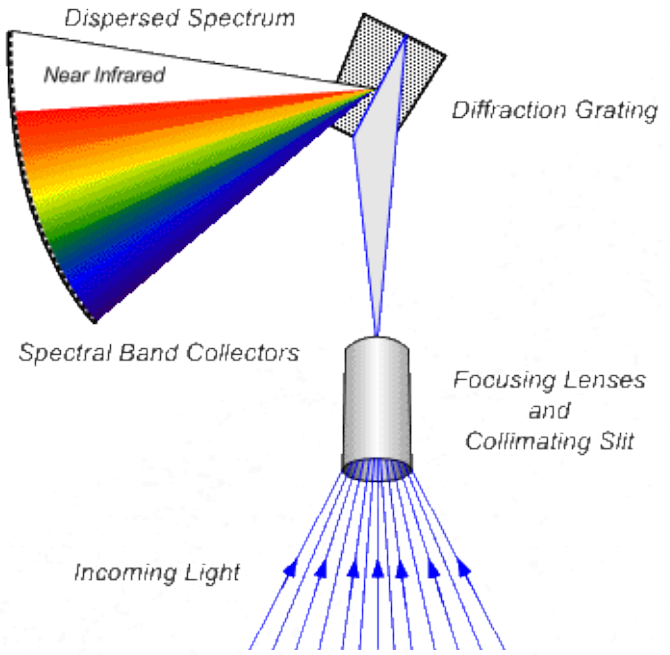
How It Works

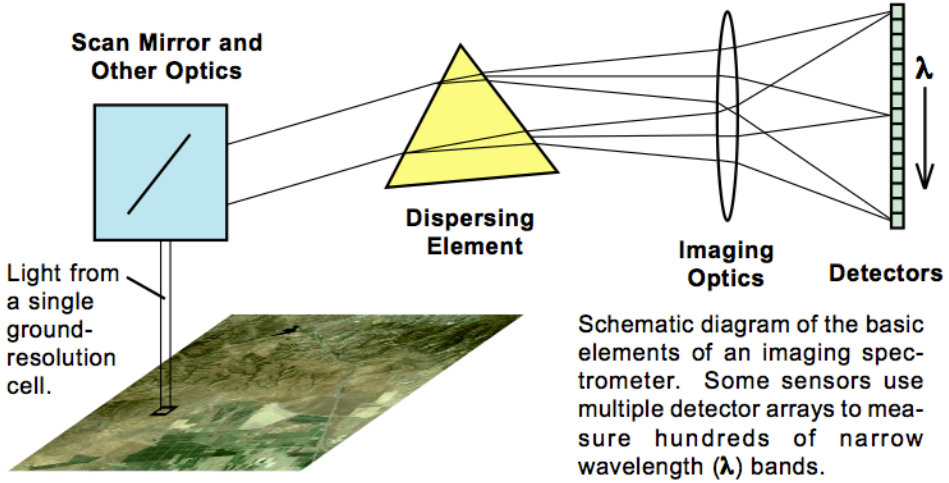
Two-dimensional projection of a hyperspectral cube

- Objects leave unique spectral signatures across the electromagnetic spectrum, which enable identification of the materials that make up a scanned object.
- Hyperspectral remote sensors, collect image data in hundreds of spectral bands, to derive a continuous spectrum for each image cell
- After adjustments for sensor, atmospheric, and terrain effects are applied, these image spectra can be compared with field or laboratory reflectance spectra in order to recognize and map surface materials.
- These images are then combined and form a three-dimensional hyperspectral data cube for processing and analysis.
- Types of sensors include airborne sensors, satellites and handheld sensors

How Sensors Work

- Hyperspectral images are produced by imaging spectrometers, which involves spectroscopy and remote imaging
- Spectroscopy is the study of light emitted by or reflected from materials and its variation in energy with wavelength. In optical remote sensing, spectroscopy deals with the spectrum of sunlight that is scattered by materials at the Earth's surface.
- An optical dispersing element such as a grating or prism splits this light wavelength bands and the energy in each band is measured by a separate detector.
- By using hundreds or thousands of detectors, spectrometers can make spectral measurements of bands over a wide wavelength range.





