Universitat de Girona

UdG VICOROB Computer Vision and Robotics

Course: Visual Perception

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Lectures: Tuesdays 10-12 h
III-03

Practical Sessions: Fri. 12-14
"L3.1 Lab". Building P2

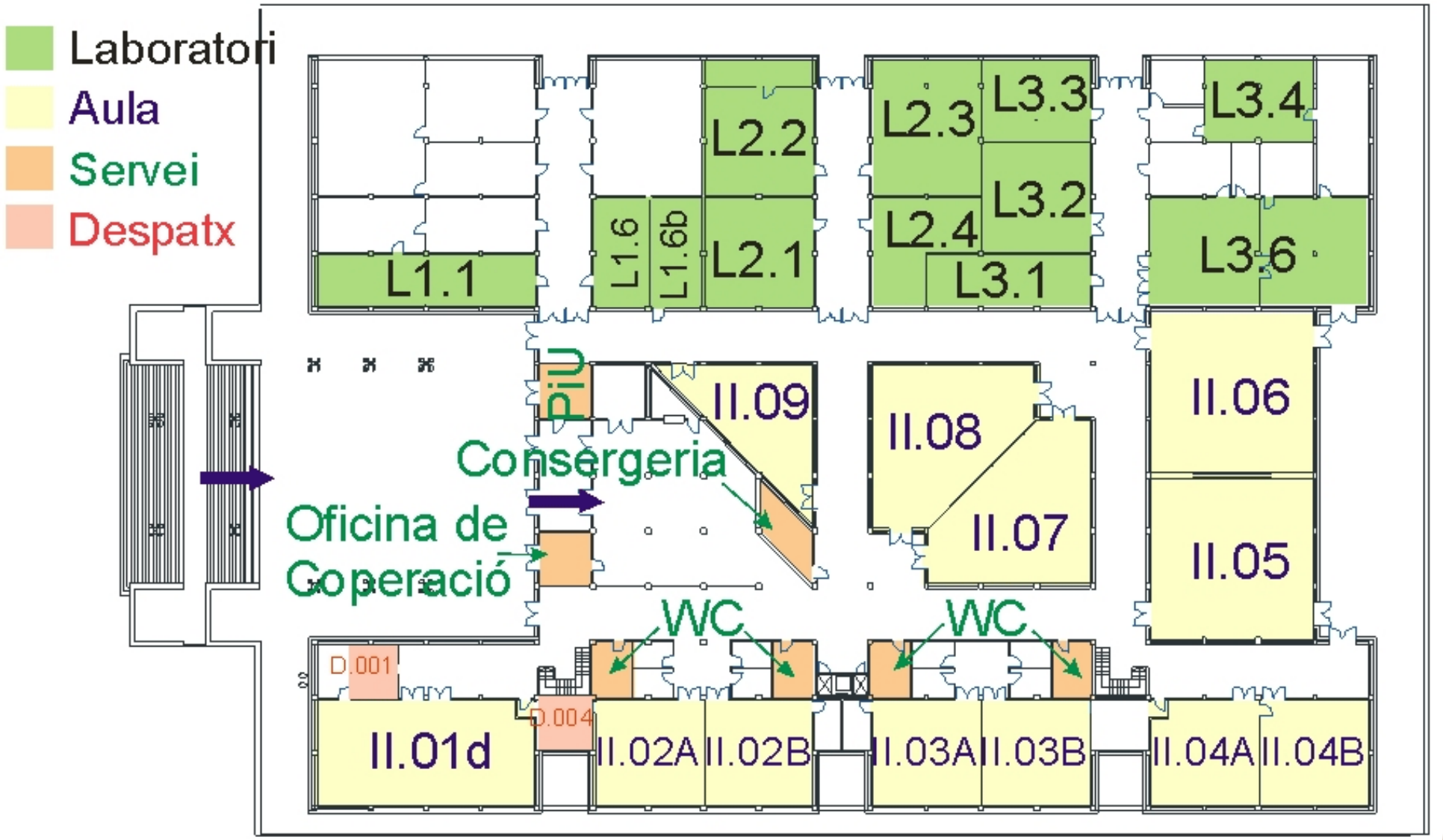
Organization: 22 hours of lectures
40 hours of lab assignments

