Data acquisition

How to acquire spatial data?

Remote sensing
- Aerial photography
- Surveying methods
- Global Navigation Satellite Systems
- “Drawing” over existing maps

Remote Sensing

Acquisition of information about an object or phenomenon, without making physical contact with the object. It generally refers to the use of aerial sensor technologies to detect and classify (map) objects on Earth.

Remote Sensing Model

Remote Sensing Model

Electromagnetic energy

Electromagnetic spectrum (ES)

Interactions with atmosphere

Atmospheric Windows

Parts of the spectrum for which the radiation with such frequencies passes through the atmosphere without suffering significant changes.
Numerical orbital images

In remote sensing images may be continuous or discrete registries.

**Aerial photography** is an example of a continuous image, where objects are represented by a gradation of colours that turn its interpretation an easy task.

Images from remote sensors are discrete and objects are represented by numerical values, named **radiometric levels (RL)**.

A sensor is a device that captures parts of the electromagnetic spectrum (reflected or emitted energy), of objects onto the Earth’s surface, and reflected or diffused energy by the floating particles of the atmosphere, converting it into a numeric signal.

A numerical orbital image is structured into a set of numerical matrices (grids), registering the radiometric levels captured by the sensor, for each of the spectral bands.

### Numerical Orbital Images

- **Radiometric level (RL)**
- **Pixel**
- **Bands**

Example: Landsat bands

<table>
<thead>
<tr>
<th>Band no.</th>
<th>µm</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.45-0.52</td>
<td>30 m</td>
</tr>
<tr>
<td>2</td>
<td>0.52-0.60</td>
<td>30 m</td>
</tr>
<tr>
<td>3</td>
<td>0.63-0.69</td>
<td>30 m</td>
</tr>
<tr>
<td>4</td>
<td>0.76-0.90</td>
<td>30 m</td>
</tr>
<tr>
<td>5</td>
<td>1.55-1.75</td>
<td>30 m</td>
</tr>
<tr>
<td>6</td>
<td>10.4-12.5</td>
<td>120 m</td>
</tr>
<tr>
<td>7</td>
<td>2.08-2.35</td>
<td>30 m</td>
</tr>
</tbody>
</table>

### Numerical Orbital Images vs Vertical Aerial Photography

- Extensive covering area (ex. LANDSAT 185km x 172km)
- Multispectral (ex. WorldView-2 bands in visible and non-visible parts of the ES)
- Multitemporal
- Multisensorial
- High Radiometric Level
- Numerical imagery

**Resolution**

Ability that a system has to resolve (distinguish, identify) two objects that are close to each other by some criteria.

Examples: spectral resolution, spatial resolution, temporal resolution and radiometric resolution.

**Spectral resolution**

Size and number of intervals that may be registered by the sensor. E.g., the smaller they are, the easier will be the discrimination between different objects.

There are sensors capturing EM energy of all the visible part, others register three bands for it, matching the three colours: **red**, **green** and **blue**.

- **High spectral resolution:** - 220 bands
- **Medium spectral resolution:** 3 - 15 bands
- **Low spectral resolution:** - 3 bands
**Numerical Orbital Images**

**Spectral Resolution**

Banda 1 - 0.50 a 0.59µm  
Banda 2 - 0.61 a 0.68µm  
Banda 3 - 0.79 a 0.89µm


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**Spatial Resolution**

Smallest angle, or smallest distance between two objects that can be distinguished by the sensor.

- High spatial resolution: 0.5 – 5 m
- Medium spatial resolution: 5 – 30 m
- Low spatial resolution: 30 – 1000 m

Terreiro do Paço (Lisbon) with 10m spatial resolution (SPOT PAN) and with 5m (IRS PAN)

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**Spectral Resolution**

- ASTER
  - Spectral Bands
  - Wavelength in micrometers
  - Terrestrial and Near-Infrared

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**Spatial Resolution**

- Terreiro do Paço with s.r.=2m (KVR1000) and with 1m (IKONOS).

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**Spatial resolution**

- 56mx79m - LANDSAT 1
- 30mx30m - LANDSAT 4
- 10mx10m - SPOT 1

- 10m x 10m - SPOT 1
- 5.8m x 5.8m - IRS 1C
- 1m x 1m - IKONOS
- 61cm x 61cm - QUICKBIRD
- 30cm x 30cm - WORLDVIEW3
**Temporal Resolution**

Time interval that a sensor requires to capture images over the same area.

There are some phenomena that, in order to analysed and evaluated, need regular images, such as in the monitoring of crops, evolution of floods or oceanic oil spills.

**Numerical Orbital Images**

**Radiometric Resolution**

Sensor sensitiveness to distinguish the EM energy, being it reflected or emitted.

A numerical value is assigner to the EM energy captured by the sensor: its radiometric level (usually named also grey level). It may have the influence of surrounding objects, and the energy interactions suffered along the atmosphere.

**Numerical Orbital Images**

**Radiometric Resolution**

Images with 256 radiometric levels (8bit $2^8$ – values 0 to 255), 32 radiometric levels (5bit $2^5$ - values 0 to 31), and 16 radiometric levels (4bit $2^4$ – values 0 to 15).

**Numerical Orbital Images**

**Radiometric Resolution**

Images with 8 radiometric levels (3bit $2^3$ – values 0 to 8), 4 radiometric levels (2bit $2^2$ - values 0 to 4), and 2 radiometric levels (1bit $2^1$ - values 0 to 1).

**Panchromatic Imagery**

Covers a large part of the visible electromagnetic spectrum and is presented in black & white.

Dili, Timor-Leste: 1 m
Multispectral Imagery

With more than one spectral interval. Each individual image covers the same area at the same scale.

Image Classification

Definition

The objective of image classification is to identify and portray, as a unique gray level (or color), the features occurring in an image in terms of the object or type of land cover these features actually represent on the ground.

Supervised classification

Common classification procedures use one of the two families of methods: supervised classification and unsupervised classification.

In a supervised classification, the analyst identifies in the imagery homogeneous representative samples of the different surface cover types (information classes) of interest. These samples are referred to as training areas.

Unsupervised classification

Unsupervised classification in essence reverses the supervised process. Spectral classes are grouped first, based solely on the numerical information in the data, and are then matched by the analyst to information classes (if possible). Algorithms are used to determine the natural (statistical) groupings or structures in the data.

Usually, the analyst specifies how many groups or clusters are to be looked for in the data. In addition to specifying the desired number of classes, the analyst may also specify parameters related to the separation distance among the clusters and the variation within each cluster.
Applications

Thematic maps

Multispectral SPOT 1995 (20m of spatial resolution)

Legend
- Água
- Rede Viária
- Estaleiros
- Floresta 1
- Floresta 2
- Herbáceas
- Urbanos Denso
- Vegetação Seca
- Aeroporto

Applications

Image map IKONOS

Feature vectorisation

Image MERIS

Spatial res. 1200 m
Wildfire detection

Aqua satellite

11 – 2 – 2004 and 13 -2- 2005
Evaluation of drought