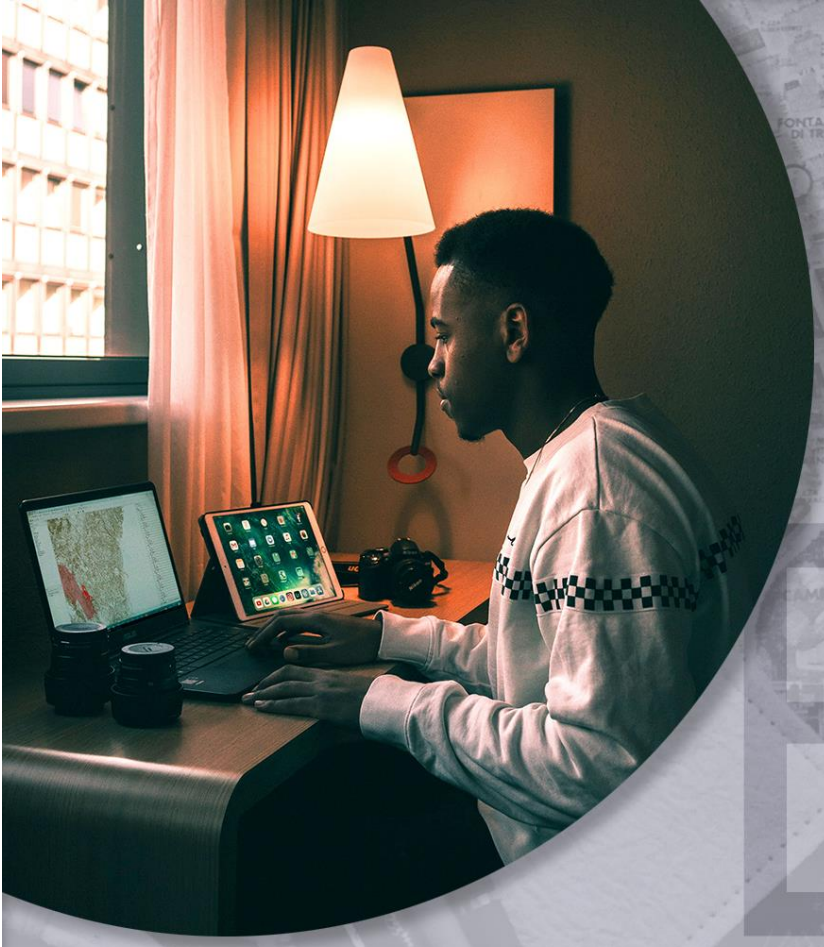

BIRGIT

BIRGIT 3D data acquisition technologies
October 2023

Erasmus+

3D Data Acquisition

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Learning outcomes

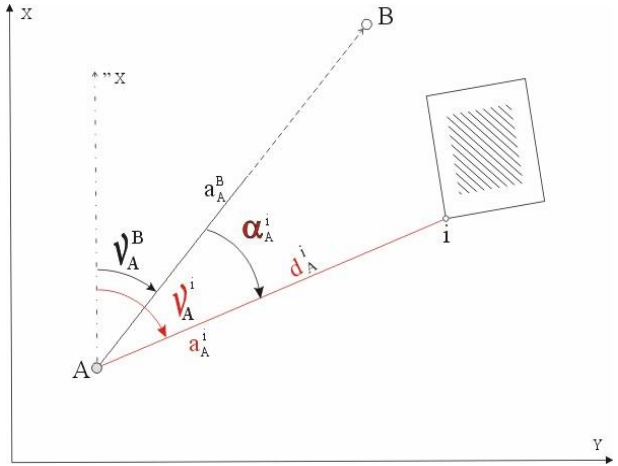
- At the end of this module, the participant is expected to be able to
  - Describe and explain 3D geospatial data acquisition technologies
  - Describe the ways of using data acquired with different sensors (UAVs, ALS, TLS, Tacheometry)