ECTS: 6
Contact hours: 60 hours
Student personal work: 90 hours

Lecture 1

Introduction

Edifici PII - Planta baixa



Outline

- Objectives
- Overview
- Contents
- Bibliography
- Evaluation
- Organization of the lab groups

Objectives

- Understand camera modeling, including lens distortion and some of the most used camera calibration algorithms.
- Study the problem of detection of interest points and how to solve the correspondence problem removing the outliers.
- Gain knowledge in recovering 3D information from 2D data,
- Introduce the students to the projective transformations, the camera matrix for single view and the fundamental matrix for two views.
- Understanding scene reconstruction methods: triangulation, registration and pose estimation.

Overview

Reconstruction from images – **The Fundamental Problem**

Input: Corresponding "features" in multiple perspective images.
Output: Camera pose, calibration, scene structure representation.

From Ma et al.

Overview: applications

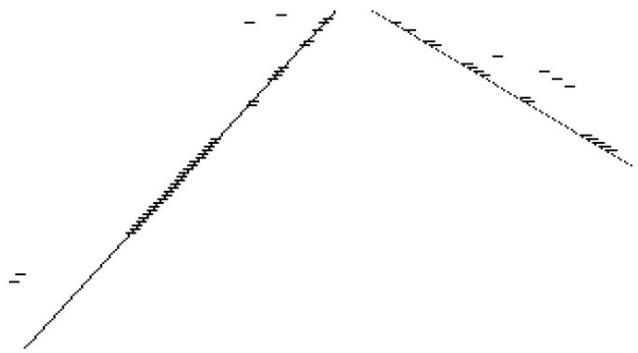
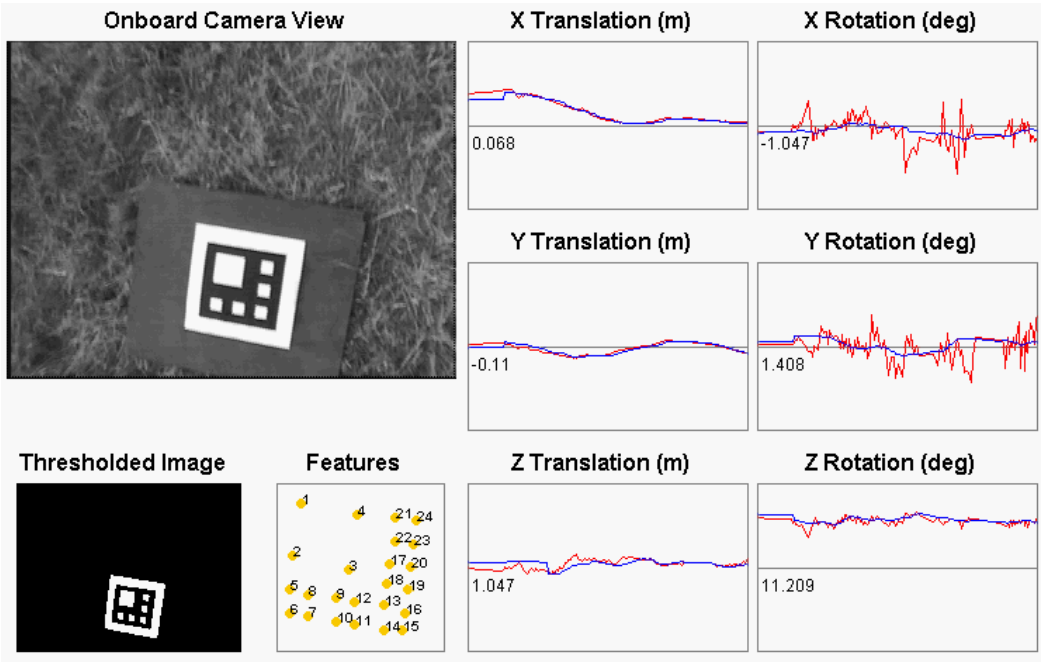


