Master in
Computer Vision
Barcelona

Module: 3D Vision
Project: 3D recovery of urban scenes
Session 1

Gloria Haro

Project goals

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

Scope:

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

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- The geometry of two views: Fundamental matrix. (lab 3)
- 3D inference from two views: triangulation and depth estimation. (lab 3)
- New view synthesis. (lab 3)

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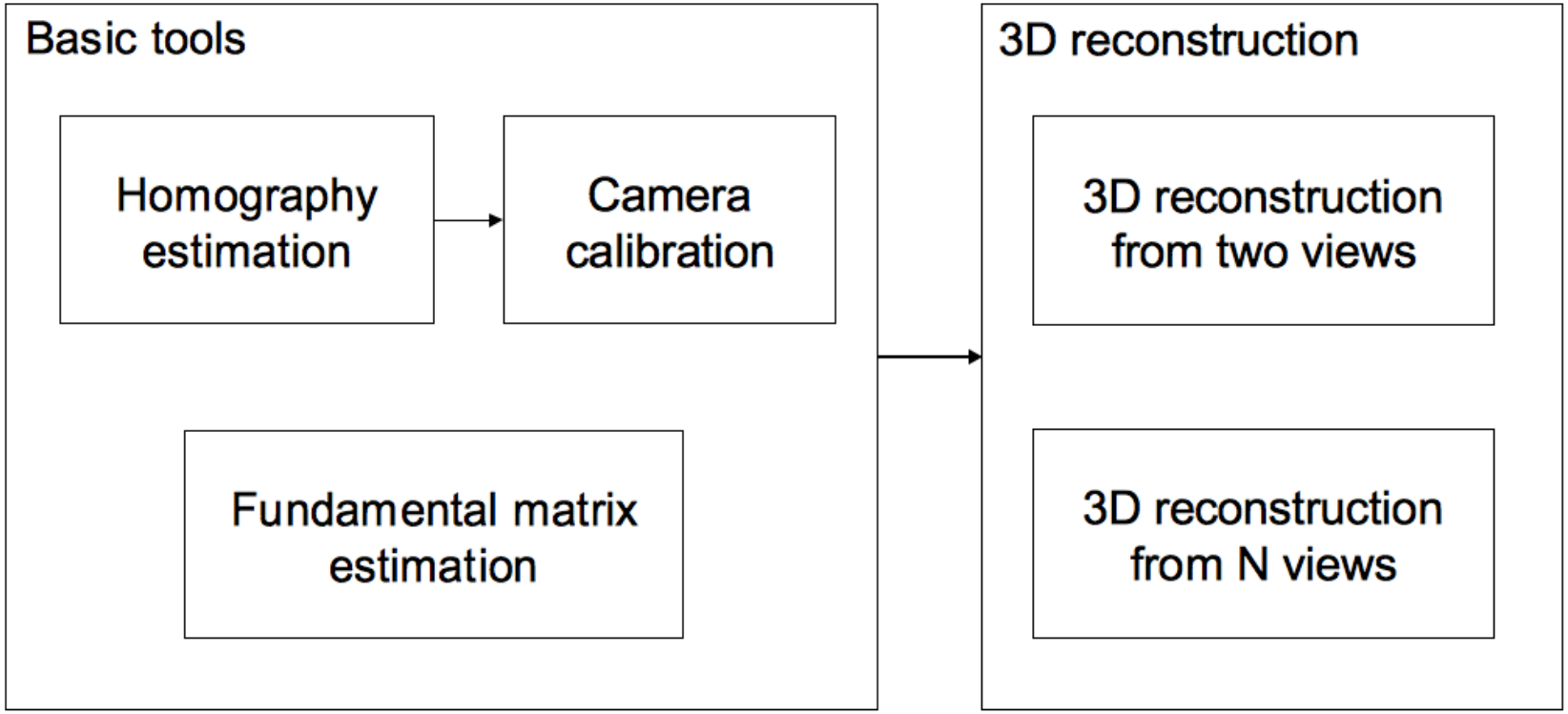
- New view synthesis. (lab 3)
- 3D reconstruction from N non calibrated cameras. (lab 4)

