

CIS565 Final Project: GPU-based Global Drone Localization

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Overview

One of my research interest is the localization system for the quadrotor drone. And for this final project, I want to use GPU to accelerate and improve the quality of the feature extraction and matching method in the drone localization system.

Background

The typical vision-based localization method using the following pipeline: capture new image frame, extract features, feature matching and estimate camera pose. In these steps, the feature extraction is the hardest to balance the speed and quality. For the speed, the following table shows the comparison of SIFT, ORB and FAST feature which are often used in Robotics and Vision domain. (the test platform is I7-4790K CPU and 32G memory, for 640*480 image).

	Extracted feature number	Time(second)
SIFT	3000	0.839
ORB	500	0.121
FAST	4532	0.053

Though ORB and FAST feature can achieve the real-time estimation, but their quality are not good. It will cause many mismatch in the feature matching part, which will got inaccurate camera pose.

Recent year, the NVIDIA release TK1, TX1 and TX2 board for the mobile computation. For example, the TX1 contain 256 cuda cores, ARMA57 and 4GB memory. With this GPU computation resource, the real-time localization method using SIFT feature might became possible.

Method

The localization method I want to try is a global method. The “global” means the estimated camera pose is in a world coordinate system, not the relative pose between continuous frames. To achieve this, I will first build a dataset using Structure-from-Motion. Then I will implement the GPU-based SIFT feature extraction and matching. The next step is estimate camera pose using linear method, PnP and non-linear optimization, Bundle Adjustment.

Plan

- 11/20 Milestone 1
 - Collect and build test dataset
 - Implement base-line CPU method
- 11/27 Milestone 2
 - Implement GPU SIFT extraction
 - Finish and test GPU and CPU SIFT method
- 11/27 Milestone 3
 - Implement feature matching
 - Complete whole pipeline (with sensor fusion, controlling)
- 12/11 Final
 - Flying test
 - Try other features