Image courtesy of California PATH

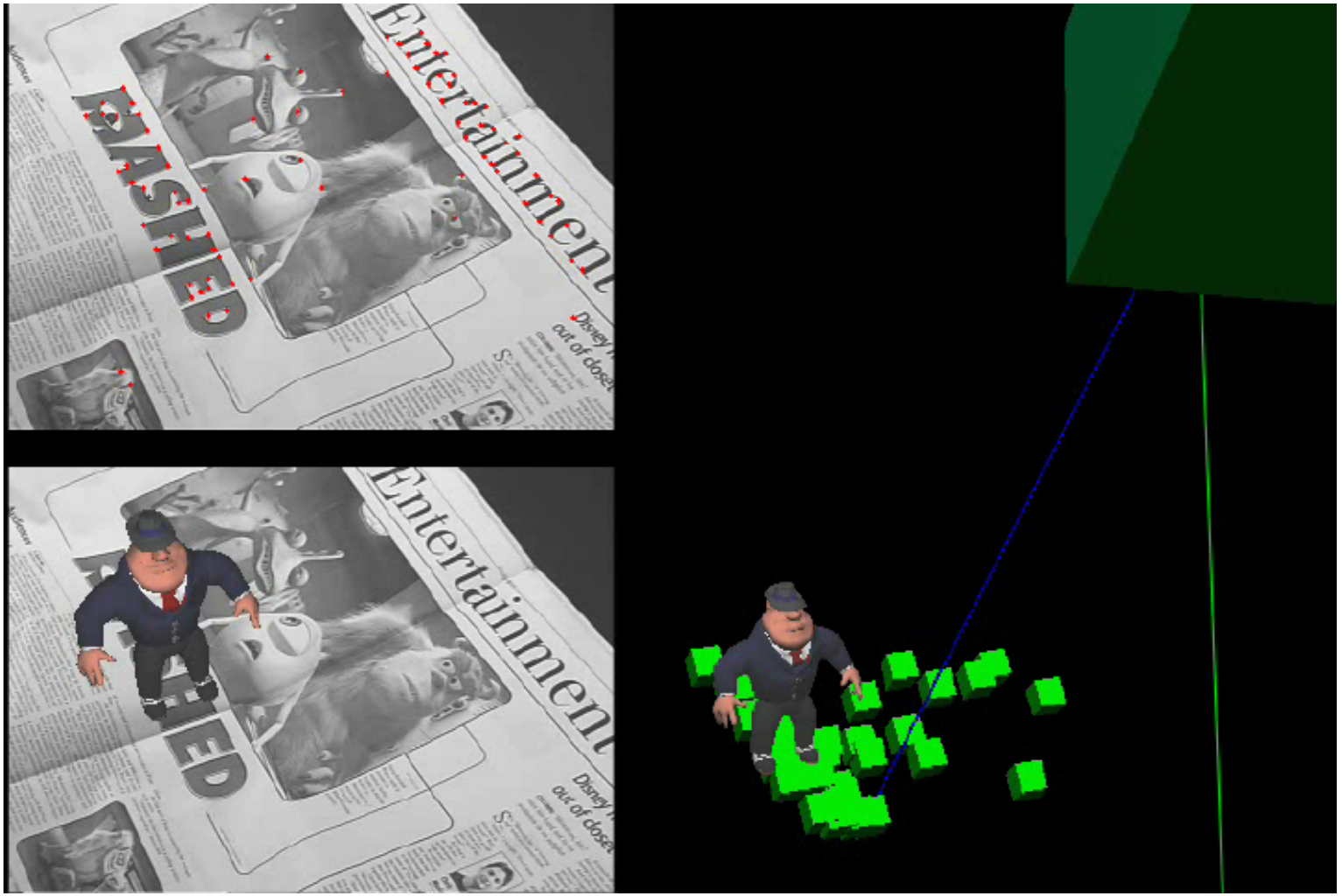
Overview: applications



Rate: 10Hz; Accuracy: 5cm, 4º

Courtesy of Berkeley Robotics Lab

Overview: applications



Real-Time Virtual Object Insertion UCLA Vision Lab

Overview: applications

First-down line and virtual advertising

Real-Time Sports Coverage

Princeton Video Image, Inc.

