



Photogrammetry as a powerful tool to gain 3D object information

Reinfried MANSBERGER

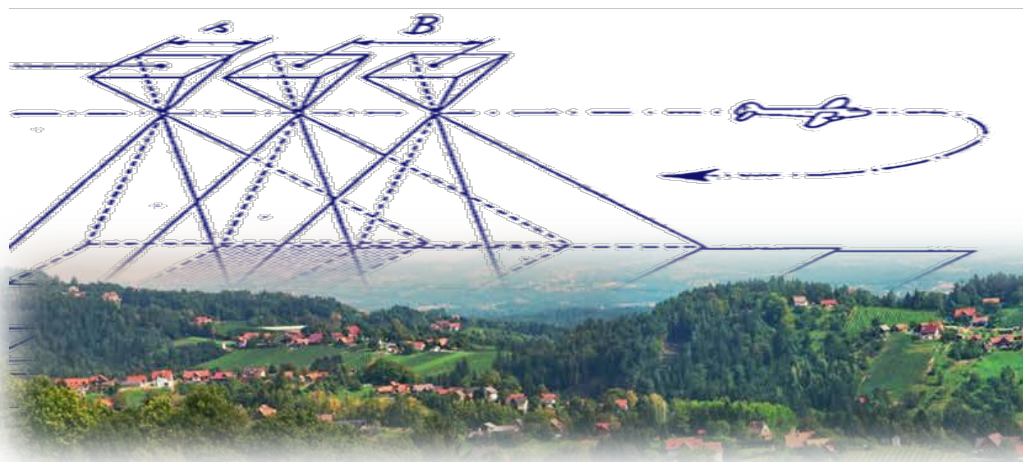


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Content

- Definition
- Stages of Photogrammetry
- Basics (photo flights, mathematical models)
- Aerotriangulation – DSM generation – OP production
- Photogrammetric project



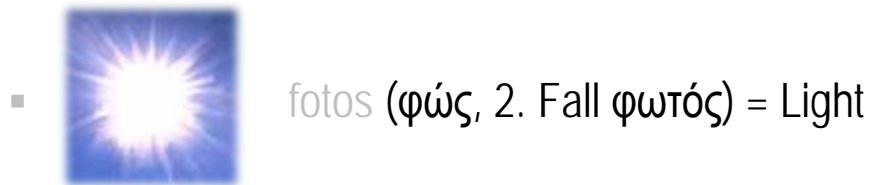
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Photogrammetry

Definition



- Photogrammetry contains three Greek Words:



- Photogrammetry = Measurement of registered light

Pros and Cons of Photogrammetry

• Pros

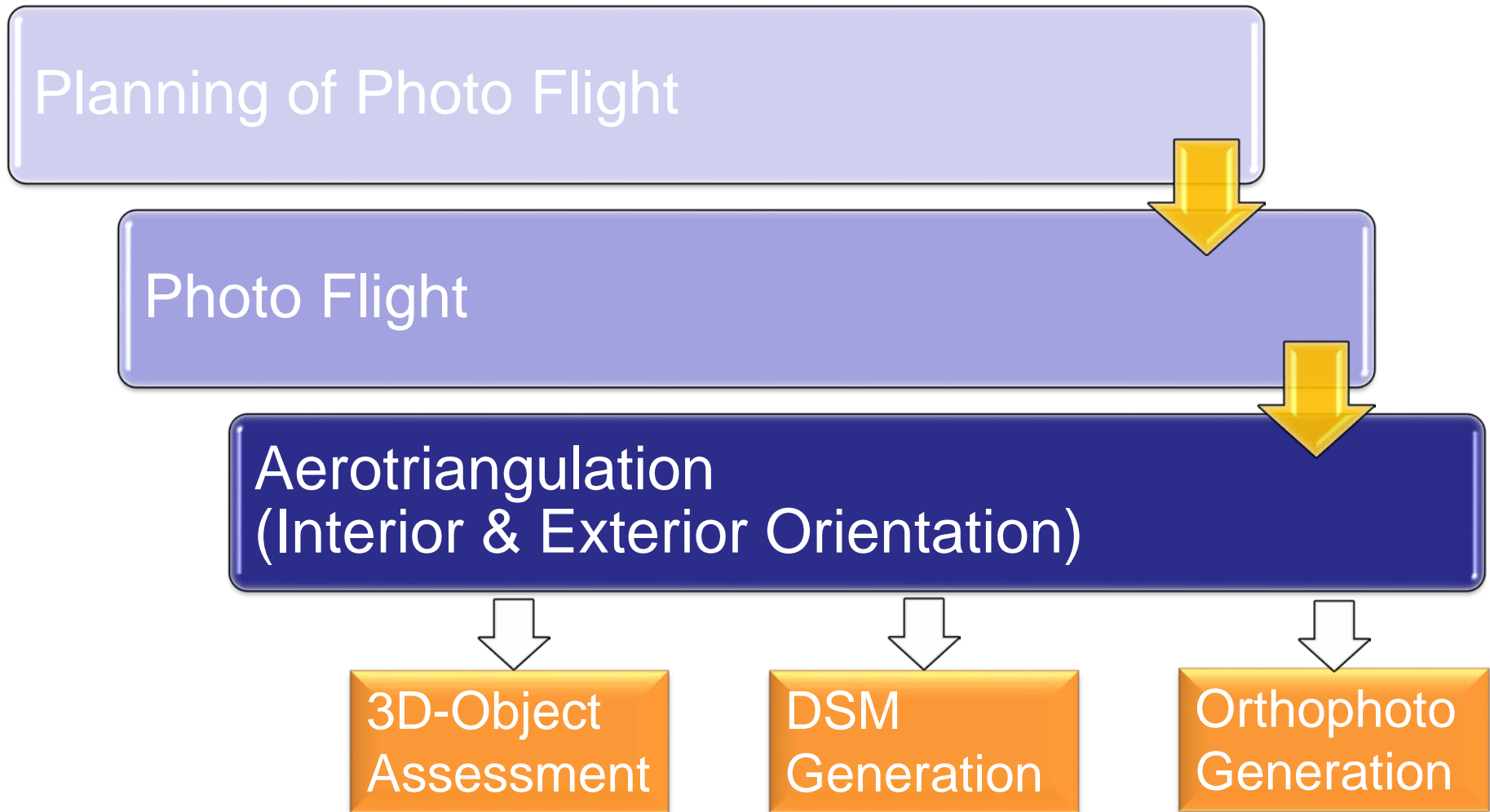
- 😊 Field work only for control point measurements
- 😊 Image analysis in office (weather independent)
- 😊 Analysis of time series – change detection of objects by using images with different acquisition dates
- 😊 Image/Photograph is a permanent document of a specific situation
- 😊 Photograph contains a lot of information all over the time
- 😊 Semi-automatic and automatic processes for data acquisition