3D Data Acquisition

- **Tacheometry**
- **Photogrammetry**
- 3D Laser Scanners

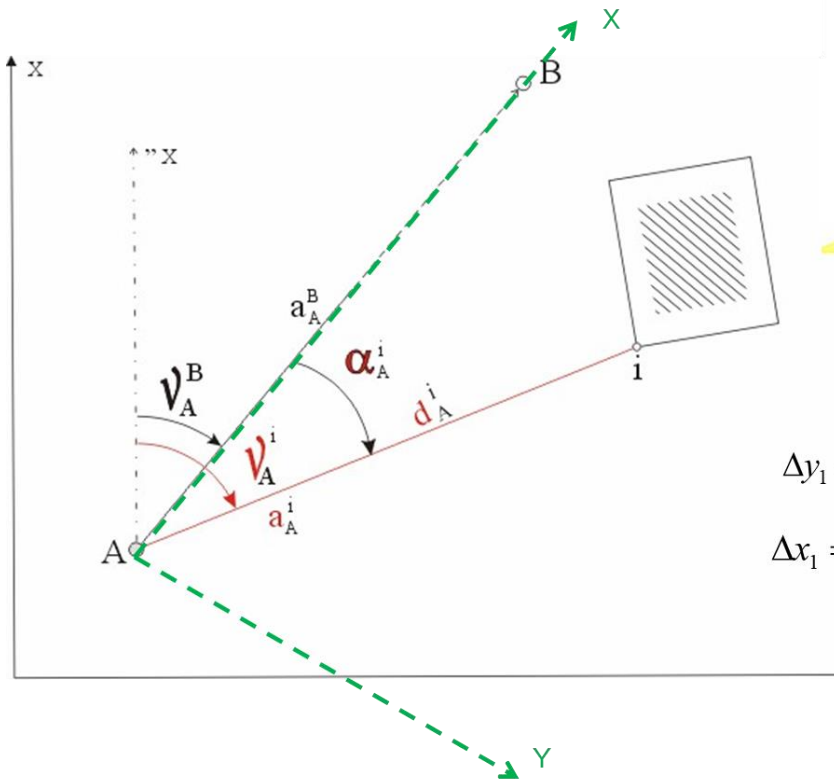
- Tacheometry determines the position and height of the point at the same time
- **The position of the point is determined in the space of coordinates (x,y,H)**
- In the **plane of projection**, the position of the point is determined with **relative polar coordinates**:
  - **horizontal angle α**
  - **and horizontal length d**
- Tacheometry is also known as a **polar method surveying**

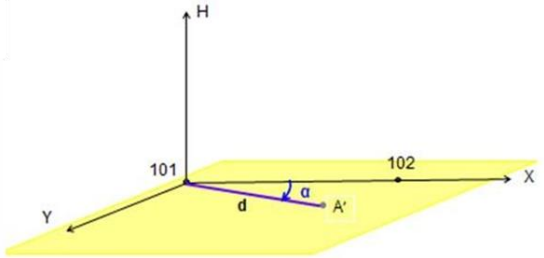
- In polar surveying we determine **relative** spatial polar coordinates of detailed points **(x,y,H) – in the system (2D + 1D)**
- **What is measured:**
  - **Horizontal angle** – angle between orientation direction (e.g. polygon side) and detailed point
  - **Slope distance** between known (e.g. polygon) and detailed point
  - **The zenith (or slope) angle** from the known to the detailed point