Overview: applications

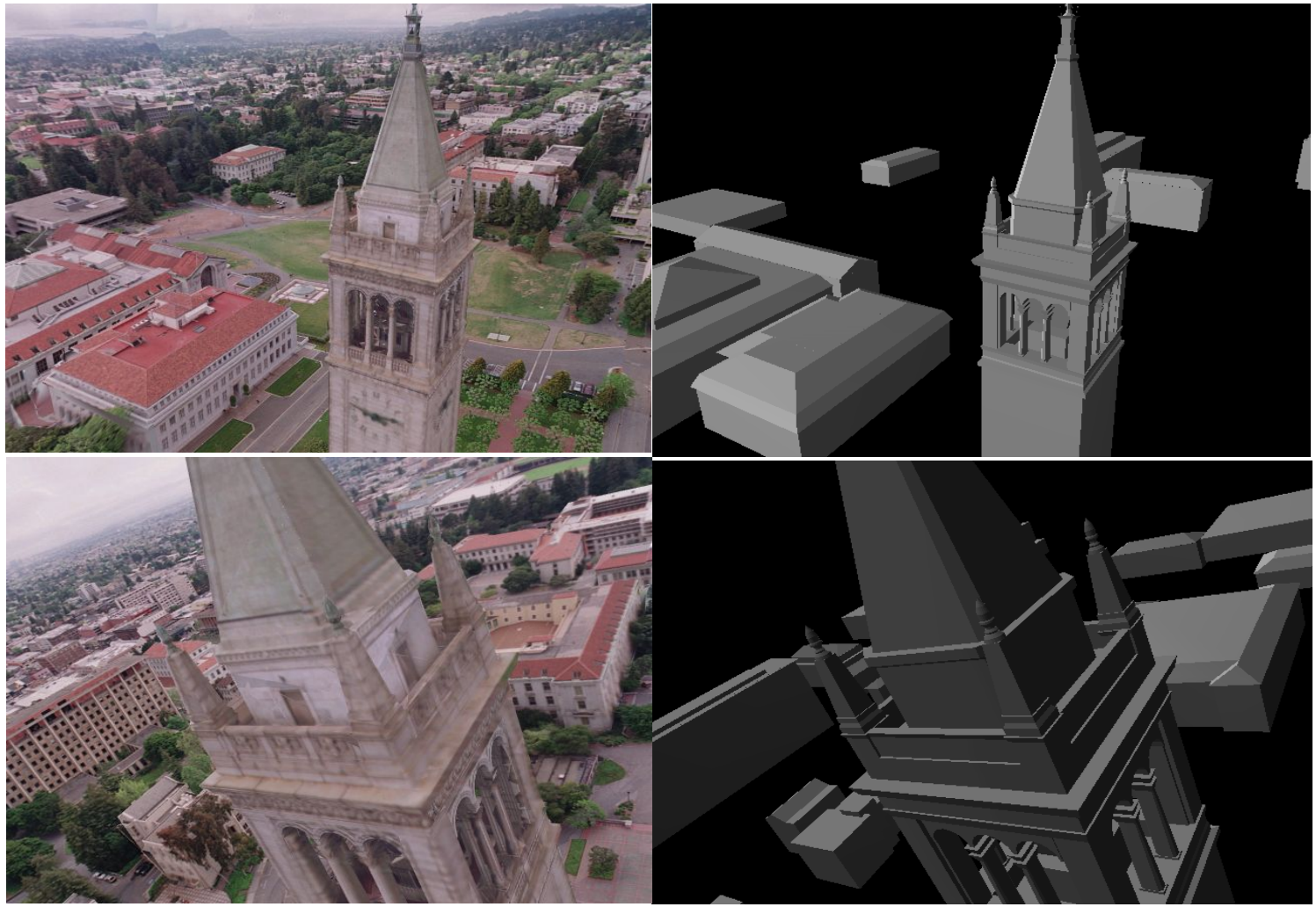


Image Based Modeling and Rendering

Image courtesy of Paul Debevec

Overview: applications

Image Alignment, Mosaicing, and Morphing

Courtesy Ma et al.