Project stages



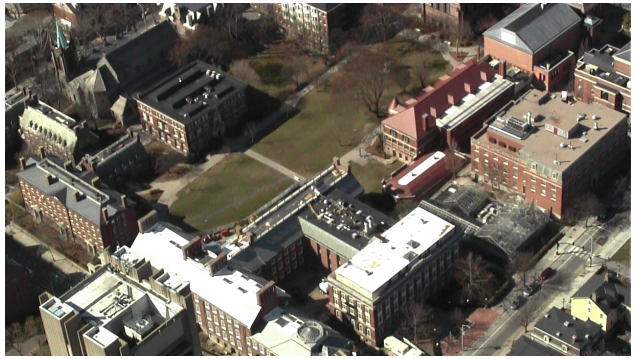
Datasets

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)

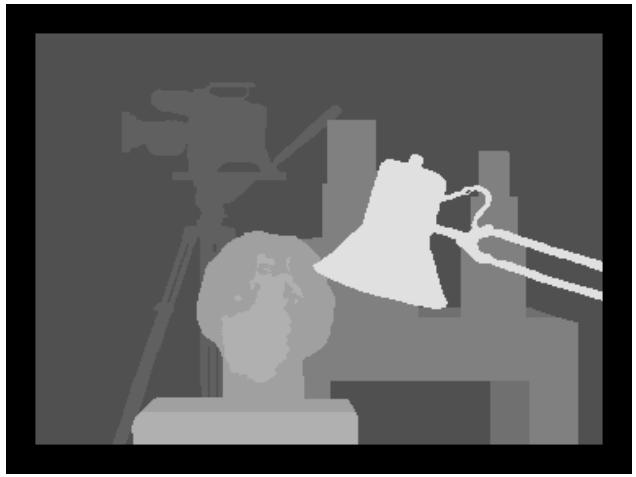
Site 22 (173 images)

Calibration matrices are available.

Datasets

Other images

- **Middlebury**
  Stereo benchmark
  Different datasets
  Ground truth disparity (depth)



Instructors

Gloria Haro: labs 1 - 2

Marc Pérez: labs 3 - 4

Evaluation

Groups of 4 students. Project organized in 4 sessions.

Grade:

$$V = 0.75 \cdot PD + 0.2 \cdot OE + 0.05 \cdot IGE$$

where

Project Development (PD) Weekly assignment:

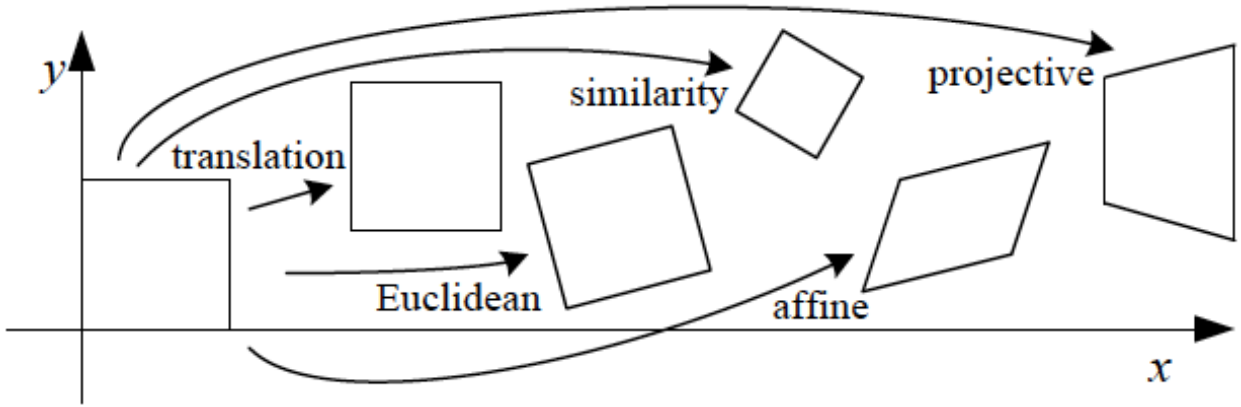
- [Code]: a working version of the developed code;
- [Report]: a short document (max. 8 pages), results and analysis, answers to questions raised in the lab notebook, final discussion including eventual problems and comments.

