UAV motion compensation using Structure form Motion and Optical Flow

Group 6

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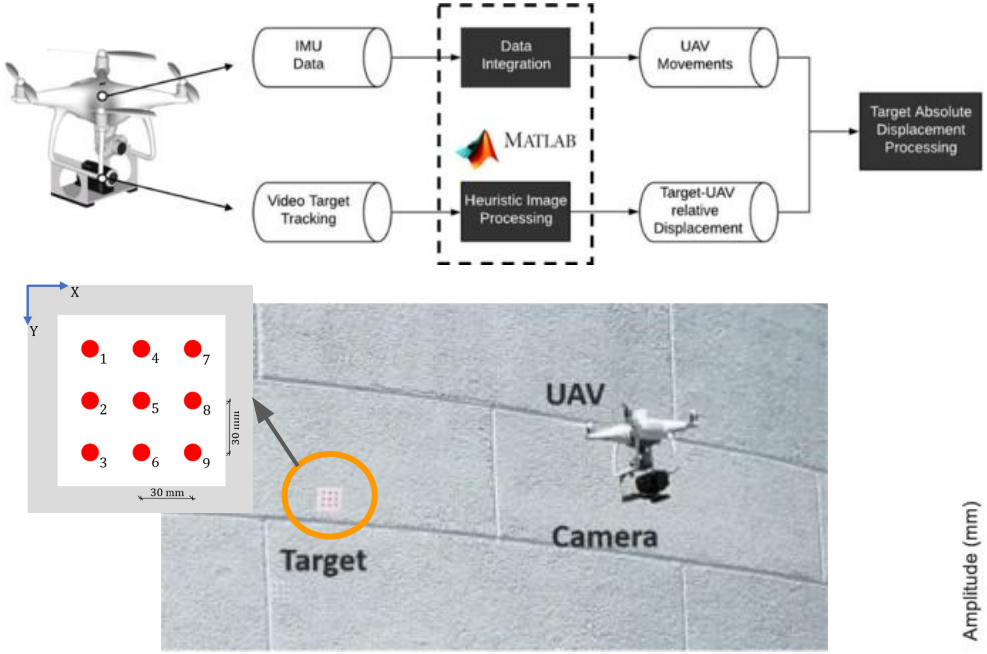
Outline

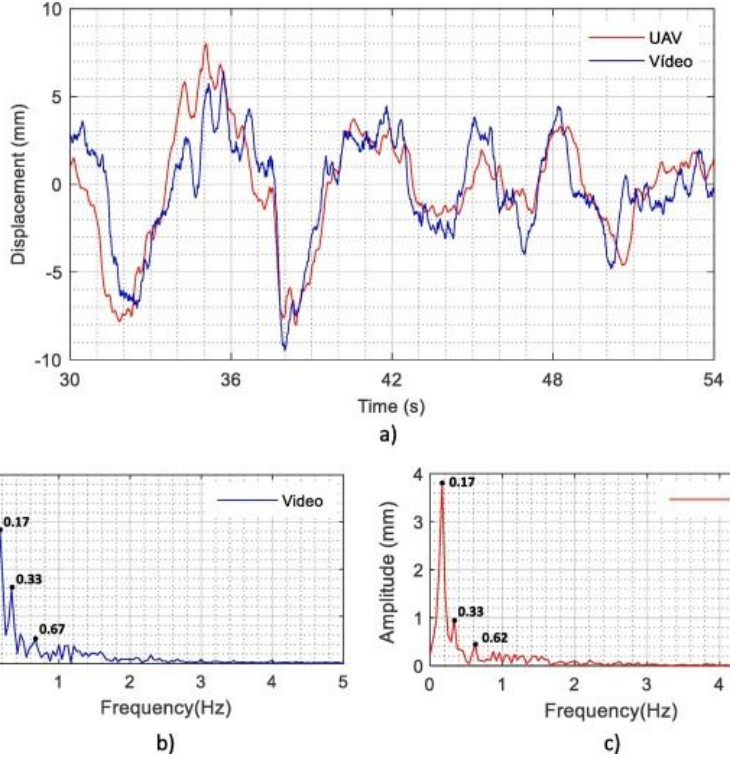
- Motivation & Related Work
- Project Workflow
- Method
- Experiment & Result
- Conclusion
- Participation