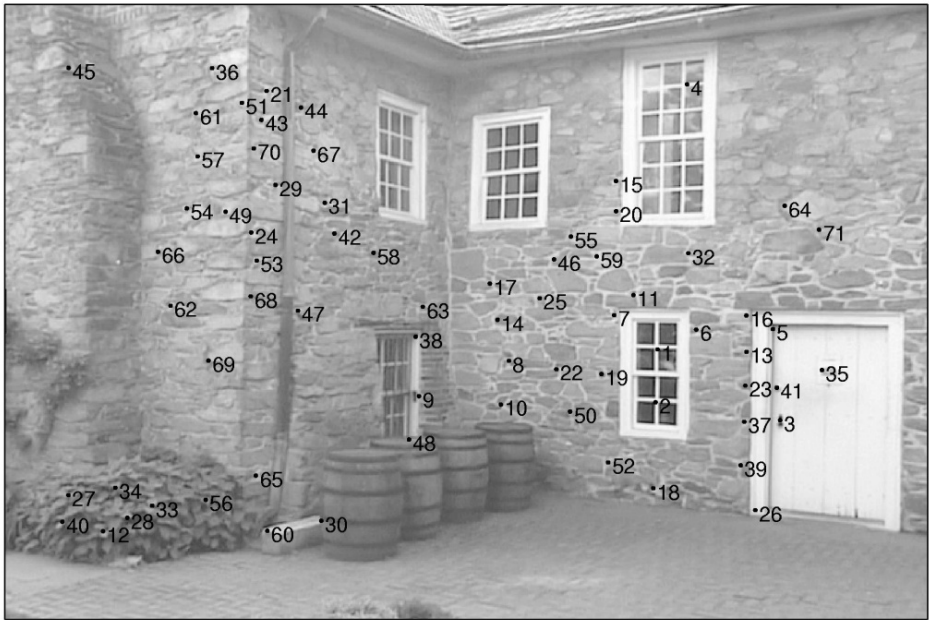
GENERAL STEPS – Feature Selection and Correspondence

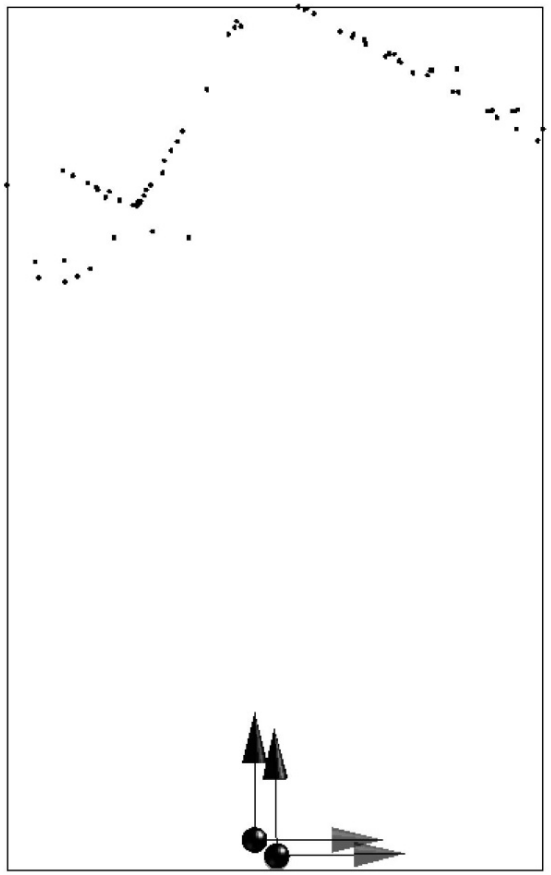




1. Small baselines versus large baselines
2. Point features versus line features

Overview: applications





Courtesy Ma et al.