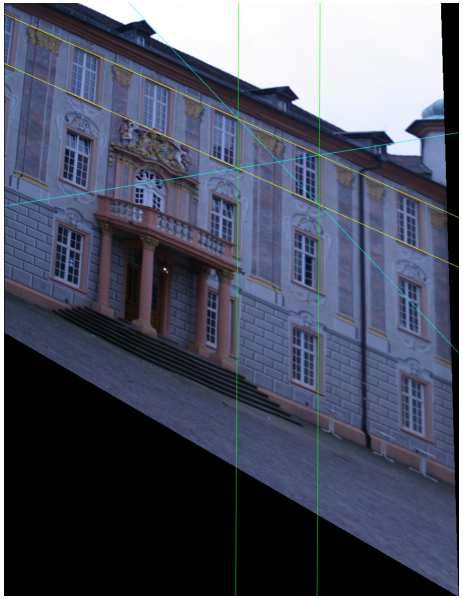
The PD mark will be computed as: $PD = \frac{1}{4} \sum_{i=1}^{4} V_{Cd_i}$.

Oral Exam (OE)

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 a short report

Session 1

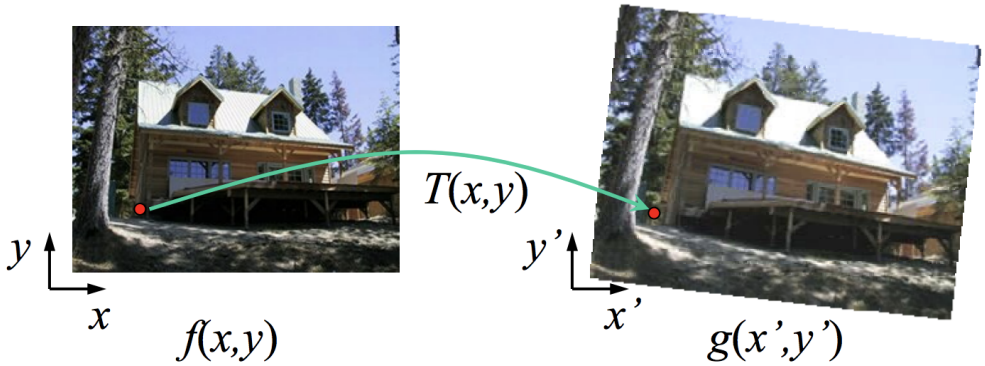
How to apply a homography to an image?

Image source: [S. Seitz]

Session 1

How to apply a homography to an image?

1) Forward warping



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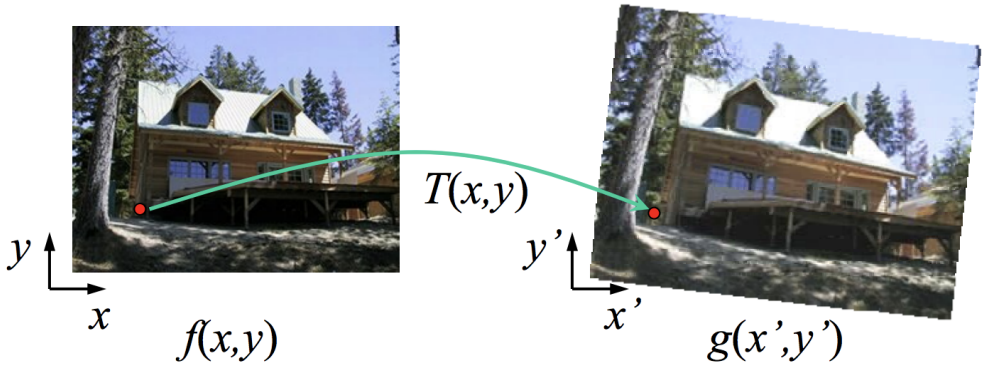

