

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

Coordinating unit:	230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit:	739 - TSC - Department of Signal Theory and Communications
Academic year:	2019
Degree:	BACHELOR'S DEGREE IN TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY (Syllabus 2010). (Teaching unit Optional) BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN ELECTRONIC SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Optional) BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2010). (Teaching unit Optional) BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2010). (Teaching unit Optional) BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Teaching unit Optional)
ECTS credits:	2
Teaching languages:	Catalan

Teaching staff

Coordinator: Josep Ramon Casas

Others: Josep Ramon Casas

Prior skills

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

Requirements

FUNDAMENTALS OF COMPUTERS - Prerequisite
INTRODUCTION TO AUDIOVISUAL SIGNAL PROCESSING - Prerequisite

Degree competences to which the subject contributes

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.

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Teaching methodology

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[®] (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

Total learning time: 50h	Hours small group:	20h	40.00%
	Self study:	30h	60.00%

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Content

Introduction to RGB+D video	Learning time: 9h Practical classes: 9h
<p>Description:</p> <ul style="list-style-type: none"> 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 	
3D sensors and range data	Learning time: 4h 30m Practical classes: 4h 30m
<p>Description:</p> <ul style="list-style-type: none"> 2.1 Types of 3D sensors 2.2 Range capture and depth data features: calibration 2.3 Range data representation: point clouds and meshes 	
3D data analysis	Learning time: 4h 30m Theory classes: 4h 30m
<p>Description:</p> <ul style="list-style-type: none"> 3.1 Filtering, registration, spurious removal 3.2 Estimation of simple geometric objects 	
3D reconstruction and scene creation	Learning time: 4h 30m Theory classes: 4h 30m
<p>Description:</p> <ul style="list-style-type: none"> 4.1 Rendering and display 4.2 3D from motion 4.3 Point cloud scenes 	

Qualification system

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.

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Bibliography

Basic:

Mutto, 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: <www.box.net/shared/static/qqt40rory.pdf>.

Prince, S.J.D. Computer vision: models, learning and inference. Cambridge: Cambridge University Press, 2012. ISBN 9781107011793.

Others resources:

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

Computer material

Màquina virtual K3D (Grup GPI / departament TSC)

K3D virtual machine (GPI research group / TSC department)