GPU-based Global Drone Localization

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Agenda

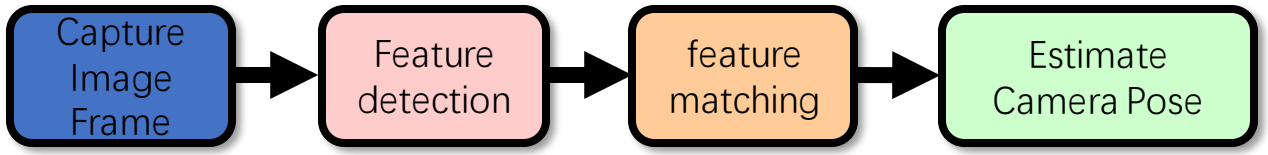
- Overview
- Background
- Method
- Plan

Overview

- Vision-based drone localization method
- Implement GPU-based feature extraction and matching
- Platform: DJI M100 Drone & NVIDIA TK1 Broad

Background

- Typical vision-based drone localization method:



- Feature detection part is hard to balance speed and quality
  - Extract feature on 640*480 image, using I7-4790K CPU
  - SIFT cost 0.839 second to extract 3000 features
  - ORB cost 0.121 second to extract 700 features
  - FAST cost 0.073 second to extract 4532 features
  - Feature quality: SIFT>>ORB>SIFT

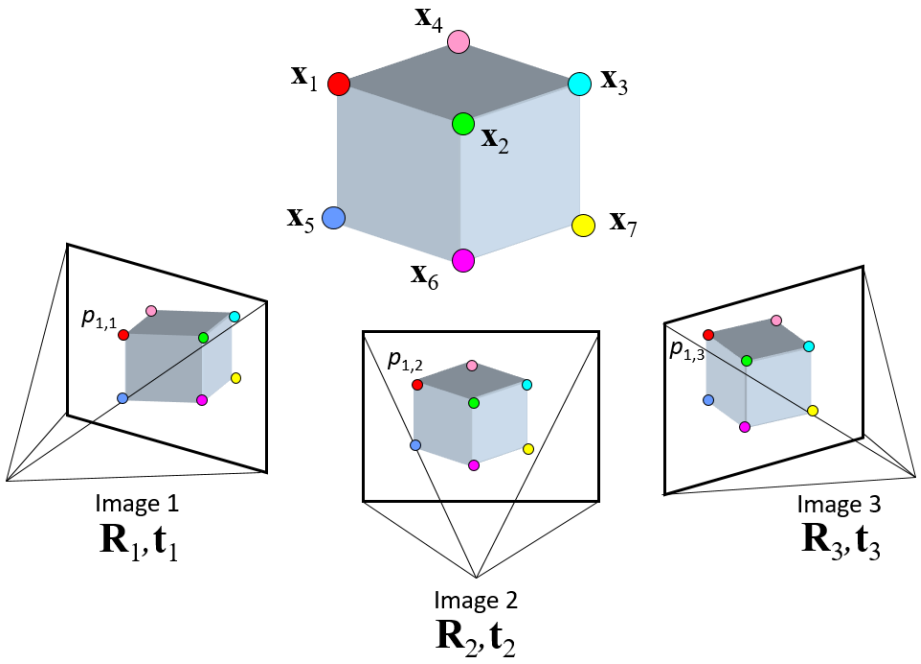
Background

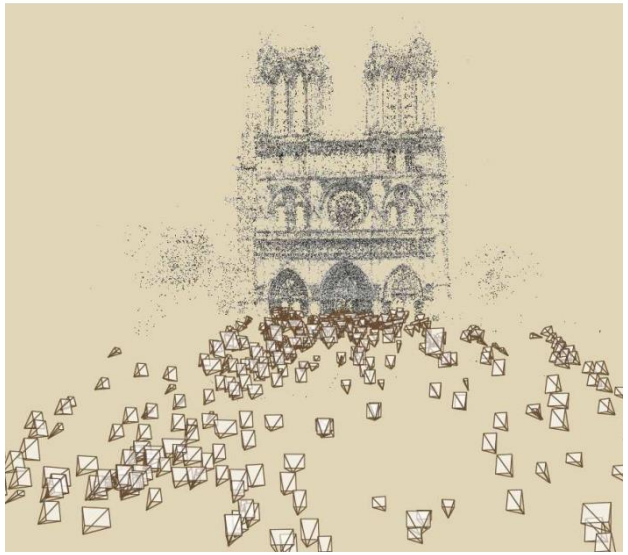
- But for the drone, computation resource is limited!
- Most solution use ORB feature to achieve the real-time localization

- Now, we have the onboard GPU, can we try SIFT feature?

