Introduction

Code and dataset for paper *Fine-scale Antarctic Grounded Ice Cliff 3D Calving Monitoring based on Multi-temporal UAV Photogrammetry Without Ground Control*. Ice cliff collapse detection and volume estimation using multitemporal aligned mesh generated from photogrammetry.

Note: Due to the randomness of the clustering algorithm, the results obtained by the code will be slightly different from the results of the paper.

Requirements

Software

1. MATLAB (tested on R2023a)
2. CloudComPy (tested on v3.9)

MATLAB file exchange

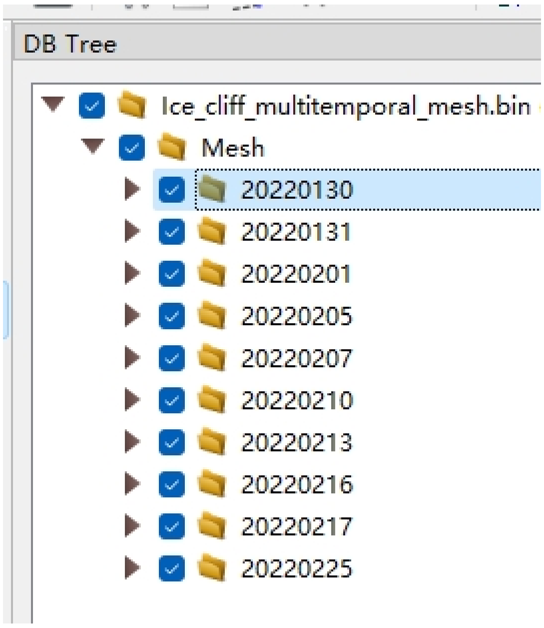
1. Triangle/Ray Intersection
2. LASRead/LASWrite

Dataset

The dataset contains geo-registrated multitemporal meshes recording the calving process of an ice cliff in Antarctica and ice cliff calving detection results.

Multitemporal meshes

The meshes were generated from UAV photogrammetry and co-alignment technique. The dataset is a single CloudCompare `.bin` file, `Ice_cliff_multitemporal_mesh.bin`. It contains meshes generated by Metashape from each epoch. The file structure is shown in the below image. Each subfoler contains a mesh of the ice cliff at `yyyymmdd` day.



