Master in
Computer Vision
Barcelona

Module: 3D Vision
Project: 3D recovery of urban scenes
Session 2

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Session 2

Goal: compute the homography that relates to images

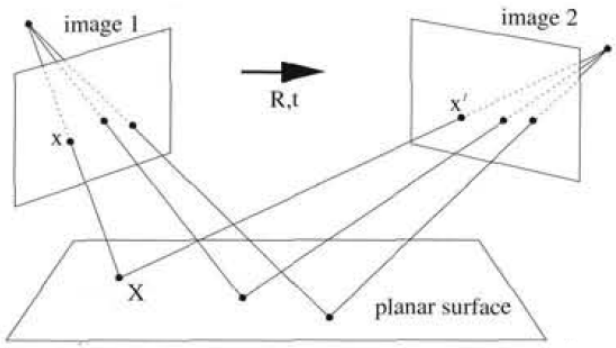
Algorithms:

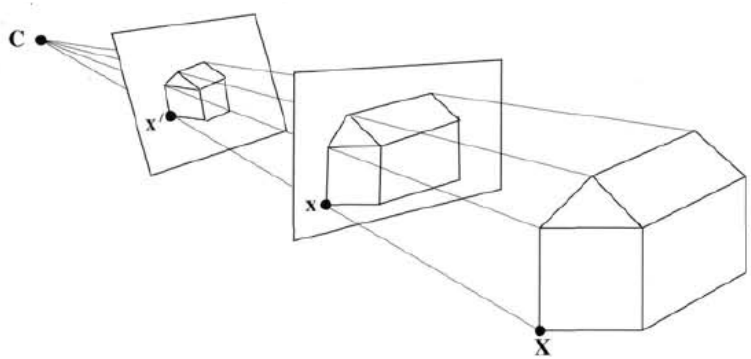
- Robust normalized DLT algorithm (algebraic method).
- Gold-Standard algorithm (geometric method).
- Camera calibration using a planar pattern.

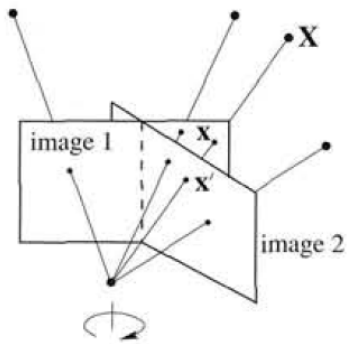
Applications:

- Image mosaics (panoramas).
- Camera calibration.
- Augmented reality.
- Logo detection in an image.
- Logo insertion in an image.

Homographies







A homography relates two images:

- of the same plane in the 3D scene;
- taken with a camera rotating about its centre;
- taken with the same static camera varying its focal length;
- the whole scene is far away from the camera.

