Detect 2D drive profile from lidar point cloud

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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.

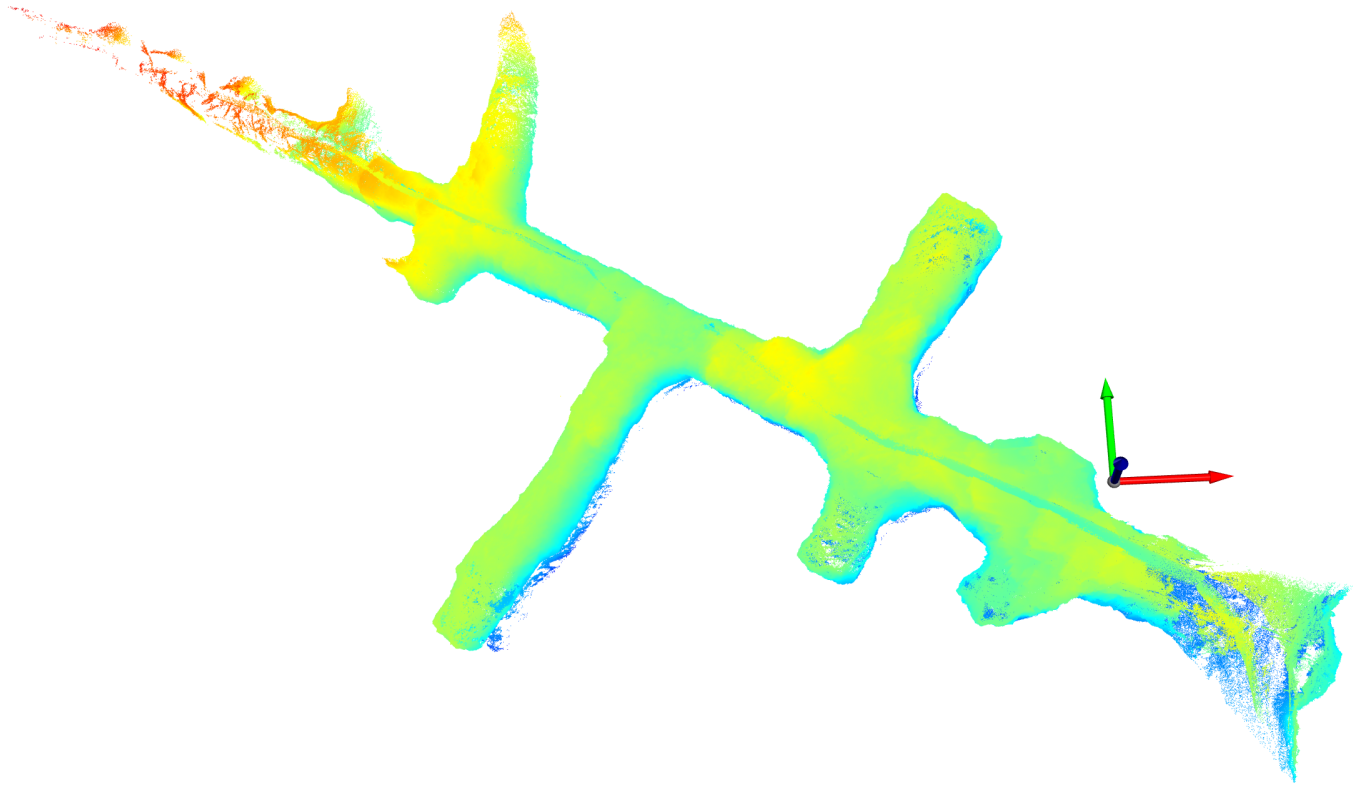
Potential todo:

- 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.

