



UNIVERSITÀ DI PISA
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

“Multi-modal Registration of Visual Data”

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Short Abstract:

Registering visual data of different type is becoming an important task in many applications such as appearance acquisition of real objects, video navigation, video editing, and data visualization. In this course, we focus mainly on the algorithms to align images on 3D objects/scenes. After a brief introduction about Computer Vision and Computer Graphics, some of the most used features detectors and descriptors for images and geometric data are presented. Then, the state of the art in image-geometry registration is discussed in depth and some of the most representative methods analyzed. Finally, we discuss recent studies about specific applications such as the registration of paintings/drawing on a 3D scene, the navigation of video through the alignment of their respective underlying geometric content and the trend in scene understanding by exploiting the relationships between natural images and large collections of 3D models.

Course Contents in brief:

- Introduction
 - Goal of the course
 - Computer Graphics
 - 3D scene representation
 - Rendering
 - Computer Vision Topics
- Features Detectors and Descriptors for Images
 - Corners and Edges
 - Scale-Invariant Features Transform (SIFT)
 - Speed-up Robust Features (SURF)
 - Histogram of Oriented Gradients (HOG)
 - Binary descriptors (BRIEF and BRISK)

- Features Detectors and Descriptors for Geometric Data
 - Spin-images
 - MeshDOG e MeshHOG
 - SIFT-inspired (meshSIFT e LD-SIFT)
 - Heat Kernel Signature (HKS)
 - Range maps alignment
- Image-geometry registration
 - Problem formulation
 - Fixed-relative methods
 - Feature-based methods
 - Statistical methods
 - Multi-View methods
- Recent advances and applications
 - Painting-to-3D scene registration
 - Video-to-geometry registration
 - Joint properties of images and 3D models for scene understanding

Total # of hours: 15

References:

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- [3] H. Bay, T. Tuytelaars, and L. Van Gool, “SURF: Speeded Up Robust Features”, ECCV’06, pp. 404-417, 2006.
- [4] N. Dalal and B. Triggs, “Histograms of oriented gradients for human detection”, in Computer Vision and Pattern Recognition, 2005 (CVPR 2005), vol.1, pp.886-893, 25 June 2005.
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- [6] S. Leutenegger, M. Chli, and R. Y. Siegwart, “BRISK: Binary Robust invariant scalable keypoints”, Proceedings of the 2011 International Conference on Computer Vision (ICCV '11). 2011.
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- [8] Y. Guo, M. Bennamoun, F. Sohel, M. Lu, J. Wan, N. Ming Kwok, ”A Comprehensive Performance Evaluation of 3D Local Feature Descriptors, International Journal of Computer Vision, 2015.

- [9] P. Pingi, M. Corsini, F. Ganovelli, R. Scopigno, “Fast and Simple Automatic Alignment of Large Sets of Range Maps”, *Computer & Graphics*, Volume 47, pp. 7888, 2015.
- [10] M. Corsini, M. Dellepiane, F. Ponchio, R. Scopigno, “Image-to-Geometry Registration: a Mutual Information Method exploiting Illumination-related Geometric Properties”, *Computer Graphics Forum*, Volume 28(7), Blackwell Publishing, 2009, pp. 1755-1764.
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- [12] M. Aubry, B. C. Russell, and J. Sivic, “Painting-to-3D model alignment via discriminative visual elements”, *ACM Trans. Graph.* 33, 2, Article 14 (April 2014), 14 pages.
- [13] M. Hueting, M. Ovsjanikov, and N. J. Mitra, “CROSSLINK: joint understanding of image and 3D model collections through shape and camera pose variations”, *ACM Trans. Graph.* 34, 6, Article 233 (October 2015), 13 pages.
- [14] M. Aubry, D. Maturana, A. Efros, B. Russell and J. Sivic, “Seeing 3D chairs: exemplar part-based 2D-3D alignment using a large dataset of CAD models”, *CVPR* 2014.
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CV of the Teacher

Massimiliano Corsini received the “Laurea in Ingegneria Informatica” degree from the University of Florence. In 2005 he received the PhD in Information and Telecommunication Engineering from the same University, working on 3D watermarking of polygonal meshes and perceptual metrics for 3D watermarking quality assessment. Currently, he is a Researcher at the Institute of Information Science and Technologies (ISTI) of the National Research Council (CNR) in Pisa, Italy.

His research interests are in the fields of Computer Graphics, Computer Vision and Image Processing and include 3D watermarking, perceptual metrics, visual appearance acquisition and modeling, multi-modal registration of visual data and image-based relighting.

He published more than 50 papers in peer-reviewed international conferences and journals. He also collaborated in several National and International projects and served on numerous program committees for several International Conferences.

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:

6, 7, 9, 10, 15 June 2016

Day 1 (10:00 - 13:00) – Introduction

Day 2 (10:00 - 13:00) – Features based detectors and descriptors for images

Day 3 (10:00 - 13:00) – Features based detectors and descriptors for geometric data

Day 4 (10:00 - 13:00) – Image-geometry registration

Day 5 (10:00 - 13:00) – Recent advance and applications