1. Brief introduction

We provide sensor data for a normal urban road scenario with a duration of 3 minutes and a total length of 3 km, an 8 square kilometers scene data containing laser reflection intensity and altitude information, and three config files. Developers can use the data for multi-sensor fusion localization module debugging.

2. Data characteristics

This data set focus on testing the multi-sensor fusion localization algorithm in normal urban road setting where the vehicle travels at about 60km/h. The following situations are included, such as cruising, lane change, overtaken by side cars and so on. The dataset consists of three parts: scene data containing reflections and altitude information, sensor data, and parameter files.

The scene data is a grid-cell representation of the environment by projecting 3d lidar point cloud to x-y plane. Each cell stores the statistics of laser reflection intensity and altitude. If you want to know more details about it, please refer to Apollo code: https://github.com/ApolloAuto/apollo/tree/master/modules/localization/msf/local_map. The below image is rendered by reflection intensity.

The sensor data includes 3d laser point cloud, IMU and GNSS. The topics in rosbag file related to multi-sensor fusion localization module are listed below:

/apollo/sensor/velodyne64/compensator/PointCloud2

/apollo/sensor/gnss/imu

/apollo/sensor/gnss/rtk_obs

/apollo/sensor/gnss/rtk_eph

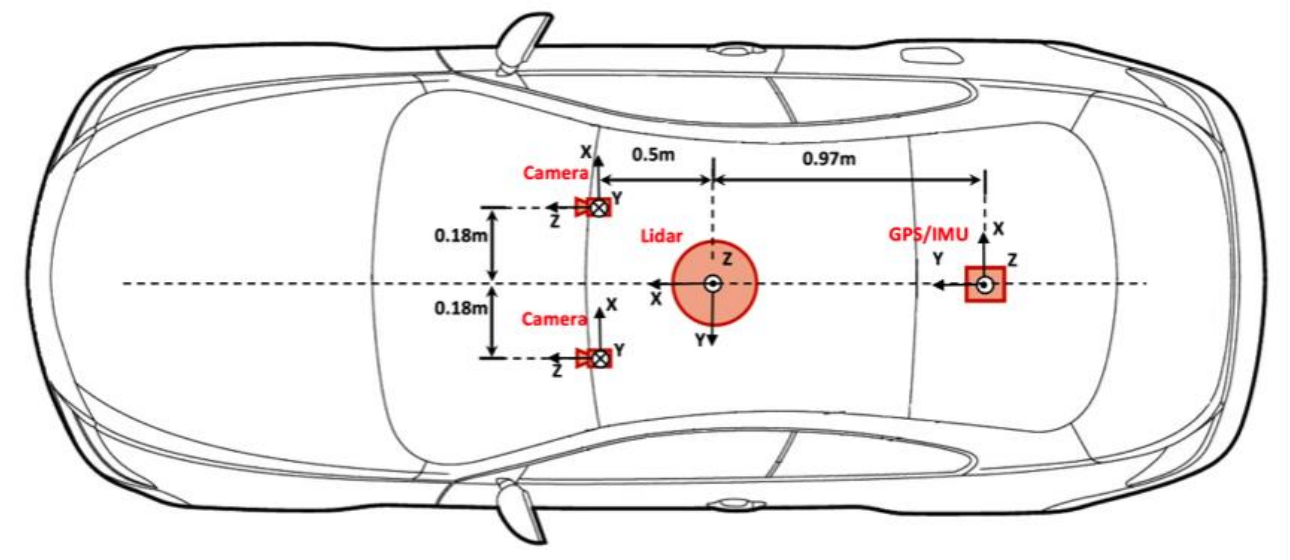
/apollo/sensor/gnss/best_pose

The frequencies of 3d laser point cloud, IMU and GNSS are 10HZ, 200HZ, and 1HZ respectively. There are two data types for GNSS localization. One is directly from INS system (e.g. NovAtel), and the corresponding topic is /apollo/sensor/gnss/best_pose. The other way is to compute GNSS localization result from the initial gnss observations and ephemeris information, and the corresponding topics are /apollo/sensor/gnss/rtk_obs and /apollo/sensor/gnss/rtk_eph. You can set the configuration in multi-sensor fusion localization module to decide which mode to be used.

The parameter files are velodyne64_novatel_extrinsics_example.yaml, velodyne64_height.yaml and ant_imu_leverarm.yaml, which represent the lidar-imu extrinsic parameter, the distance between lidar and ground, and antenna-imu extrinsic parameter. The files should be put into apollo/modules/localization/msf/params of Apollo code.

3. Device introduction

This data set contains 3d lidar point cloud, IMU data, and GNSS data. The 3d lidar point cloud are sampled by Velodyne HDL64S3D. The IMU and GNSS data are sampled by NovAtel ProPak6. Lidar and GPS/IMU installation location as shown below:



The details of the devices are showed in the table:

LiDAR	HDL64S3D
Measurement range	120 meter (~0.80 reflectivity)
FOV (vertical)	26.8° (+2° to -24.33°)

Accuracy	< 2cm distance accuracy (one sigma)
Angular resolution (vertical)	+2 to -8.33 @ 1/3 degree spacing -8.83 to -24.33 @ 1/2 degree spacing
FOV (horizontal/azimuth)	360°
Angular resolution (horizontal/azimuth)	0.09°
Rotation rate	5 - 20 Hz
Power consumption	60W (typical)
Operating voltage	12- 32 VDC
Weight	30 lbs [13.6 Kg] Sensor Unit
Dimensions	283mm x 223.5mm x 231.1mm
Vibration	0.1 g2 /Hz from 24 to 1000 Hz, 9.9G rms
Environmental Protection	IP67
Operating temperature	-40° to +85° C
Storage temperature	- 50° to +90°
GPS/IMU	NovAtel ProPak6

4. Folder description

The folder of data set

```
data/                                                  // Scene data, sensor data, and parameter files
├── local_map                                          // Scene data
│   ├── image                                          // Rendered reflection intensity images
│   ├── map                                            // Binary files containing reflection and altitude
│   └── config.xml                                     // configuration file
├── bags                                               // Sensor data
│   ├── ***.bag                                        // Rosbag data of the first minute
│   ├── ***.bag                                        // Rosbag data of the second minute
│   └── ***.bag                                        // Rosbag data of the third minute
└── params                                             // Parameter files
    ├──velodyne64_novatel_extrinsics_example.yaml      // Lidar-imu extrinsic parameter
    ├──velodyne64_height.yaml                          // Distance between lidar and ground
    └──ant_imu_leverarm.yaml                           // Antenna-imu extrinsic parameter
```