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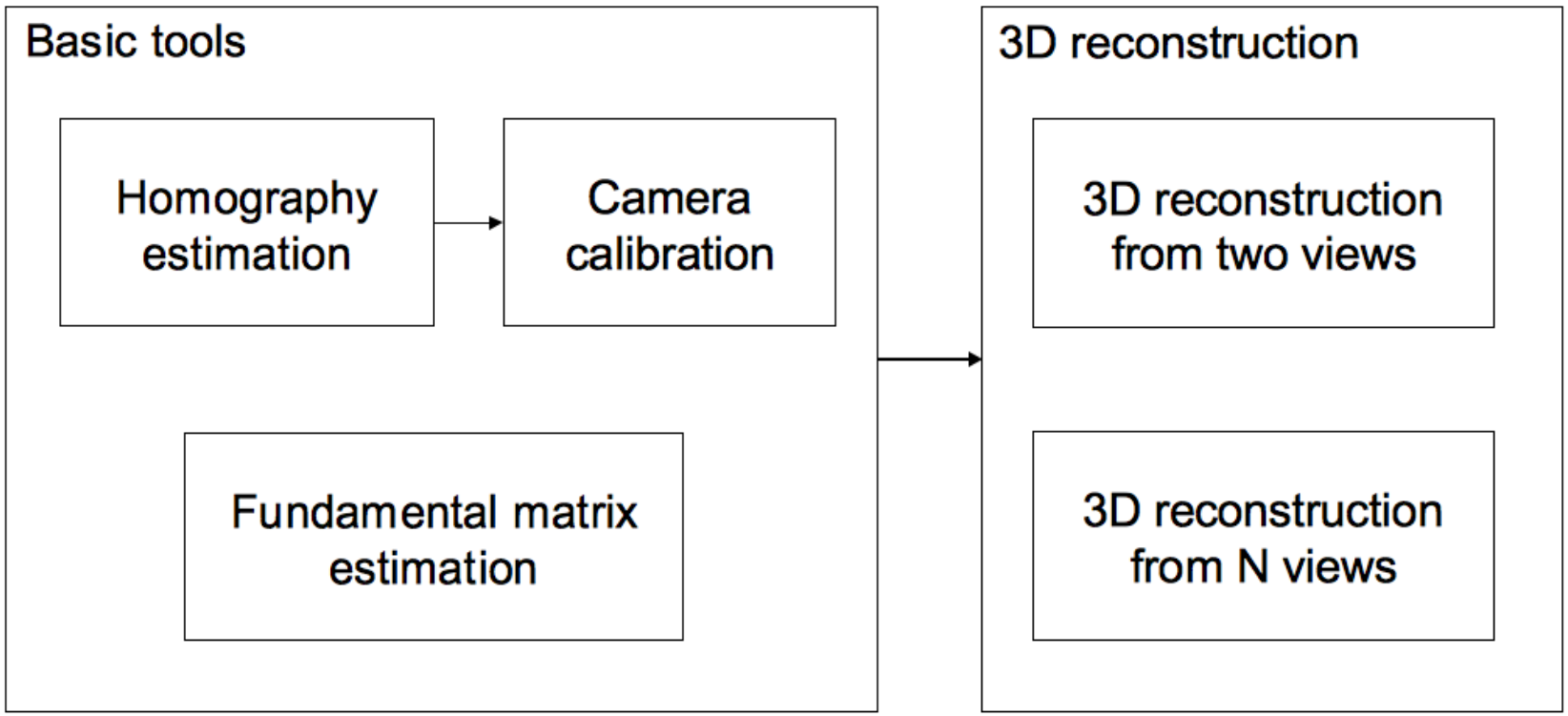
- 3D reconstruction from N non calibrated cameras. (week 5)

Project stages



labs 1, 2, 3

labs 4, 5

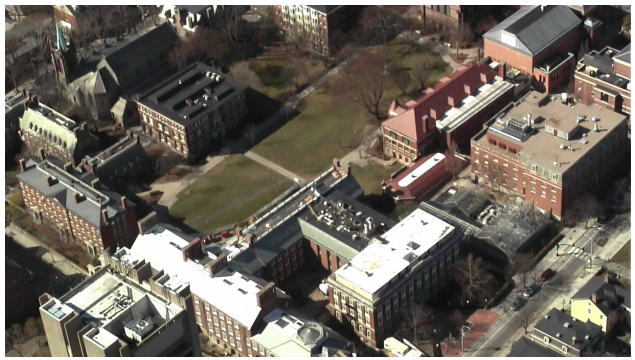
Datasets

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

Daniel Ordóñez: 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:

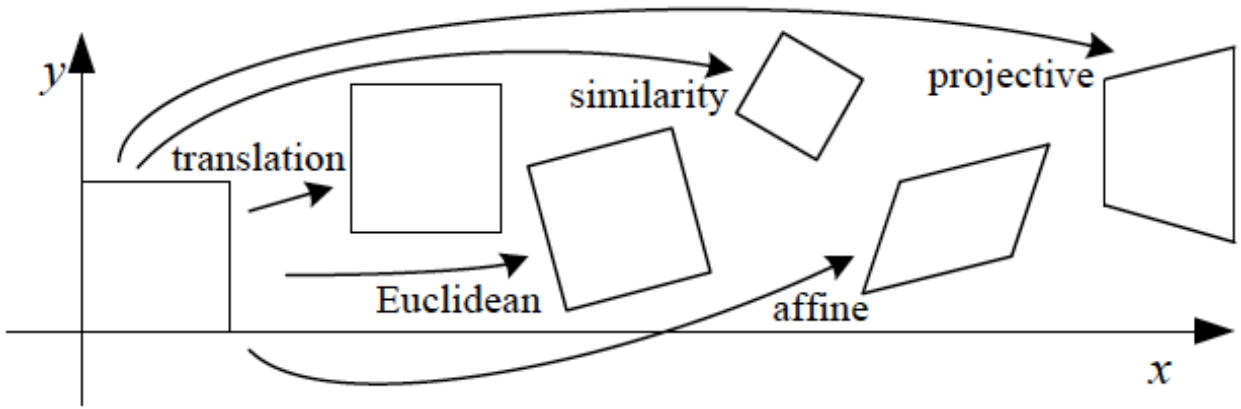
- [Code]: a working version of the developed code;
- [Report]: a short document (max. 10 pages), summarizing used approach, results ans analysis, problems and comments, as well as answers to questions raised in the provided lab files.

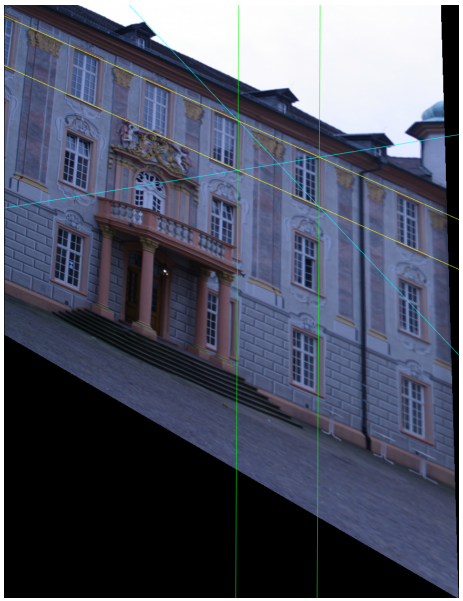
The PD mark will be computed as: $PD = \frac{1}{5} \sum_{i=1}^{5} V_{Cd_i}$.

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 tranformed 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

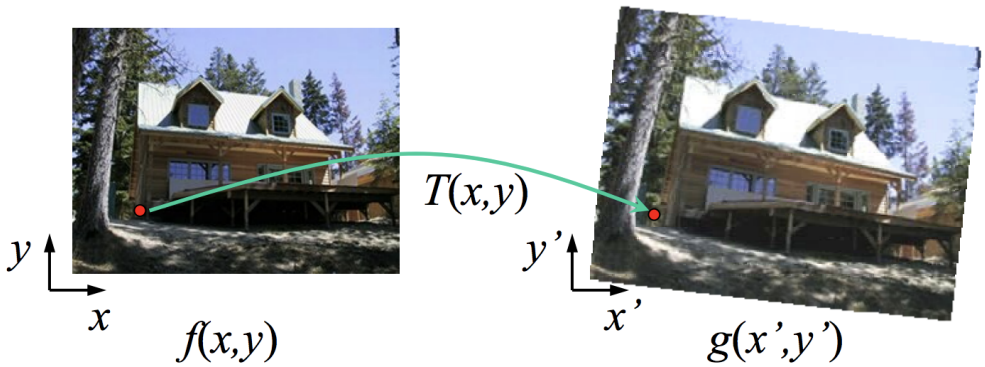


Image source: [S. Seitz]