Motivation

- Recently, researchers have conducted studies on vision-based structural health monitoring, which provides noncontact and efficient measurement.
- However, these approaches have been limited to stationary cameras, which have the challenge of finding a location to deploy the cameras.
- To overcome the limitations of finding optimal locations, the UAV can potentially overcome.
- However, the drift of UAV is neglectable. To compensate the drift of camera, we want to use SfM techniques which can estimate the camera pose from a set of 2-D images.

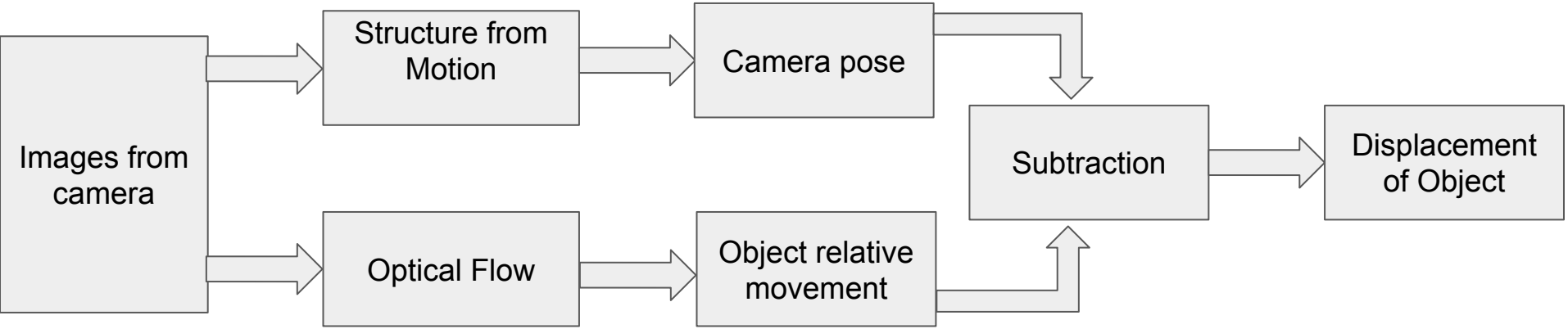
Related Work





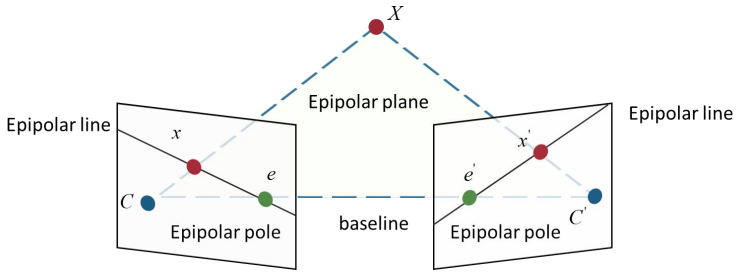
Ribeiro, D., et al. "Non-contact structural displacement measurement using unmanned aerial vehicles and video-based systems." *Mechanical Systems and Signal Processing* 160 (2021): 107869.

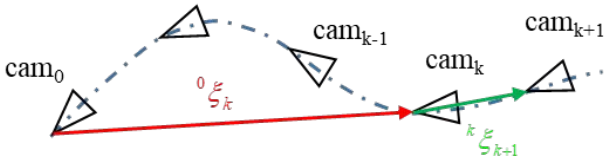
Project Workflow

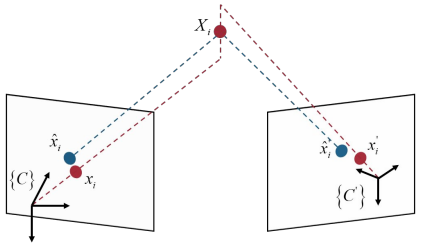


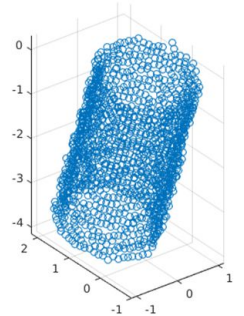
Method (Structure form Motion)

- Epipolar geometry
  - Estimate essential matrix.
- Relaive pose form epipolar geometry
  - Estimating the relative pose from the essentail matrix.
- Triangulation
  - Sparse 3D scene reconstructing from 2D correspondences.
- Scale recovery
  - Fit a cylinder to point cloud.



