Master program : Information Processing and Complexity of the Living

Mastère de recherche : Traitement de l’Information et Complexité du Vivant (TICV)

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|  | **TC – 3D Imaging** |
| **Semester:** Fall, **Academic Year:** 2020/21 |

**Instructor information**

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**Course Description**

Recovering three-dimensional scene properties is ubiquitous for several fields such as robotics, autonomous vehicles, virtual tourism, quality control and medicine. This course opens the doors for student who are interested in learning the fundamentals of 3D computer vision. It addresses the pipeline of 3D modeling from data acquisition to surface reconstruction with a focus on image-based techniques. The goal of the course is to develop an understanding of the current state of the art and gain appreciation of its limits and potential. The course primary involves lectures by the instructor. Students are also required to read papers related to approaches that are not addressed during lectures.

**Objectives and Learning Outcomes**

Upon successful completion of the course, students will have an understanding of the following topics:

* 3D data representation
* Fundamental principles of main acquisition techniques
* Image-based reconstruction techniques
* Mesh reconstruction from point clouds.

Students will also demonstrate the ability to read papers that are not addressed within lectures and evaluate the advantages and the limitations of the studied techniques. Hence, they are more prepared to conduct research projects.

**Prerequisites**

* Basic knowledge of image processing
* A background in linear algebra

**Learning Resources**

* Textbook: Computer Vision: Algorithms and Applications, by Rick Szeliski
* Papers (e.g) :
	+ Schönberger,J. L., and J.-M.Frahm . 2016. “Structure-from-Motion Revisited.” In *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (2016)*, 4104–4113.
	+ Curless, b. abd Levoy, M., “Avolumetric method for building complex model from range images”. *In Proceedings of SIGGRAPH’96, ACM Press (1996),* 303-312.

**Assessments**

The final course grade will be calculated using the following categories:

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| **Assessment** | **Percentage of Final Grade** |
| Final exam: |  |
| Questions related to the content of lectures | 50% |
| Questions related to the reading of papers | 50% |

Students will be assigned the following points, based on calculations coming from the course assessment section: **Grade** = gained points from a total of 20 points

**Course Schedule**

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| **Lecture #** | **Theme/Topic** | **Learning Outcomes Addressed** |
| #1 (1H30) | Introduction | Applications of 3D modeling |
| #2 (1H30) | 3D data representations | Point cloud, Depth map, polygonal meshes, implicit, parametric surfaces, volumetric representation (voxel, tetrahedral meshes representation) |
| #3 (3H) | Revue of 3D acquisition techniques | * Reflective VS transmissive techniques
* Passive (image based) VS active techniques
* Single-view (Based on CNNs) VS Multi-view techniques
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| #4 (3H) | Stereovision | Epipolar Rectification, Stereo Matching, Triangulation |
| #5 (3H) | Shape from Motion | Feature tracking, 3D Points and Camera Poses estimation, Bundle Adjustment |
| #6 (3H) | Mesh Reconstruction from Point Clouds  | * Implicit Surface Techniques
* Voronoi/Delaunay Techniques
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| **Homework** | **Theme/Topic** | **Learning Outcomes Addressed** |
|  (6H) | Papers Reading | Reading of papers proposing different approaches to solve problems addressed within lectures  |