• Cons

- 😞 High costs for cameras, software and images
- 😞 Huge amount of data
- 😞 Limited accuracy
- 😞 Restricted operation of photo flights due to weather conditions

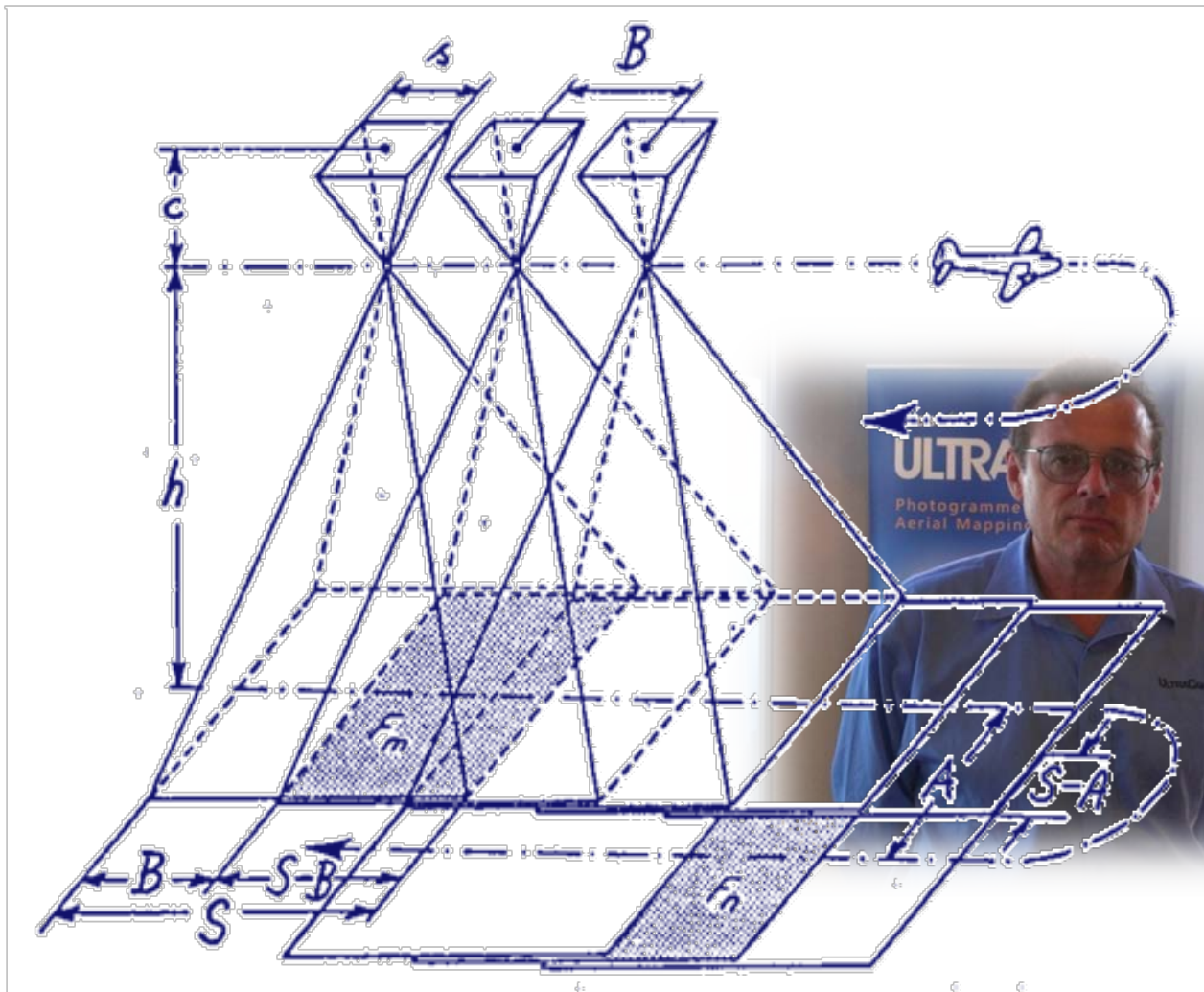
Photogrammetry

Stages of a photogrammetric project



Photogrammetry

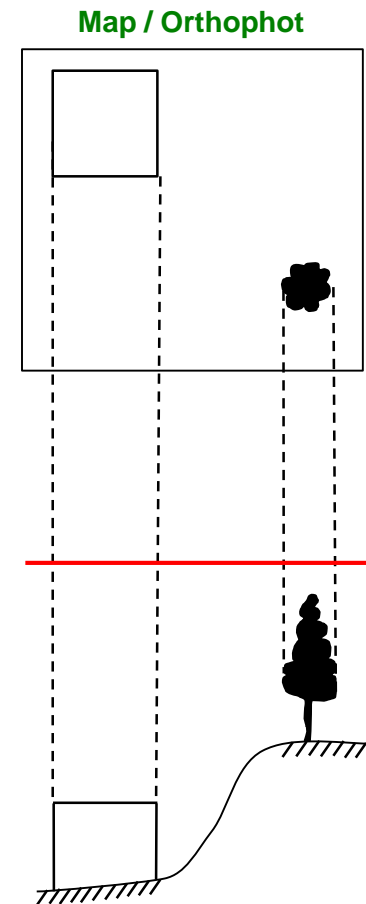
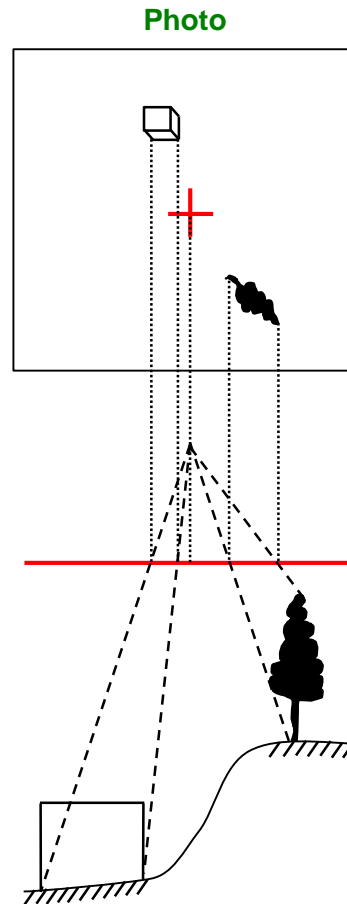
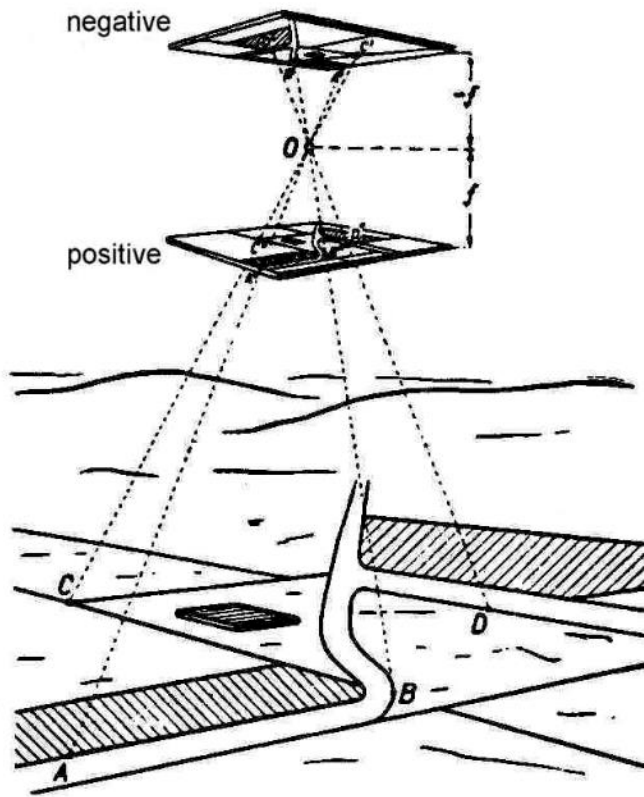
Photo Flight