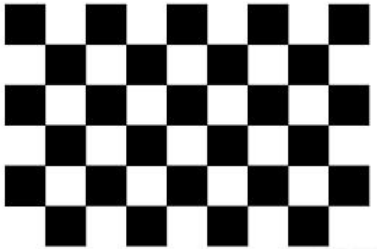


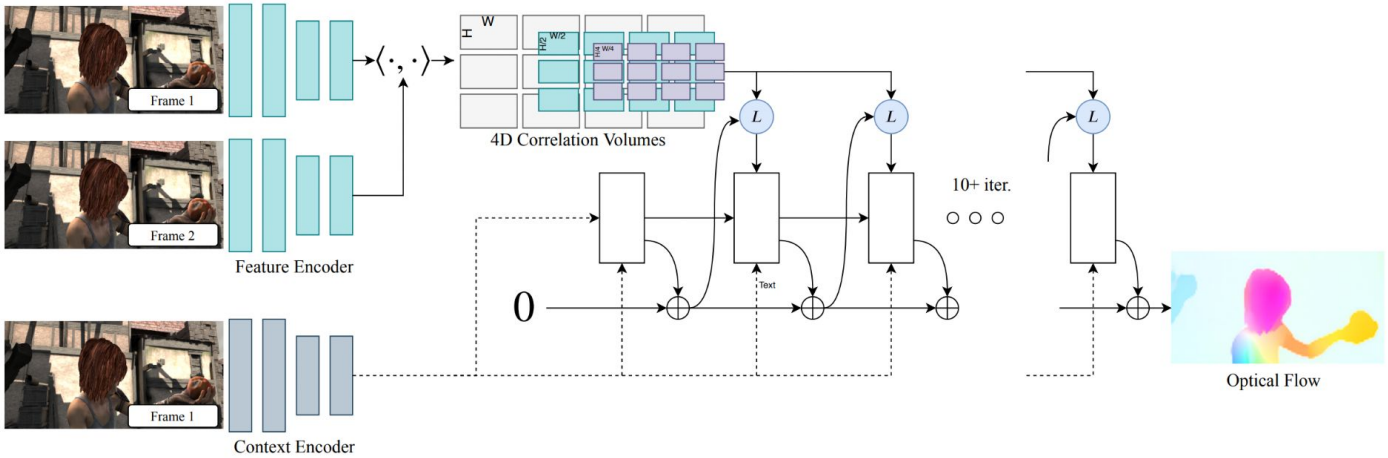




Method (Optical flow)

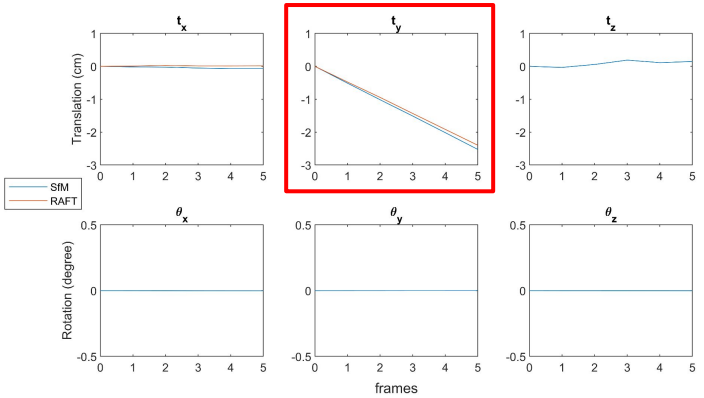
Using RAFT to get displacement of ROI region between frames