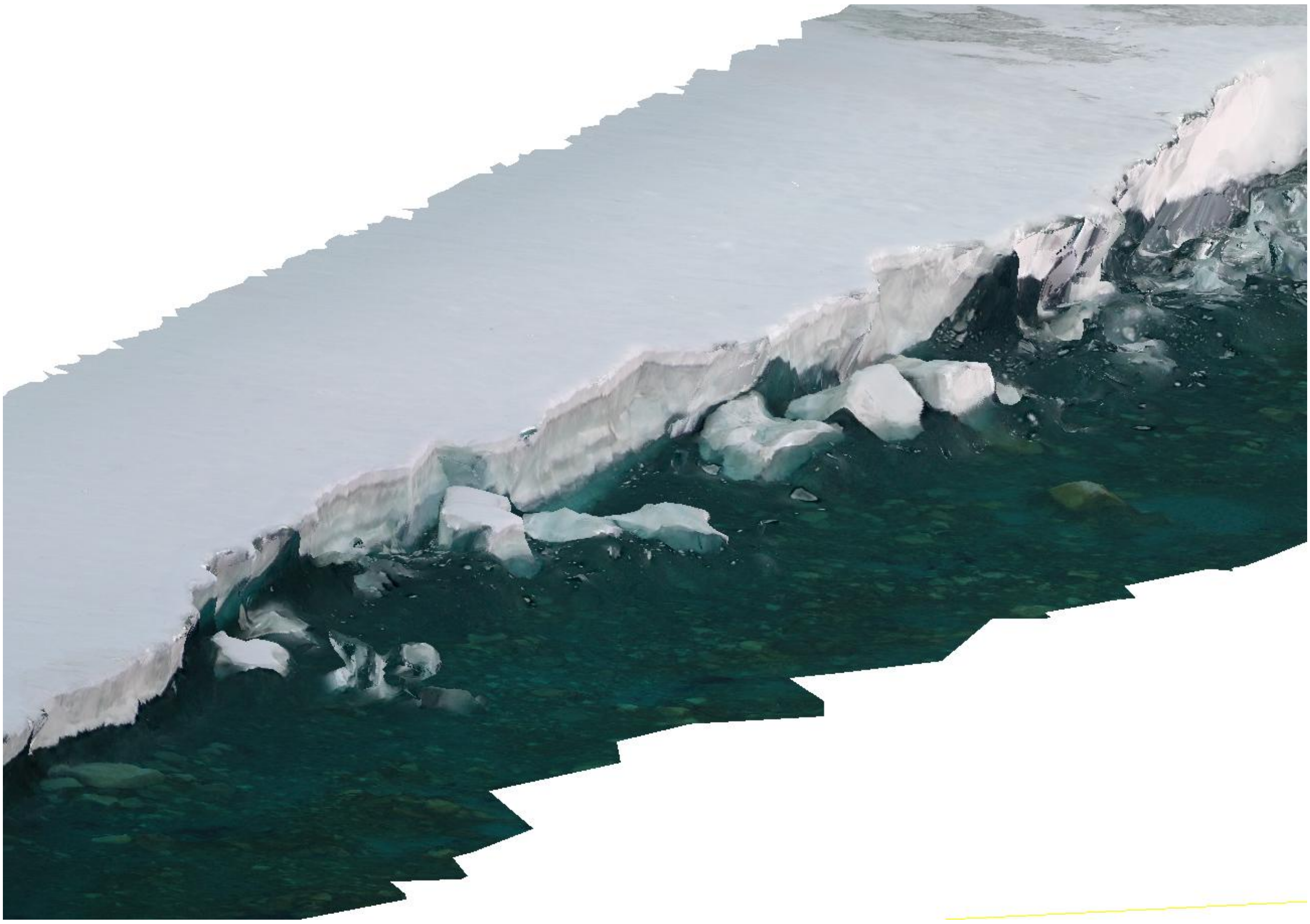
The ice cliff is located between the Qinling station area $(74^\circ56' S, 163^\circ 42' E)$ and the Nansen Ice shelf, Inexpressive Island in Victoria Land, East Antarctica. The length of its coastline is approximately 0.89 km.

