Electrical Engineering and Computer Science

Ph.D. Dissertation Defense

Towards Optimal 3D Reconstruction and Semantic Mapping

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Schedule

Date: 05/06/2021
Time: 9:00 am- 10:00 am
Zoom Link:
https://ucmerced.zoom.us/j/6404390317

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Biography

Guoxiang Zhang is a Ph.D. Candidate at the University of California, Merced. Before joining UC Merced, he received his M.S. degree and B.E. degree from Xidian University. His research centers around 3D scene reconstruction and understanding. His current research interests are visual simultaneous localization and mapping, fractional order calculus, and 3D semantic mapping.

Abstract

3D reconstruction and semantic mapping are of great importance for many tasks and applications, such as consumer robots, augmented reality, and autonomous vehicles. Despite the drastic advancements in solving the 3D reconstruction problem, it is still challenging to reconstruct accurate 3D models and create semantic maps. Within this dissertation, contributions are made to take steps closer towards optimal 3D reconstruction and semantic mapping. First, we introduce a novel 3D reconstruction system that corrects surface loops with sparse feature-based bundle adjustment. In the system, fast 3D surface-based loop detection is done by a GPU-accelerated random sample consensus algorithm (RANSAC) with optimized randomness supported by fractional calculus. Then, to solve a low-precision problem in surface loop detection, an online method for loop sifting is proposed for real-time feedback to the users. For the best 3D reconstruction performance, an offline method for loop sifting and majorization is also proposed. To overcome the difficulty in collecting ground truth data for evaluating 3D mapping systems, we propose dense map posterior (DMP) as a metric for 3D reconstruction and mapping evaluation that can work without any costly ground truth data. Finally, a simple and effective real-time 3D semantic mapping method is proposed. Besides, a benchmark suite for semantic mapping evaluation is presented.

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