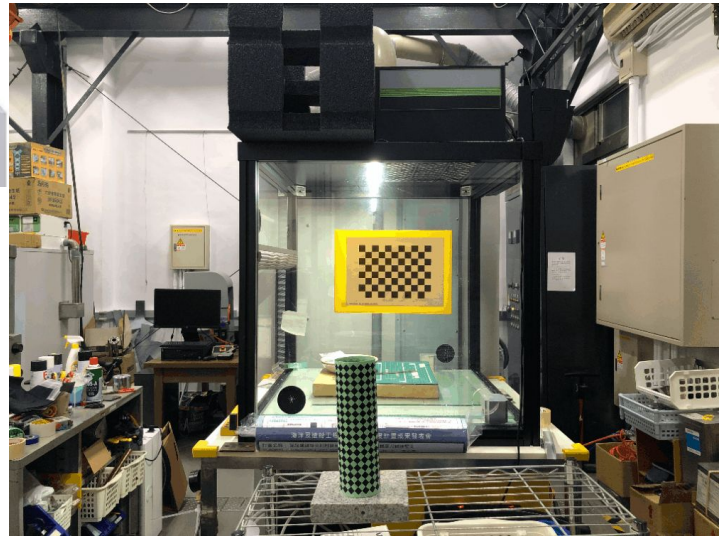


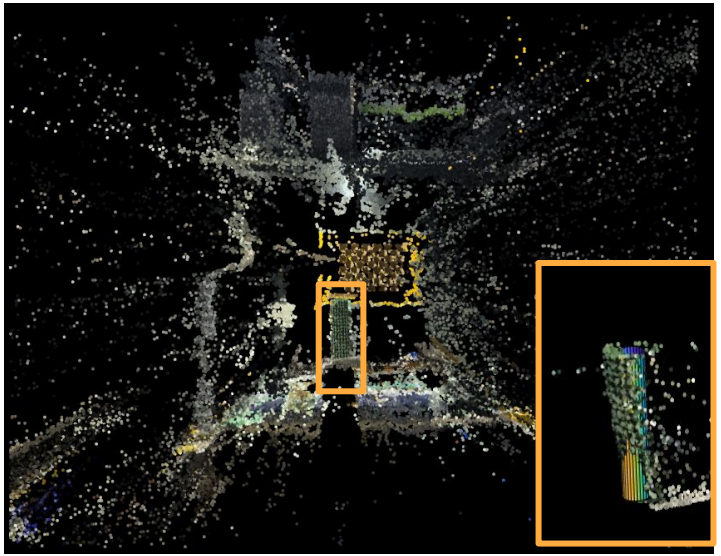


Experiment #1 & Result

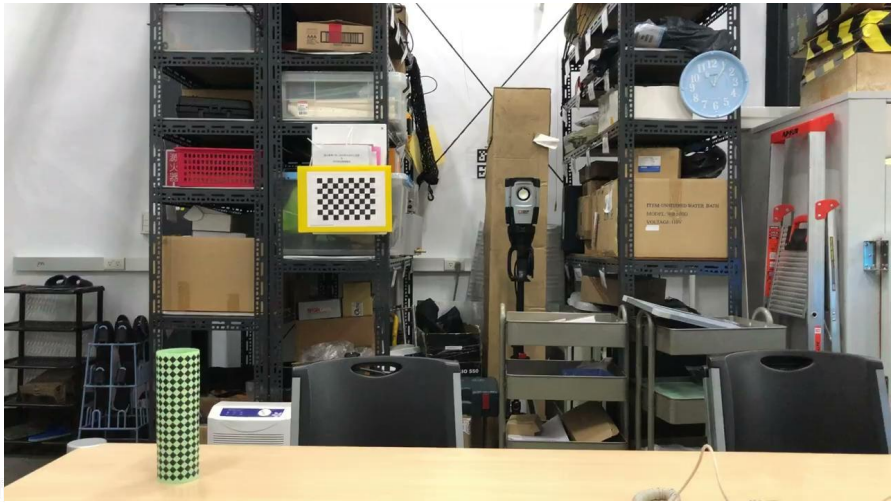
movement: 5mm/frame
total movement: 25mm