Photogrammetry

Mathematical Model of Photo Recording

Zentral perspective



Photogrammetry

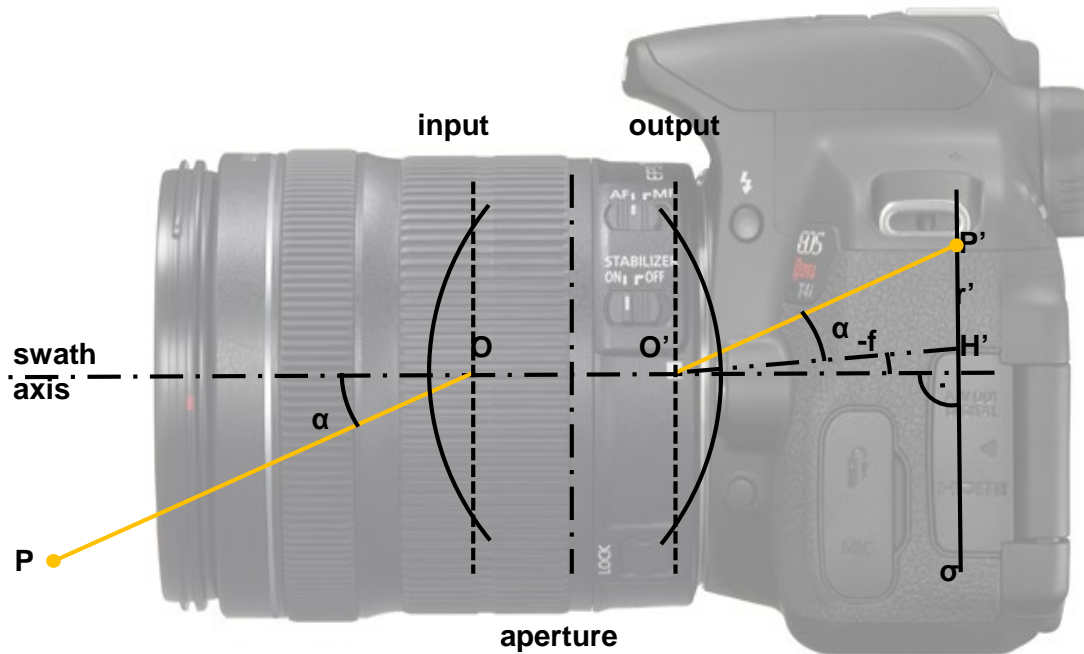
Titling effects



Photogrammetry

Reality of Recording

- Camera objective lenses consists of many optical elements
- Thickness of objective is to consider