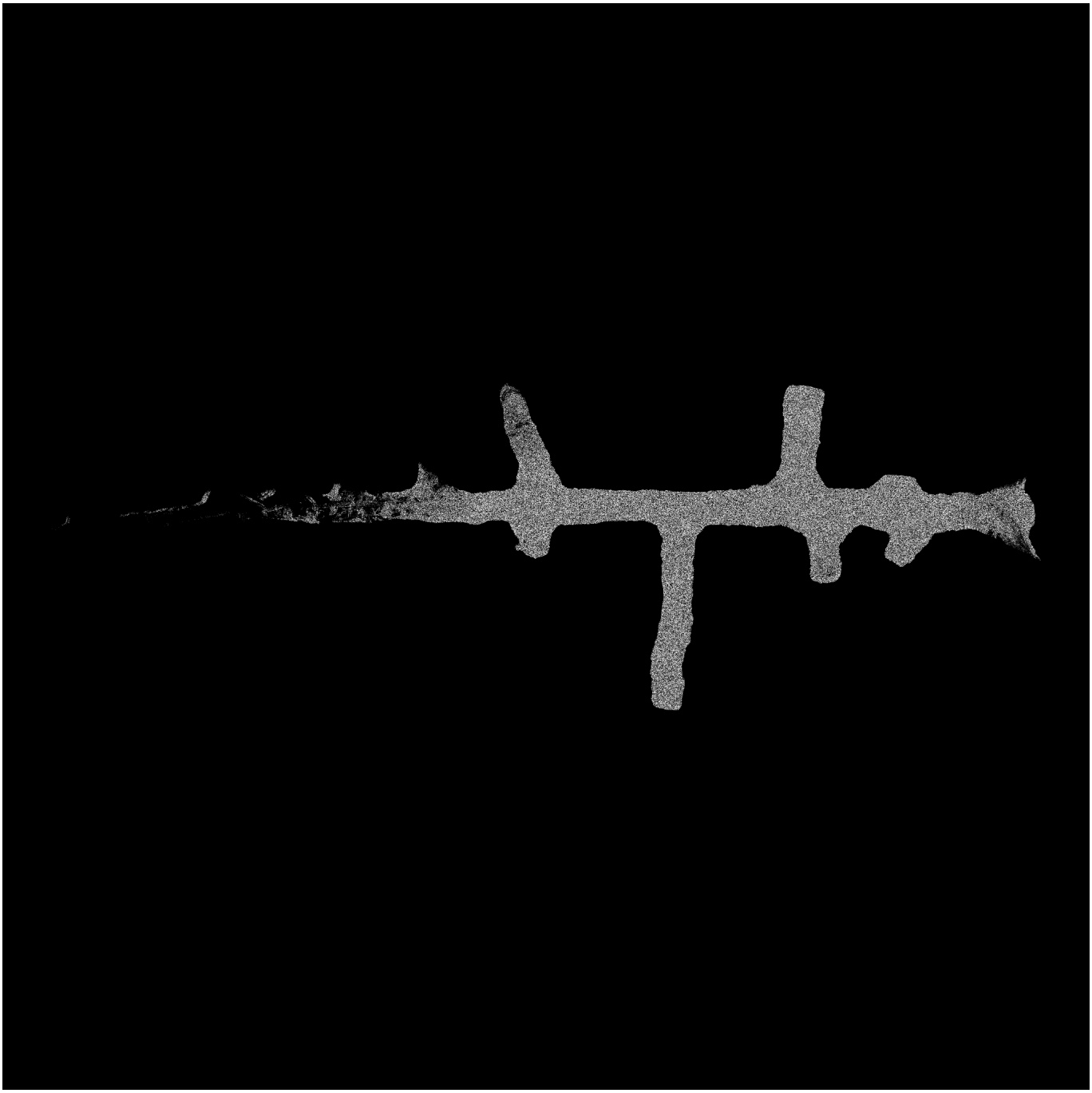
- Explore more efficient and robust solution, such as forground mask segmentation, end-to-end curve detection.
- Incremental solution