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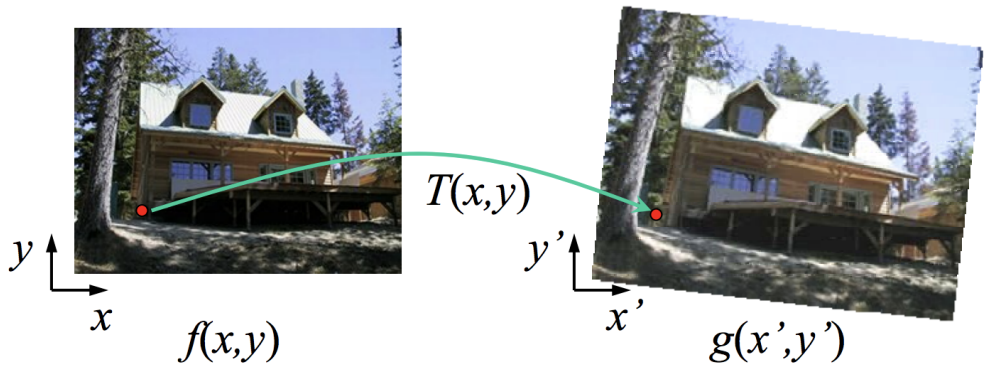

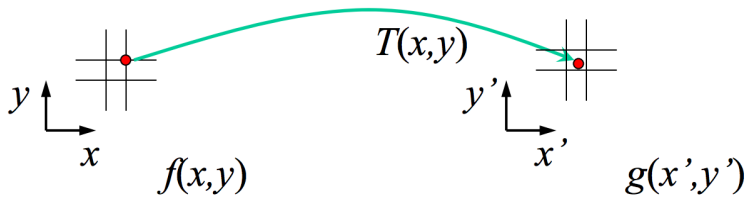

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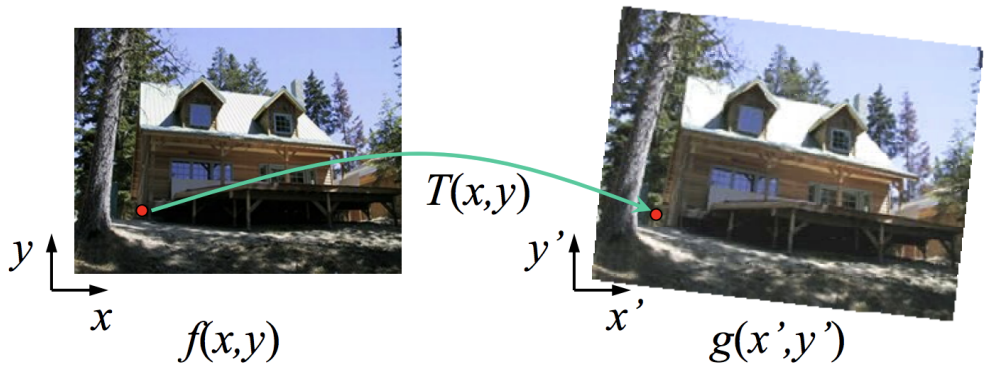

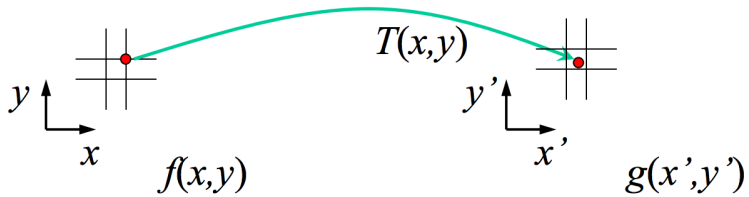

Cons (Solution)

- Pixels may land in non integer locations → Splatting
- Holes may be created

Image source: [S. Seitz]

How to apply a homography to an image?

2) Inverse warping

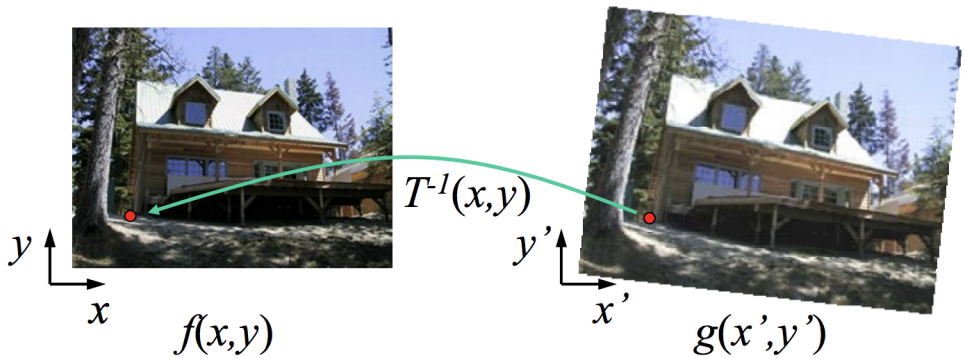

Image source: [S. Seitz]