Fast and efficient way of collecting spatial data using modern instrumentation

Computation: Coordinates of detailed points



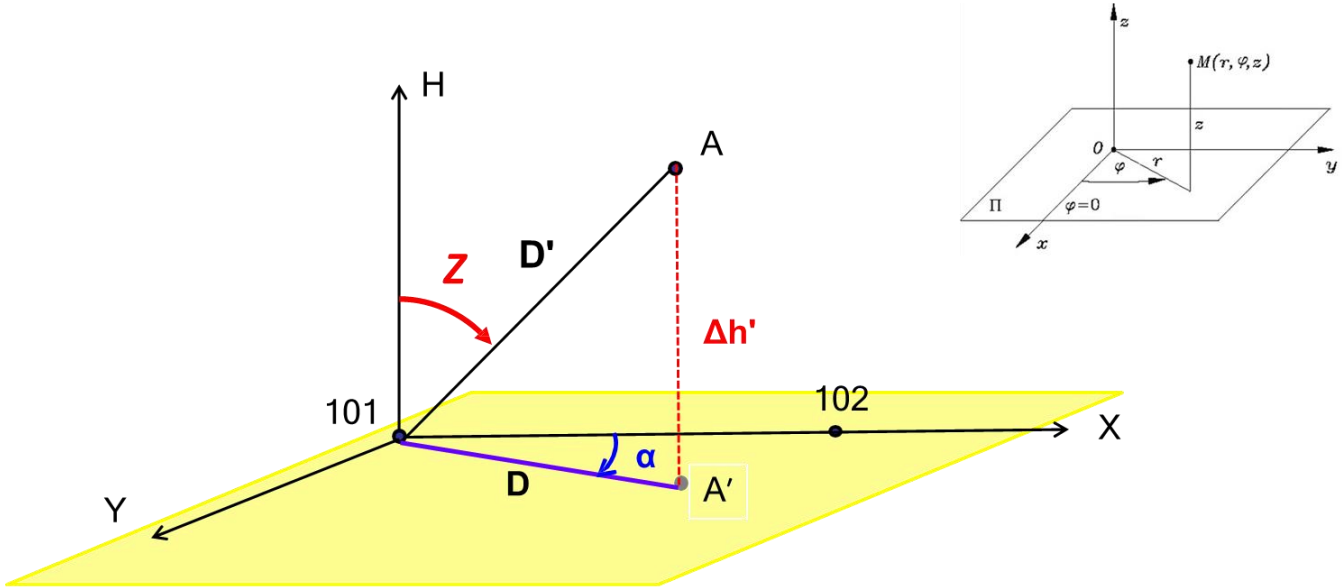


$$\upsilon_A^1 = \upsilon_A^B + \alpha_A^1$$

$$\Delta y_1 = d_A^1 \cdot \sin\upsilon_A^1 \qquad y_1 = y_A + \Delta y_1$$

$$\Delta x_1 = d_A^1 \cdot \cos\upsilon_A^1 \qquad x_1 = x_A + \Delta x_1$$

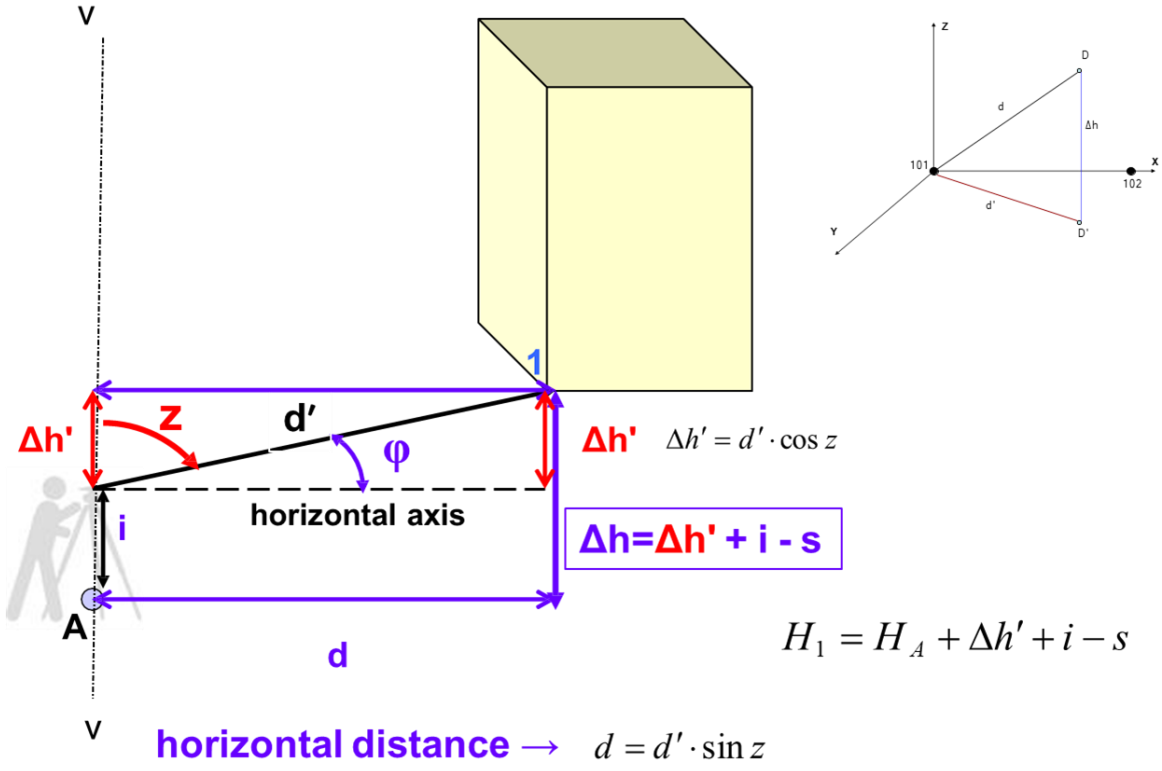
Relative spatial polar coordinate system



measured:

- **Slope distance - Distance D'** from known point to point of detail
  - horizontal projection - horizontal length **D**
  - vertical projection - height difference **Δh'**
- **horizontal angle– α**
- **zenith Angle - Z**

Calculating the altitude of detailed points

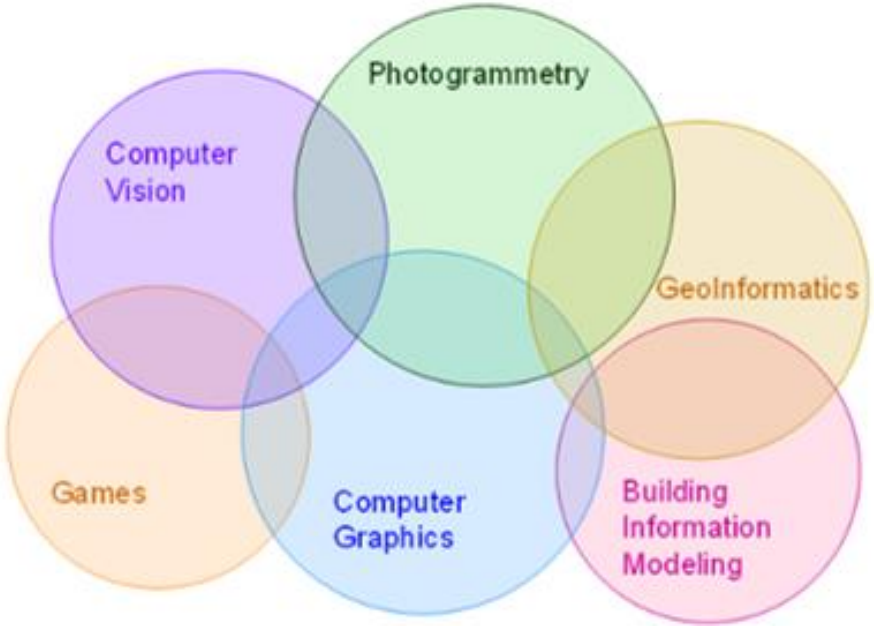


- Detailed survey
- Tacheometric method of measurement – obtained **horizontal and vertical perception of the terrain**