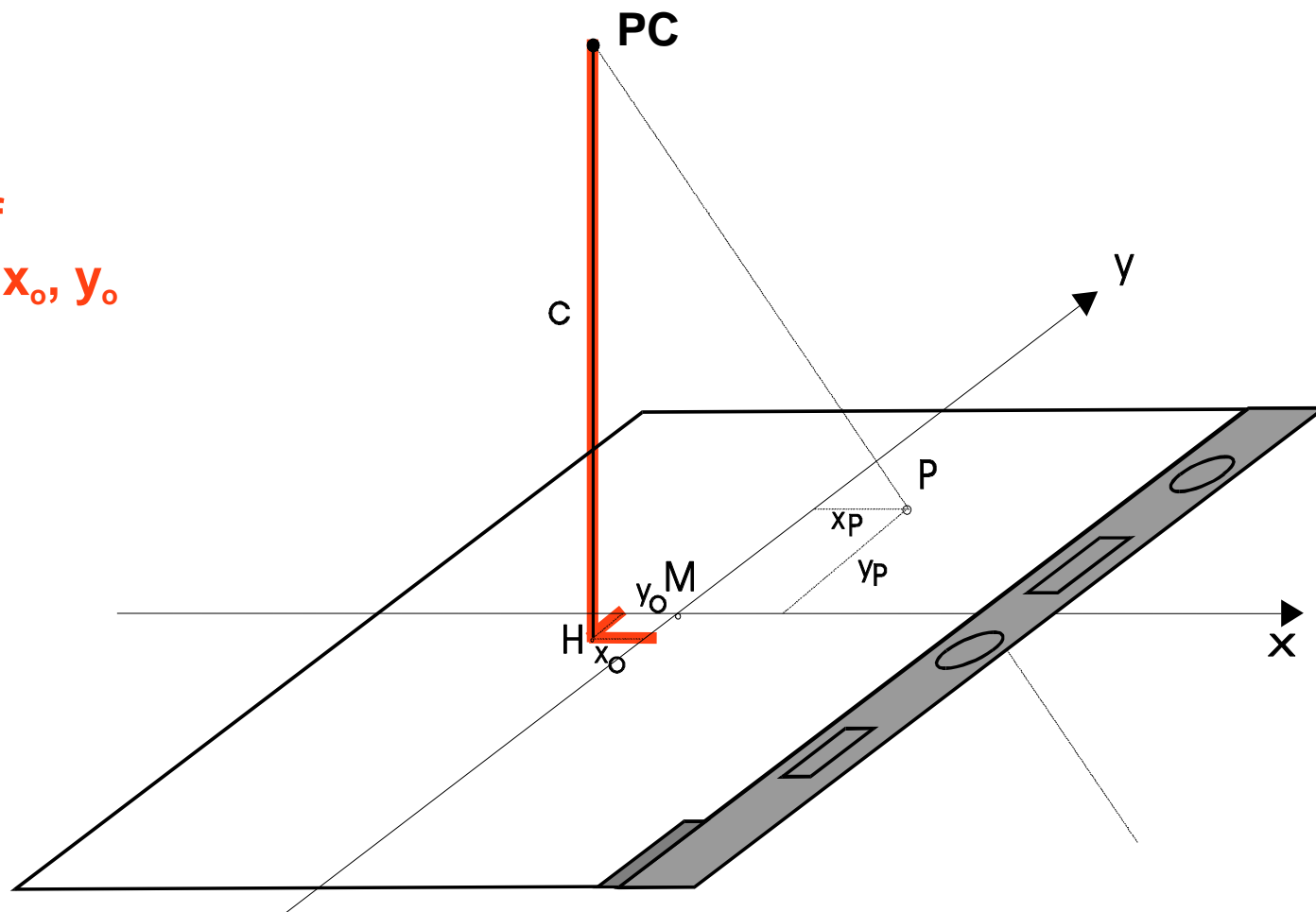


→ Projection not fitting to mathematical model

Inner (Interior) Orientation

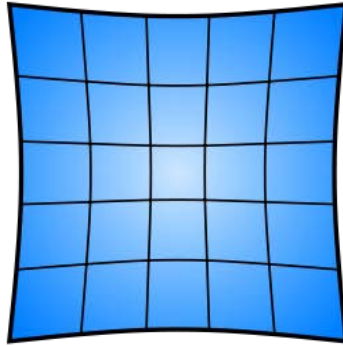
Focal length c

**Coordinates of
Principal Point of
Autocollimation: x_o, y_o**

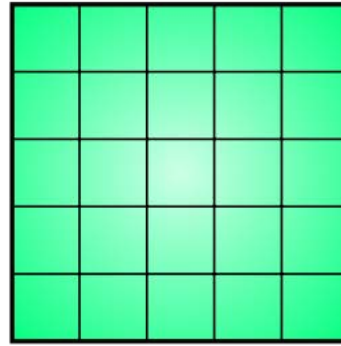


Photogrammetry

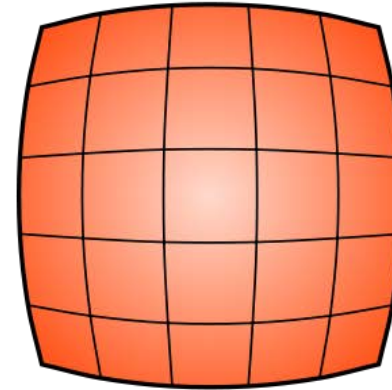
Lens Distortion



pincushion
distortion

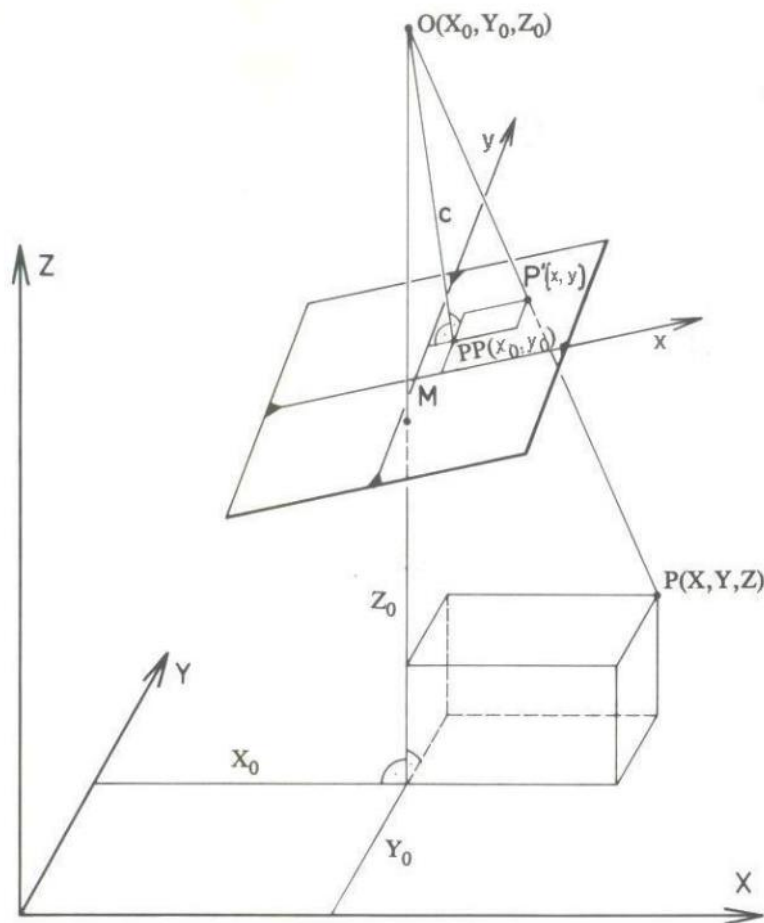


no
distortion



barrel
distortion





Collinearity Equations: $X = f(x, IO, EO)$

$$x = x_0 - c \frac{r_{11}(X - X_0) + r_{21}(Y - Y_0) + r_{31}(Z - Z_0)}{r_{13}(X - X_0) + r_{23}(Y - Y_0) + r_{33}(Z - Z_0)}$$

$$y = y_0 - c \frac{r_{12}(X - X_0) + r_{22}(Y - Y_0) + r_{32}(Z - Z_0)}{r_{13}(X - X_0) + r_{23}(Y - Y_0) + r_{33}(Z - Z_0)}$$

x, y

Image Coordinates

X, Y, Z

Object Coordinates

$x_0, y_0, -c$

Coordinates of Principle Point, focal length (IO)