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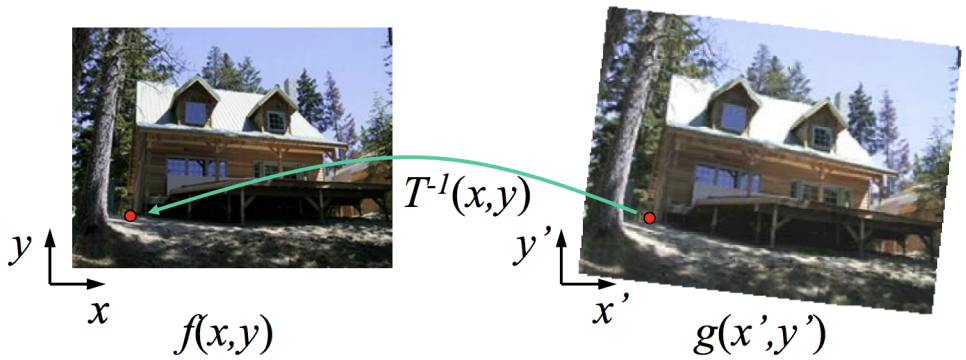
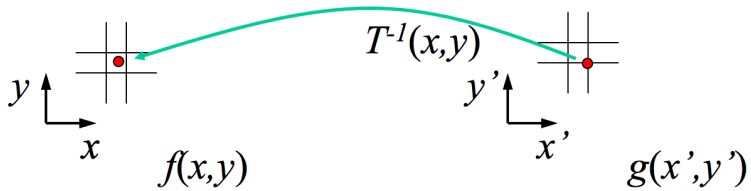




Cons (Solution)

- Pixels may come from non integer locations → Interpolation

Image source: [S. Seitz]

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.

http://www.ipol.im

Session 1

Provided information:

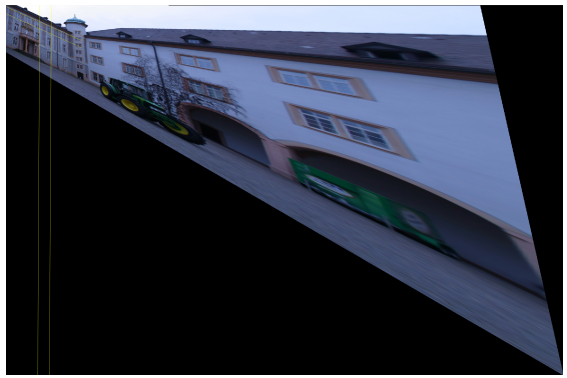
You can assume that windows are square.

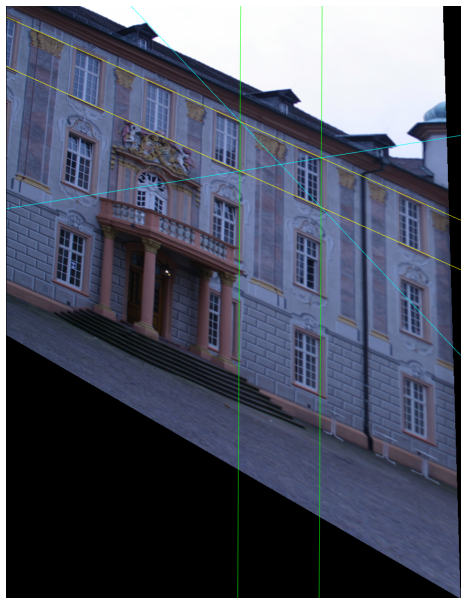
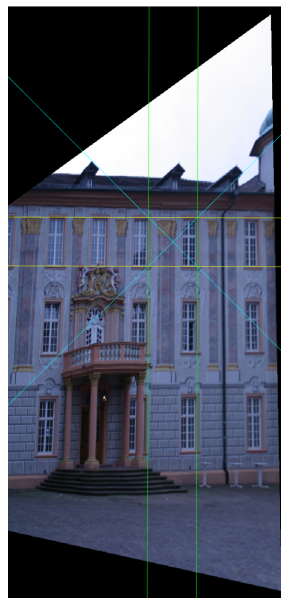
Session 1

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:**
  - READY TO BE LAUNCHED on the provided images
- **Short document (max. 10 pages):**
  - 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