- The instruments for tachymetry are:
  - **TS** – Total Station
    - electro-optical tachymeter and computer
- According to the accuracy of the tacheometry we divide into:
  - simple tacheometry – dm accuracy
  - precise tacheometry – cm accuracy

THE MULTIDISCIPLINARY NATURE OF PHOTOGRAMMETRY

Photogrammetry is a highly acknowledged Applied Computer Sciences discipline, cooperating with neighbouring disciplines.



DEFINITIONS

Photogrammetry and Remote Sensing is the art, science, and technology of obtaining reliable information from non-contact imaging and other sensor systems about the Earth and its environment, and other physical objects and processes through recording, measuring, analyzing and representation. (https://www.isprs.org/society/history.aspx)

- a technique used to create 3D models from a series of 2D photographs
- it involves analyzing the images and extracting geometric information to reconstruct the shape and appearance of the photographed object or scene

TWO DIFFERENT TYPES OF PHOTOGRAMMETRY

AERIAL PHOTOGRAMMETRY

- involves capturing photographs from an elevated position
- using aircraft or drones
- used for large-scale mapping, surveying, and monitoring applications
- land surveying, urban planning, environmental monitoring, and agriculture
- cost-effective and efficient way to capture large-scale 3D data over extensive areas

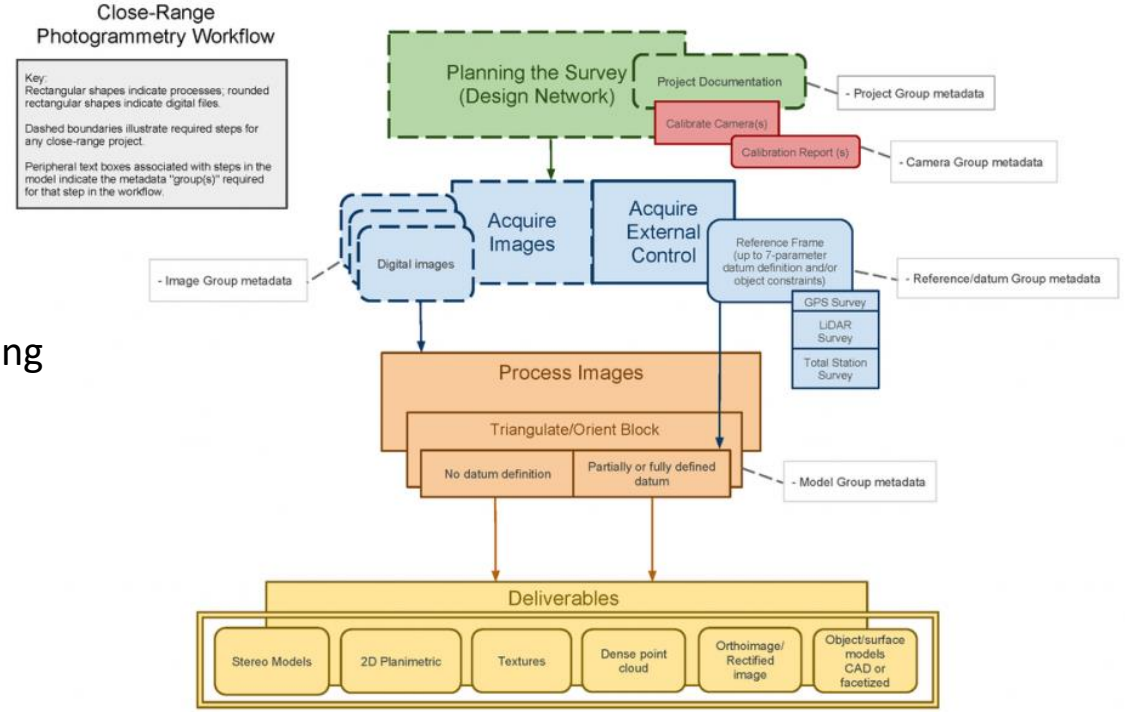
CLOSE-RANGE PHOTOGRAMMETRY/TERRESTRIAL PHOTOGRAMMETRY

- refers to situations where the camera is relatively close to the subject being captured
- commonly used for small- to medium-sized objects or scenes
- used in controlled environments
- suitable for applications requiring detailed measurements and accurate 3D models
- archaeology, cultural heritage documentation, product design, forensics, reverse engineering, virtual reality

CLOSE-RANGE PHOTOGRAMMETRY WORKFLOW

Areas of application:

- Architecture and Construction
- Cultural Heritage Preservation
- Archaeology
- Forensic Investigation
- Industrial Design and Manufacturing
- Virtual Reality and Gaming
- Medicine and Healthcare
- Film and Animation



https://gmv.cast.uark.edu/photogrammetry/four-basic-steps-of-a-close-range-photogrammetry-project-3/