Method

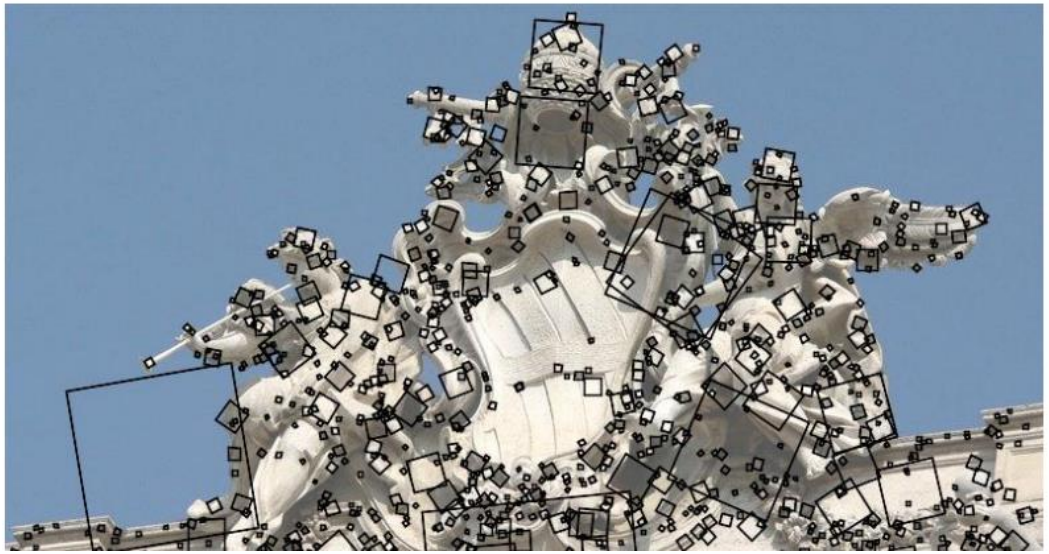
- Build test data set: Using Structure-From-Motion





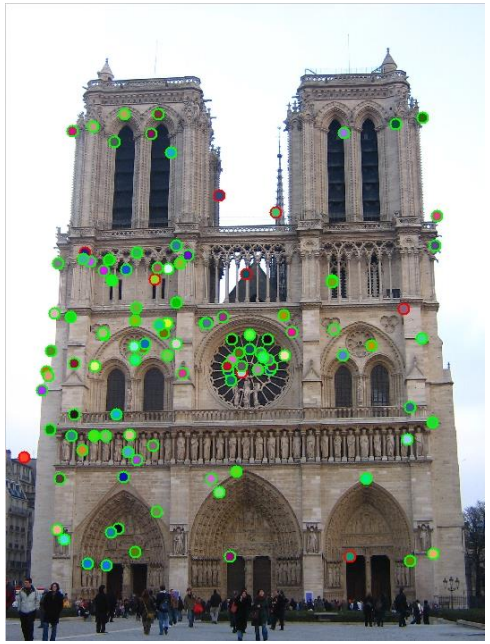
Method

- Extract feature in real-time using onboard GPU



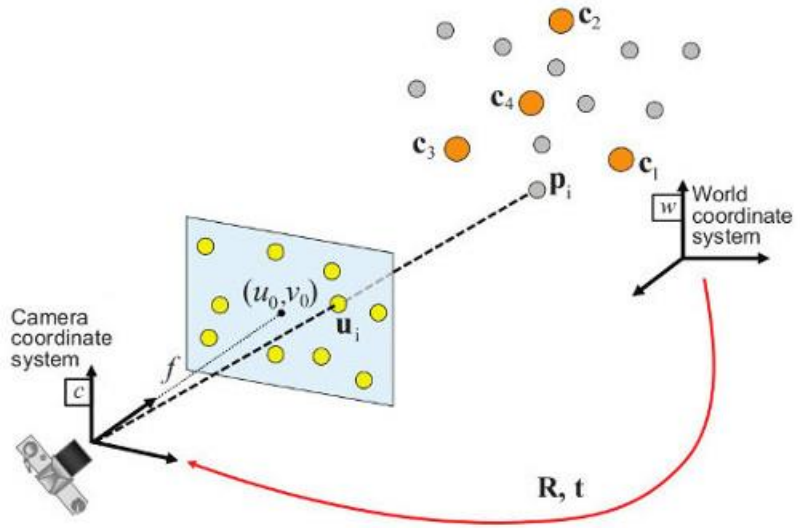
Method

- Feature matching

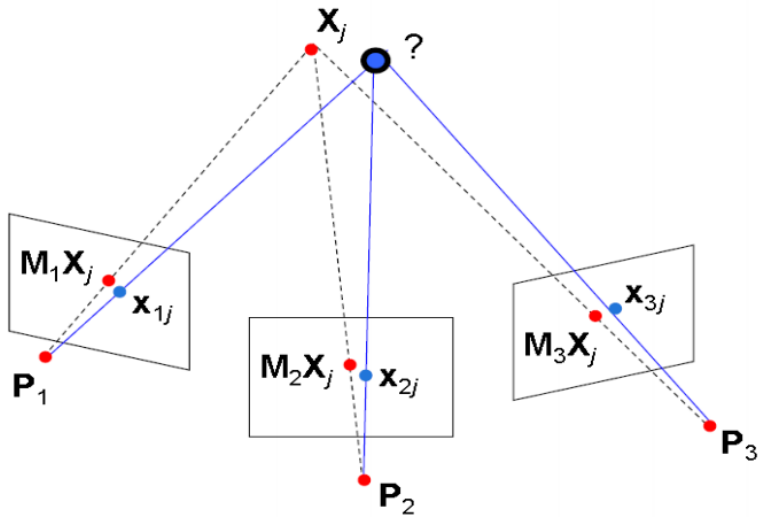


Method

- Estimate camera pose using PnP method and then Bundle-Adjustment



$$E(M, X) = \sum_{i=1}^{m} \sum_{j=1}^{n} D\left(x_{ij}, M_i X|_j\right)^2$$



Expectation

- Goal 1:
  - Accelerate the SIFT feature extraction and matching to 20 fps
- Them interpolate the estimated camera poses using sensor fusion to achieve 100 fps

- Goal 2:
  - Accelerate the SIFT feature extraction and matching to 5 fps
  - Using Optical flow to track the SIFT feature to achieve 20 fps

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
  - More test
  - Further work if performance is not good
  - Try other feature