X_0, Y_0, Z_0

Coordinates of Projection Centre

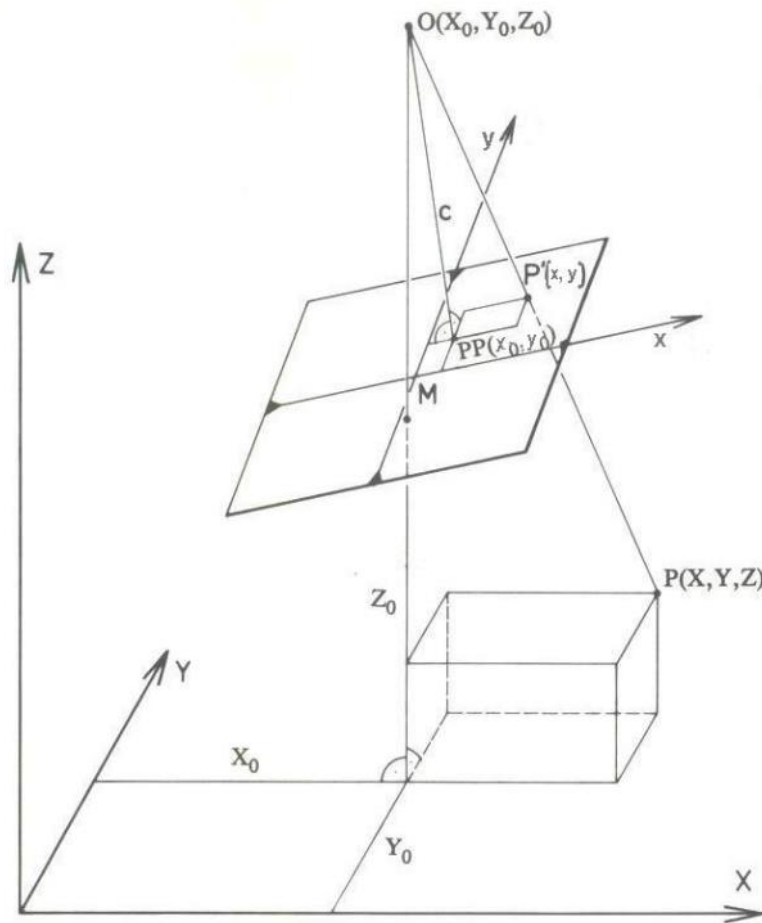
$r_{11} \dots r_{33}$

Elements of Rotation Matrix (Ω, Φ, κ)

$$R_{\omega, \varphi, \kappa} = \begin{pmatrix} \cos \varphi \cos \kappa & -\cos \varphi \sin \kappa & \sin \varphi \\ \cos \omega \cos \kappa + \sin \omega \sin \varphi \cos \kappa & \cos \omega \sin \kappa - \sin \omega \sin \varphi \sin \kappa & -\sin \omega \cos \varphi \\ \sin \omega \sin \kappa - \cos \omega \sin \varphi \cos \kappa & \sin \omega \cos \kappa + \cos \omega \sin \varphi \sin \kappa & \cos \omega \cos \varphi \end{pmatrix}$$

Photogrammetry

Relation Object Coordinates – Image Coordinates



Collinearity Equations: $X = f(x, IO, EO)$

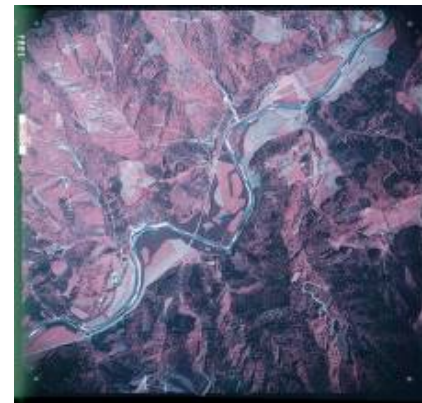
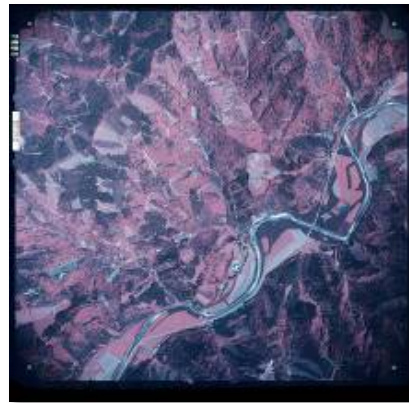
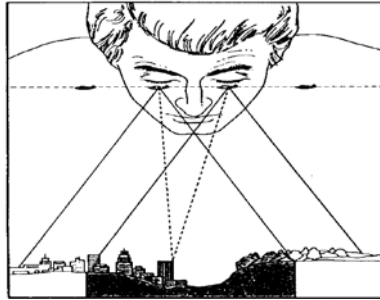
$$\boxed{X} = X_0 + \boxed{Z - Z_0} \frac{r_{11}(x - x_0) + r_{12}(y - y_0) - r_{13}c}{r_{31}(x - x_0) + r_{32}(y - y_0) - r_{33}c}$$

$$\boxed{Y} = Y_0 + \boxed{Z - Z_0} \frac{r_{21}(x - x_0) + r_{22}(y - y_0) - r_{23}c}{r_{31}(x - x_0) + r_{32}(y - y_0) - r_{33}c}$$

- x, y Image Coordinates
- $\boxed{X}, \boxed{Y}, \boxed{Z}$ Object Coordinates
- $x_0, y_0, -c$ Coordinates of Principle Point, focal length (IO)
- X_0, Y_0, Z_0 Coordinates of Projection Centre
- $r_{11} \dots r_{33}$ Elements of Rotation Matrix (Ω, Φ, K)