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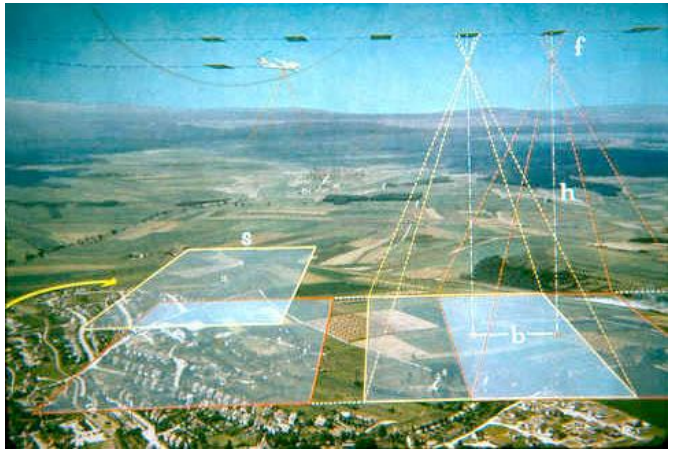
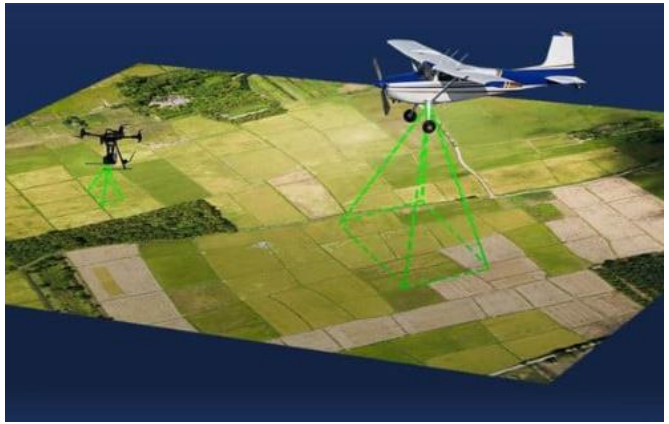
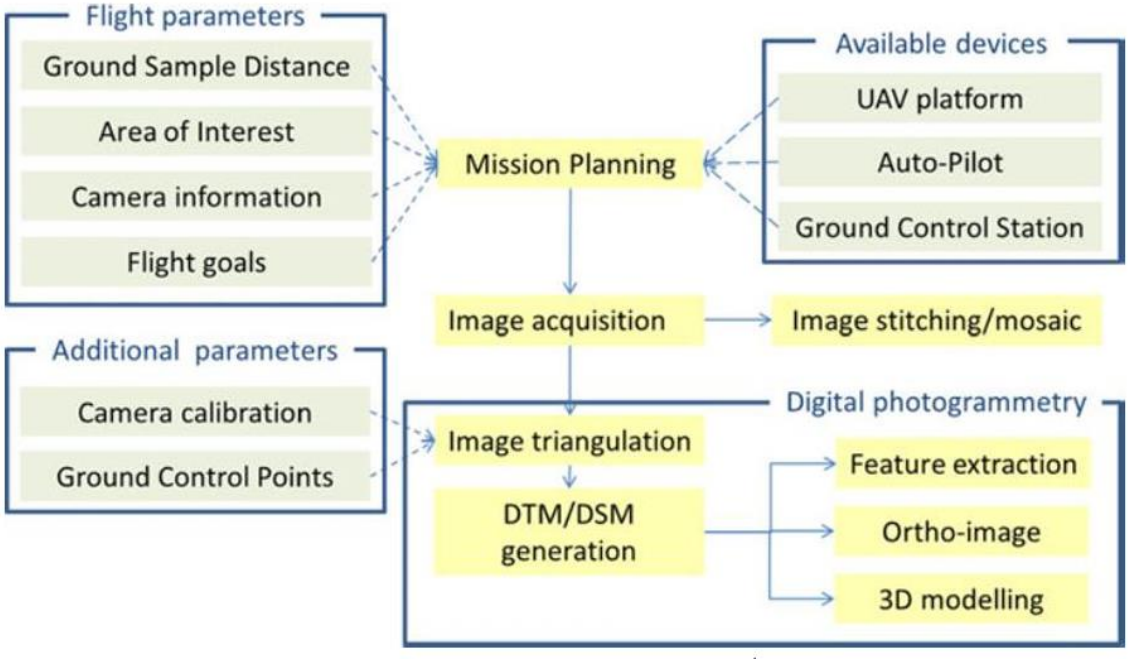




https://geo-matching.com/content/comparison-of-aerial-surveying-with-a-manned-aircraft-or-uas-for-mapping-and-3d-modelling
https://www.b-29s-over-korea.com/aerial%20photography/aerial%20photography-pg1.html