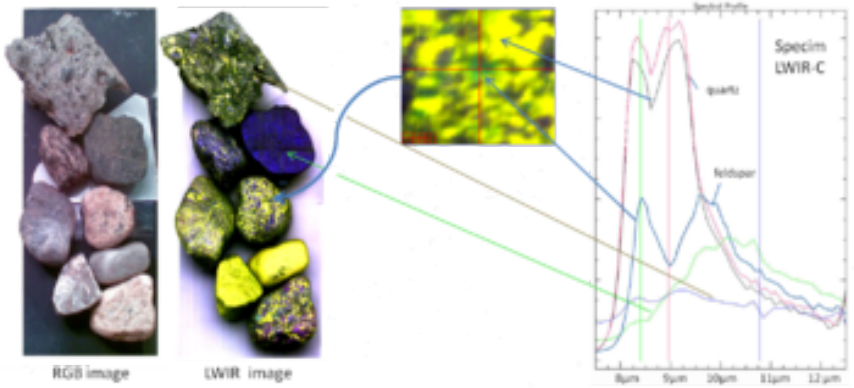
Schematic diagram of the basic elements of an imaging spectrometer. Some sensors use multiple detector arrays to measure hundreds of narrow wavelength (λ) bands.

Applications

- Geology and Mining
- Agriculture
- Mineralogy
- Surveillance
- Environment
- Chemical Imaging

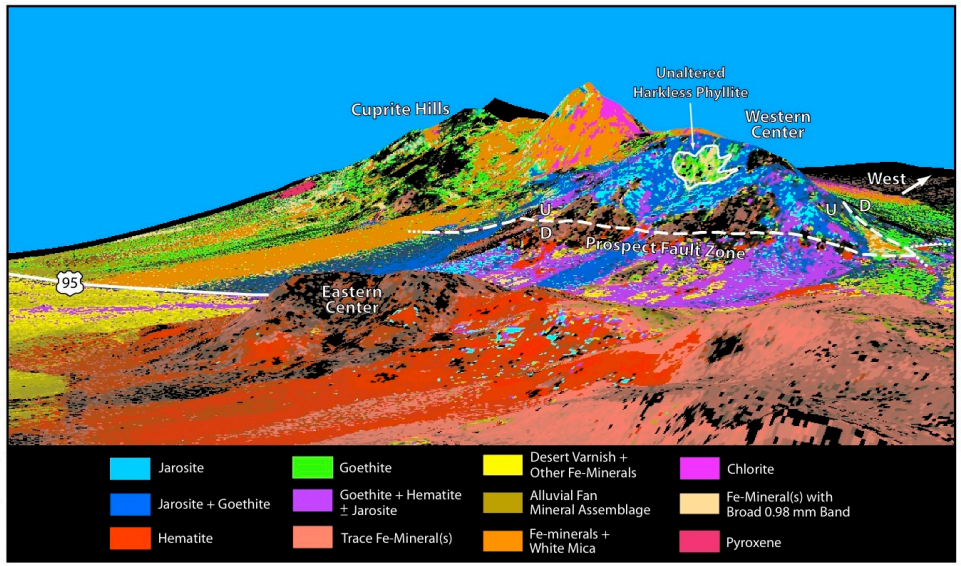
Geology, Mining and Mineralogy

- Hyperspectral Imaging was first developed for geology and mining.
- Identifies various minerals, where it can be used to look for ore and oil and find new oil fields.
- In mineralogy, hyperspectral imaging is used to map minerals from geological samples.
- Many minerals can be identified from airborne images, and their relation to the presence of valuable minerals, such as gold and diamonds.