Image mosaics

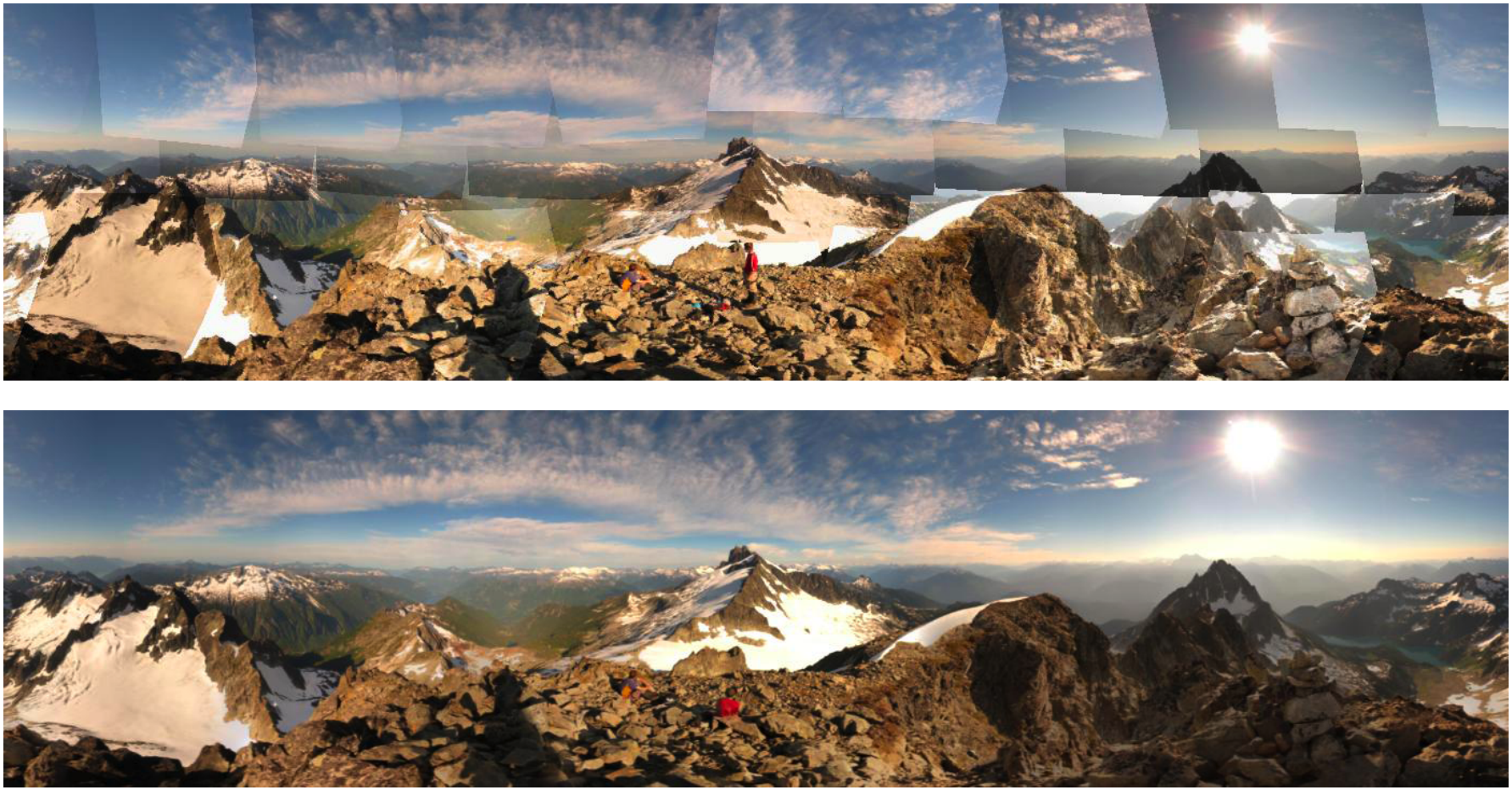


Image mosaics

Setting the canvas




Gold-Standard algorithm

Geometric algorithm: It minimizes the reprojection error

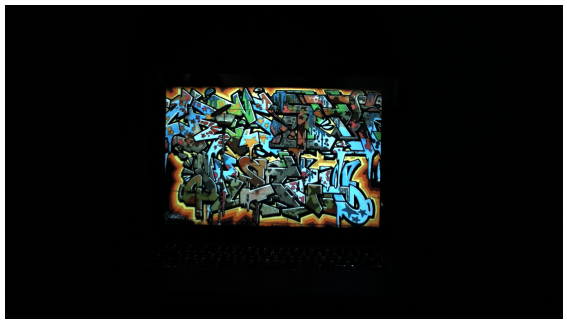
$$\min_{\hat{H},\hat{x}_i,\hat{x}'_i} \sum_i d([x_i],[\hat{x}_i])^2 + d([x'_i],[\hat{x}'_i])^2 \text{ s. t. } \hat{x}'_i = \hat{H}\hat{x}_i \forall i$$

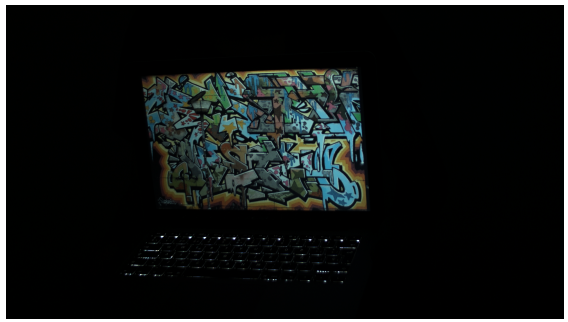
where different matchings $x_i \longleftrightarrow x'_i$ are the available data, [.] is the projection operator to Euclidean coordinates.

