



Master in Computer Vision *Barcelona*

Module: 3D Vision

Project: 3D recovery of urban scenes

Session 2

Gloria Haro

Session 2

Goal: compute the homography that relates to images

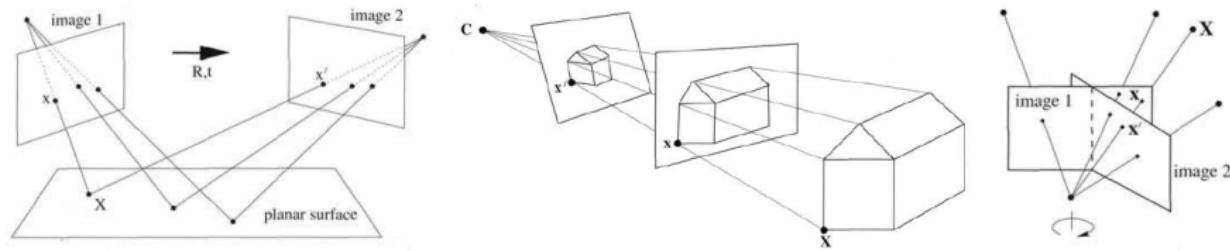
Algorithms:

- 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.

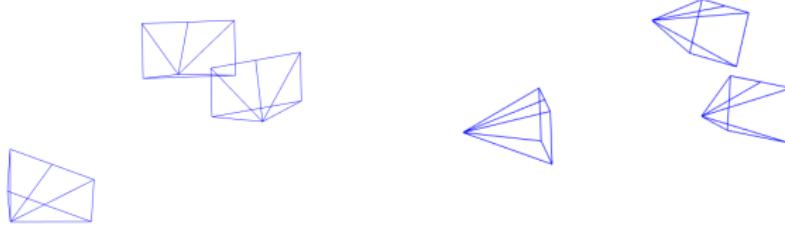
The above problem simplifies to the non-constrained minimization problem:

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

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



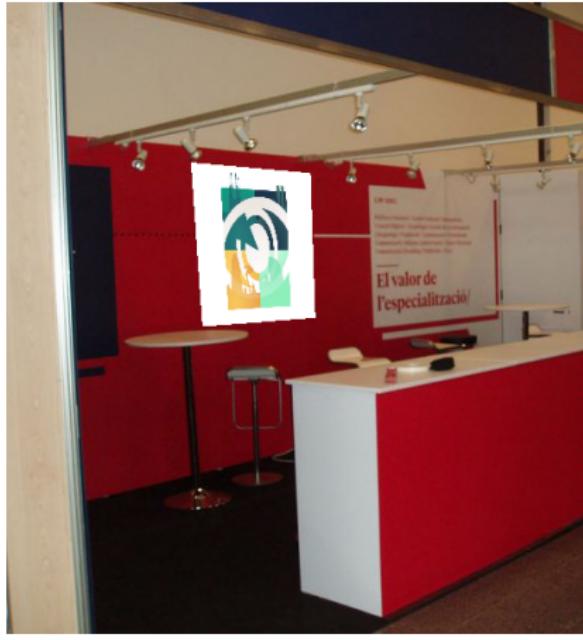
Logo detection

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 homography with the Gold-Standard algorithm.
- Complete the code on camera calibration using a planar pattern and answer (in the report) the questions raised in the file lab2.ipynb.

Optional tasks:

- Augmented reality (understand the code).
- 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 8am, January 2, 2025**:

- **Code deliverable:**

- READY TO BE LAUNCHED on the provided images

- **Short document:**

- Results
- Problems and comments
- Conclusions

Evaluation

Grading:

- Report: **2 points**
- DLT function: **2 points**
- RANSAC: **1 points**
- 4 mosaics: **1.5 point**
- Gold-Standard algorithm: **2.5 points**
- Calibration: **1 point**
- Optional augmented reality: **+ 0.25 points**
- Optional detect logo in an image: **+ 0.5 points**
- Optional replace logo in an image: **+ 0.25 points**



HAPPY NEW YEAR

