

## Course guide

### 230306 - K3D - 3D with Kinect, Hands-On-Seminar

**Last modified:** 24/05/2024

**Unit in charge:** Barcelona School of Telecommunications Engineering  
**Teaching unit:** 739 - TSC - Department of Signal Theory and Communications.

**Degree:** BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Optional subject).

**Academic year:** 2024    **ECTS Credits:** 2.0    **Languages:** Catalan

#### LECTURER

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**Coordinating lecturer:**

**Others:**

#### PRIOR SKILLS

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Advanced programming skills in C/C++. Basics of Linux OS. Basic concepts of Image and Video Processing.  
We suggest taking the 5 days C++ course by P. Machanick, "C and C++ in Five Days", Univ. of Queensland, 2003 or a similar crash course.

#### REQUIREMENTS

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INTRODUCTION TO AUDIOVISUAL SIGNAL PROCESSING - Prerequisite

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Generical:**

10 ECI N3. They will have acquired knowledge related to experiments and laboratory instruments and will be competent in a laboratory environment in the ICC field. They will know how to use the instruments and tools of telecommunications and electronic engineering and how to interpret manuals and specifications. They will be able to evaluate the errors and limitations associated with simulation measures and results.

08 CRPE N3. ABILITY TO IDENTIFY, FORMULATE AND SOLVE ENGINEERING PROBLEMS Level 3. To identify and model complex systems. To Identify methods and tools appropriate to pose the equations and descriptions associated with the models and to solve them. To carry out qualitative analysis and approaches. To determine the uncertainty of the results. To formulate hypotheses and experimental methods to validate them. To set up and manage undertakings. To identify major components and establish priorities. To develop critical thinking.

#### TEACHING METHODOLOGY

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Project based learning. The professor explains the conceptual basis of point clouds and 3D sensors, and then proposes as final target for this seminar implementing a functional application working on the data of a real-time 3D sensor. The students progress towards the proposed objective in five lab sessions, first getting familiar with the programming environment (Eclipse IDE for C/C++ on linux, PCL library), working later with detection functionalities of the PCL for geometrical object analysis, then analyzing actual off-line data from the environment to end up with the proposed challenge of analysis and detection over online data from the 3D sensor.

## LEARNING OBJECTIVES OF THE SUBJECT

Recent advances in consumer depth cameras such as Microsoft Kinect<sup>®</sup> (released October 2010), Asus Xtion, Structure or Carmine, have fostered growing interest thanks to the possibility of acquiring 3D data quickly, reliably and at low cost. Numerous applications have appeared in multiple industry sectors as in robotics, 3D reconstruction, object, body pose and gesture recognition, and even first applications in audiovisual production.

The target of this seminar is to quickly introduce the student in the concepts and basic techniques of 3D capture, analysis and representation using a commercial consumer depth camera. Practical sessions will include data acquisition from the sensor, and then analysis, manipulation, rendering and display with the tools available from Point Cloud Library (PCL).

## STUDY LOAD

Type	Hours	Percentage
Self study	30,0	60.00
Hours small group	20,0	40.00

**Total learning time:** 50 h

## CONTENTS

### Introduction to RGB+D video

#### Description:

- 1.1 Standards and Applications
- 1.2 3D scene representation: images, depth, 3D sensors and multiple cameras
- 1.3 From 2D to 3D: camera calibration, projection and reconstruction. Geometry of single views and multiple-views

**Full-or-part-time:** 9h

Practical classes: 9h

### 3D sensors and range data

#### Description:

- 2.1 Types of 3D sensors
- 2.2 Range capture and depth data features: calibration
- 2.3 Range data representation: point clouds and meshes

**Full-or-part-time:** 4h 30m

Practical classes: 4h 30m

### 3D data analysis

#### Description:

- 3.1 Filtering, registration, spurious removal
- 3.2 Estimation of simple geometric objects

**Full-or-part-time:** 4h 30m

Theory classes: 4h 30m



### 3D reconstruction and scene creation

**Description:**

- 4.1 Rendering and display
- 4.2 3D from motion
- 4.3 Point cloud scenes

**Full-or-part-time:** 4h 30m

Theory classes: 4h 30m

## GRADING SYSTEM

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The seminar will be assessed on the basis of a report presented by the student corresponding to the last lab session (application), together with a brief online questionnaire about course contents.

## BIBLIOGRAPHY

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**Basic:**

- Muto, Carlo Dal; Zanuttigh, P.; Cortelazzo, G.M. Time-of-flight cameras and microsoft kinect. New York: Springer, 2014. ISBN 9781461438069.
- Rusu, R.B.; Cousins, S. "3D is here: point cloud library (PCL)". International Conference on Robotics and Automation (ICRA) [on line]. 9-13 May 2011, pp. 1-4 [Consultation: 15/10/2014]. Available on: <http://dx.doi.org/10.1109/ICRA.2011.5980567>.
- Zhang, Z. "Microsoft kinect sensor and its effect". IEEE Multimedia [on line]. v. 19, Issue 2, 2012, pp. 4-10 [Consultation: 15/10/2014]. Available on: <http://dx.doi.org/10.1109/MMUL.2012.24>.

**Complementary:**

- Machanick, P. C and C++ in 5 days [on line]. South Africa: University of the Witwatersrand. Computer Science Department, 1994 [Consultation: 15/10/2014]. Available on: <http://www.box.net/shared/static/qgtm40rory.pdf>.
- Prince, S.J.D. Computer vision: models, learning and inference. Cambridge: Cambridge University Press, 2012. ISBN 9781107011793.

## RESOURCES

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**Computer material:**

- Màquina virtual K3D (Grup GPI / departament TSC). K3D virtual machine (GPI research group / TSC department)

**Other resources:**

Remote access to K3D virtual machine from the AV recording lab D5-S105