The above problem simplifies to the non-constrained minimization problem:

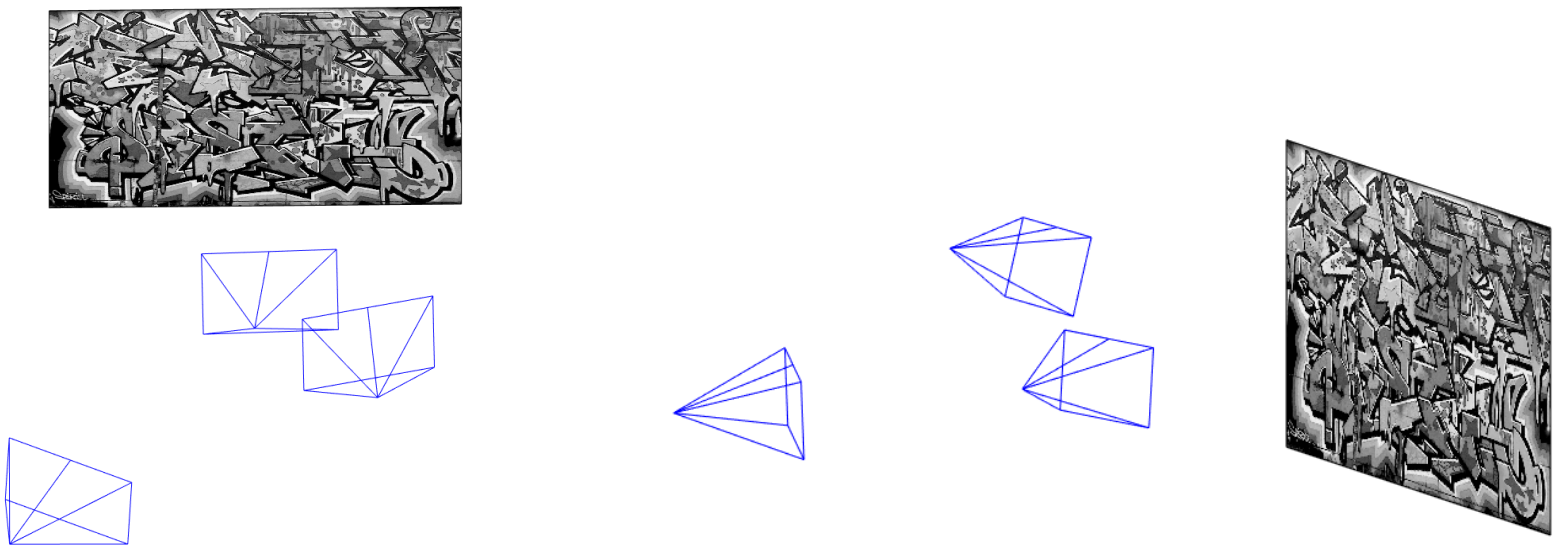
$$\min_{\hat{H},\hat{x}_i} \sum_i d([x_i],[\hat{x}_i])^2 + d([x'_i],[\hat{H}\hat{x}_i])^2$$

