Detect 2D drive profile from lidar point cloud

- Author: Yongzhi (Matt) Xu
- Email: z5105843@zmail.unsw.edu.au

Installation

```
conda env create --file=env.yaml
```

Usage

```
conda activate drive_profile
python detect_drive_profile.py
```

Overview

Task: Detect 2D profile from 3D point cloud.
Assumption: The point cloud has already been aligned with gravity.
Method:

- First, project the 3D point cloud into BEV density image.
- Second, detect the contour from the BEV density image.
- Third, if necessary, the 2D contour can be lifted into 3D.

Args:

- laz_path: path of input data
- out_dir: output directory
- sampling_ratio: Small sampling ratio enable fast detection but may result in inaccurate result if it is too small.
- out_height:
- out_width: Larger output image size results in better result, but costs more time.

Performance:

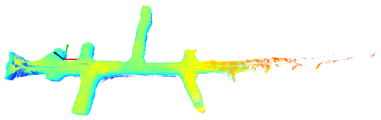
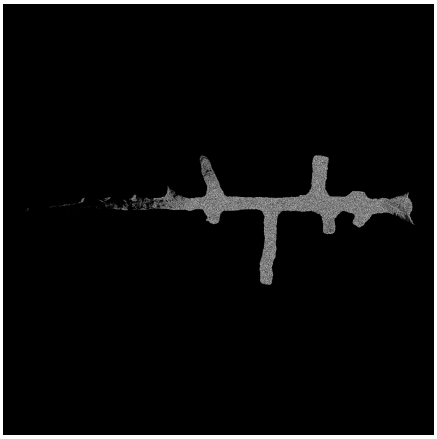
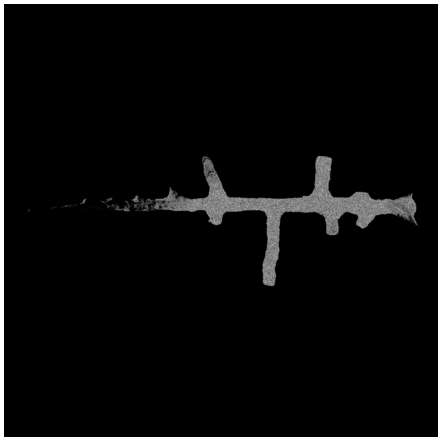
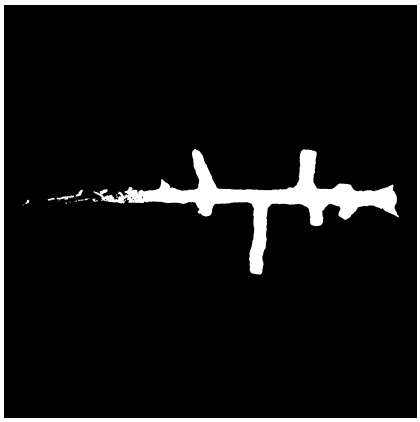
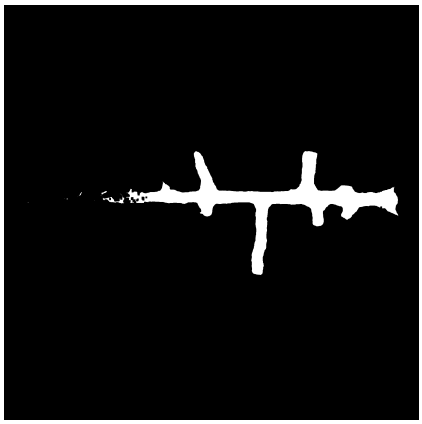
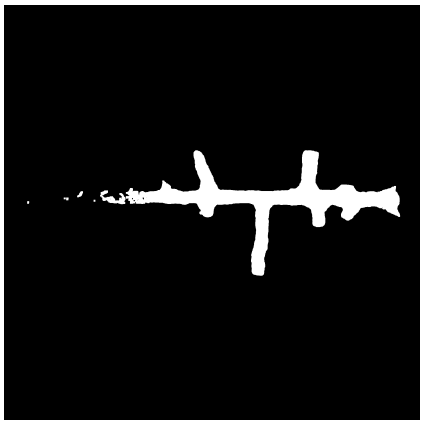
- The detection taks about 9 seconds on a Macbook Pro with sampling ratio of 0.1 and image size of (2048,2048). The current version can be significantly improved in efficiency.
- The criterion for accuracy is not well defined yet.

Potential todo:

- Fitting the detected contour to one single smooth and connected curve.
- Improve the efficiency by simplify the pipeline and multi-processing.
- Explore how to handle noisy and incomplete point cloud with more experiments.

- Explore more efficient and robust solution, such as forground mask segmentation, end-to-end curve detection.
- Incremental solution
- Fit the polynomial curves of all tunnel branches, which enables the width calculation at any point and path generation for the drone.

Experiments

(1) Input	(2) BEV density image	(3) Gaussian blur the image to overcome small holes in the point cloud (acturally not exist in this sample)
		
(4) Binary image using a small threshold	**(5) Erode the binary image to filter small isolated pieces**	**(6) Dilate back to retain profile size.**
		
(7) Detect the contours as the final result	**(8) Transform the 2D profile back to 3D space**	**(9) Fit the profile by polynomial curves and calculate the tunnel width.**

(7) Detect the contours as the final result	(8) Transform the 2D profile back to 3D space	(9) Fit the profile by polynomial curves and calculate the tunnel width.