



Master in Computer Vision *Barcelona*

Module: 3D Vision

Project: 3D recovery of urban scenes

Session 1

Gloria Haro

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Main Goal: Learn the basic concepts and techniques to reconstruct a real world scene given several images (points of view) of it.

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- Use of different image transformations. (week 1)
- Learn affine and metric rectification. (week 1)

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- 3D inference from two views: triangulation and depth estimation. (week 4)
- New view synthesis. (week 4)

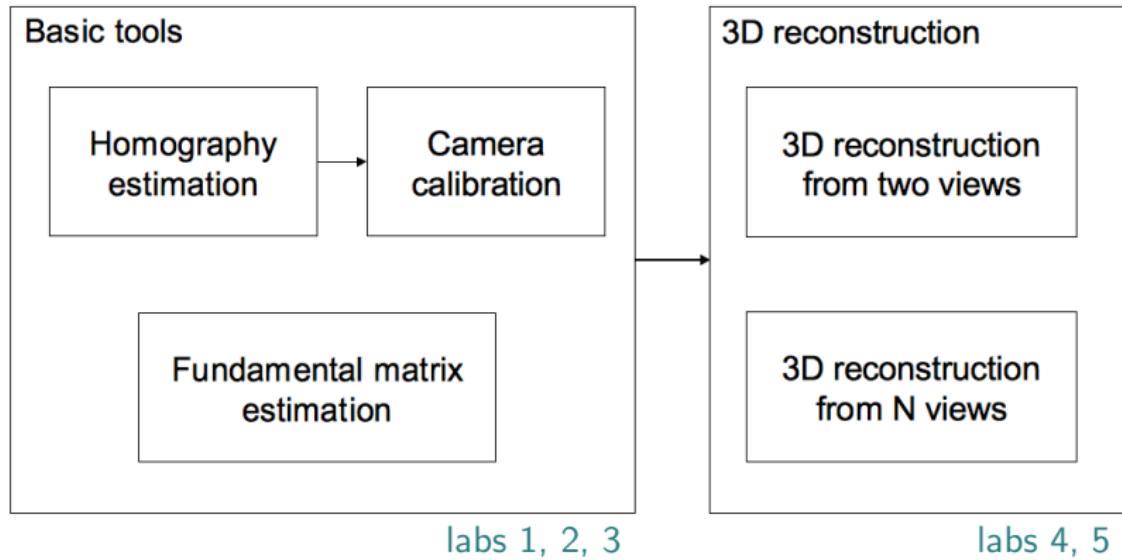
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- 3D reconstruction from N non calibrated cameras. (week 5)

Project stages



Datasets

Images of buildings and facades.

- **Facades**

EPFL-Stretcha dataset
castle images: 19 cameras
(calibration matrices)



- **Aerial images**

Brown university 27 different sites of Providence city



Site 13 (234 images)



Site 22 (173 images)

Calibration matrices are available.

Datasets

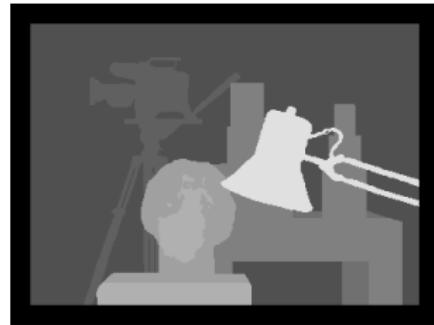
Other images

- **Middlebury**

Stereo benchmark

Different datasets

Ground truth disparity (depth)



Instructors

Gloria Haro: labs 1 - 3

Marc Pérez: labs 4 - 5

Evaluation

Groups of 4 students. Project organized in 5 weeks.

Grade:

$$V = 0.8 \cdot PD + 0.15 \cdot PP + 0.05 \cdot IGE$$

where

Project Development (PD) Weekly assignment:

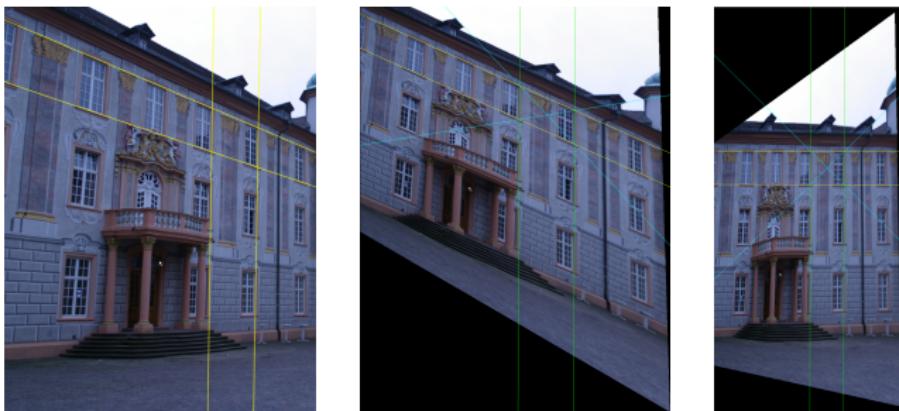
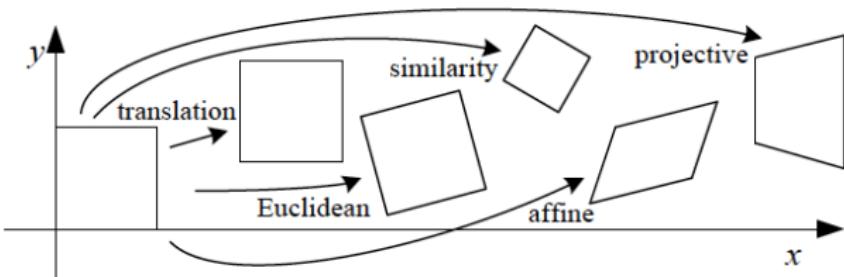
- [Code]: a working version of the developed code;
- [Report]: a short document (max. 10 pages), summarizing used approach, results and analysis, problems and comments, as well as answers to questions raised in the provided lab files.

The PD mark will be computed as: $PD = \frac{1}{5} \sum_{i=1}^5 V_{Cd_i}$.

Project Presentation (PP)

Intra-Group Evaluation (IGE)

Session 1



Session 1

Mandatory tasks:

- Function that applies a given homography to an image.
- Play with the hierarchy of planar transformations.
- Compute a line that passes through two points.
- Compute vanishing points.
- Compute a transformed line.
- Affine rectification of an image.
- Metric rectification of an image.

Optional tasks:

- Metric rectification of an image with a single step (pages 55-57, Hartley-Zisserman book).

Session 1

Language: PYTHON

Provided functions: lab1.ipynb,
guide of the lab with the different steps of the lab session.

To Do:

- Complete the code in lab1.ipynb as indicated in the same file
- Write the function apply_H

Session 1

How to apply a homography to an image?

1) Forward warping

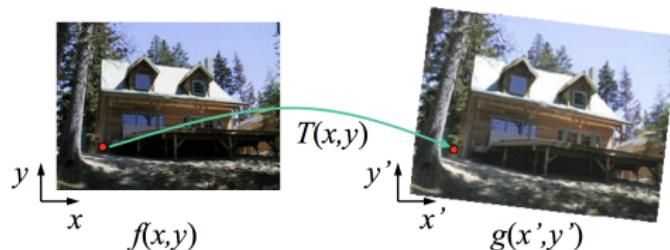


Image source: [S. Seitz]

Session 1

How to apply a homography to an image?

1) Forward warping

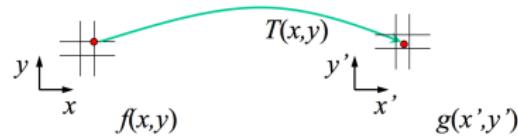
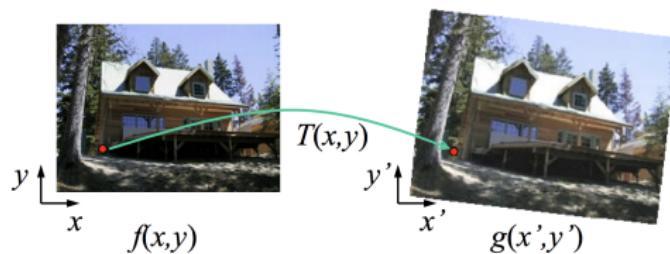


Image source: [S. Seitz]

Session 1

How to apply a homography to an image?

2) Inverse warping

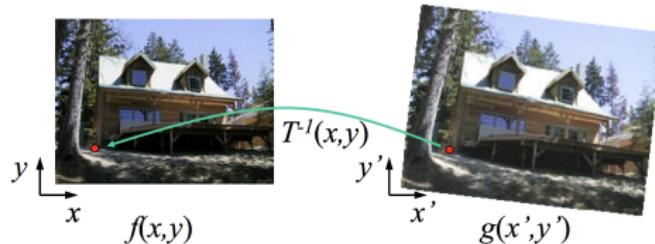
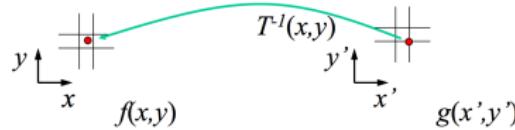
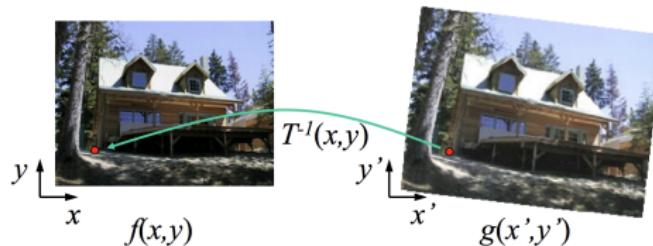


