[Final project 1] Investigate the misalignment between Point Cloud and aerial image

Description

The fusion of aerial imagery and abstract features, for example, road network, point of interest (POI) and building -- as known as hybrid map -- can help user has a better understanding of a region (Figure 1), and help map company to generate more accurate product (HD City, HD Maps).

Figure 1.

Aerial imagery is acquired by airborne platform, for example, satellite, airplane of drone. In industry, maps, POIs, especially HD Maps, are generated from the data - for example, LiDAR and street view imagery - acquired by ground based devices. These two data sources have misalignment from sub-meter level to ten-meter level (see Figure 2).

Figure 2. An example of 100-meter misalignment between satellite image and road network map near [33.525138, 111.079484].
Please read support document **"Coordinate Transformations.pptx"**, use given Point Cloud file and tile image from Bing Map **Tile System** (*http://a0.ortho.tiles.virtualearth.net/tiles/* (Links to an external site.)*a/ [quadkey].jpeg?g=[map version]&[APIKEY]*), to investigate the misalignment between these two datasets.

Project requirements

You should think about:

1. Demands of "perfect" aligned image and Point Cloud.
2. Projection error between tile **coordinate** and your Point Cloud **coordinate**.
3. Methodologies of automatically and manually Point Cloud to aerial image alignment.
4. Representation of transformation vector (2D).

Please submit your **source code** (+ **readme**) and report slides, contains introduction, methodology (how to project points to the image coordinate, etc.) with figures (generated by you), experiment, conclusion, futures and references (if any).

[Final project 2] Investigate the misalignment between Point Cloud and perspective image

Description

Like project “Investigate the misalignment between Point Cloud and aerial image”, in this project, you are going to investigate the misalignment between camera and Point Cloud (see Figure 3).

Figure 3. Visualization of Point Cloud (bottom) and original image (top).

Please read support document **“Coordinate Transformations.pptx”**, use given Point Cloud file and perspective image file (with configuration), to investigate the misalignment between them.

Project requirements

You should think about:

1. Demands/Applications of “perfect” aligned perspective image and Point Cloud.
2. Methodologies of automatically and manually Point Cloud to perspective image alignment.
3. Representation of transformation vector.

Please submit your **source code** (+ **readme**) and report slides, contains introduction, methodology (how to project points to the image coordinate, etc.) with figures (generated by you), experiment, conclusion, futures and references (if any).

[Final project 3] Terrain model generation from Point Cloud

Description

Digital Elevation Modeling (DEM) has been a widely-used methodology in plethora of application domains, ranging from climate and geological studies, through temporal evolution of various migration patterns, to Geographic Information Systems (GIS) broadly. However, the existing DEM methodologies and systems cannot quite straightforwardly be extended to catch up with the demands due to recent developments in autonomous driving, vehicle localization, drone and dynamically evolving high-definition smart city modeling.

High-definition (HD) DEM data can be generated from ground based LiDAR Point Cloud. In this task, with given Point Cloud file, you are going to generate HD Digital Terrain Model (DTM) (please read DTM vs. DSM, https://en.wikipedia.org/wiki/Digital_elevation_model).

Figure 4. Raw DSM (have not been interpolated) and corresponding satellite image.

Project requirements

You should think about:

1. Read related papers, summarize demands/applications of HD DTM/DEM.
2. Methodology of local (region of given Point Cloud) HD DEM generation.
3. Representation of HD DEM (for example, gridded map, polygon, etc.).

Please submit your **source code** (+ **readme**) and report slides, contains introduction, methodology with figures (generated by you), experiment, conclusion, futures and references (if any).

[Final Project 4] Object detection in Point Cloud: pole

Description

Object detection in Point Cloud is popular in HD Map and sensor-based autonomous driving. There basically four types of object you can obtain in daily scenario: road surface - contains painted lane marking and pavement area, support facility - contains road boundary (guardrail and curb), road sign, light pole, etc., uncorrelated object - for example, sidewalk, building, etc., and moving object - such like pedestrian, vehicle, bicycle, etc.

In this project, please search references, design and prototype your **pole** detection algorithm.