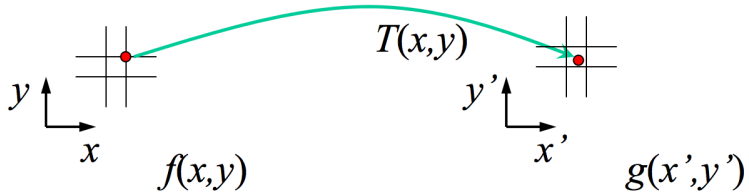

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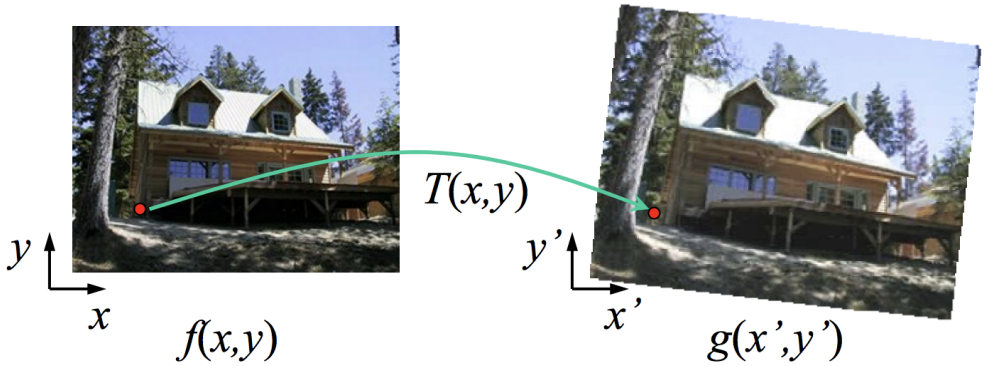

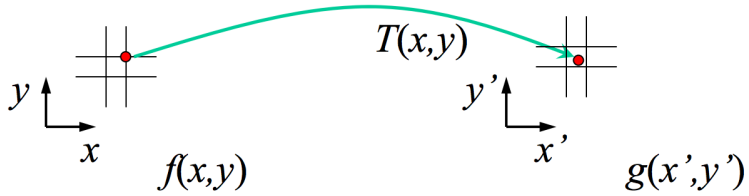

Cons (Solution)

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

Image source: [S. Seitz]

Session 1

How to apply a homography to an image?

2) Inverse warping

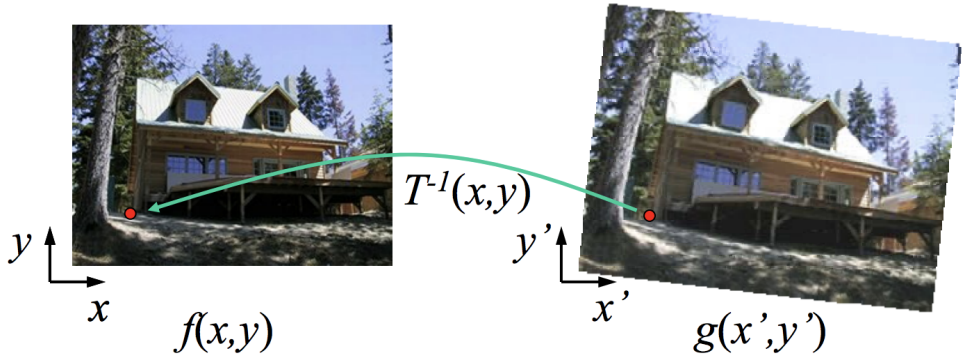

Image source: [S. Seitz]

How to apply a homography to an image?