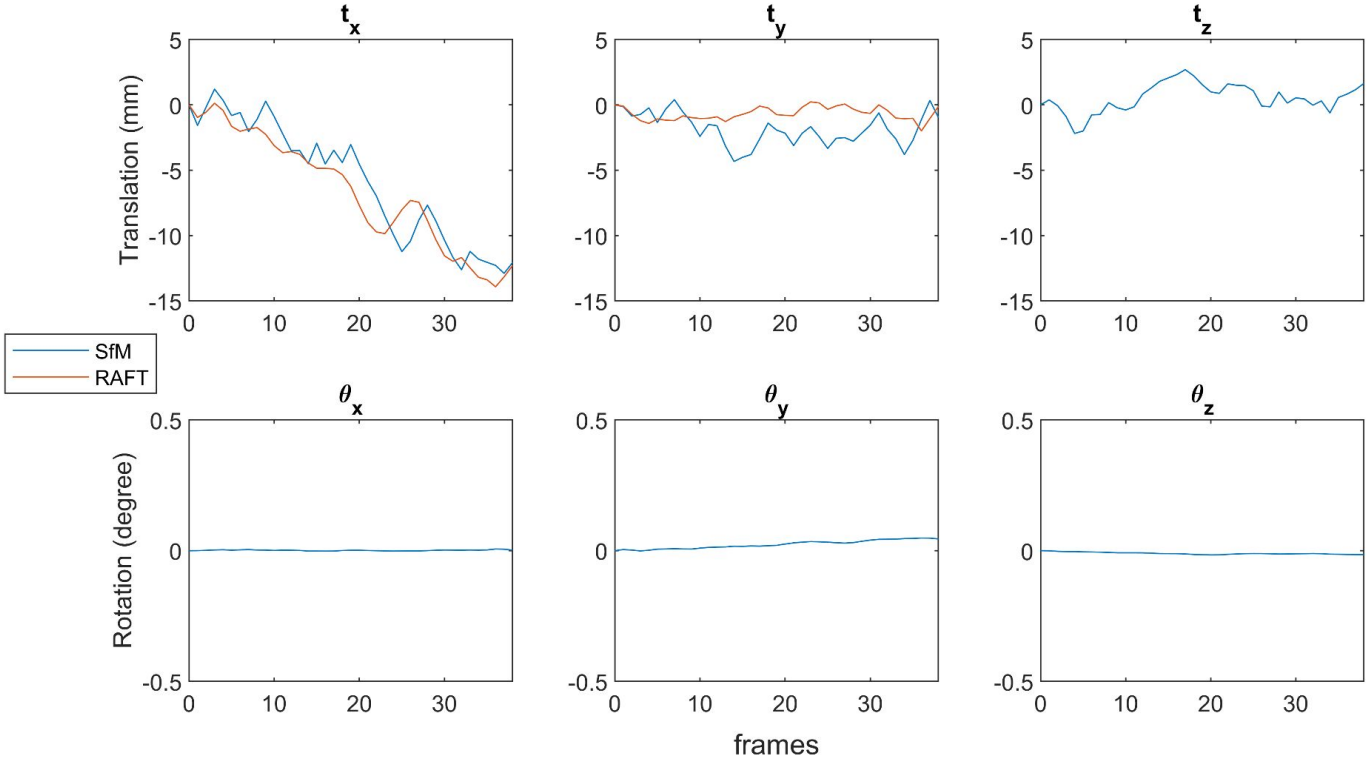


Experiment #2 & Result



camera movement by hand

Experiment #2 & Result



Conclusion

- In experiment 1, we obtained ground truth of camera pose by precision machinery, and used SfM to estimate camera pose and using optical flow to estimate target's(checkboard) displacement, the result shows that our method is correct. (the tanslation of camera pose is negative of optical flow.)
- In experiment 2, we do camera movement by hand, so we do not have ground truth this time, and the result also show that our method can correctly estimate object(checkboard) displacement that the tanslation of camera pose is similar to negative of optical flow.

Participation

蔡承恩: structure form motion implementation, experiment, presentation, writing

吳泓毅: RAFT implementation, presentation, writing

江昱翰: structure form motion implementation

Thank you for your time and attention