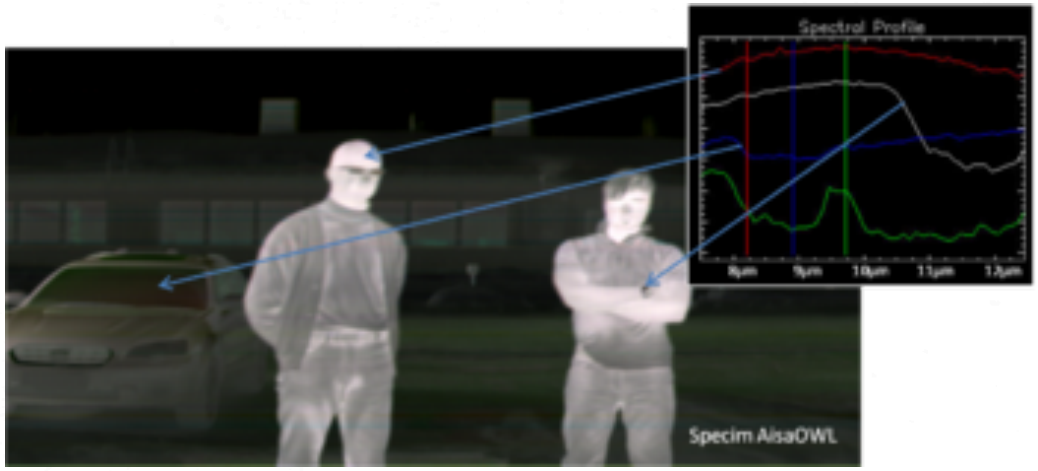
Agriculture

- Hyperspectral remote sensing use is increasing for monitoring the development and health of crops.
- Used to detect disease outbreaks, chemical composition of plants, nutrient and water status, and levels of animal proteins in compound feeds.



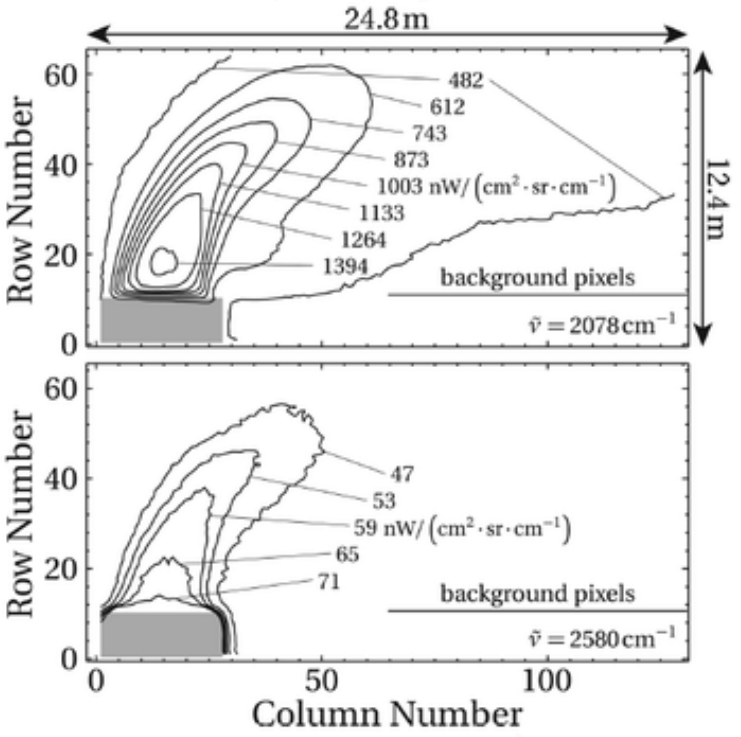
Surveillance

- Hyperspectral surveillance is the implementation of hyperspectral scanning technology for surveillance purposes.
- Most often used by the military for aerial surveillance



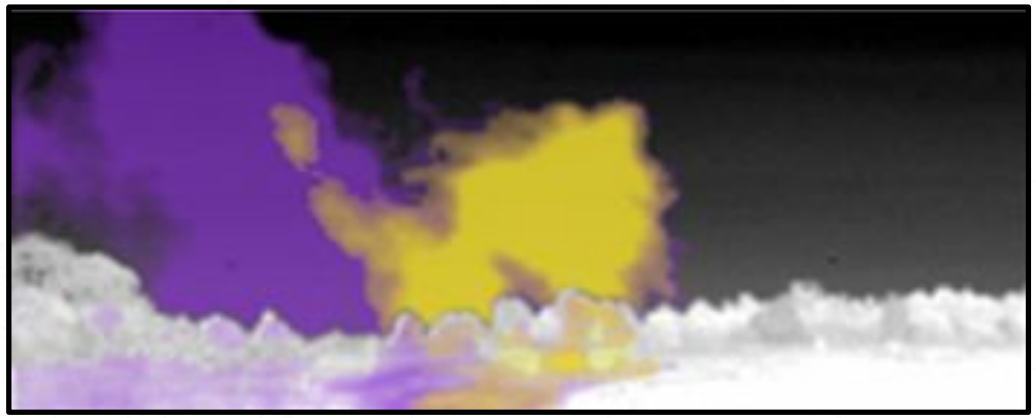
Environment

- To identify and quantify polluting emissions with the Hyper-Cam, an infrared hyperspectral imager.
- Can monitor emissions produced by coal and oil-fired power plants, municipal and hazardous waste incinerators, cement plants, and other types of industrial sources