Photogrammetry

Stereoscopic View (3D-view)



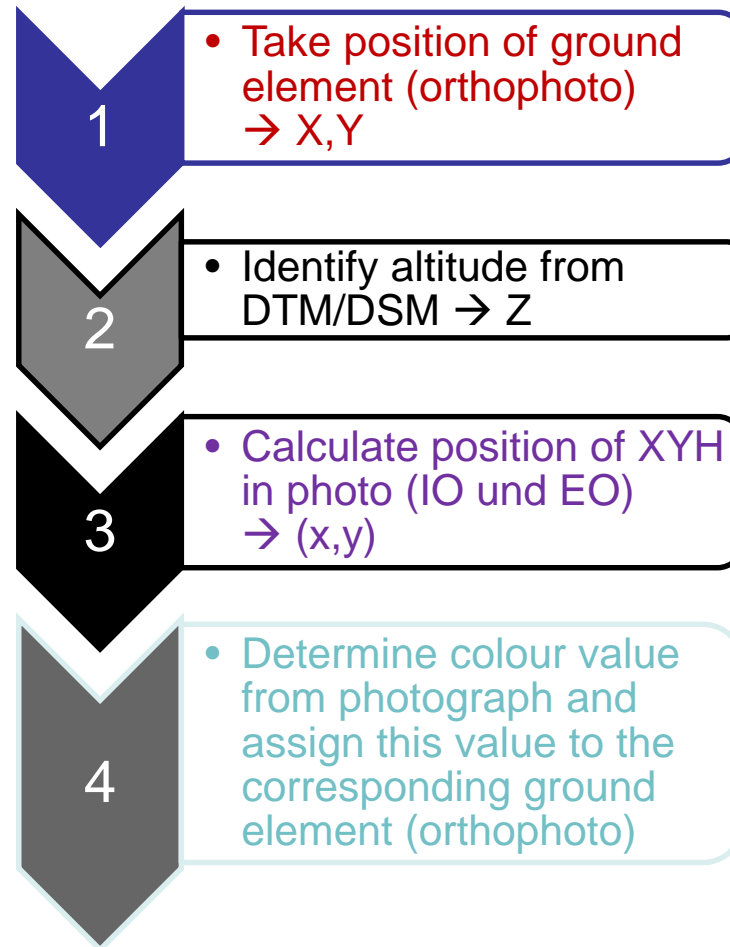
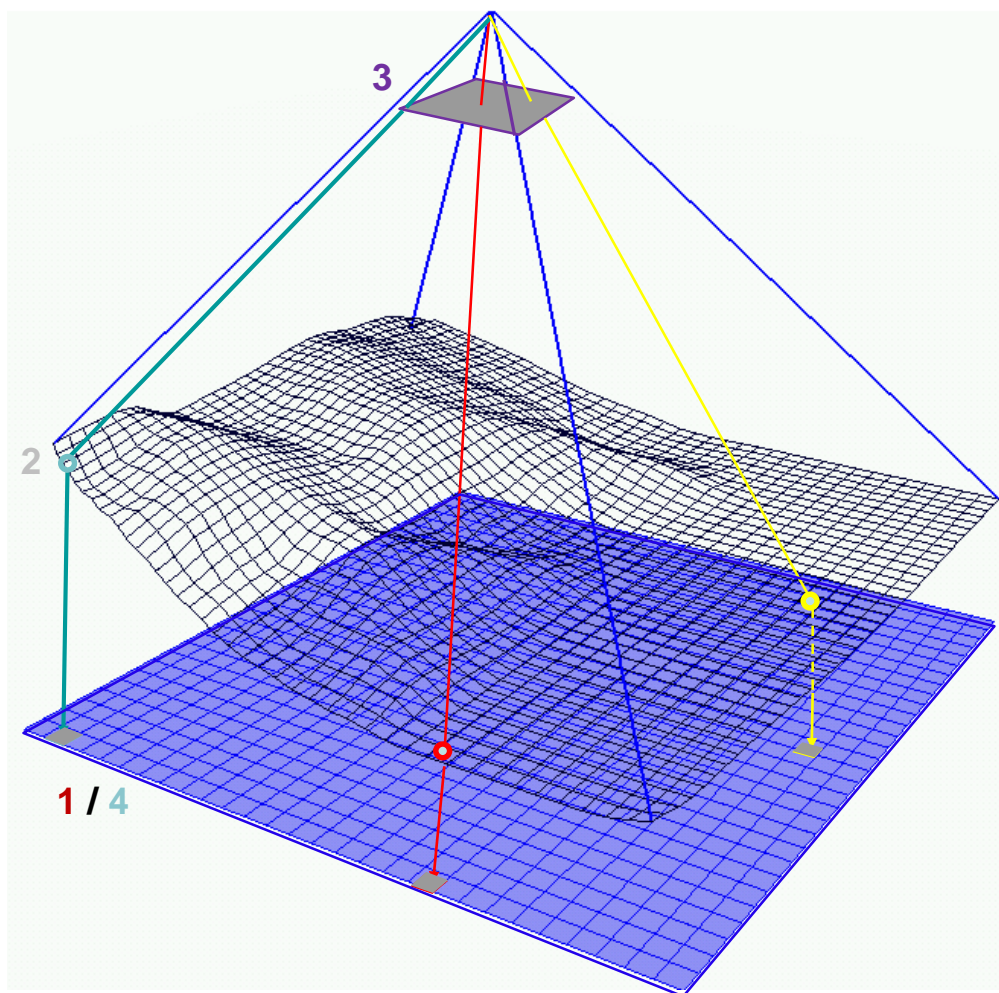
Surface 1 (retina left)
2 - dimensional

