An open monoplotter to register landscape oblique images and generate their synthetic model.

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Monoplotter !?

• **A monoplotter** is a software which links pixel of an image with its 3D world coordinates.

• **What do you need?**
  – Camera coordinate
  – Camera orientation
  – Camera intrinsics
  – DEM

• **Why?** Our research focuses on the automatic pose estimation of landscape images.
Plan

• Involved technologies

• Processing
  – Image registration (co-linearity)
  – Z-buffer computation
  – Functionalities

• Case studies
  – Aletsch glacier
  – Chateau-d’Oex postcard collection
Involved technologies

1. DEM storage
   - PostGIS Database

2. GCP digitization
   - Python Programming Language
     - Shapely
     - Scipy, Numpy
     - Matplotlib

3. Image registration
   - OpenCV Computer Vision Libraries

4. DEM projection in the image
   - TIN generation
   - Z-buffering

Ortho-rectified image

Synthetic image
Image registration:

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

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

1. DEM storage
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     - Database

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Ortho-rectified image

Synthetic image
Processing

Z-buffer:

- **Computer graphics** technology used to render synthetic images.
- 3D objects are modeled with geometric primitives (Triangle Irregular Network)
- Primitives are projected in the screen plan
- And rasterized
- Closest pixels are displayed
Processing

Ortho-rectification:

- During z-buffering, each pixel in the image obtains a 3D world coordinate.
- Intensity values at each point of a regular grid are interpolated.

Synthetic images are generated by coloring z-buffer with the real ortho-image

GIS vectors are projected in the image plane using colinearity equations

Vectors drawn in the image are projected in the map
Aletsch glacier

What happened during the last century?

Aletsch glacier

What happened during the last century?

• Re-photography
• Widely used to show landscape change
Aletsch glacier

1. Ground Control Points Digitization

-> Camera pose is computed
Aletsch glacier

1. Synthetic image computation
2. Analysis

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Château-d’Oex, ski resort

- Collection of ancient postcards
- Assessment of the evolution of landscape
- Oblique aerial images
Château-d’Oex, ski resort

How did the builded area grow?
1. Orthorectified image computation
2. Augmented image computation
Château-d’Oex, ski ressort

• A second **overlapping** postcard?
• Computer vision feature detectors / descriptors are able to detect matches
Château-d’Oex, ski ressort

Automatic pose estimation of the second camera

RANSAC to depict outliers:
- 4 correspondences are picked randomly,
- A camera pose is computed,
- If a sufficiently high ratio of other correspondences match with this pose, the pose is kept in memory,
- Until a «better» one is found.

Case Studies

SURF matching

RANSAC computation

Visual quality assessment
Conclusion

- Registration of oblique image has several applications:
  - Ancient and non-photogrammetric image valuation
  - Landscape survey with terrestrial images
  - Augmented reality applications
Conclusion

Why open? You just can’t avoid it!

• Most computer vision libraries are open
• Multiple softwares interaction (GIS, Computer Vision, Image Processing, Scientific computing)
• Interaction with other labs and students

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