CIS 565 Final Project Proposal

Incremental Visual-Inertial 3D Mesh Generation with Structural Regularities

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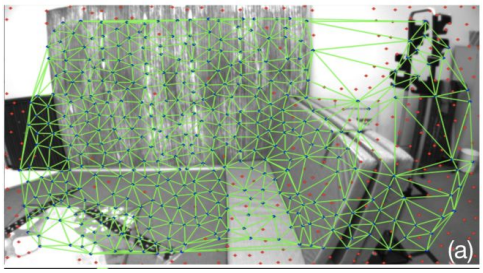
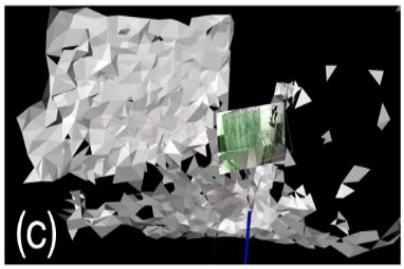
Overview:

Visual-Inertial Odometry (VIO) algorithms typically rely on a point cloud representation of the scene that does not model the topology of the environment. The start of the art approaches decoupled state estimation from the 3D mesh regularization step, and either limit the 3D mesh to the current frame, or let the mesh grow indefinitely. In this project, we will be incrementally building a 3D mesh restricted to the receding horizon of the VIO optimization [1]. The paper also proposes to use the 3D mesh to detect and enforce structural regularities in the optimization problem, thereby improving the accuracy of both the state estimation and the mesh at each iteration, while circumventing the need for an extra regularization step for the mesh.

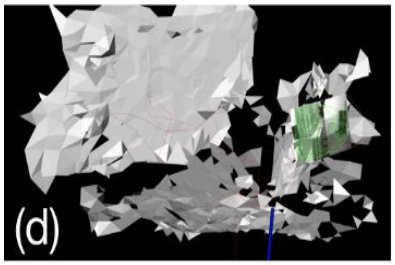
In the paper, the approach runs in real-time by using a single CPU core. We will be trying to run the algorithm on GPU for Delaunay triangulation [2] and enforcing structural regularities. Once the baseline of the project is achieved, we can reach out to the researchers/authors of the above proposal and learn more about the issues they faced while using single CPU cores and any other methods we can use to improve the performance further.



3D mesh with 2D Delaunay Triangulation



3D mesh without Structural Regularities



3D mesh with Structural Regularities

Milestone Timelines:

1. 11/06: Pitch for the Project proposal and feedback from instructors
2. 11/18: Baseline Implementation (Single CPU Core)
3. 11/25: Baseline Flow and Start GPU Core Implementation for 2D Delaunay Triangulation
4. 12/02: Reaching to authors (if possible) and implement Structural Regularities in GPU
5. 12/09: Trying some of Improvements on algorithms and final documentation

References:

1. Incremental Visual-Inertial 3D Mesh Construction
2. Delaunay Triangulation
3. Simultaneous Localization and Mapping