Experiments

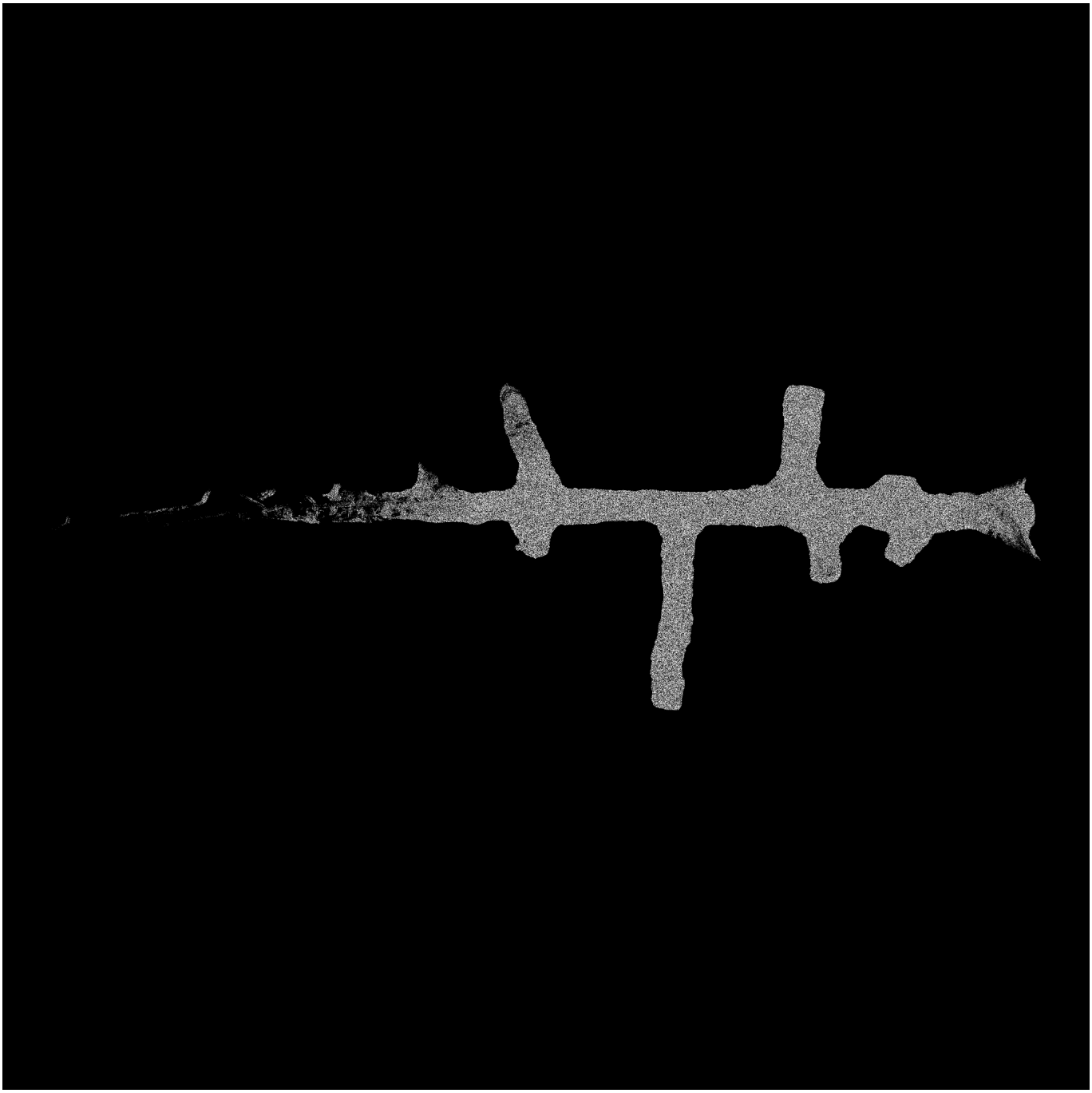
(1) Input:



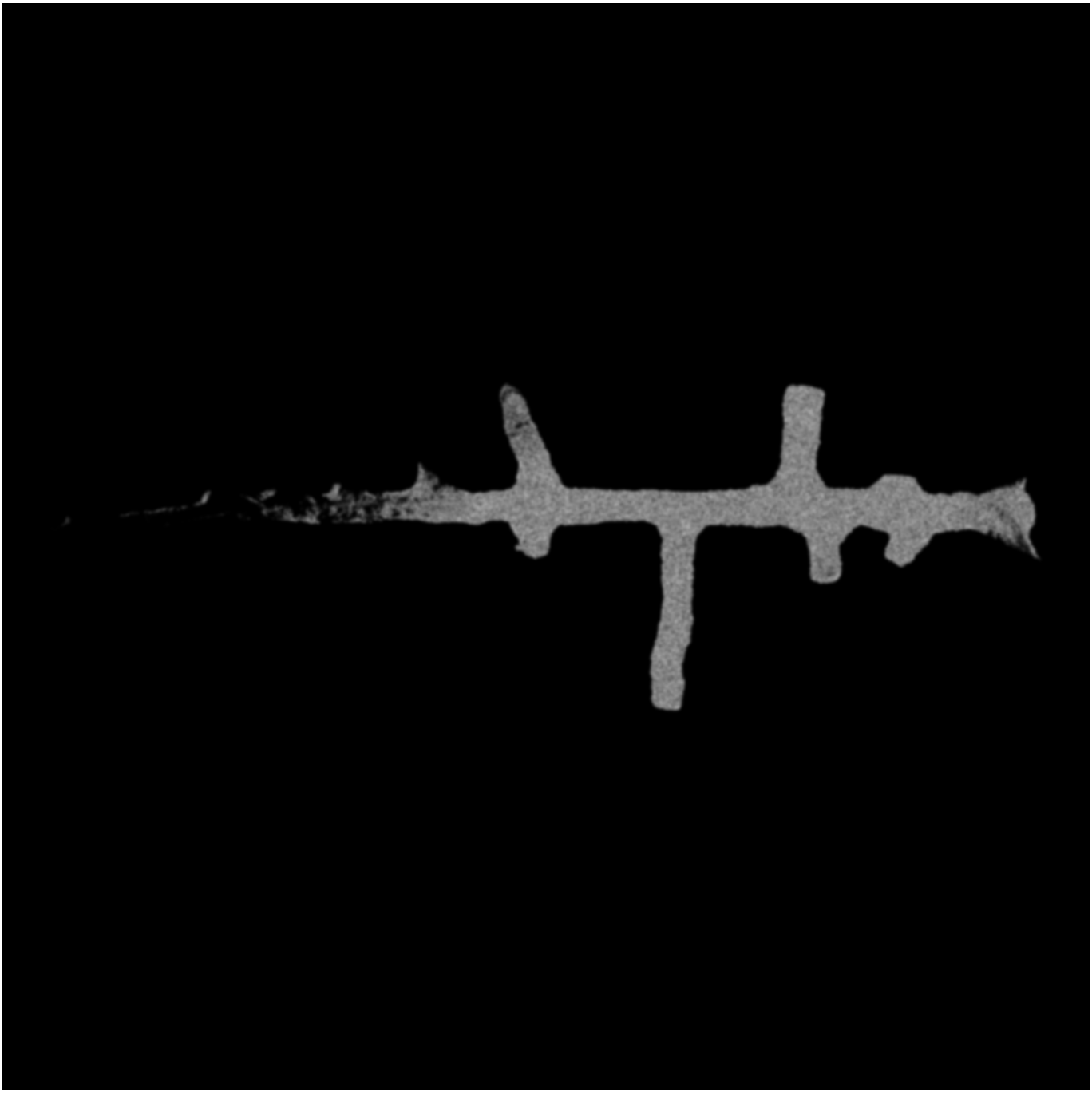
(2) BEV density image:



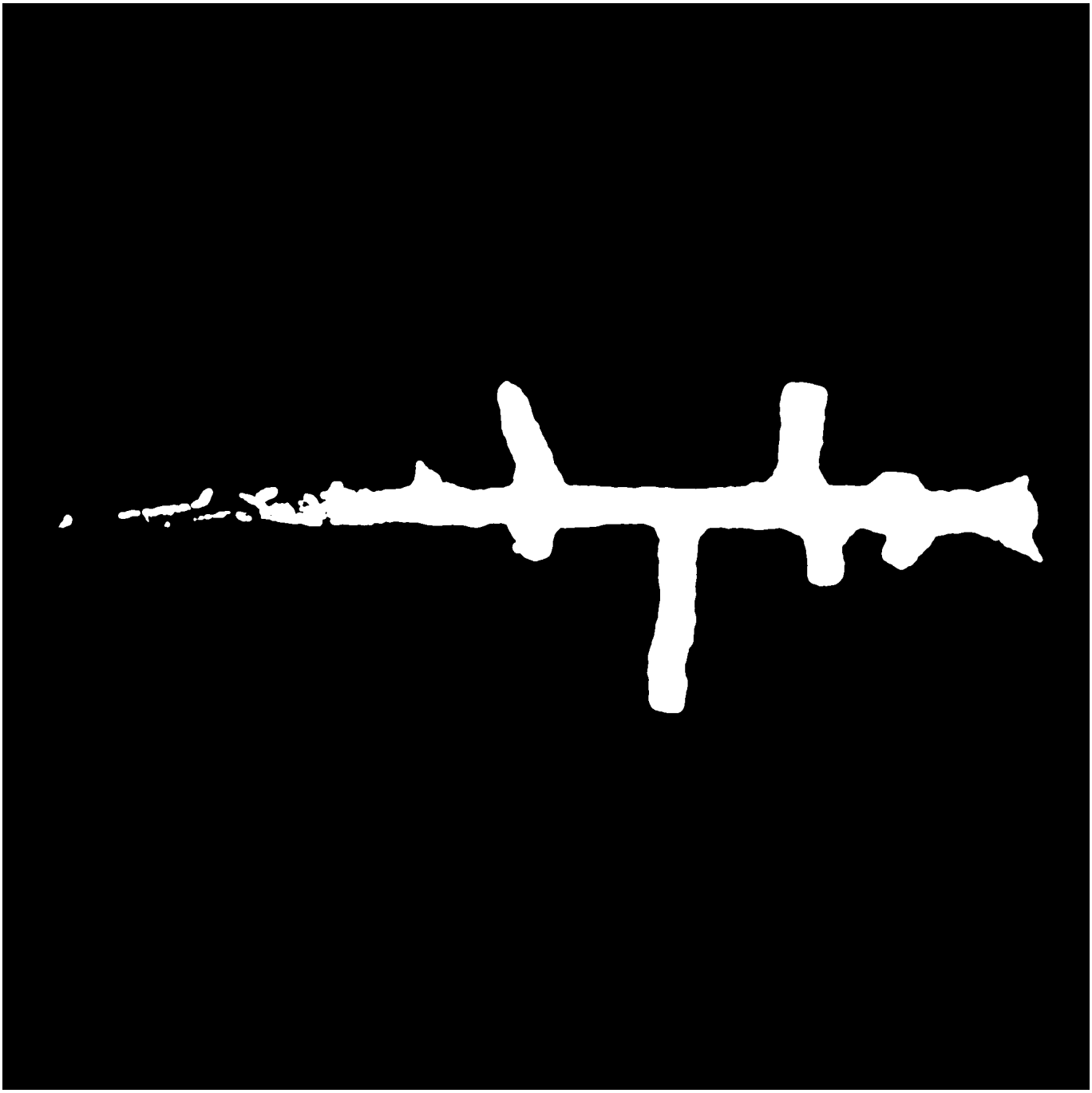
(3) BEV density image after histograms equalization:



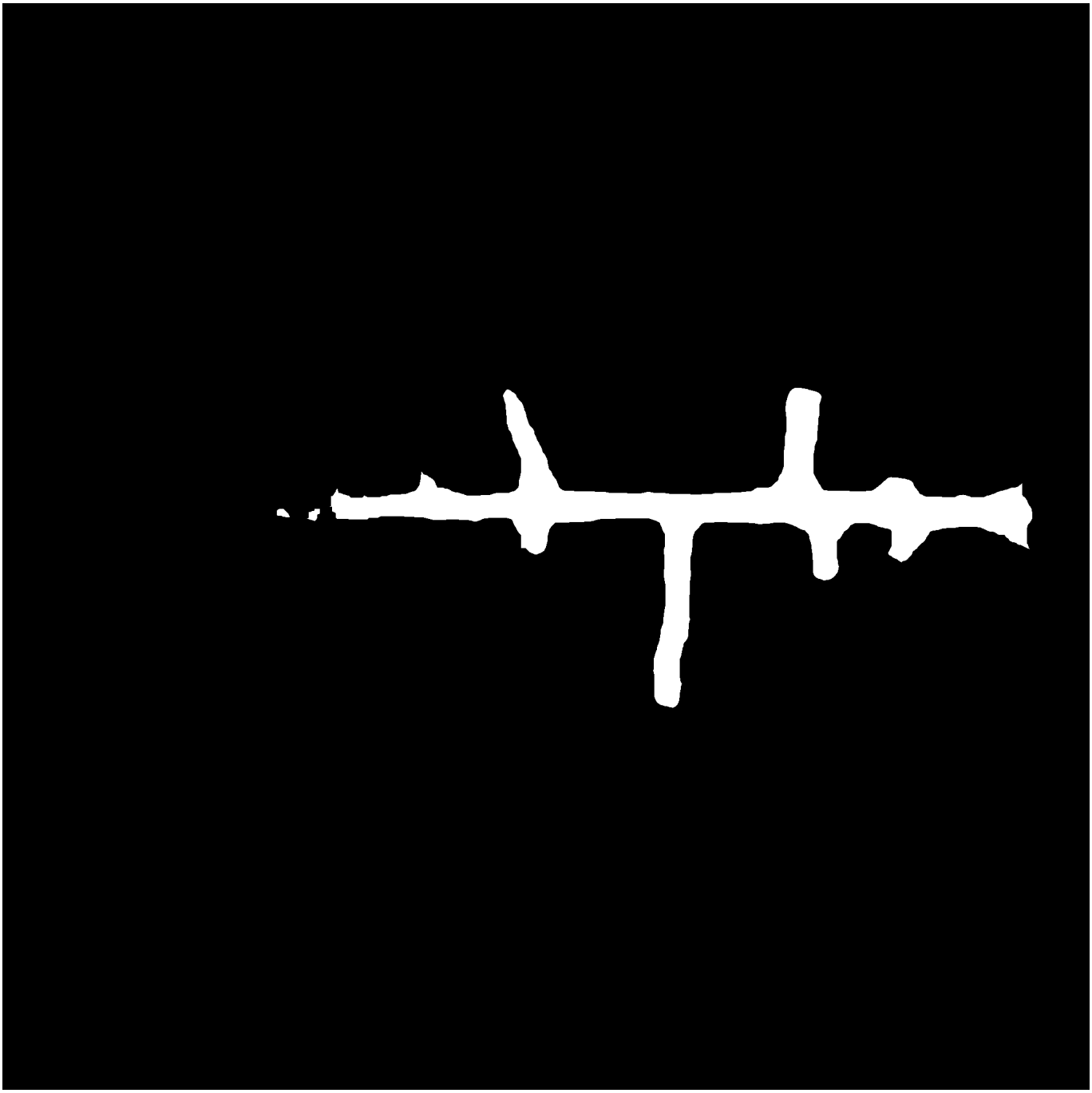
(4) Gaussian blur the image to overcome small holes in the point cloud (acturally not exist in this sample):