Surface 2 (retina right)
2 - dimensional

stereo image
3 - dimensional

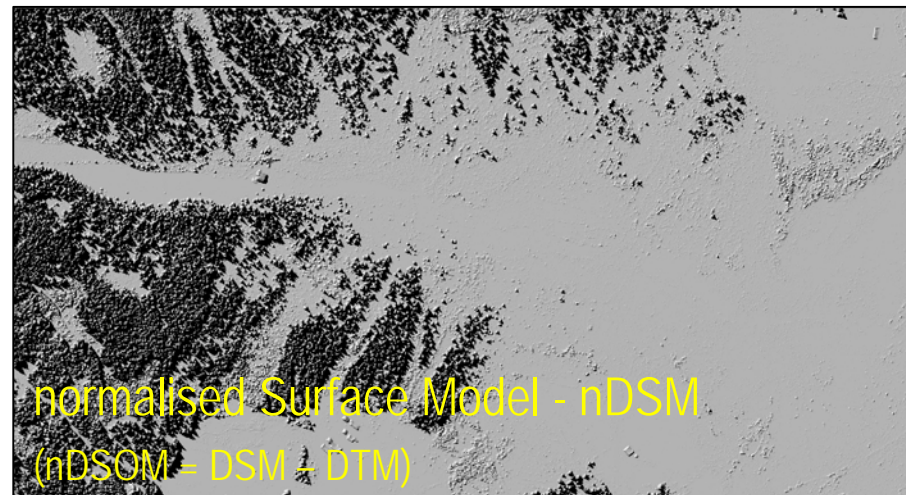
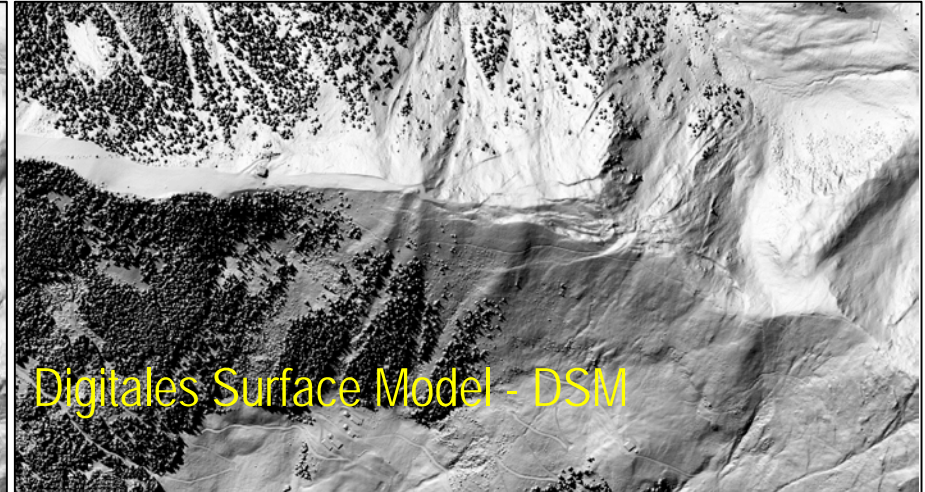
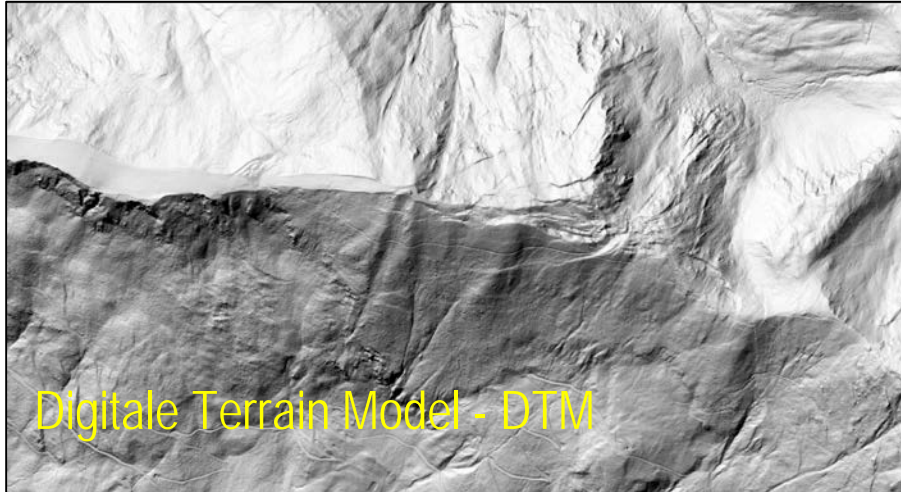
Photogrammetry

Orthophoto Generation



Photogrammetry

Digital Terrain Model



Photogrammetry

Demo Project 1



UAV-flight; 5 photographs; fish-eye



G0015630.JPG



G0015631.JPG



G0015632.JPG



G0015633.JPG



G0015634.JPG

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