Chemical Imaging

- Hyperspectral imaging technology offers a unique standoff detection, identification and imaging capability for detecting chemical warfare agents.
- Most commonly used in War to detect chemical hazards



Art Proposal

- This exhibit will invite artists and viewers to view artwork from a new perspective, a hyperspectral image.
- The hyperspectral Image can itself be a pioneering image redefining a typical work of art.
- Artists will be invited to bring their own artwork to be viewed and there will also be artwork supplied by the gallery that can be viewed.
- The exhibit will be divided into two parts, one that shows artwork in the form of a hyperspectral image and the other that shows the body as a hyperspectral image

Gallery Space

- The exhibit will be set up in an open gallery room
- The room will be divided into two parts, In the front of the room will be a large projector screen where hyperspectral images of artwork will be shown. In the back of the room will be another large screen displaying hyperspectral images of the human body.
- Around the walls of the room will be side by side examples of an art piece, and the corresponding hyperspectral image of that art piece.

Part 1

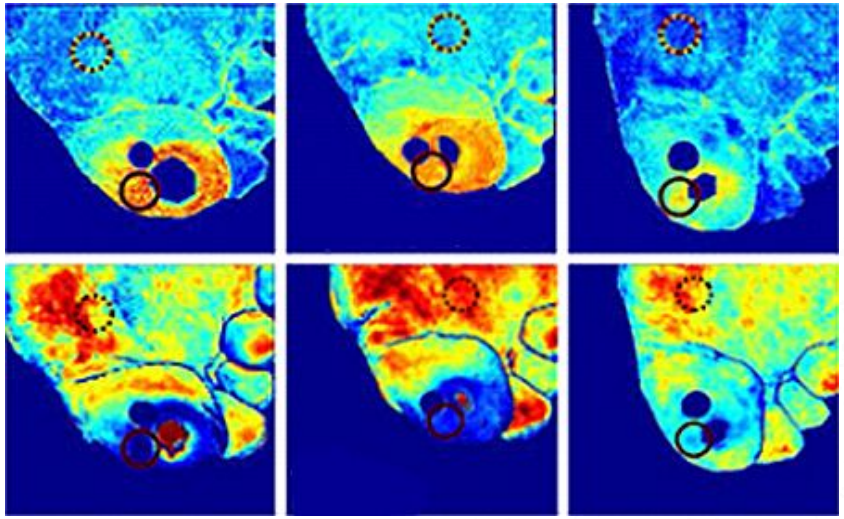
- In the center of the room, there will be a table with the hyperspectral imaging sensor on it.
- People will be invited to view an artwork of their own or provided by the gallery to be viewed under the sensor.
- The hyperspectral image of the artwork will then be projected on the screen at the front of the gallery.

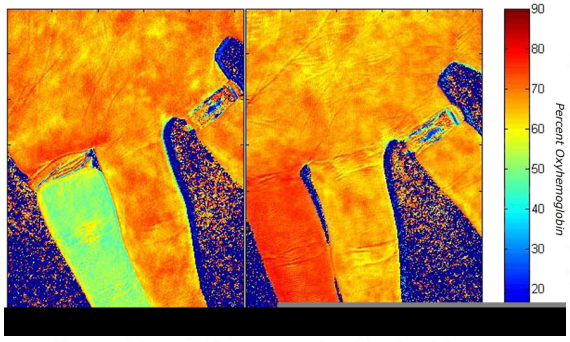
Example of how an aerial photograph of a city can be transformed into a work of art through hyperspectral imaging.