Camera calibration with a planar pattern





Camera calibration with a planar pattern



Augmented reality

Logo insertion

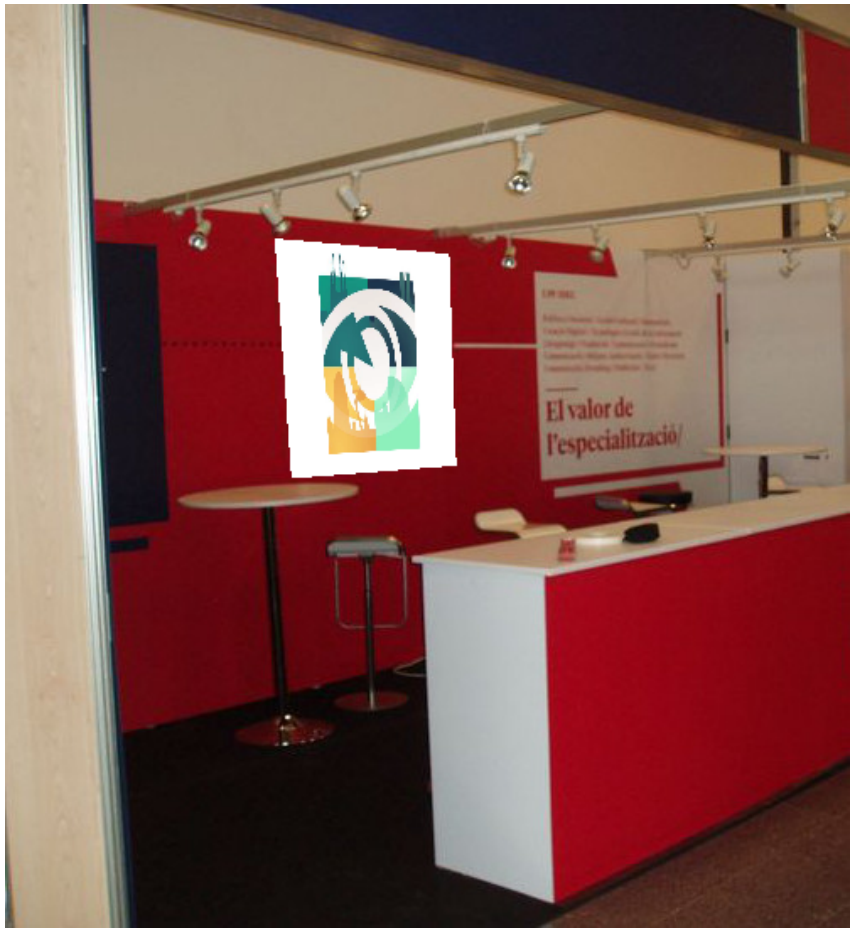
Manually selecting the four corners in the target image

Logo detection

Fully automatic

Logo replacement

Fully automatic



Session 2

Mandatory tasks:

- Function that estimates the homography with the normalized DLT algorithm given $n \geq 4$ image correspondences.
- Complete the RANSAC function.
- Compute an image mosaic with four different sets of data; compare and comment the results (why it works or it does not work in the different cases).
- Estimation of the homogaphy with the Gold-Standard algorithm.

Optional tasks:

- Complete the code on camera calibration using a planar pattern and answer (in the report) two questions raised in the file lab2.ipynb.
- Detect a logo in an image.
- Replace a logo in an image.

Session 2

Language: PYTHON

To Do:

- Complete the code in lab2.ipynb as indicated in the same file
- Write the function 'DLT_homography' (DLT algorithm)
- Complete the function 'Inliers' in 'Ransac_DLT_homography'
- Prepare the input variables and function to call the 'least_squares' function (Gold-Standard algorithm)
- (Complete the code on camera calibration)
- (Detect a logo in an image using the DLT algorithm)
- (Replace a logo in an image using the DLT algorithm)

Evaluation

To deliver **before 9am of the day before** the next lab session:

- **Code deliverable:**
  - READY TO BE LAUNCHED on the provided images
- **Short document:**
  - Results
  - Problems and comments
  - Conclusions

Evaluation

Grading:

- Report(including answers to questions): **2.5 points**
- DLT function: **2.5 points**
- RANSAC: **1.5 points**
- 4 mosaics: **1 point**
- Gold-Standard algorithm: **2.5 points**
- Optional calibration: **+ 1 points**
- Optional detect logo in an image: **+ 0.25 points**
- Optional replace logo in an image: **+ 0.25 points**