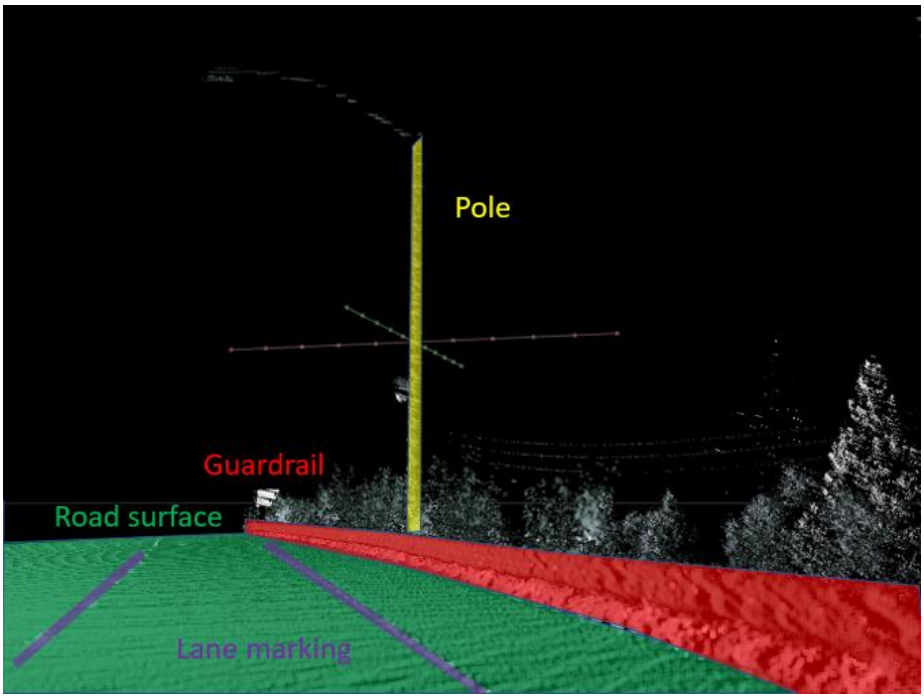

Figure 5. Point Cloud view and highlighted objects.

Project requirements

You should think about:

1. Representation of your object, for example, for lane marking <-> spline/line segment.
2. Methodology of automatically object detection.

Please submit your **source code** (+ **readme**) and report slides, contains introduction, methodology with figures (generated by you), experiment, conclusion, futures and references (if any).

[Final project 5] Object detection in Point Cloud: lane marking

Description

Object detection in Point Cloud is popular in HD Map and sensor-based autonomous driving. There basically four types of object you can obtain in daily scenario: road surface - contains painted lane marking and pavement area, support facility - contains road boundary (guardrail and curb), road sign, light pole, etc., uncorrelated object - for example, sidewalk, building, etc., and moving object - such like pedestrian, vehicle, bicycle, etc.

In this project, please search references, design and prototype your **lane marking** detection algorithm.

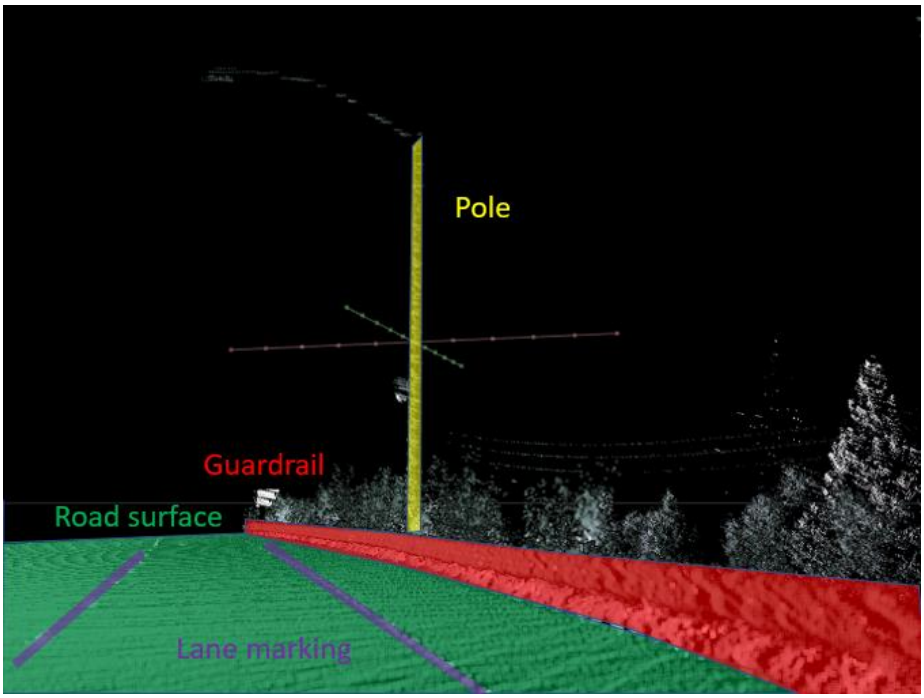

Figure 6. Point Cloud view and highlighted objects.