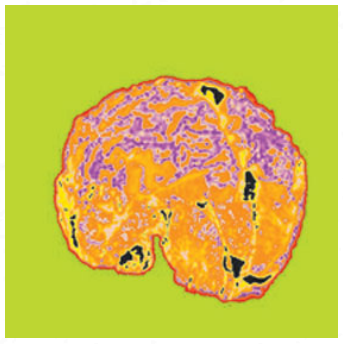
Part 2

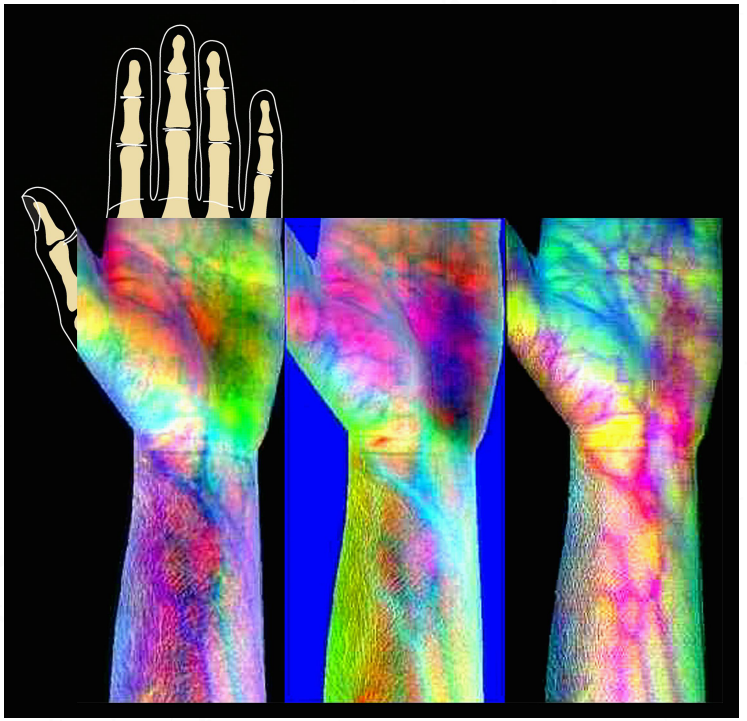
- The second part of the exhibit gives the viewers a first-hand experience of the hyperspectral remote sensing technology as they are invited to become part of the artwork.
- There will be a large screen set up at the back of the room, one side lined with spectral sensors.
- As people walk behind the screen a hyperspectral image of their body will be displayed on the other side of the screen.
- This gives viewers a chance to become part of the exhibit and experience the human body from an internal viewpoint that they are normally unable to see.

Examples

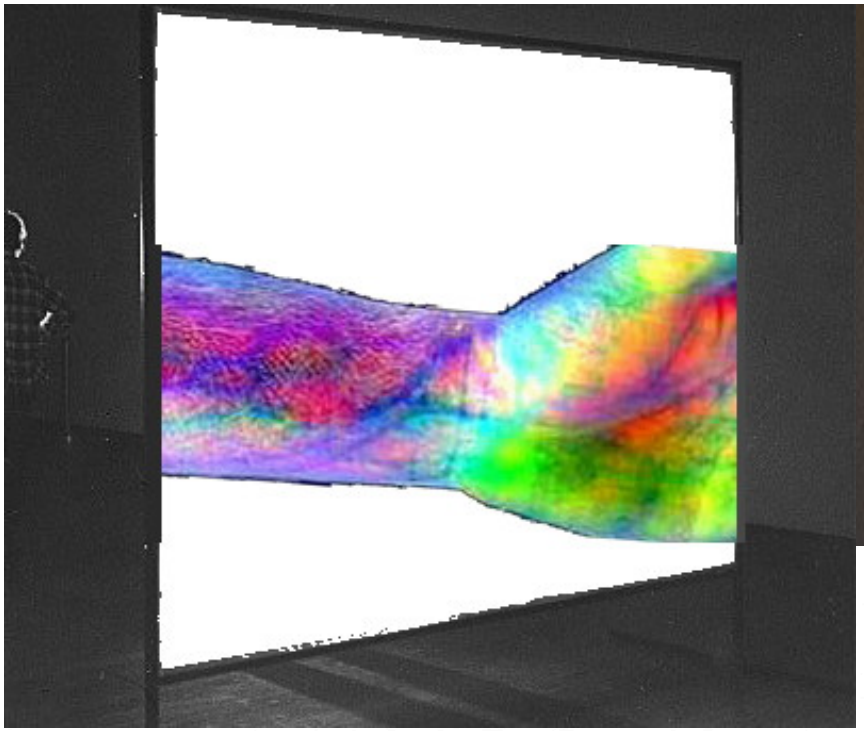








Realization



Sources

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