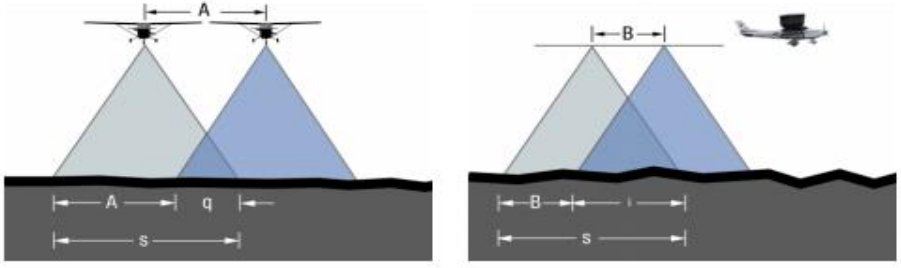
AERIAL PHOTOGRAMMETRY WORKFLOW

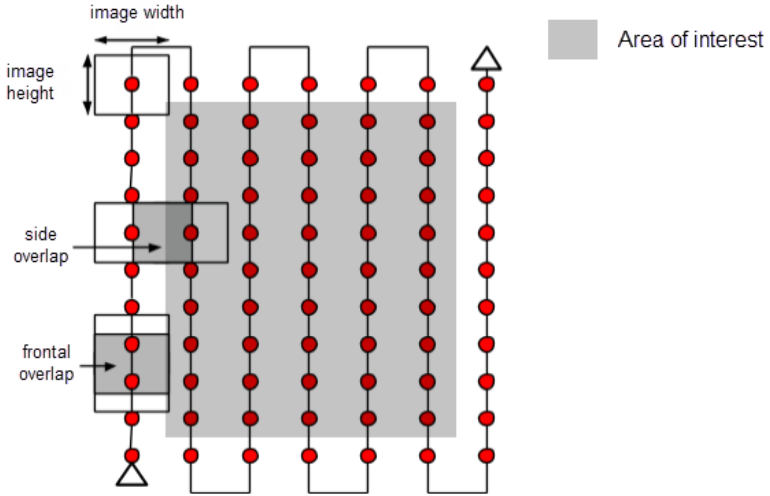


FLIGHT PLANNING

Aerial photogrammetry requires flight planning to optimize image coverage and overlap.

Flight planning software helps determine:
- the flight path
- overlap and coverage (q and i)
- Ground Sample Distance (GSD)
- flight altitude
- Ground Control Points (GCPs)
- image parameters for efficient data capture





FRONT-LAP AND SIDE-LAP

https://www.aerotas.com/overlap-flight-pattern

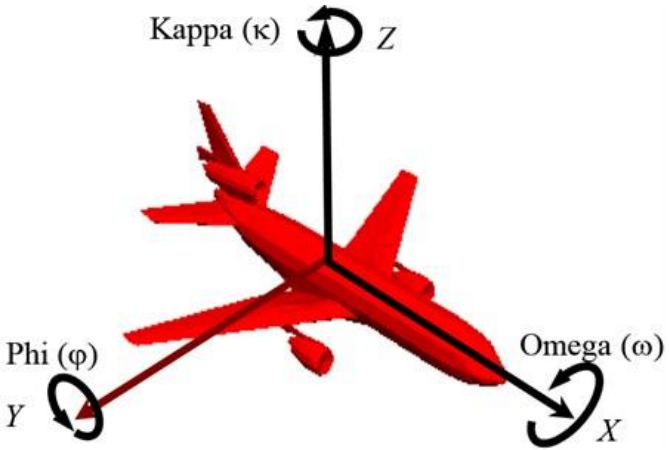
CAMERA CALIBRATION

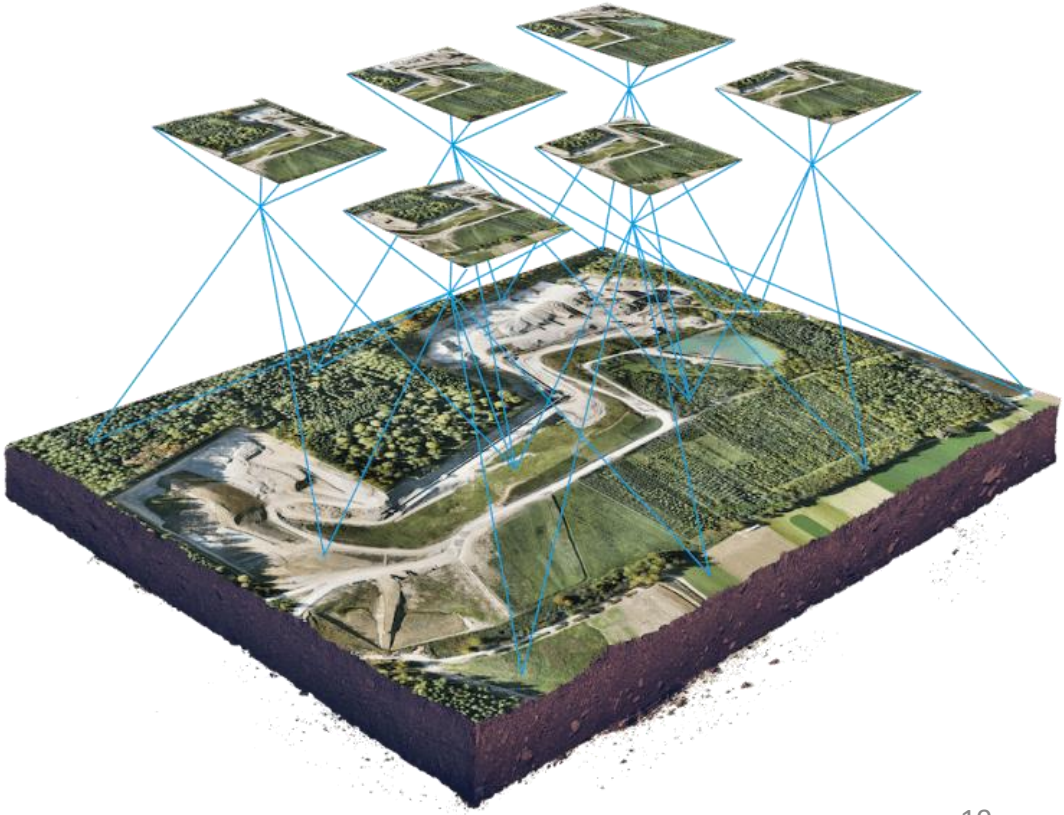
The geometry of the image that passes through the camera system is defined by the **calibration procedure**.
The result of the calibration is the **elements of internal orientation.**
The measuring camera is considered to have known elements of internal orientation.

