INTRODUCTION TO REMOTE SENSING
eTRAINING

Introduction

Learn the basic concepts of imagery, how imagery is made, types of imagery, and image resolution.

Software

- N/A

Data

- Continuous and thematic images. Multispectral and panchromatic images.

Transcript

0:09

Hello and thank you for watching Hexagon Geospatial eTraining: an Introduction to Remote Sensing. In this module we will cover understanding imagery, a look at how imagery is made, types of imagery, and finally image resolution.

0:24

Let's begin by understanding imagery. Imagery consists of data that are organized on a grid of columns and rows, and usually represents a geographical area. In this slide we see several examples: an image of an entire continent, a near infrared image of the great lakes region, a panchromatic image of a city, and finally a thematic image showing information as categories. Although each image is different, they all have one thing in common: each is made of pixels displayed on an X and Y axis.

0:55

Images are the result of energy - in most cases, light from the sun - reflecting off of objects on the Earth's surface. The Sun shines energy in the form of waves to the Earth. When the energy reaches the Earth's atmosphere, some of that energy is absorbed, some is scattered, and some continues to the surface of the Earth, where it interacts with an object or target. When interacting with the target, again some of the energy is absorbed, some scattered, and some is reflected back up into the atmosphere.

1:23

A sensor flying overhead measures the amount of reflected light. The amount of light detected is recorded as a digital number – sometimes called a DN value. If a lot of energy is detected, a large number is recorded. If only a small amount of energy is detected, a small number is recorded. The range of digital number values is determined by the data range of the image being collected.

Once the information is collected, the sensor downloads the data to a receiving station, where the information is processed to an image format that can now be visually interpreted.

When working with an airborne sensor, the same process takes place; however, the information is sometimes collected on film and scanned into a digital format.

2:04

The result is an image made of pixels. Each pixel represents an individual area scanned by the sensor and is the smallest piece of an image that contains unique information. The smaller the pixel, the easier it is to see detail. Each pixel stores a single digital number – which is displayed in a viewer as brightness. Small digital numbers result in dark pixels; larger values result in bright pixels.

2:29

There are two basic types of imagery –

- **Remotely sensed images** made of continuous data from measured values and
- **Thematic images** made of discrete data representing class values.

Let's take a further look at both types.

2:42

Thematic images store information as categories. Each pixel contains a value which represents a class or category of information. These images are most often a single layer created from the analysis of multispectral imagery. They can be used for further analysis and mapping.

To better understand multispectral imagery, we need to first have a better understanding of light and how it's measured.

3:05

Energy can be measured according to the length of its wave. Our energy source – the Sun – shines a wide range of wavelengths to the Earth's surface. We use the Electromagnetic Spectrum to plot and classify the different wavelengths. Some wavelengths – such as visible light – we as humans can detect. However the visible portion of the spectrum is quite small and there are a lot of other wavelengths interacting with the Earth's surface that we can't detect.

Because of this, we build our sensors to detect wavelengths that we can't see. Multispectral sensors have many bands that detect specific wavelengths. Doing this allows us to "see" outside the visible spectrum and gain even more information about the Earth and its features.

3:45

Many objects have characteristic spectral signatures. For example, healthy vegetation has relatively low reflectance in the visible, red, and blue, with slightly higher reflectance in green. When we look outside the visible spectrum, there is a relatively high reflectance in the Near Infrared. Knowing this allows us to use this information to detect and study vegetation.

Other targets also have characteristic spectral signatures. Water absorbs a lot of energy and therefore has low reflectance in most bands and appears very dark on a multispectral image. Bare Earth tends to have moderate reflectance in most bands and has moderate brightness on an image.

4:25

There are two types of continuous images:

- Panchromatic and
- Multispectral.

Panchromatic images are single layer greyscale images and they look like black and white photographs.

4:36

Multispectral imagery consists of two or more layers – each layer containing digital numbers collected in a single band or wavelength.

Each layer of a multispectral image can be viewed independently. Because each wavelength interacts with the Earth's surface differently, each provides different information about the Earth's surface. We can see that in this case Band 1 – or the blue band – shows urban development very well. When we look at the same area using Band 4 – in this case the Near Infrared band – we see water features very clearly. Band 5 – the Short wave Infrared – again shows us something much different. We can see water features and urban areas, but differently than in band 1 and 4.

5:17

We can also use the color guns in the Viewer to load 3 bands simultaneously. This creates the colors we see in the Viewer. Each band or layer in an image is sent through one color gun. The digital numbers for each layer determine how much color is given to a pixel. If a layer of an image is sent though the red color gun and has a high digital number, then a lot of red is added to that pixel. A low digital number will have only a small amount of red added to the pixel. Combining the colors from each layer in various amounts creates the colors we see in the Viewer. This color wheel shows how the colors combine to form the colors we see. Now let's see some examples.

5:56

Here we see the layers of a multispectral image along with the three color guns: red, green, and blue. In this first example, we have taken the Near Infrared and sent it though the red color gun. The red band is going through the green color gun, and the green band though the blue color gun. This band combination creates a false color infrared image. Vegetation is red, bare ground cyan or blue, and water is very dark – almost black.

6:21

If we change the bands so Shortwave Infrared is sent though the red color gun, Near infrared is sent through green, and the red band is sent through the bluecolor gun, we now see something very different. Vegetation is now orange, urban and bare ground are lavender, while water is still very dark.

Finally, if we want to view the image in true color, we send the red band though the red color gun, the green band though the green gun, and the blue band though the blue color gun. The image now is displayed using natural colors.

Through this example, we can see that by using different band combinations, different features become more obvious. We can use these band combinations to help locate and extract the information we are most interested in.

7:02

Let's move on and discuss image resolution. There are four types of image resolution:

- Radiometric,
- Spatial,
- Spectral, and
- Temporal resolution.

Let's take a few minutes to understand each of them.

7:17

Radiometric resolution refers to the bit depth, and it determines the range of digital numbers stored within an image.

Computers store information using ones and zeros. Each bit within an image has 2 possible values, a 1 or a 0. Therefore, 2 to the exponent bit value defines the range of values found in an image. For example, if we have a 2 bit image, we can calculate 2 to the 2nd power = 4. There are four possible values in a 2 bit image. Because zero is a value, the range is 0 – 3.

7:50

If we increase the bit value to 4, we can calculate 2 to the 4th power = 16, resulting in a data range of 0-15.

8 bit imagery has 2 to the 8th power – or 256 values, resulting in a range of 0 –255.

The number of values increases as the bit range is increased. There is also a difference between signed and unsigned data. Both have the same number of total values, but signed data will have both positive and negative values, while unsigned data will have only positive values.

8:24

Next we have **Spectral resolution**. This is determined by the number of bands in an image. A multispectral image is typically considered to have moderate spectral resolution, while hyperspectral imagery, containing hundreds of bands, is considered to have high spectral resolution.

Temporal resolution refers to how frequently a sensor can image the same area. Each collection method, and each satellite, has a unique revisit time. Knowing your image collection frequency in contrast to the temporal resolution of a sensor can help determine which sensor or collection method is best for a given project.

9:00

Finally we have **Spatial resolution**. This is the type of resolution most commonly discussed with imagery. Each sensor has an inherent limitation on its spatial resolution, and each sensor is unique in this value. Expressed as the smallest object that can be detected by the sensor, the smaller the number, the higher the spatial resolution.

Understanding these concepts - how imagery is collected, types of imagery, and image resolution - can help you get the most out of your imagery and remote sensing.

9:30

Thank you for watching this eTraining module from Hexagon Geospatial. For more eTraining please visit hexagongeospatial.com/eTraining.