Thesis title: Geometry meets Machine Learning

Thesis description

The development of large 3D shape databases has fostered the development of learning based solutions to motion estimation, stereo matching and 3D reconstruction. Recent methods have demonstrated impressive results. However, most of the existing methods are applicable to object reconstruction because they solve the 3D reconstruction problem via recognizing the scene content. Moreover, the physical constraints of perspective geometry and occlusion relationships across viewpoints are not fully integrated to the reconstruction process. As a result, the proposed solutions require an enormous amount of labelled training data.

The aim of this phd thesis is to propose a 3D reconstruction framework based on machine learning which gives accurate and dense 3D scenes and which generalize well to full scenes. For this purpose we will investigate the combination of the powerful tools in Machine Learning with the geometric models that gives a deep understanding of 3D scenes. The goal is to model the known perspective projection and occlusion, while learning the effects that are difficult to model such as surface appearance variations across different views.

One way to do so consists in fusing the depth maps of several views in a voxelized volume. The limitation of this approach is in the huge number of voxels needed to accurately model the 3D scene when using high resolution images in large scale environments which makes the system require huge labeled data bases and huge memory during both learning and reconstruction stages. The goal is to exploit the application context to make the reconstruction resolution adaptive thanks to scene segmentation. Specifically, we will focus on images of road scenes in the context of vision-based autonomous navigation.

Application:

- Candidates must hold a master's degree in (or equivalent), and have taken specialized courses in computer vision and machine learning.
- Programming experience (C/C++/Python/...) is necessary.
- English language is required, as well as good communication skills.

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