Overview: applications

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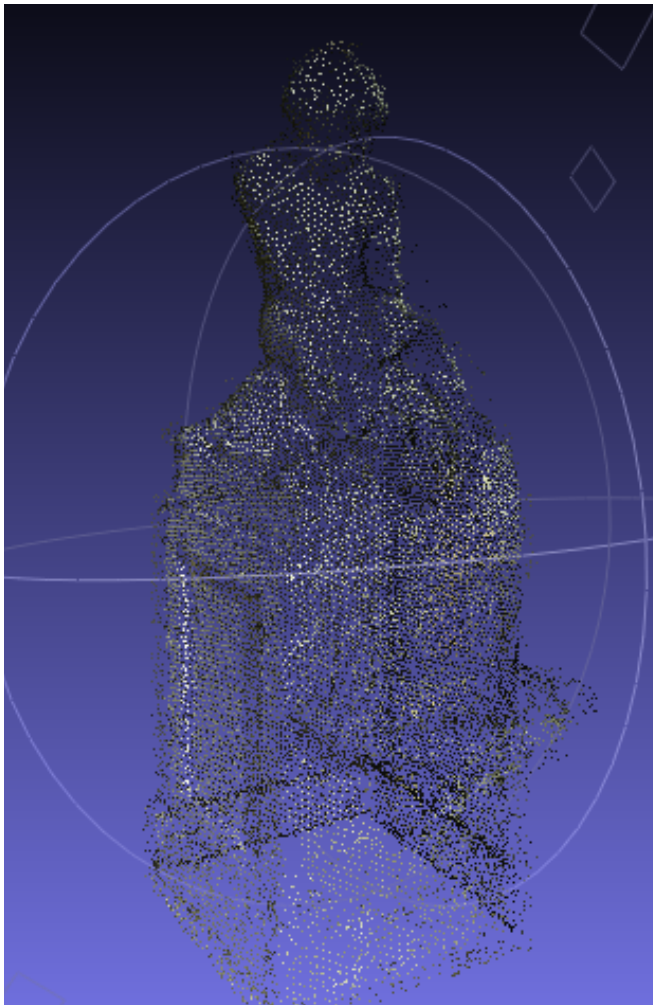
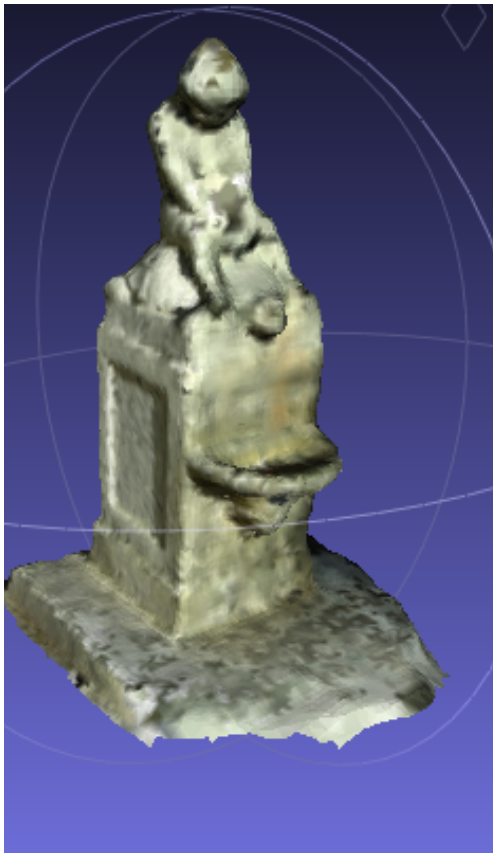


Overview: applications



Overview: applications

Overview: applications

Contents

Lecture 1a.- Introduction (1 hour) RG 07/02/2017

- Objectives
- Overview
- Contents
- Bibliography
- Evaluation
- Practical Sessions

Lecture 1b.- Rigid body transformations (1 hour) QS 07/02/2017

- Linear algebra
- Points and vectors
- Translations and rotations
- Homogeneous coordinates
- Inverses and Transposes

Contents

Lecture 2. Camera modelling and calibration (2 hours) QS 14/02/2017

- The pinhole camera
- Intrinsic and extrinsic parameters
- Computing the calibration matrix
- Accuracy Evaluation

Lecture 3. Image primitives (2 hours) RG 21/02/2016

- Interest point detectors
- Harris and Hessian detectors
- Similarity measures

Contents

Lecture 4.- Reconstruction from 2 views (2 hours) QS 28/02/2017

- The principle of Triangulation
- Epipolar geometry
- Computing the Fundamental matrix
- Accuracy Evaluation
- Experimental Results

Lecture 5.- Correspondence and Planar transformations (2 hours)

- SIFT
- 20' SIFT test RG 07/03/2017

Contents

Mid- term Evaluation. Exam on 14/03/2017
This exam has a weight of 30% of the theory grade.
The other 70% will be assigned to the final exam

Lecture 6.- Pattern Projection techniques (2 hours) QS 21/03/2017

- The principle of codification
- State of art
- Time multiplexing, spatial codification, direct codification
- Steps to implement a pattern projection technique

Contents

Lecture 7.- Applications to 3D Scanning (2 hours) 28/03/2017 Josep Forest

- Calibration
- 3D scanning

Lecture 8.- Outlier Rejection (2 hours) RG 04/04/2017

- A hierarchy of transformations: Euclidean, Similarity, Affine, Projective
- Computing the homography matrix
- Random Sampling Consensus
- Applications: Planar motion estimation, Mosaicing, etc.