The process of internal orientation involves
- the elements of internal orientation of the camera
- the elements of internal orientation of the image

AEROTRIANGULATION

Determining the geometric relationship between the aerial images captured during aerial photogrammetry and their corresponding positions in 3D space.





https://zssglobal.com/drone-mapping

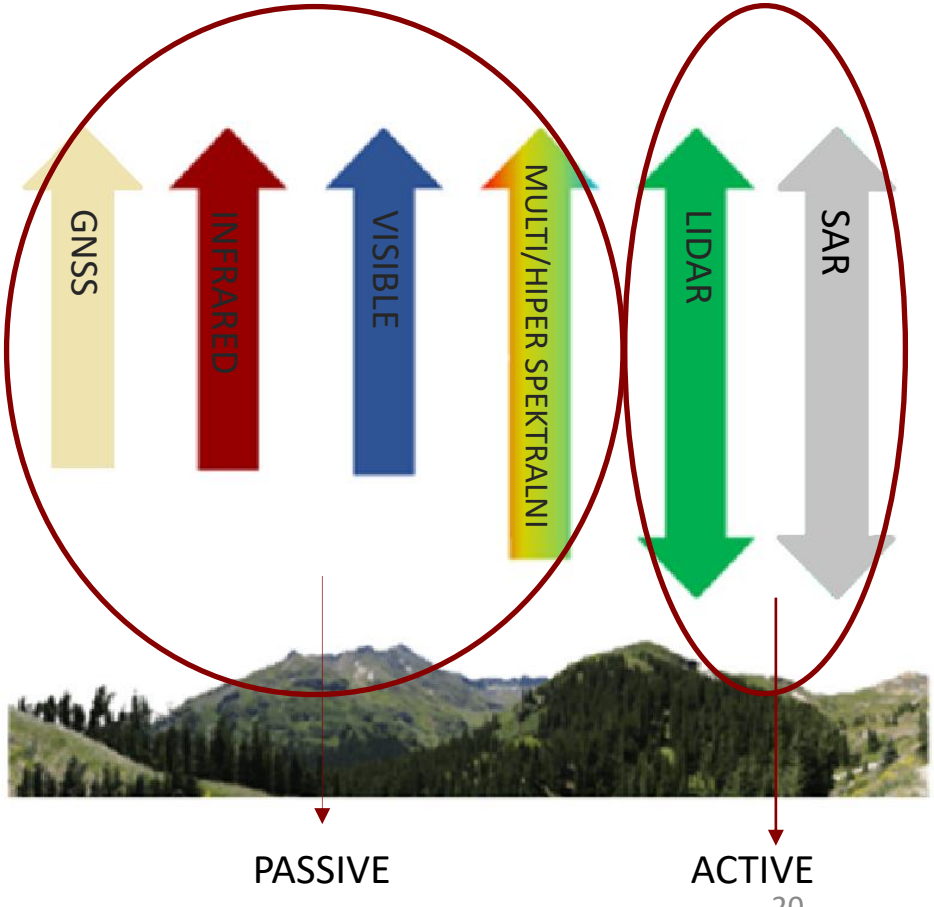
SENSORS

Devices used to capture images or data from the scene being observed

- multiple sensors on one platform
- **pictometry –** systems designed for capturing oblique imagery from various angles

