**3D Reconstruction and Mapping**

**in Computer Vision, Robotics, and Augmented Reality**

**Course Topics**

* Loop Closures (papers)
* Location Recognition (papers)
* 2D and 3D Geometry
* Unit Quaternions
* Absolute Orientation
* Cameras and RANSAC
* Projective Geometry
* Planar Homographies
* DLT for homographies, tensors
* Multiview Geometry w Diagrams
* 2D-2D Wide baseline Matching
* Bayes Networks
* Factor Graphs
* SLAM/SFM Factors
* Discrete vs Continuous Factor Graphs
* Visual Odometry
* Second-Order Methods
* Lie Groups and Lie Algebras
* Multiview Stereo
* Dense Reconstruction
* DTAM
* KinectFusion

**Informal Prerequisites**

Linear algebra, esp. the Singular Value Decomposition (SVD). Familiarity with graphical models is a plus but not a must.

**Class Goals**

The desired learning outcomes for the students are:

* Know what SLAM, SFM are
* Know graphical model inference
* Know its implementation using linear algebra
* Understand the practical issues regarding multi-platform reconstruction

**Organization**

The course is organized into five main sections:

* Reasoning about images and scenes (feature detection, descriptors, clustering, etc.)
* Data association, and basic multi-view geometry
* Visual odometry, Structure from Motion, and Bundle Adjustment
* Dense multi-view reconstruction
* Student Projects

**Assignments**

There will be a series of programming assignments to provide familiarity with the techniques we learn in class. Some of these will be done in teams, others individually.

In addition to these, there will be a couple of small exercises to [prime](http://en.wikipedia.org/wiki/Priming_%28psychology%29) your thoughts about the topic of the next week, or quizzes to assess your understanding. They are graded at about 1% each and are not expected to be much work at all.

**Final Project**

Finally, there will be a team-based final project where the goal is to demonstrate multi-platform 3D reconstruction and/or mapping. Each team will be asked to present this project in class. The final project will consist of (a) a 1-page proposal, and (b) a 3-5 page final project report.

The one-page proposal should consist of a title, authors, and five sections:

1. Problem addressed and its importance
2. Related work in this area
3. Description of what you will implement
4. Description of how you will evaluate the results
5. References Section

The final paper can build upon your proposal and should be between 3 and 5 pages, and should consist of the following sections:

1. Problem addressed and its importance
2. Related work in this area
3. Approach (What was done?)
4. Evaluation (What were the results)
5. Discussion (How to interpret the results)
6. References Section