



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

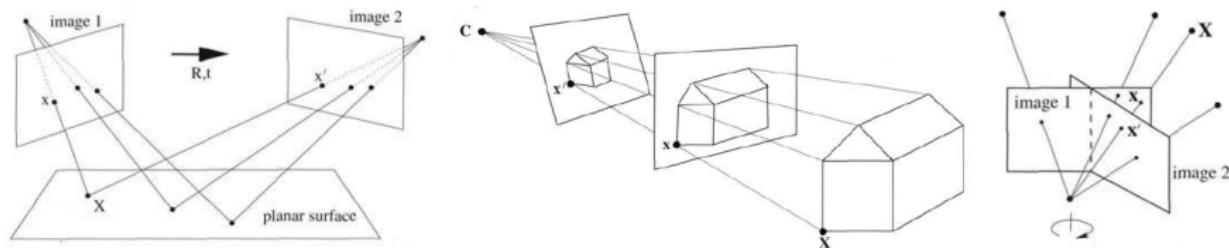
Algorithms:

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

Applications:

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



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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



Augmented reality



Logo insertion

Manually selecting the four corners in the target image



Logo detection

Fully automatic



Logo replacement

Fully automatic



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Mandatory tasks:

- Function that estimates the homography with the normalized DLT algorithm given $n \geq 4$ image correspondences.
- Complete the RANSAC function and the lab2.m file.
- 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.

Optional tasks:

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

Session 2

Language: MATLAB

Provided functions: lab2.m, apply_H_v2.m, euclid.m, optical_center.m, plot_camera, ransac_homography_adaptive_loop.m, vgg_gui_H.m, vgg_scatter_plot.m, view_direction.m, sift functions.

lab2.m is the guided file with the different steps of the lab session.

To Do:

- Complete the code in lab2.m as indicated in the same file
- Complete the code in ransac_homography_adaptive_loop.m as indicated
- Write the function homography2d.m
- (Write the function gs_errfunction.m)
- (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 (10 pages):**

- 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**

2018



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