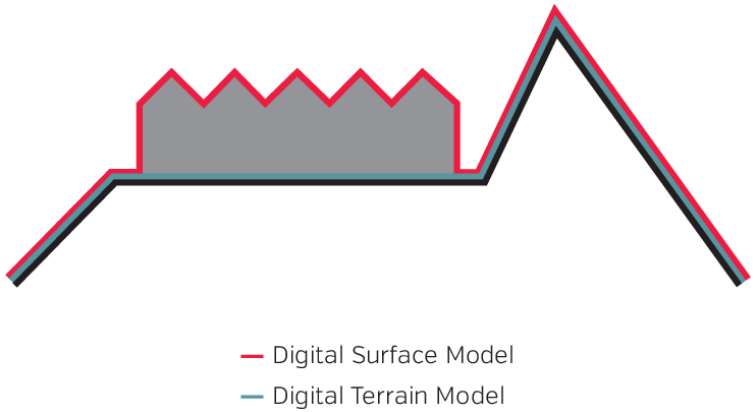
The choice of sensor depends on the specific requirements of the photogrammetric project, including desired data quality, resolution, accuracy, spectral information, and environmental conditions.

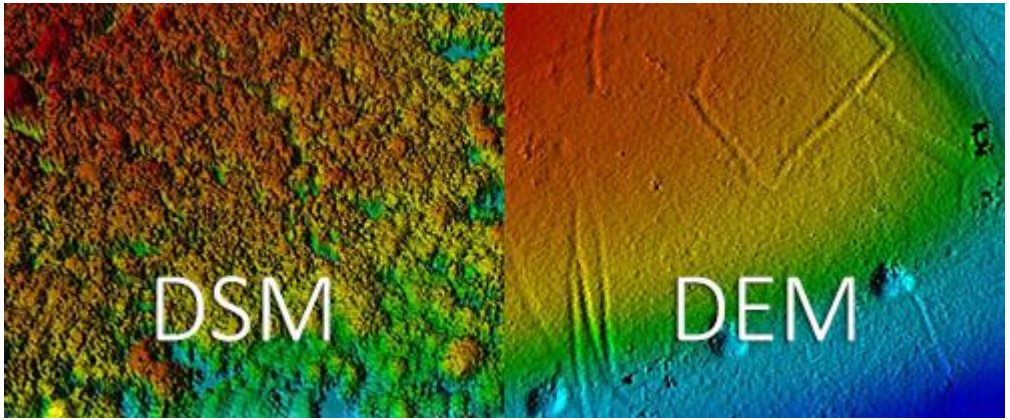
DIVERSE SENSORS INTEGRATION - STRENGTHENING ANALYSES



DIGITAL MODELS

Digital Terrain Model (DTM) - the bare Earth surface by removing above-ground features like buildings, trees, and vegetation
Digital Surface Model (DSM) - represent the Earth's surface as it appears, including both natural terrain and above-ground features like buildings, vegetation, and infrastructure





https://www.researchgate.net/figure/Difference-between-DEM-DTM-and-DSM-Digital-Elevation-Model-DEM-and-Digital-Terrain_fig2_346902099
http://skymapsurvey.com/dsm_dem_creation.html

ORTHOPHOTO

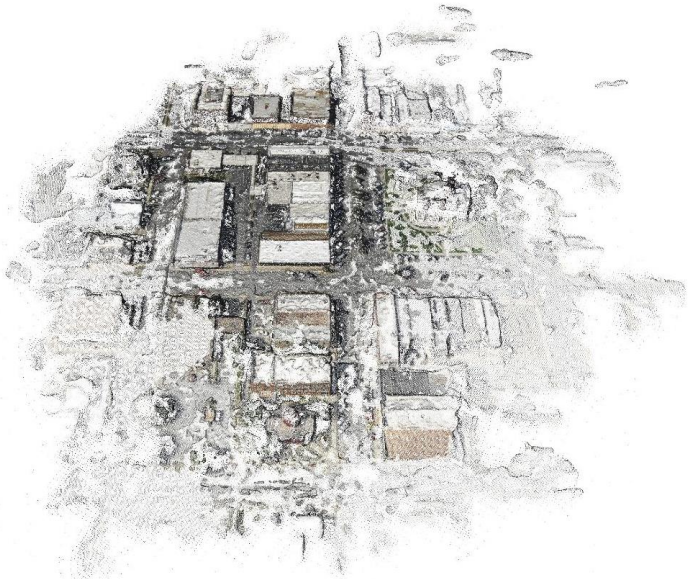
Orthophoto - georeferenced aerial images that have been geometrically corrected to remove distortions caused by terrain relief, camera perspective, and lens distortion
Thrue Orthophoto - in addition to correcting the geometric distortions, a true orthophoto compensates for variations in terrain relief by adjusting the pixel values to represent the ground surface as if it were imaged from directly overhead.

Comparison of a traditional (left) and true (right) orthophoto

https://www.geavis.si/en/2015/09/how-are-true-orthophoto-mosaics-made/

3D POINT CLOUDS

Collection of data points in three-dimensional space that represent the coordinates of objects.



The point cloud data (with color information) resulting from a batch of aerial photos

A triangulated irregular network overlaid on top

https://gis.stackexchange.com/questions/189700/creating-photogrametric-point-cloud-of-an-object-from-distributed-photographs-h

Thank you for your attention

BIRGIT Erasmus+

Some logo’s and links to web site and social media here

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