Contents

Eastern Break 10-17/04/2017

Lecture 9.- Appl. to Motion Segmentation (2 hours) QS 18/04/2017

- Structure from Motion
- Motion segmentation

Lecture 10.- Seminar on Deep Learning Jordi Vitria 19/04/2017
(12-14h Sala d'Actes P4)

Contents

Lecture 11.- Applications to Mapping (2 hours) RG 25/04/2017

- 2D mapping
- 3D mapping

Practical Exercises

- **Lab 1. Calibration a simulated camera.** Build the transformation matrix from a set of parameters. Obtain 3D and 2D points. Calibrate the camera by using the method of Hall. Check the accuracy against the increase of noise in the location of the image points. (4 hours).

  17-02-2017, 03-03-2017

- **Lab 2. Estimate the interest points of a checker board calibrating pattern**. (4 hours)

  24-02-2017, 10-03-2017

Practical Exercises

- **Lab 3. Epipolar Geometry**. Describe two simulated cameras and their transformation matrices. Get the Fundamental matrix analytically. Compute the Fundamental matrix by using the 8-point method. Compare both fundamental matrices. Draw the epipolar geometry in both images planes. Increase the noise in 2D points and repeat the computation. Check the consistency of the epipolar geometry (6 hours).

  17-03-2017, 24-03-2017, 31-03-2017
- **Lab 4. Experimenting with SIFT descriptors to solve the correspondence problem** (6 hours)

  07-04-2017, 28-04-2017, 05-05-2017

All practical exercises and lab sessions are individual.

They require delivering a report and code (1 report and code/student)

Bibliography:

- Yi Ma, Stefano Soatto, Jana Kosecka, S. Shankar Sastry. **An Invitation to 3-D Vision**. Springer. ISBN: 0-387-00893-4

- R. Hartley and A. Zisserman. **Multiple View Geometry in Computer Vision**. Cambridge University Press. ISBN: 0-521-62304-9

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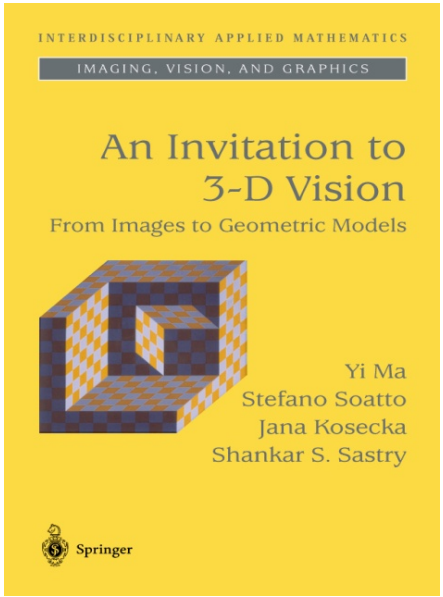
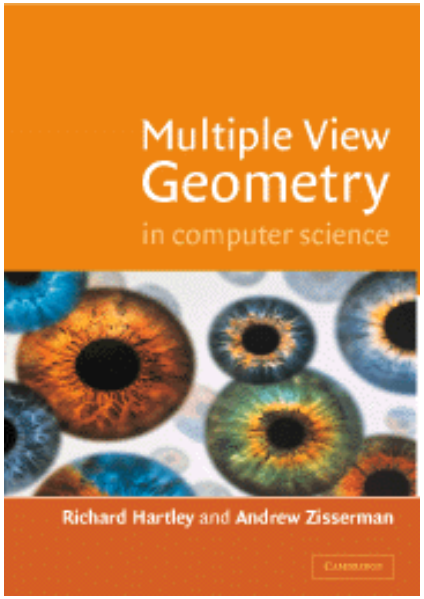
Research papers





Evaluation:

- Lab assignments: 50%
- Final exam: 50% (first one 30%, second one 70%). Summative evaluation

Questions?