Advanced Visual Geometry

Credits: 4	**Semester 3**	**Compulsory: yes**	
Format	Lectures 20 h	Examples, Laboratory 12 h	Private study 68 h

Lecturers: O. Kermorgant (ECN), D. Marquez Gamez (IRT Jules Verne)

Objectives: This course presents the fundamentals of the advanced vision-based perception algorithms. Vision is one of the most promising senses to be used in robotics, providing important geometrical information on the surroundings of the robot. In this way, two-view geometry extended to multiple-view geometry will be investigated in order to address the difficult problems of relative pose estimation, 3D registration, pose and velocity estimation, and Simultaneous Localization And Mapping. Depth cameras will also be introduced as they are more and more used in robot perception.

Contents: The following subjects will be treated:

- Projective geometry
- Epipolar geometry (Homography, Essential and fundamental matrix)
- Multi view geometry
- Visual odometry
- Pose and velocity estimation
- 3D registration
- Visual SLAM (Mono, stereo)
- RGB-D cameras

Practical Work: Exercises will be set, which will involve pose and velocity estimation, visual odometry, visual SLAM, RGB-D cameras

Abilities: After completing this course the students will be able to:

- Understand what can be done from visual geometry
- Develop algorithms for visual odometry
- Develop algorithm for SLAM application
- Perform 3D registration

Assessment: 30% continuous assessment, 70% from end of semester examination.

Recommended texts:

- Multiple View Geometry in Computer Vision, Richard Hartley, Andrew Zisserman, Barnes&Nobles, 2nd edition 2004, ISBN-10: 0521540518
- Three-Dimensional Computer Vision, Olivier Faugeras, MIT Press, November 1993, ISBN: 0262061589
- An invitation to 3D vision: from images to geometric models, Yi Ma, Stefano Soatto, Jana Kosecka, S. Shankar Sastry, Springer, 2010, ISBN-10: 1441918469, ISBN-13: 9781441918468
- Visual Odometry, Part I - The First 30 Years and Fundamentals, Scaramuzza, D., Fraundorfer, F., IEEE Robotics and Automation Magazine, Volume 18, issue 4, 2011.
- Visual Odometry: Part II - Matching, Robustness, and Applications, Fraundorfer, F., Scaramuzza, D., IEEE Robotics and Automation Magazine, Volume 19, issue 1, 2012
- Simultaneous localization and mapping: part I, Durrant-Whyte, H. ; Australian Centre for Field Robotics, Sydney Univ., NSW ; Bailey, Tim, IEEE Robotics & Automation Magazine, 3(2):99-110, June 2006
- Simultaneous localization and mapping (SLAM): part II, Bailey, Tim ; Australian Centre for Field Robotics, Sydney Univ., NSW ; Durrant-Whyte, H., IEEE Robotics & Automation Magazine, 13(3) : 108 -117, Sept. 2006