Image source: [S. Seitz]

Session 1

How to apply a homography to an image?

2) Inverse warping



Cons (Solution)

- Pixels may come from non integer locations \rightarrow Interpolation

Image source: [S. Seitz]

Session 1

How to apply a homography to an image?

Comments on the function `apply_H`

- ▶ Inverse mapping

$$u_H(x, y) = u([H^{-1}\mathbf{x}])$$

where $\mathbf{x} = (x, y, 1)^T$

and $[.]$ denotes $[(x_1, x_2, x_3)^T] = (x_1/x_3, x_2/x_3)^T$

- ▶ Use SCIPY function `map_coordinates`

```
from scipy.ndimage import map_coordinates
```

- ▶ Automatically adjust the size of the transformed image

Session 1

Affine and metric rectification need the identification of some lines.



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LSD: a Line Segment Detector

Rafael Grompone von Gioi, Jérémie Jakubowicz, Jean-Michel Morel, Gregory Randall

<http://www.ipol.im>

Session 1

Provided information:



You can assume that windows are square.

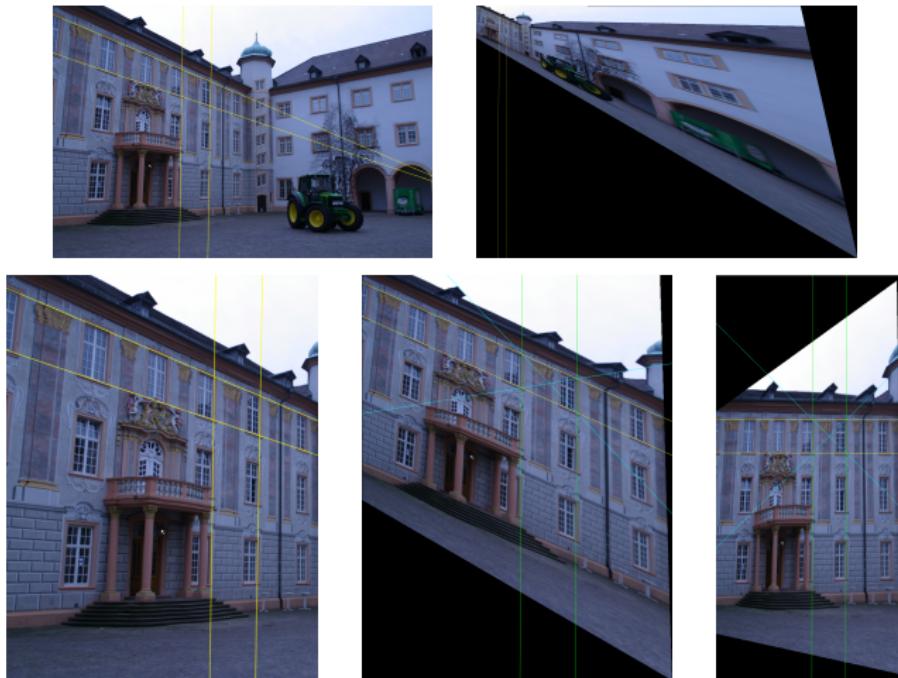
Session 1

Provided information:



Session 1

Affine and metric rectification of left facade image 0001



- ▶ Crop original image (only left facade)
- ▶ Show properly transformed lines

Evaluation

To deliver by 11 am of January 4th

- **Code deliverable:**

- Completed lab1.ipynb file and all cells already executed.

- **Short document**

- Results and analysis.
- Conclusions: Final discussion, eventual problems and comments.

Evaluation

Grading:

- Report: **2 points**
- apply_H function: **2 points**
- Play with different transformations: **0.5 points**
- Decompose affinity: **0.5 points**
- Affine rectification + angles: **2 points**
- Metric rectification + angles: **2 points**
- Affine + metric rectification 2nd facade: **1 point**
- Optional Metric rectification (single step): **+ 1 point**



HAPPY NEW YEAR