Project requirements

You should think about:

1. Representation of your object, for example, for lane marking <-> spline/line segment.
2. Methodology of automatically object detection.

Please submit your **source code** (+ **readme**) and report slides, contains introduction, methodology with figures (generated by you), experiment, conclusion, futures and references (if any).

[Final project 6] Object detection in Point Cloud: road boundary

Description

Object detection in Point Cloud is popular in HD Map and sensor-based autonomous driving. There basically four types of object you can obtain in daily scenario: road surface - contains painted lane marking and pavement area, support facility - contains road boundary (guardrail and curb), road sign, light pole, etc., uncorrelated object - for example, sidewalk, building, etc., and moving object - such like pedestrian, vehicle, bicycle, etc.

In this project, please search references, design and prototype your **road boundary** (guardrail) detection algorithm.

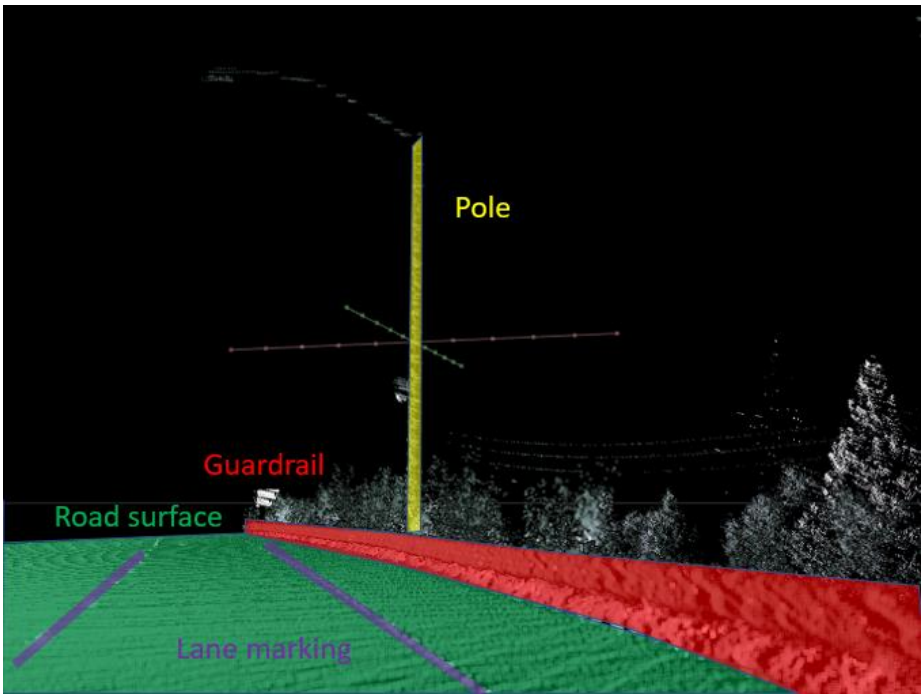

Figure 7. Point Cloud view and highlighted objects.

Project requirements

You should think about:

1. Representation of your object, for example, for lane marking <-> spline/line segment.
2. Methodology of automatically object detection.

Please submit your **source code** (+ **readme**) and report slides, contains introduction, methodology with figures (generated by you), experiment, conclusion, futures and references (if any).

[Final project 7] Point Cloud Registration

Input:

2 point clouds of the same scene (point_cloud_registration.rar)

Output:

Transformation matrix to align point cloud 1 to point cloud 2

Goal:

-Familiarize geo-referenced 3D LIDAR point clouds from ground level mobile mapping

-Practice ICP algorithm http://www.cs.virginia.edu/~mjh7v/bib/Besl92.pdf (Links to an external site.) (Links to an external site.)

Please submit your **source code** (+ **readme**) and report slides, contains introduction, methodology with figures (generated by you), experiment, conclusion, futures and references (if any).