Sensor Data Sample

Sensor data collected in an urban scene is provided here, including light detection and ranging (LiDAR), camera and radar data, which is the main source data of Apollo perception module.

LiDAR

The 3D range data is acquired by a Velodyne HDL64S3D, which is mounted on the top of the vehicle. The laser scanner rotates at a speed of 10Hz and covers a total vertical range of 26.8 degrees. Each point can be described with its 3D coordinates and reflected intensity of the laser.

Object detection and recognition algorithms are designed on the point cloud data to detect vehicles, pedestrians, bicyclists and so on, to make sure the autonomous driving system could recognize and avoid obstacles on the road.

The specification for HDL64S3D is as below:

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

LiDAR	HDL64S3D
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° C

Camera

Two monocular cameras are used to detect traffic lights and obstacles for Apollo perception module. Image data could provide rich visual features for autonomous driving system and help to recognize obstacle type and color of traffic lights.

The parameters for the two cameras are as below:

Camera	LI-USB30-AR023ZWDR
Resolution @ Frame rate	1920 x 1080 @ 15 fps, WDR
Sensor specification	ONSEMI AR023Z 1080p HD Sensor
HDR	95dB
Pixel size	3.0 um*3.0 um
Lens mount	CS mount
Color / Mono	Color
Focal Length	6.0 mm, 25 mm, respectively for two cameras
Electrical Interface	USB 3.0
Current consumption	Approx. 297 mA at 5 VDC

Radar

Radar could precisely estimate the velocity of moving obstacles, while LiDAR point cloud could give a better description of object shape and position. The autonomous driving system collects both the two sensor data to implement an obstacle fusion algorithm, which could output accurate object detection and tracking results for the following prediction and planning modules.

The specification for the radar is as below:

Radar	**Continental ARS 408-21**
Distance range	0.20 ...250 m far range, 0.20...70m/100m@0… ±45° near range and 0.20…20m@±60° near range
Resolution distance measuring	1.79 m far range, 0.39 m (0.20m@standstill) near range; ability to separate targets and objects 1.5…2 x resolution
Accuracy distance measuring	±0.40 m far range, ±0.10 m (±0.05m@standstill) near range
Resolution azimuth angle	1.6° far range, 3.2°@0° / 4.5°@±45° / 12.3°@ ±60° near; ability to separate targets and objects 1.5…2 x resolution
Accuracy azimuth angle	±0.1° far range, ±0.3°@0°/ ±1°@±45°/ ±5°@ ±60°near range
Velocity resolution	0.37 km/h far field, 0.43 km/h near range
Velocity accuracy	±0.1 km/h
Cycle time	app. 72ms near and far measurement