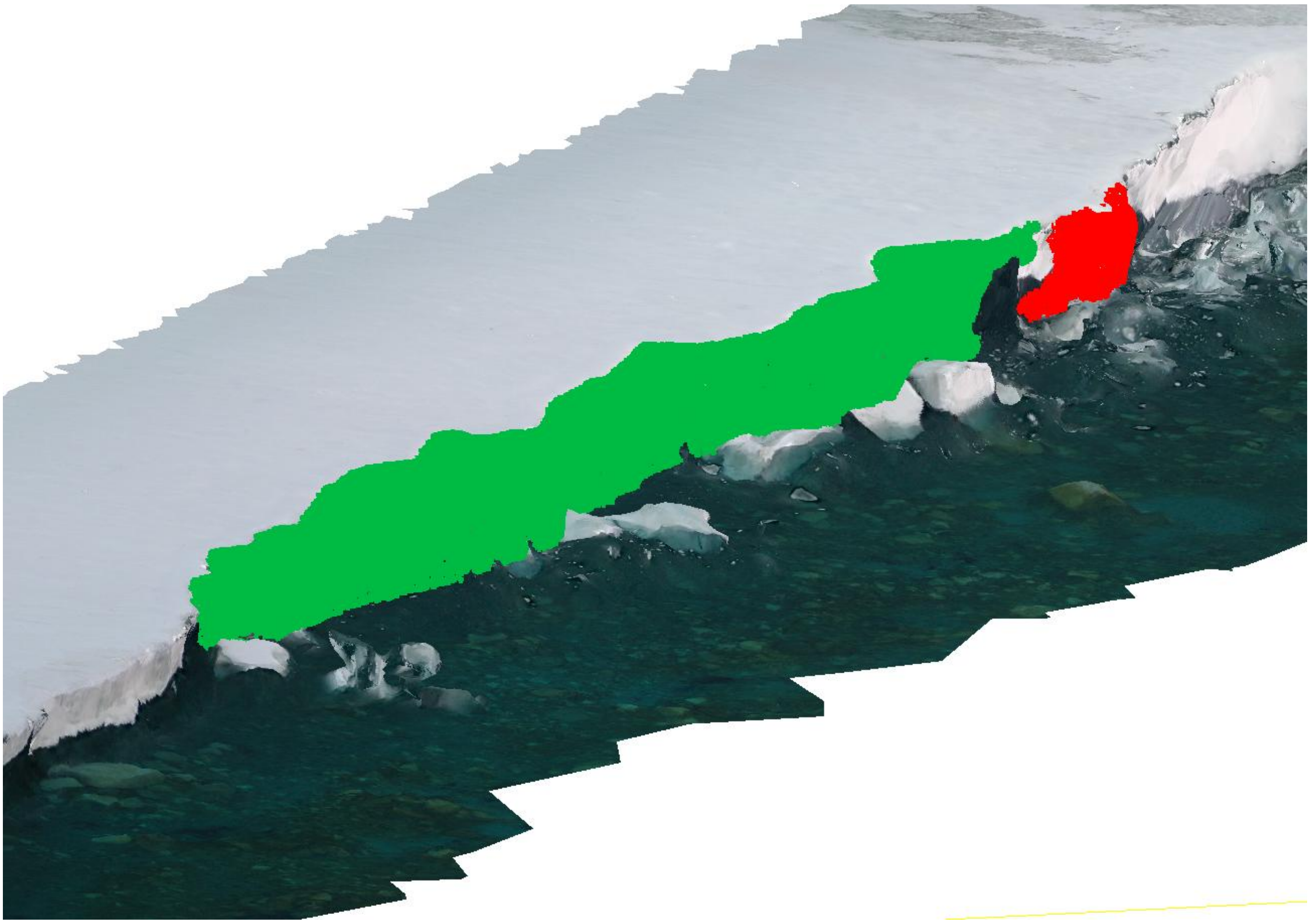
The UAV for collecting aerial images was a DJI Mavic 2 Pro drone, which carries a Hasselblad L1D-20c gimbal camera \citep{dji2018Mavic}. Its 28 mm-equivalent lens has a 77° field of view (FoV). From 30-Jan to 25-Feb 2022, 10 flights were performed with the same flight parameters in 26 days. The date of flights were 30-Jan, 31-Jan, 1-Feb, 5-Feb, 7-Feb, 10-Feb, 13-Feb, 16-Feb, 17-Feb and 25-Feb.

Parameter name	**Value**
Flying height	100 m
Image front/sidelap	80% / 60%
# of images planned	330
GSD	2.1 cm
Image coverage	159 $\times$ 106 m

Calving deteciton results

In the `\result` folder stores a series of point cloud files `mmdd-mmdd_diff.ply`. They are calving object detection result of our paper. Below are two screenshots showing ice cliff mesh and calving object detection result from our paper.





Run

Generate valid space for change detection

1. Set the parameter `STEP` in `CloudComPy_scripts\run_change_detection.py` to 9, and the parameter `path` to the location of `Ice_cliff_multitemporal_mesh.bin`.
2. Run `CloudComPy_scripts\run_change_detection.py` (CloudComPy required), it creates a point cloud file `mmdd-mmdd.las` under the subfolder of `distance_threshold_xx`. This compares the mesh between the first and the last epoch.
3. Set the `folder` in line 4 of `run_generateValidSpace.m` to the subfolder created in step 2.
4. Run `run_generateValidSpace.m`, it will create a `pointcloudValidSpace.mat` storing the point cloud for valid space in the `export` subfolder.

Ice cliff change detection and volume calculation

1. Set the parameter `STEP` in `CloudComPy_scripts\run_change_detection.py` to 1, and the parameter `path` to the location of `Ice_cliff_multitemporal_mesh.bin`.
2. Run `CloudComPy_scripts\run_change_detection.py` (CloudComPy required), it creates a series of point cloud file `mmdd-mmdd.las` under the subfolder of `distance_threshold_xx`. This compares the mesh between each epoch.
3. Set the `folder` in line 4 of `run.m` to the subfolder created in step 2.
4. Run `run.m`, it will export the calving volume result to the console, and store it to an Excel table. It will also create a series of point cloud file `mmdd-mmdd_diff.ply`. They are calving objects detected by the algorithm.