UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"Marker-based and marker-less 3D video-based tracking with and without deep learning"

Vincenzo Ferrari
Fabrizio Cutolo

Dipartimento di Ingegneria dell'Informazione, Università di Pisa

Largo Lucio Lazzarino, 2 - 56122 Pisa, Italy

Short Abstract:

AI and deep learning are improving and revolutionizing machine vision and, while 2D elaboration are almost all camera model agnostic, their 3D application require a deep understanding of the projective geometry and the basic concepts of traditional localization approaches.

This course offers an overview on the matter starting from the basic concepts up to some demos with the application of the most advanced AI powered localization algorithms.

Course Contents in brief:

1. Camera modeling.
2. Tracking of points and structured markers with mono e stereo cameras.
3. 3D scan elements and their application to tracking.
4. Marker-less model (edge) based tracking.
5. Marker-less DL tracking: detection, instance and model aware approaches.

Total # of hours: 20

References:

-*Elements of Geometric Computer Vision* Andrea Fusiello,
http://www.diegm.uniud.it/fusiello/teaching/mvg/vismacGenova2012.pdf

CV of the Teachers

Vincenzo Ferrari received the Ph.D. degree from the University of Pisa. He is currently Associate Professor of biomedical engineering with the Department of Information

Engineering, University of Pisa. He is the author of more than 150 peer-reviewed publications and has five patents. His research interests involve image-guided surgery and simulation, computer vision and augmented reality devices and applications in medicine. He is involved in several national and international research projects.

Fabrizio Cutolo received BSc and MSc degrees in Electrical and Computer Engineering and a Ph.D. degree in Translational Medicine from the University of Pisa, Italy, in 2015. He is currently a postdoctoral researcher at the Department of Information Engineering of the University of Pisa. He has been involved in several national and international research projects. His research interests are in developing and evaluating new mixed reality solutions for image-guided surgery and surgical simulation, machine-vision applications, visual perception, human-computer interaction, and multi-modal tracking.

Room and Schedule

Room: *Aula Riunioni, Dipartimento di Ingegneria dell'Informazione, Largo L. Lazzarino 1, 56122 Pisa, Building A, Floor 6*

Schedule:

N.	Lesson	Day
1	Principles of geometric optics and camera model. Geometric and algebraic pinhole model of common cameras. Camera calibration algorithms and demo.	February 20, 2025 - 9:00-13:00
2	PnP based tracking of structured planar markers. Tracking of planar unstructured markers. Tracking accuracy of planar markers.	February 21, 2025 - 9:00-13:00
3	Multiview tracking. Accuracy of stereo tracking. 3D scan elements and their application to tracking.	February 25, 2025 - 14:00-18:00
4	Introduction to marker less tracking. Model (edge) based tracking.	February 27, 2025 - 14:00-18:00

	Marker-less DL tracking: detection, instance and model aware approaches.	
5	EXAM	February 28, 2025 - 9:00-13:00