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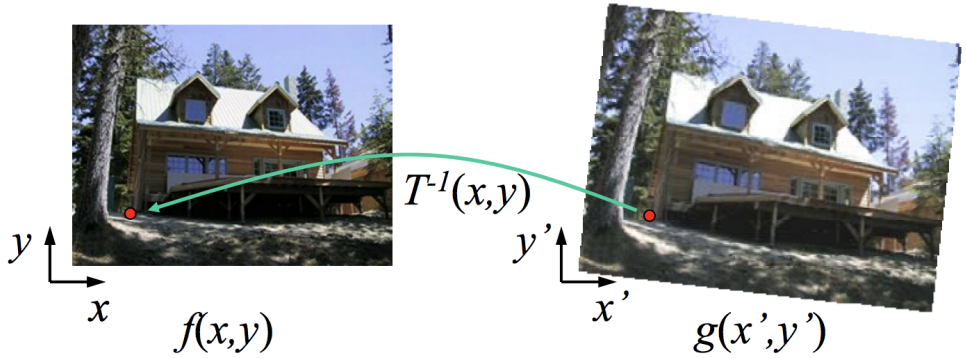

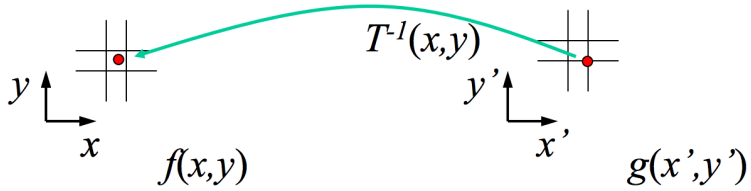

Cons (Solution)

- 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.

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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:

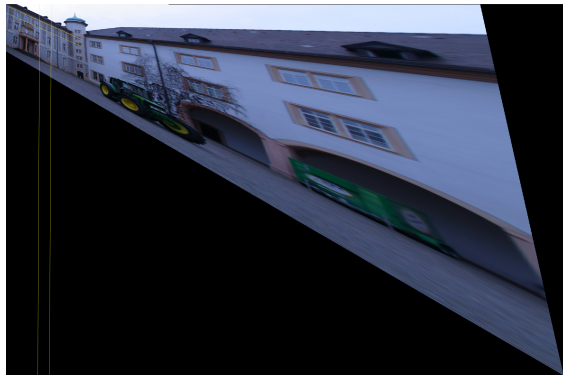
You can assume that windows are square.

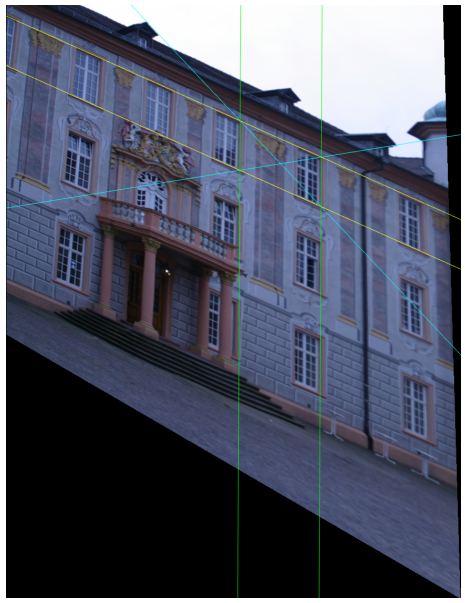
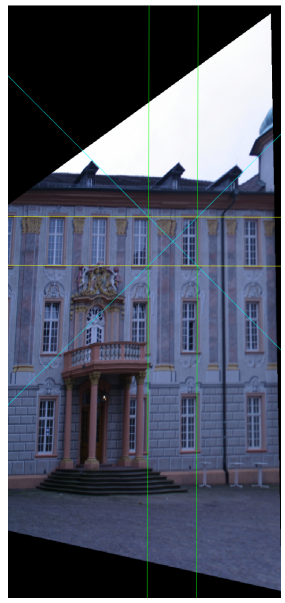
Session 1

Provided information:

Session 1

Affine and metric rectification of left facade image 0001

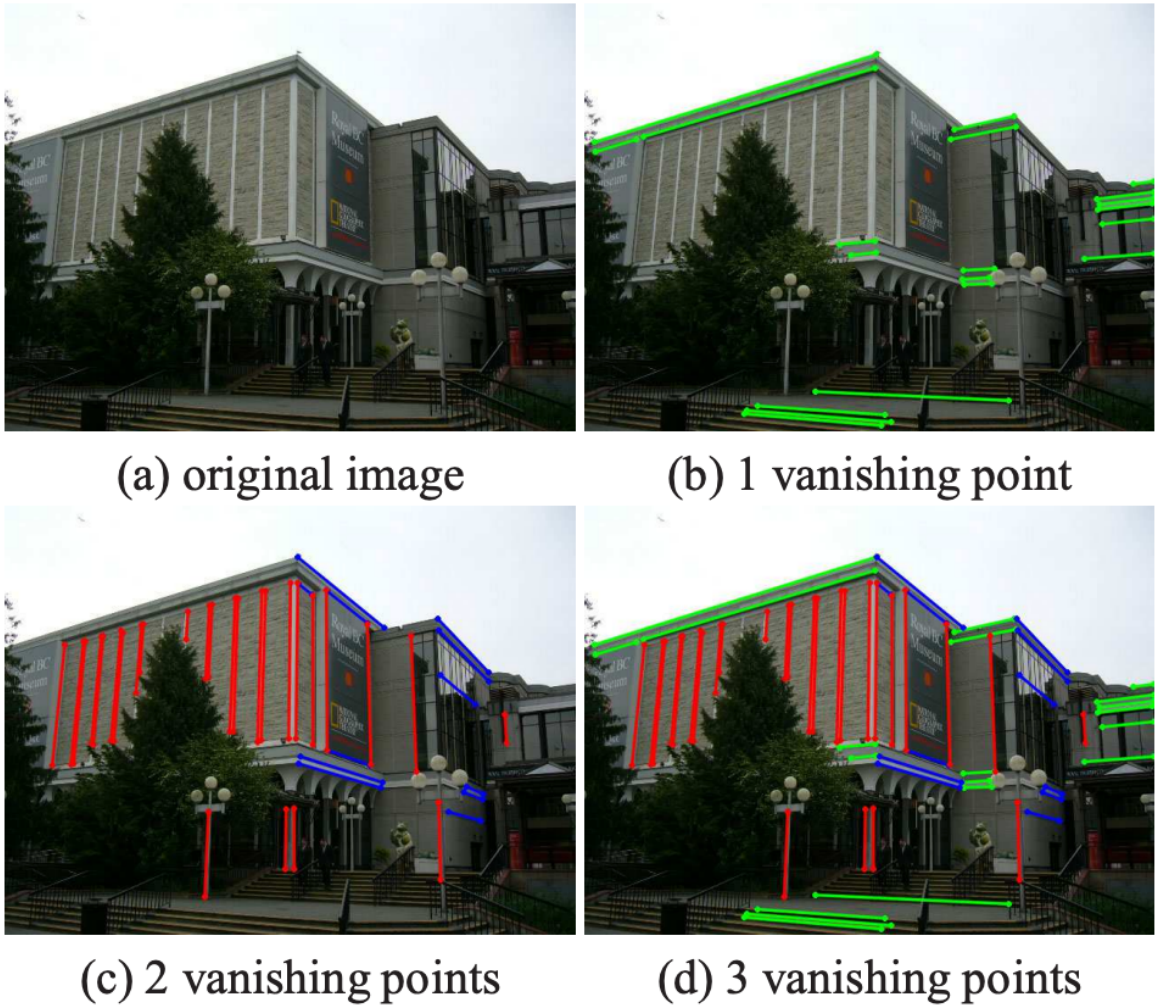



- Crop original image (only left facade)
- Show properly transformed lines

Session 1

Automatic vanishing point estimation



X. Lu, J. Yao, H. Li, Y. Liu. 2-Line Exhaustive Searching for Real-Time Vanishing Point Estimation in Manhattan World. WACV, 2017.

Evaluation

To deliver **by 8am of December 11th**

- **Code deliverable:**
  - Completed lab1.ipynb file and all cells already executed.

- **Short document** (max. 8 pages):
  - Results and analysis.
  - Answers to questions raised in the notebook.
  - 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 + cross-ratio: **2 points**
- Affine rectification with estimated vanishing points: **0.5 points**
- Metric rectification + angles: **1.5 points**
- Affine + metric rectification 2nd facade: **1 point**
- Optional Metric rectification (single step): **+ 1 point**