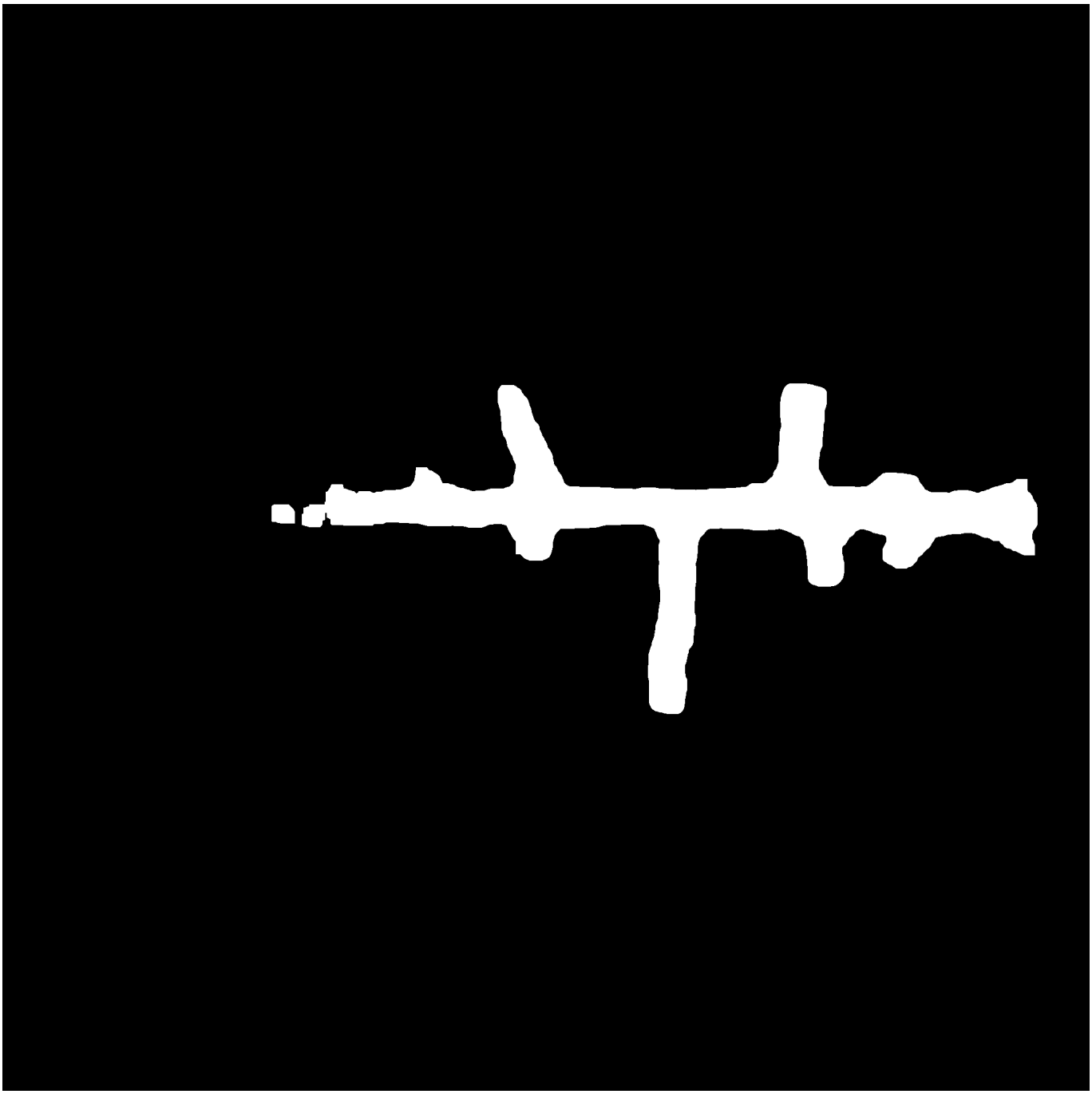


(5) Binary image using a small threshold:



(6) Erode and dilate the binary image to filter small isolated pieces.





(7) Detect the contours as the final result: