

AutoWare

Autoware

ROS-based OSS for Urban Self-driving Mobility

<https://github.com/CPFL/Autoware>

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Founder and CTO, Tier IV Inc.



A 3D rendered white metal chassis for a self-driving car. The chassis is rectangular with rounded corners and features a central gear-like sensor or camera lens. The sensor has a blue circular logo in the center. The chassis is supported by four legs and has various mounting points and slots for components. The text "How to build a self-driving autonomous vehicle using ROS?" is overlaid on the image in a bold, blue, sans-serif font.

How to build a self-driving autonomous vehicle using ROS?

- ✓ In urban city areas.
- ✓ Up to 40 mph velocity.
- ✓ Safety not certified.






Velodyne HDL-64e (3D LiDAR)

A close-up photograph of a Velodyne HDL-64e 3D LiDAR sensor. The sensor is a white cylindrical unit with the Velodyne logo, mounted on a silver aluminum frame. A red camera lens is visible below the LiDAR unit.



Point Grey Ladybug 5 (Camera)

A close-up photograph of a Point Grey Ladybug 5 camera. The camera is a small, black, cylindrical unit mounted on a silver aluminum frame. The brand name 'inno.' is visible on the side of the frame.



Velodyne HDL-32e (3D LiDAR)

A photograph of a Velodyne HDL-32e 3D LiDAR sensor mounted on a black metal frame. The sensor is a white cylindrical unit with a green light on top. The background shows a city street with buildings and trees.



Velodyne VLP-16 (3D LiDAR)

A photograph of a Velodyne VLP-16 3D LiDAR sensor mounted on a black metal frame. The sensor is a white cylindrical unit with a blue light on top. The background shows a city street with buildings and trees.



IBEO LUX 8L (3D LiDAR)

A photograph of an IBEO LUX 8L 3D LiDAR sensor mounted on a white car. The sensor is a white cylindrical unit with a black frame. The background shows a city street with buildings and trees.



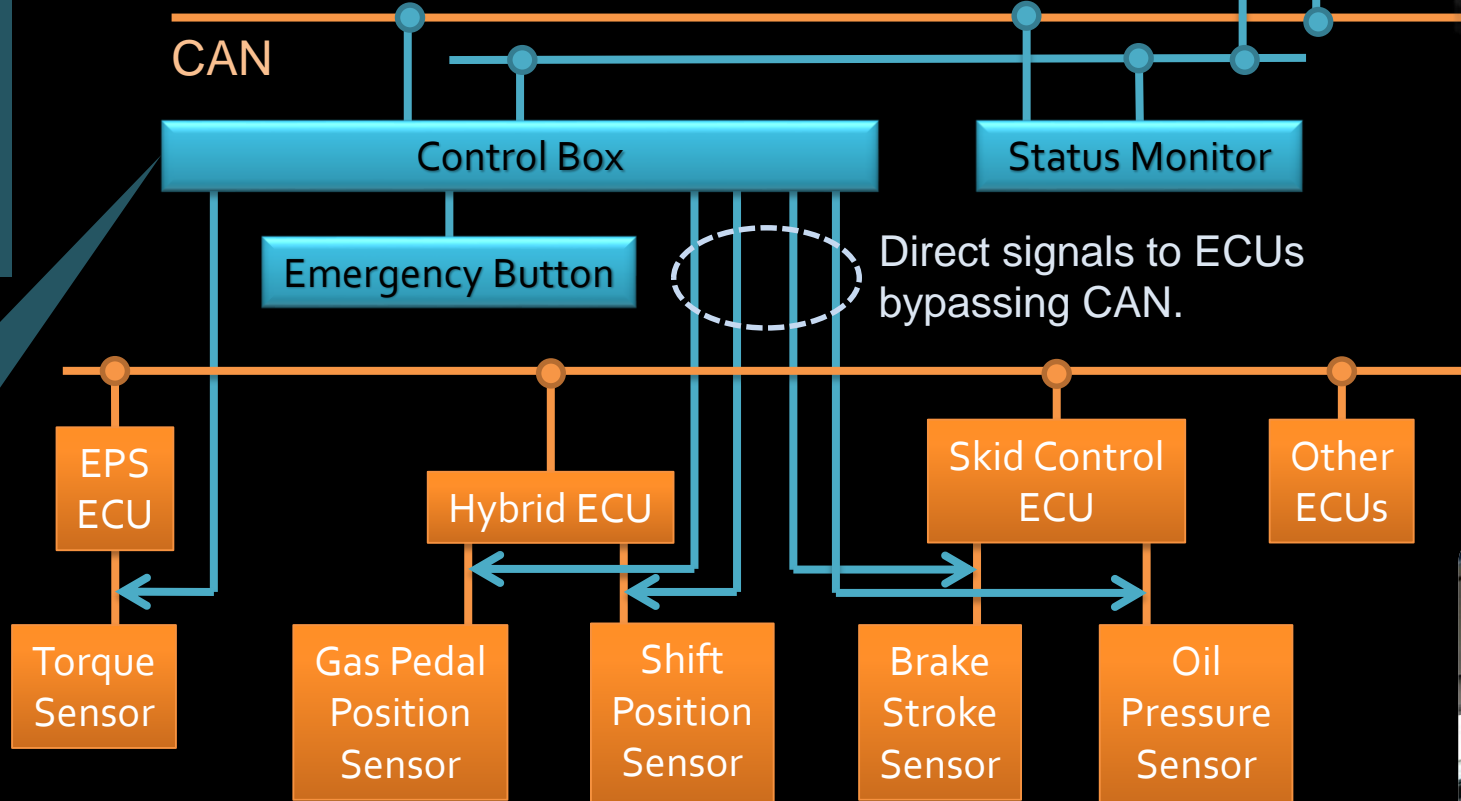
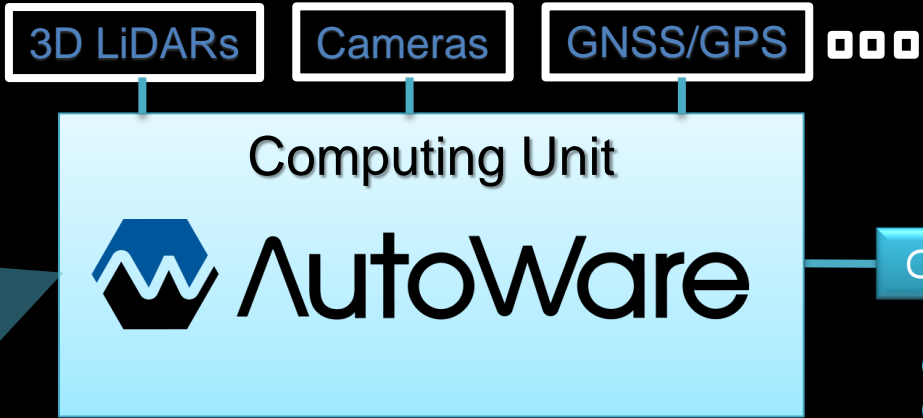
JAVAD RTK-GNSS (GNSS/GPS)

A photograph of a JAVAD RTK-GNSS sensor mounted on a white car. The sensor is a small, black, cylindrical unit with a green light on top. The background shows a city street with buildings and trees.



Point Grey Grasshopper3 (Camera)

A photograph of a Point Grey Grasshopper3 camera mounted on a white car. The camera is a black, cylindrical unit with a lens. The background shows a city street with buildings and trees.



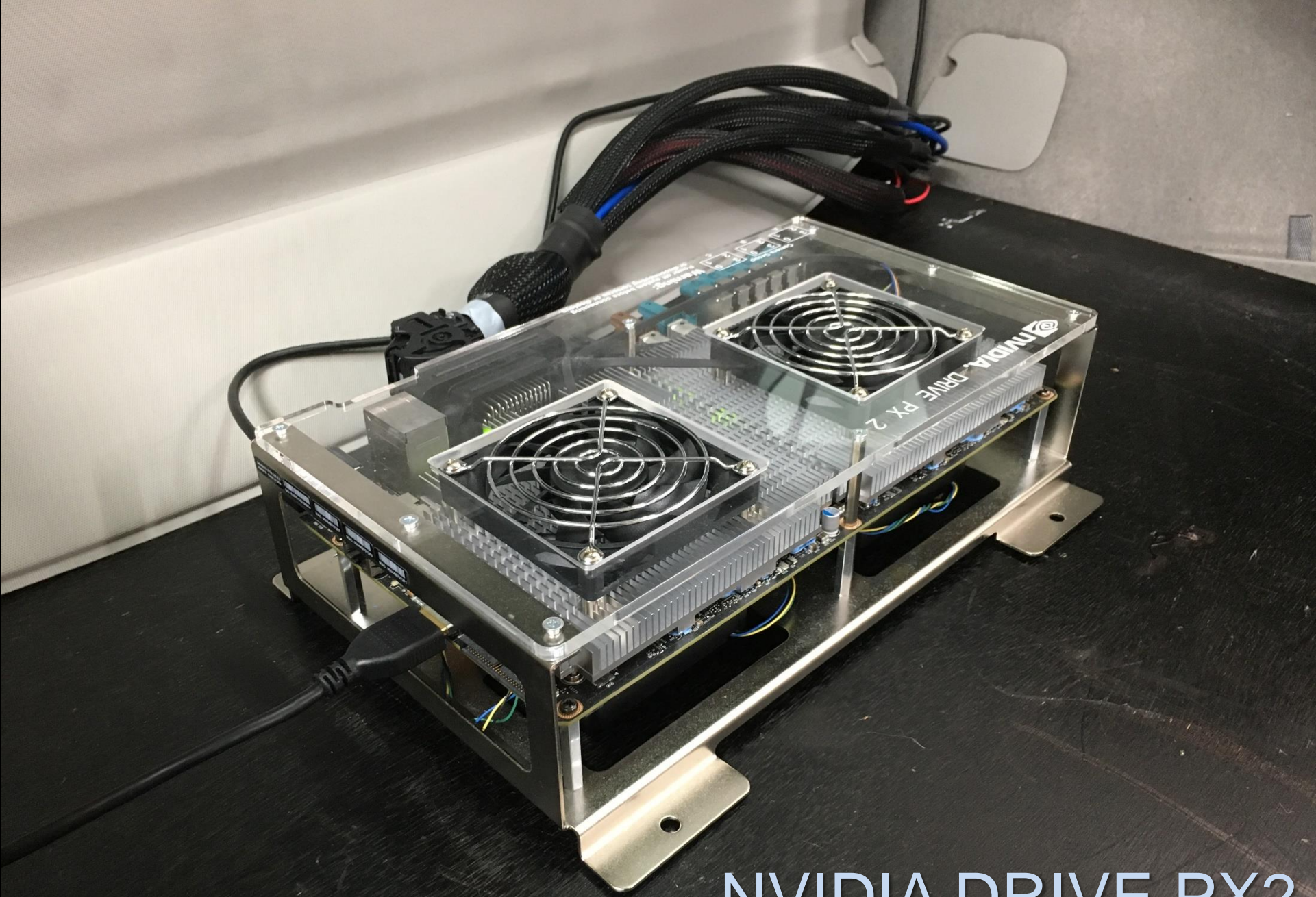
Reconnected wires.



Accessories.



Car interior monitors.



NVIDIA DRIVE PX2



```

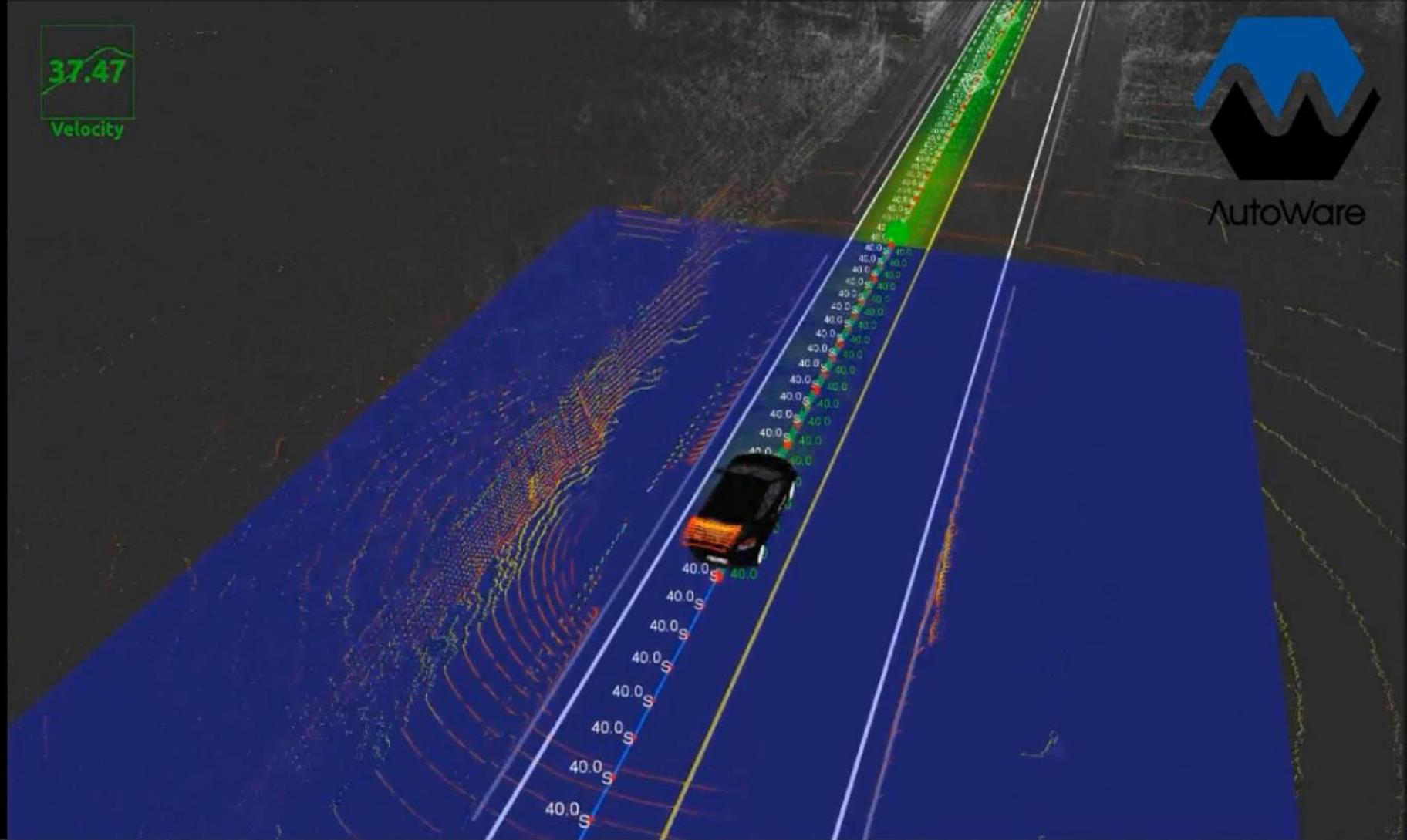
nvidia@tegra-A_ubuntu: ~/Autoware/ros
nvidia@tegra-A_ubuntu: ~/Autoware/ros$ .

```



Aisan Technology's Minivan (ZMP RoboCar)





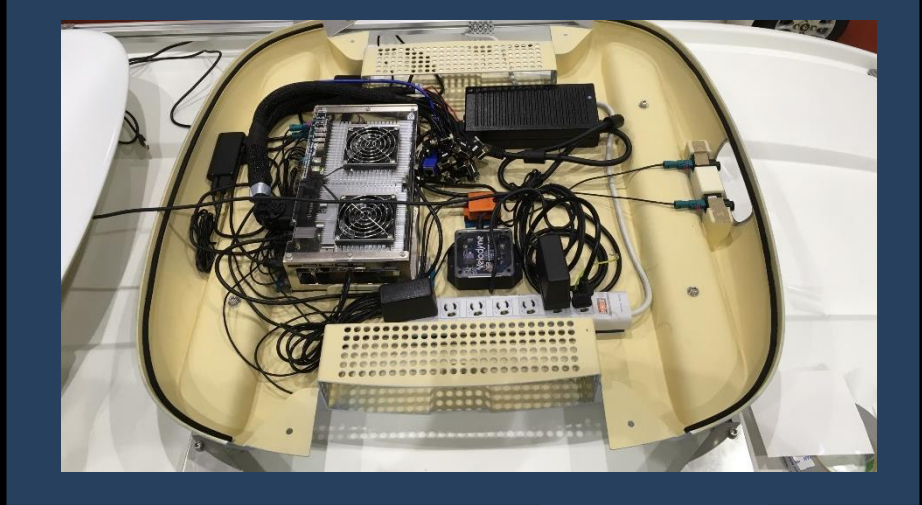
37.47
Velocity



 **Tier IV**
Intelligent Vehicle

Public road demonstration

Yamaha Motor's Golf Cart



Yamaha Motor's Baggy







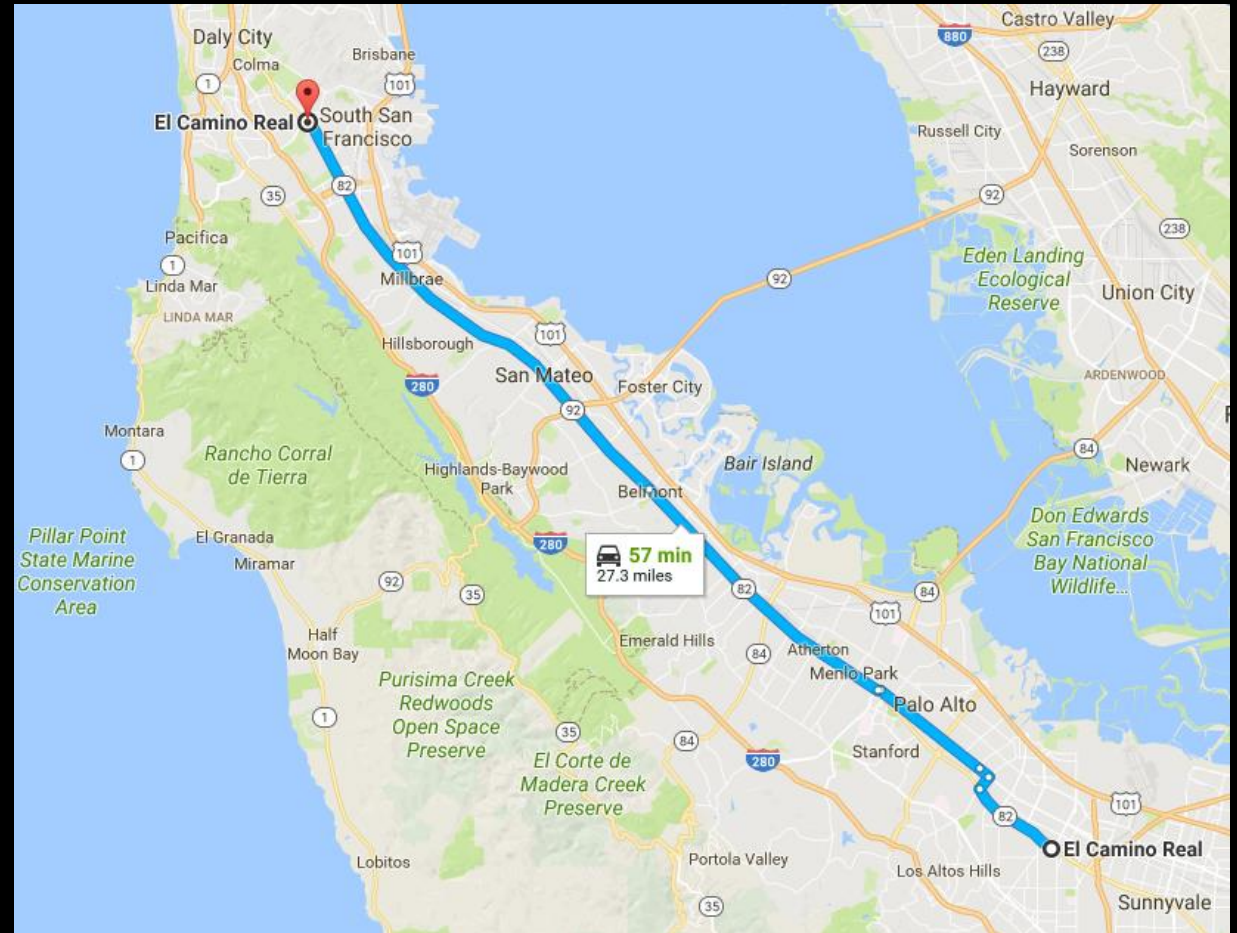
October 25, 2016 1:00 pm JST

Udacity, Tier IV tie up in driverless car development

KAZUYUKI OKUDAIRA, Nikkei staff writer



To help develop a new autonomous vehicle, contestant ideas will be tested using Udacity's Lincoln MKZ.



31 miles along the El Camino Real in the Bay Area along 140 traffic signals and crosswalks during regular traffic over a period of an hour-and-a-half.

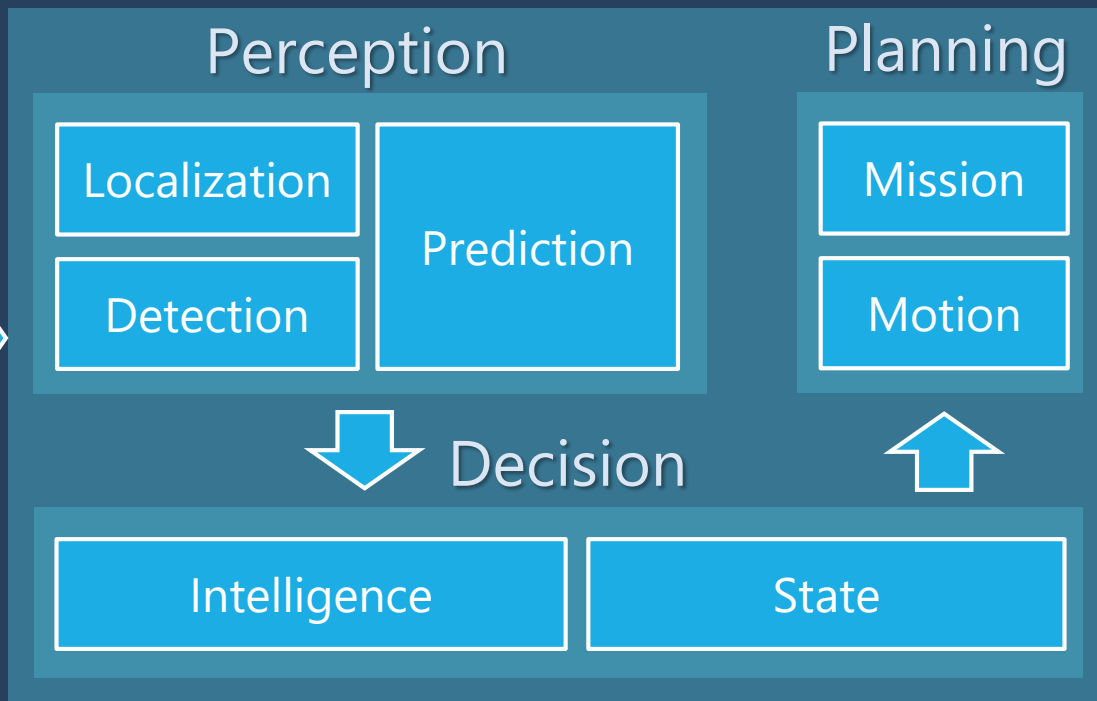


Autoware

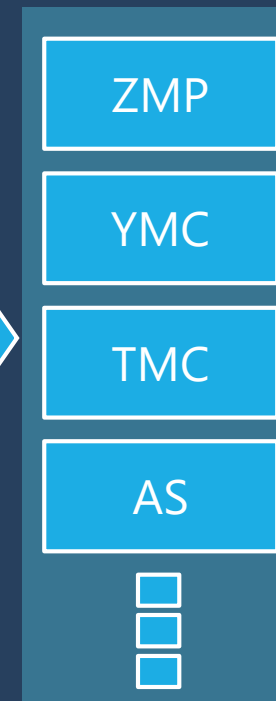
Sensing



Computing



Actuation



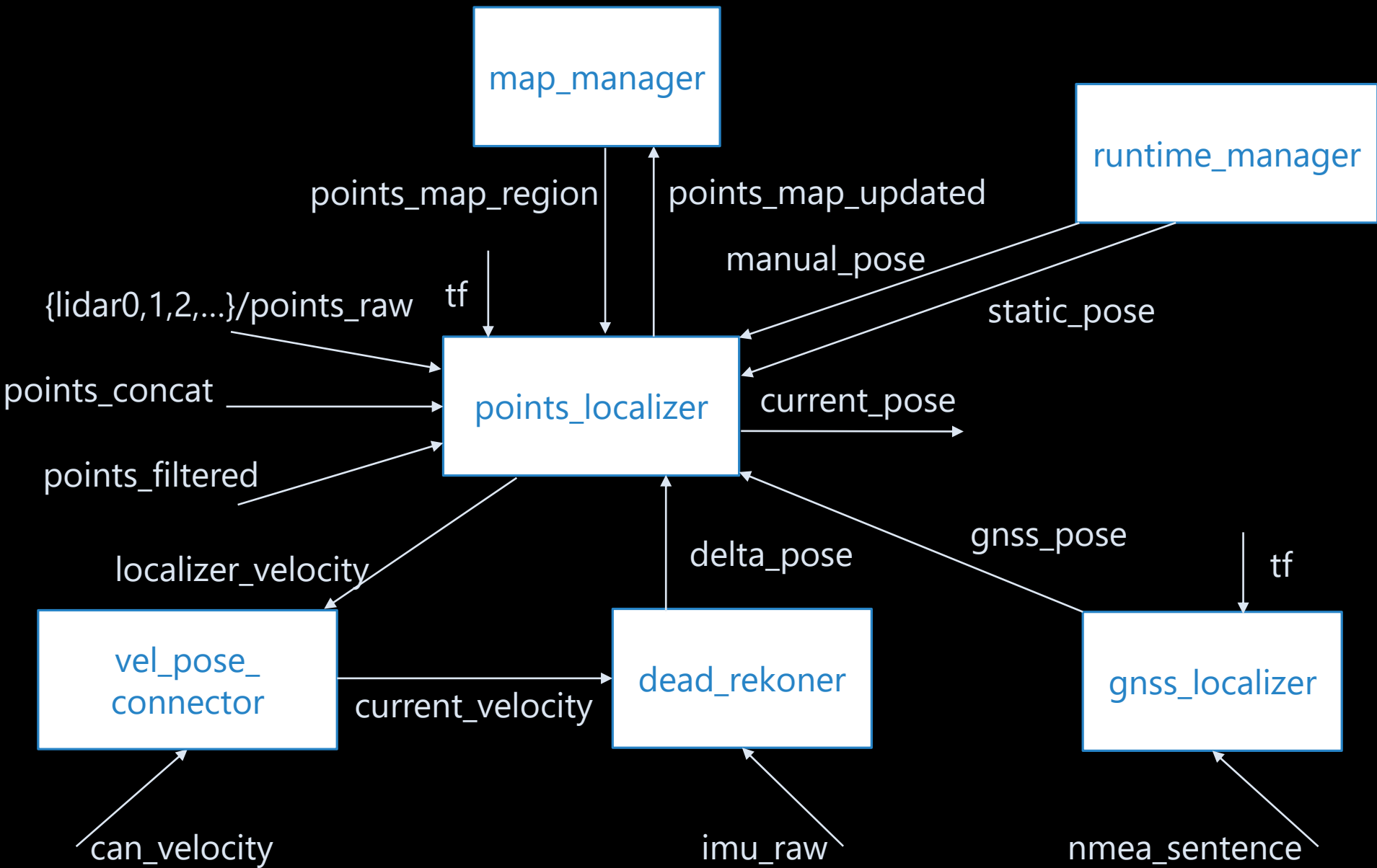
Data

Socket

System

Util

Packages Example (Localization)



WING over the World
AISAN TECHNOLOGY



Aisan Technology (Partner Company)

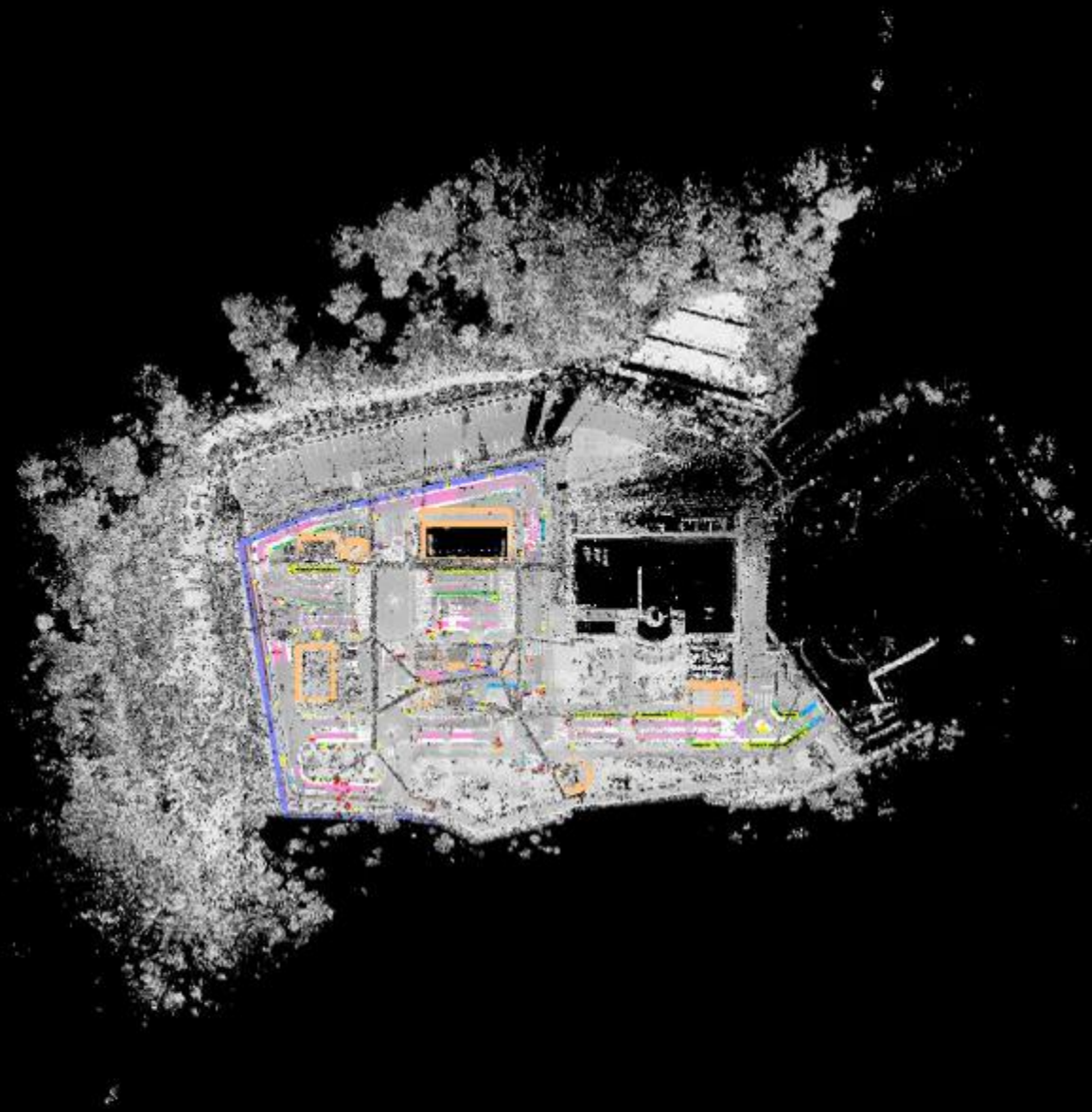




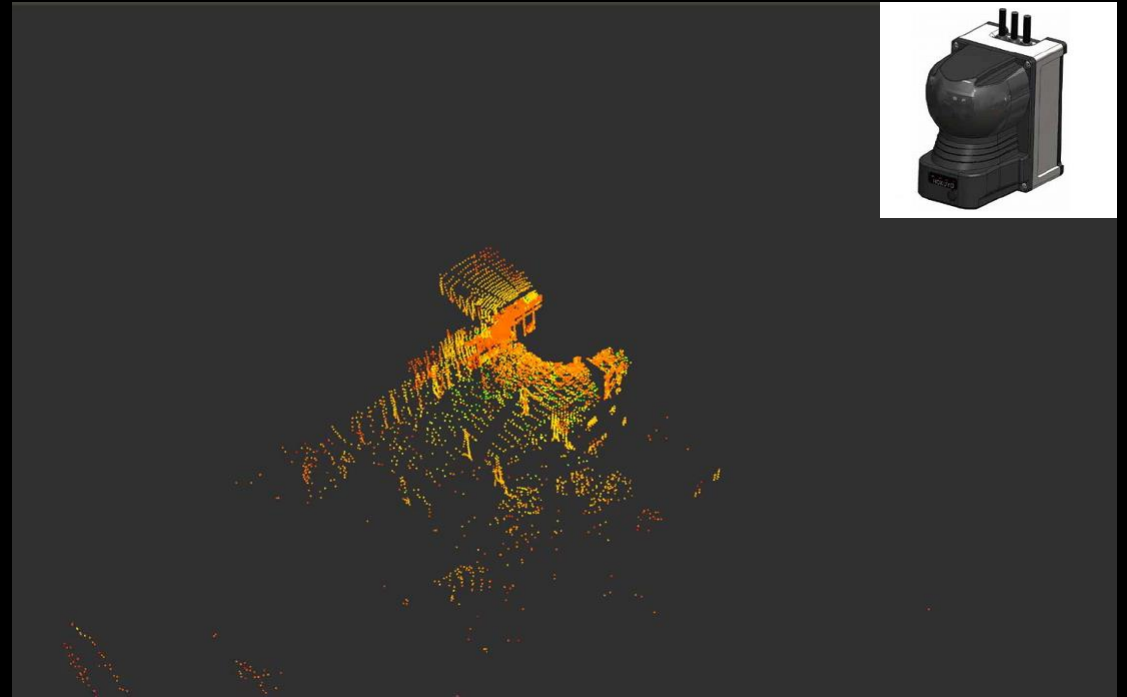
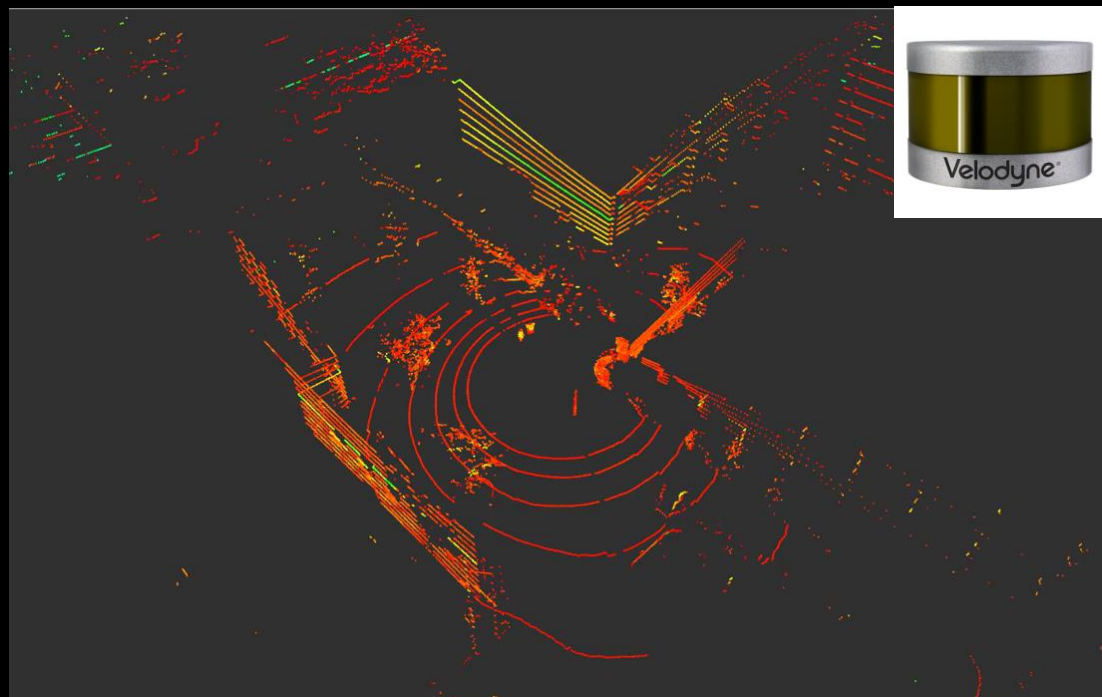
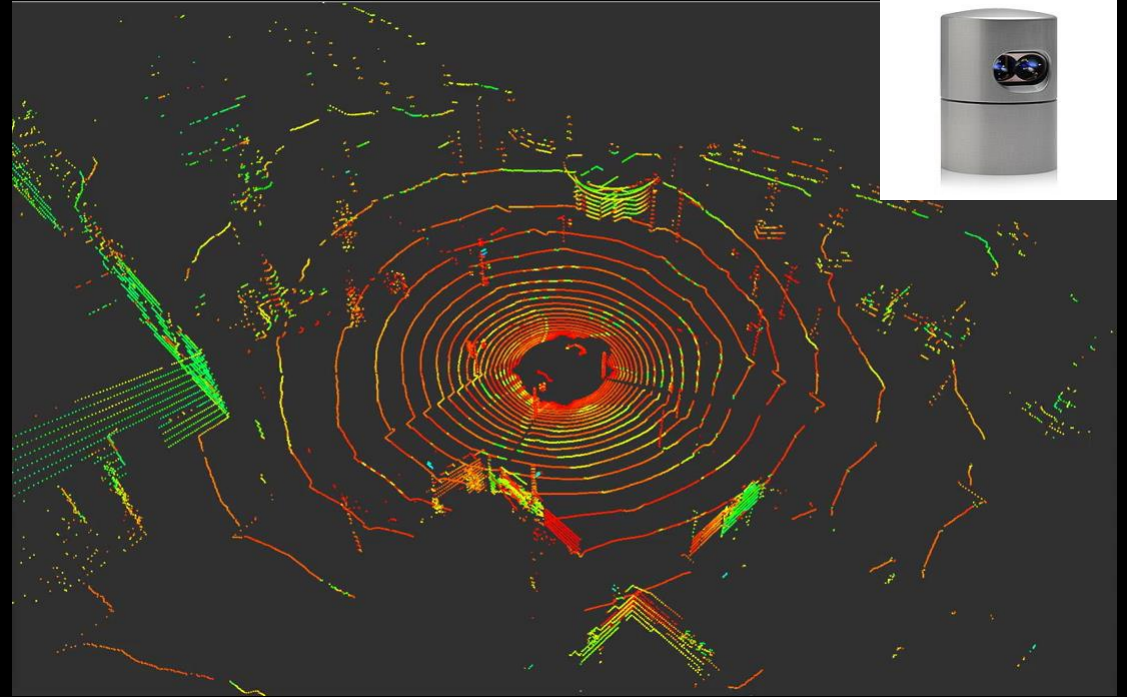
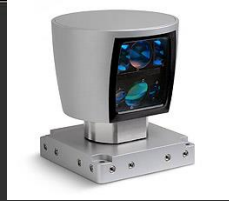
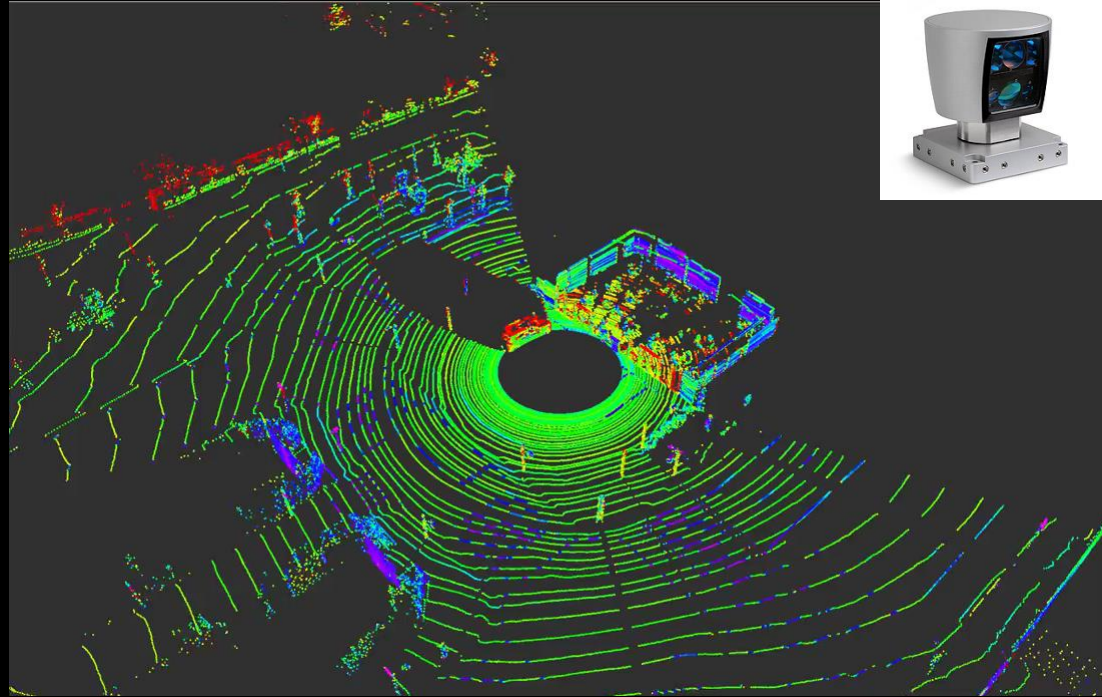
High-Definition 3D Mapping



High-Definition 3D Mapping





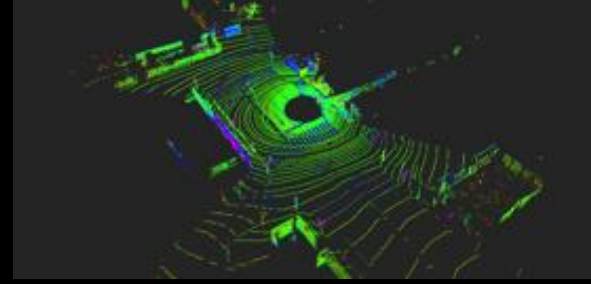


Normal Transform Distributions (NDT) for Localization

3D map data

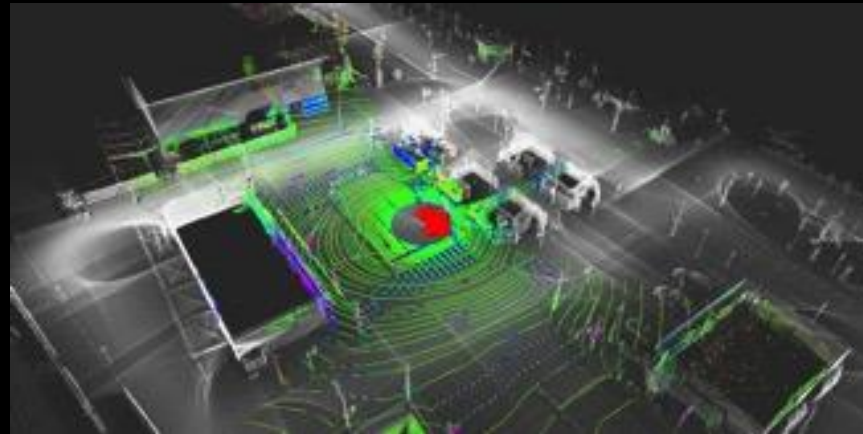


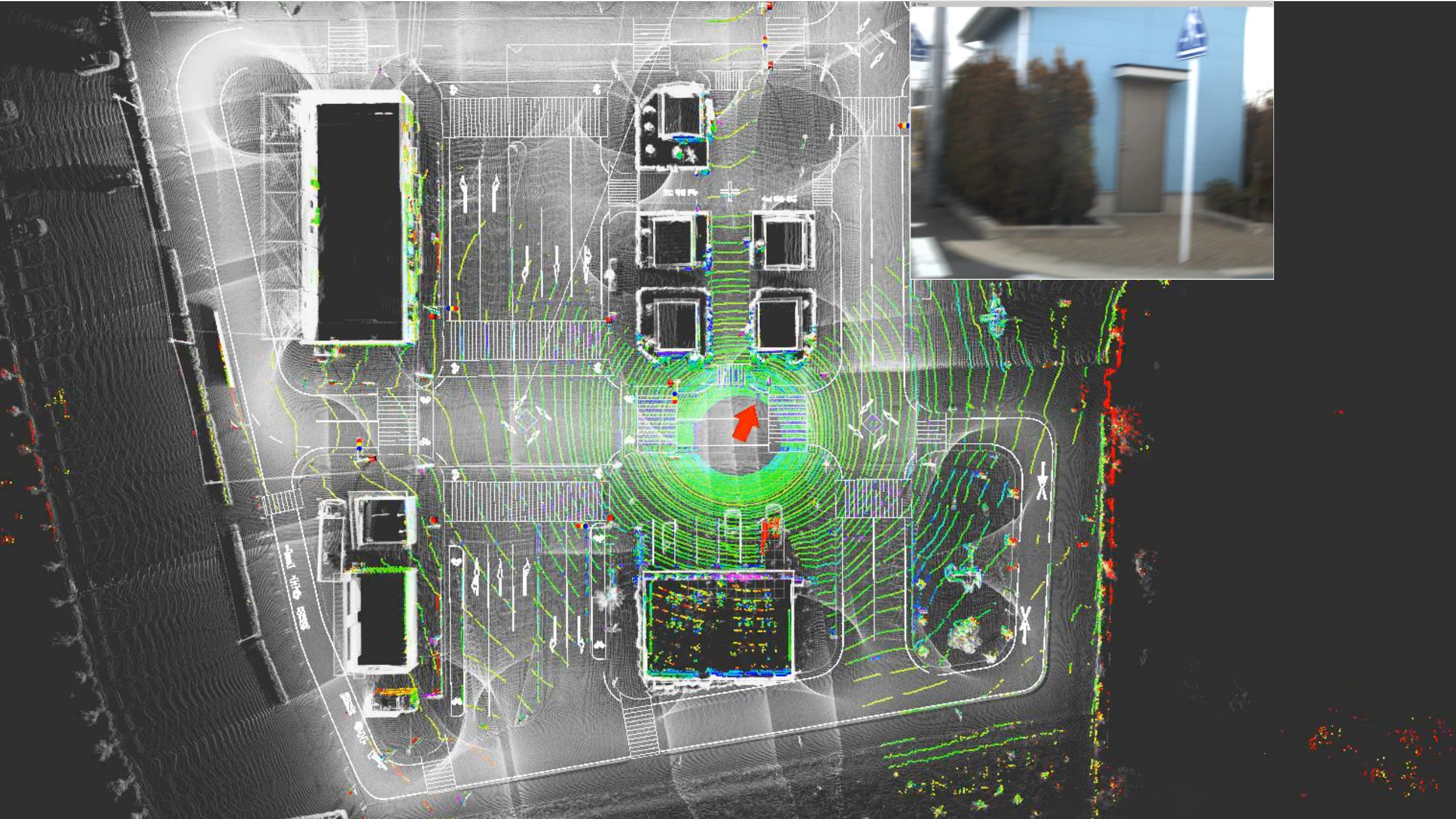
Sensor scan data



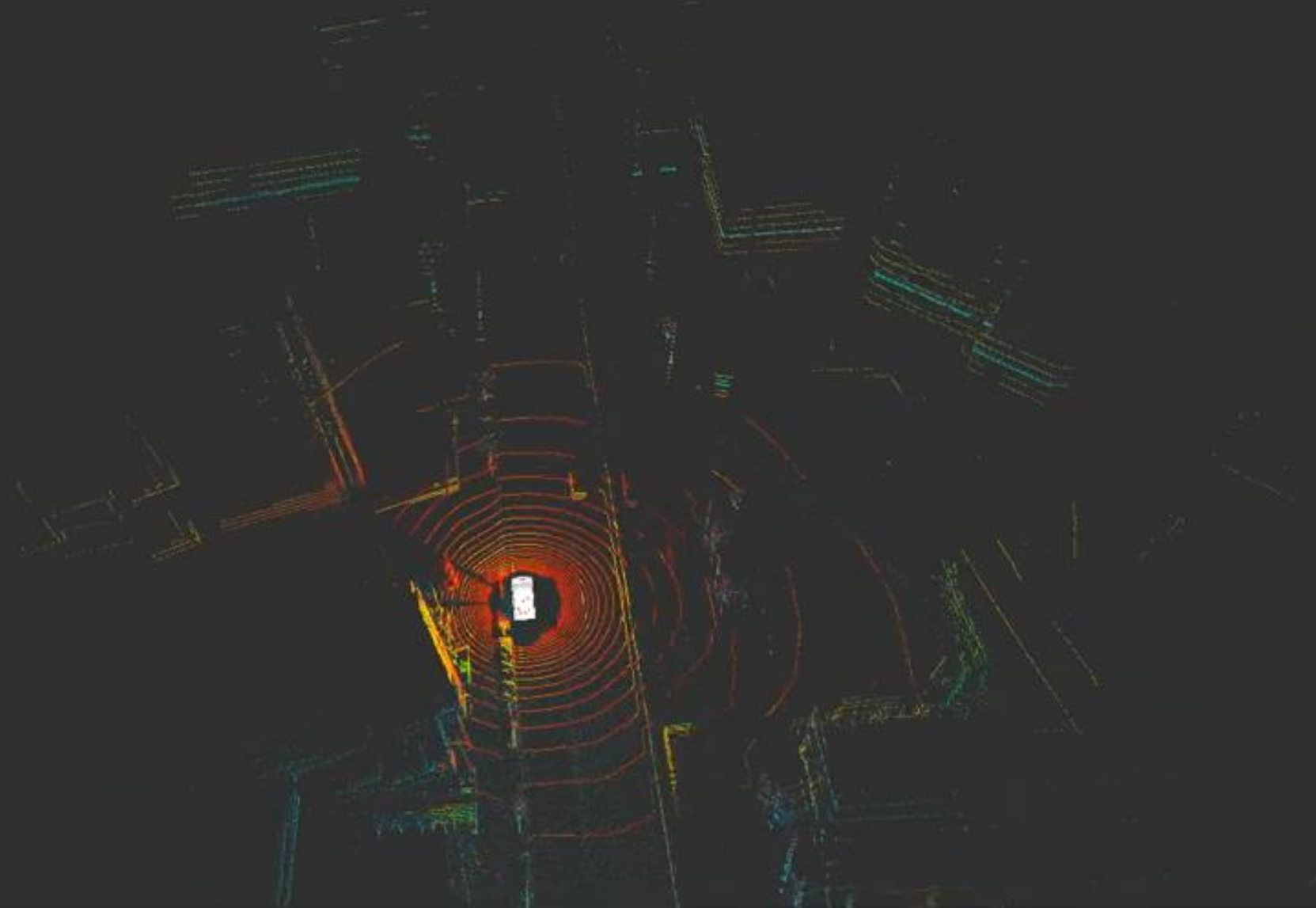
Matching

Localization



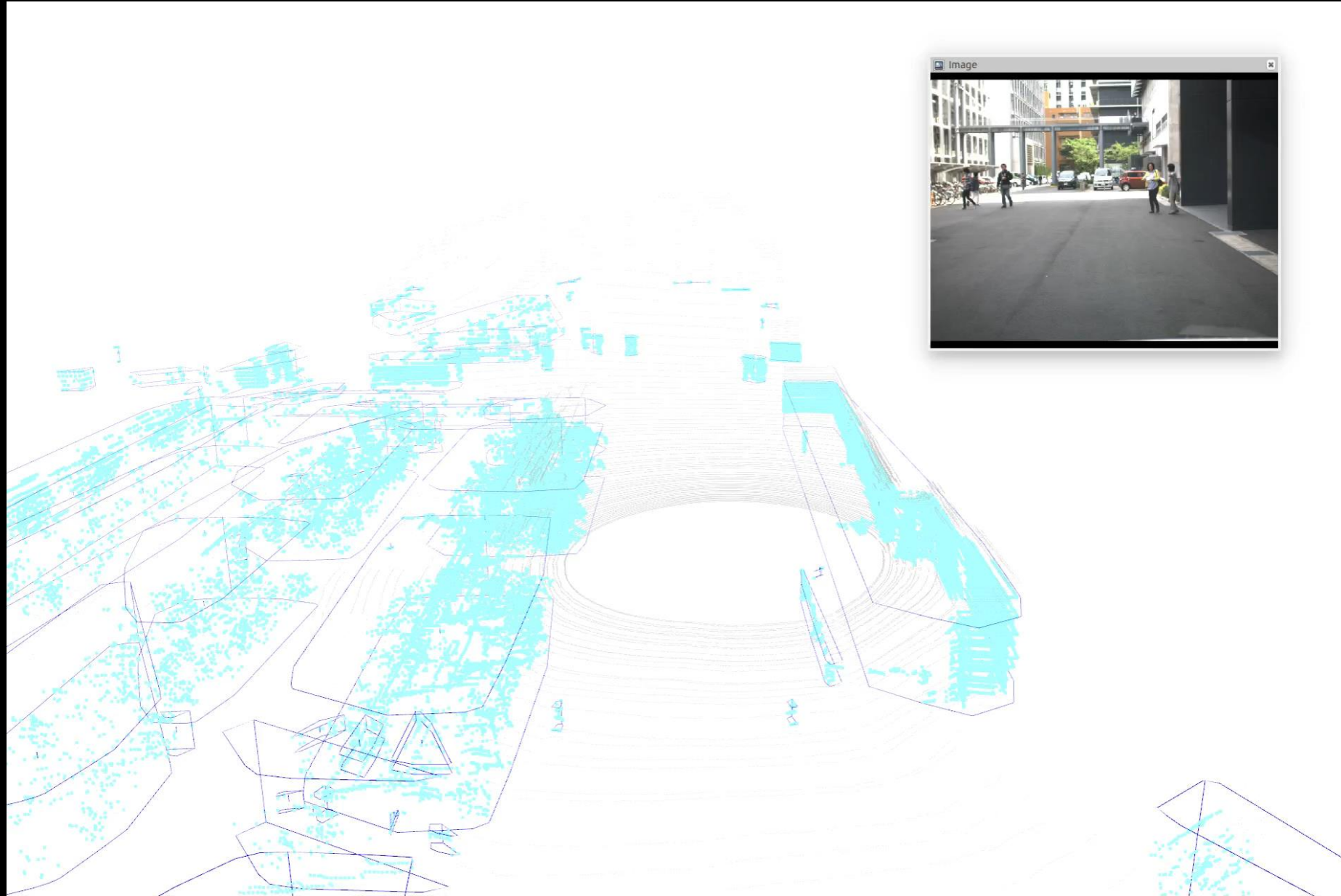


Normal Transform Distributions (NDT) for Mapping





Euclidean Clustering for Detection

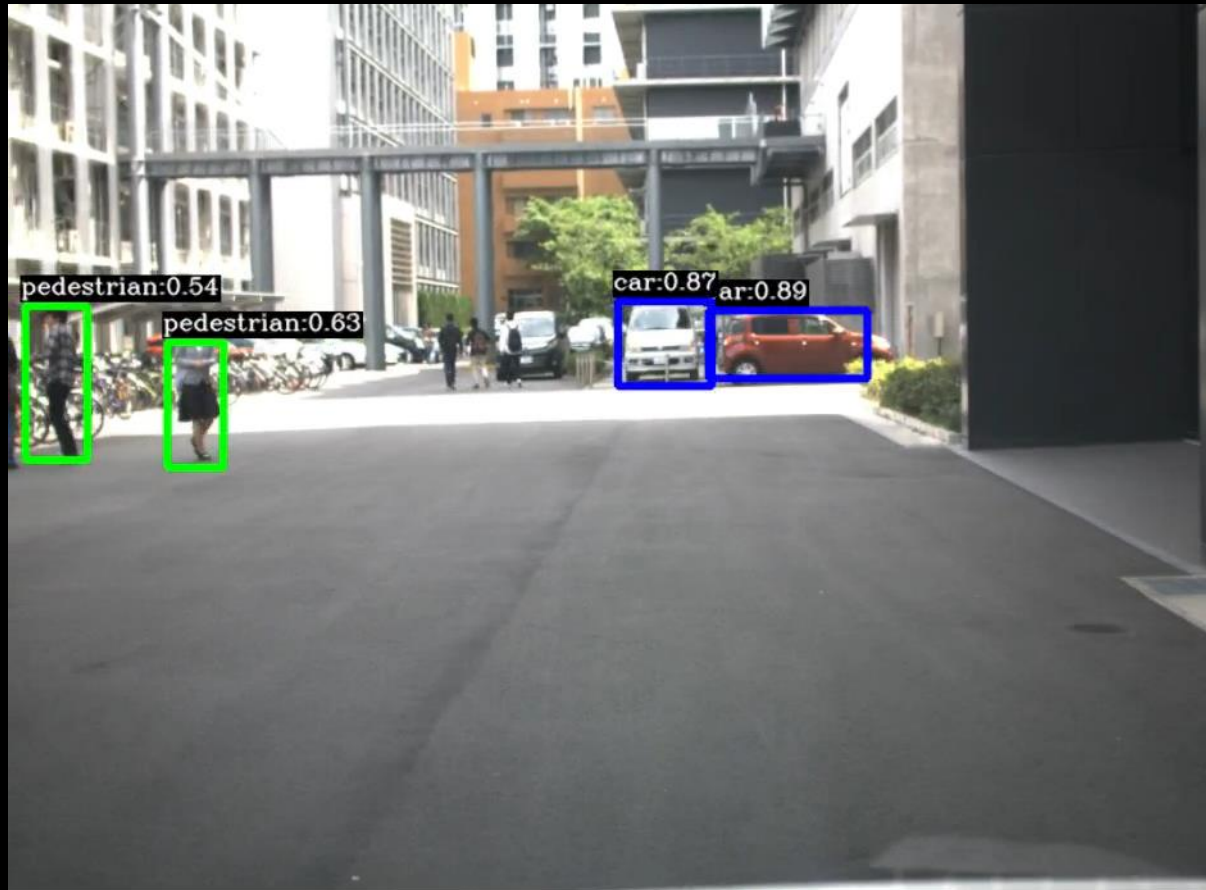


Convolutional Neural Networks (CNN) for Detection

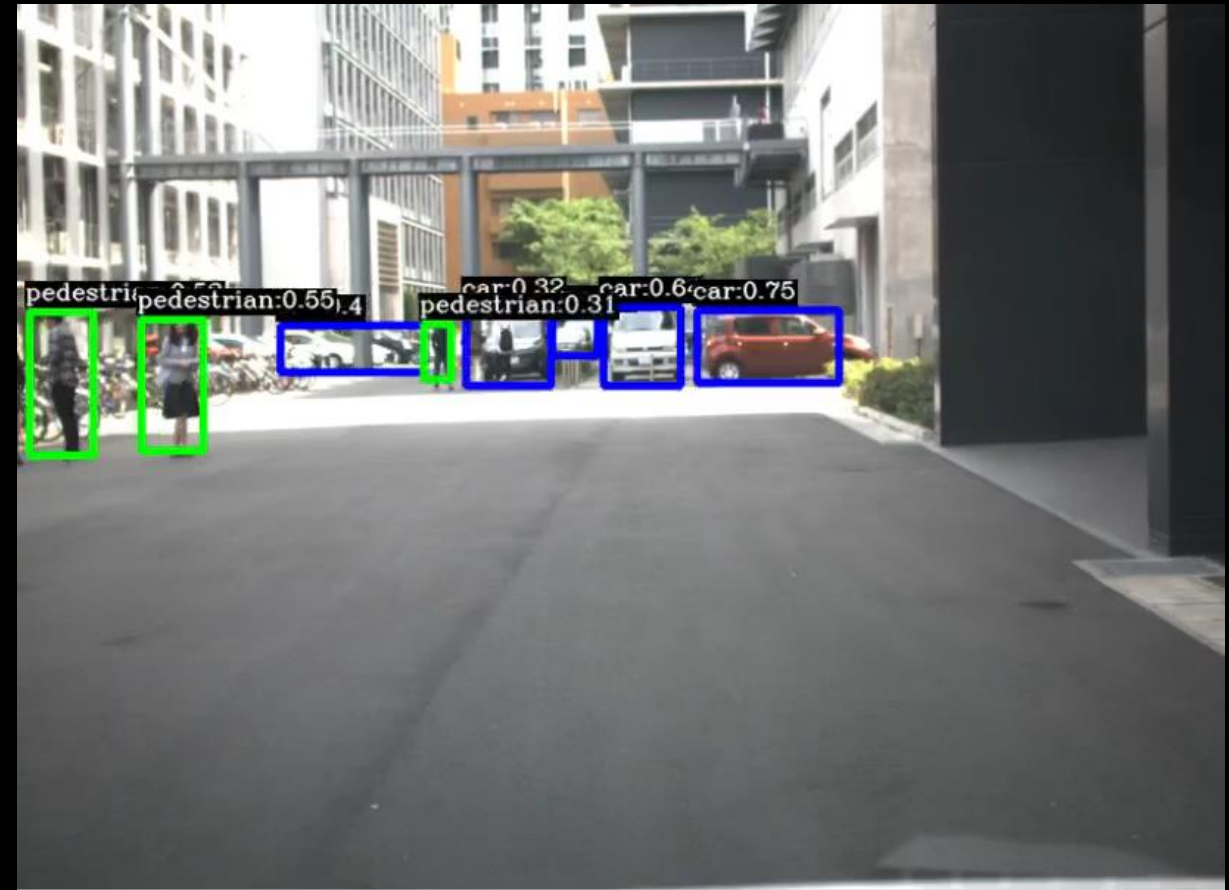


Convolutional Neural Networks (CNN) for Detection

SSD

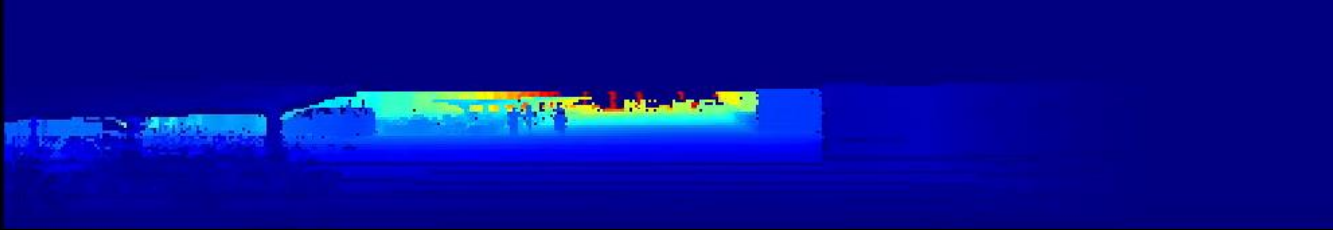


Yolo2

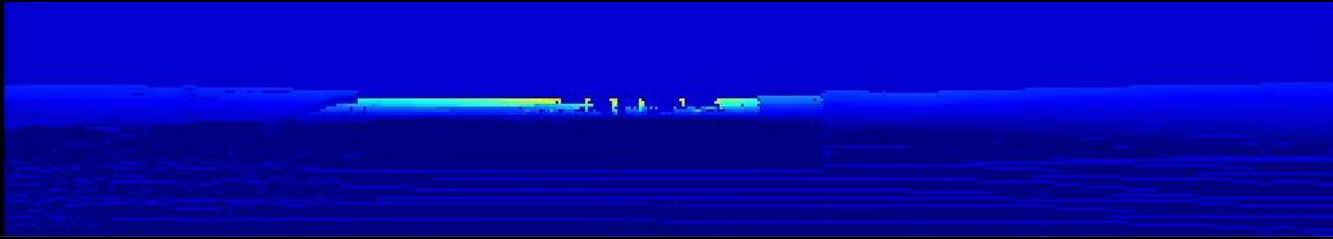


Convolutional Neural Networks (CNN) for Detection

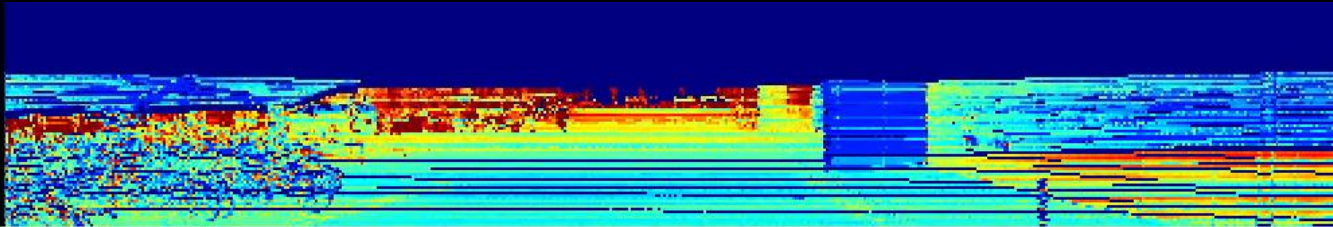
Depth Image



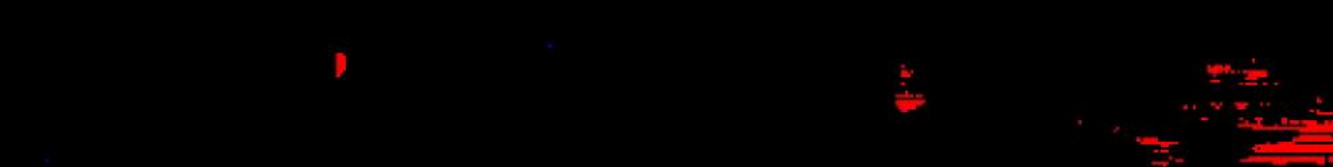
Height Image



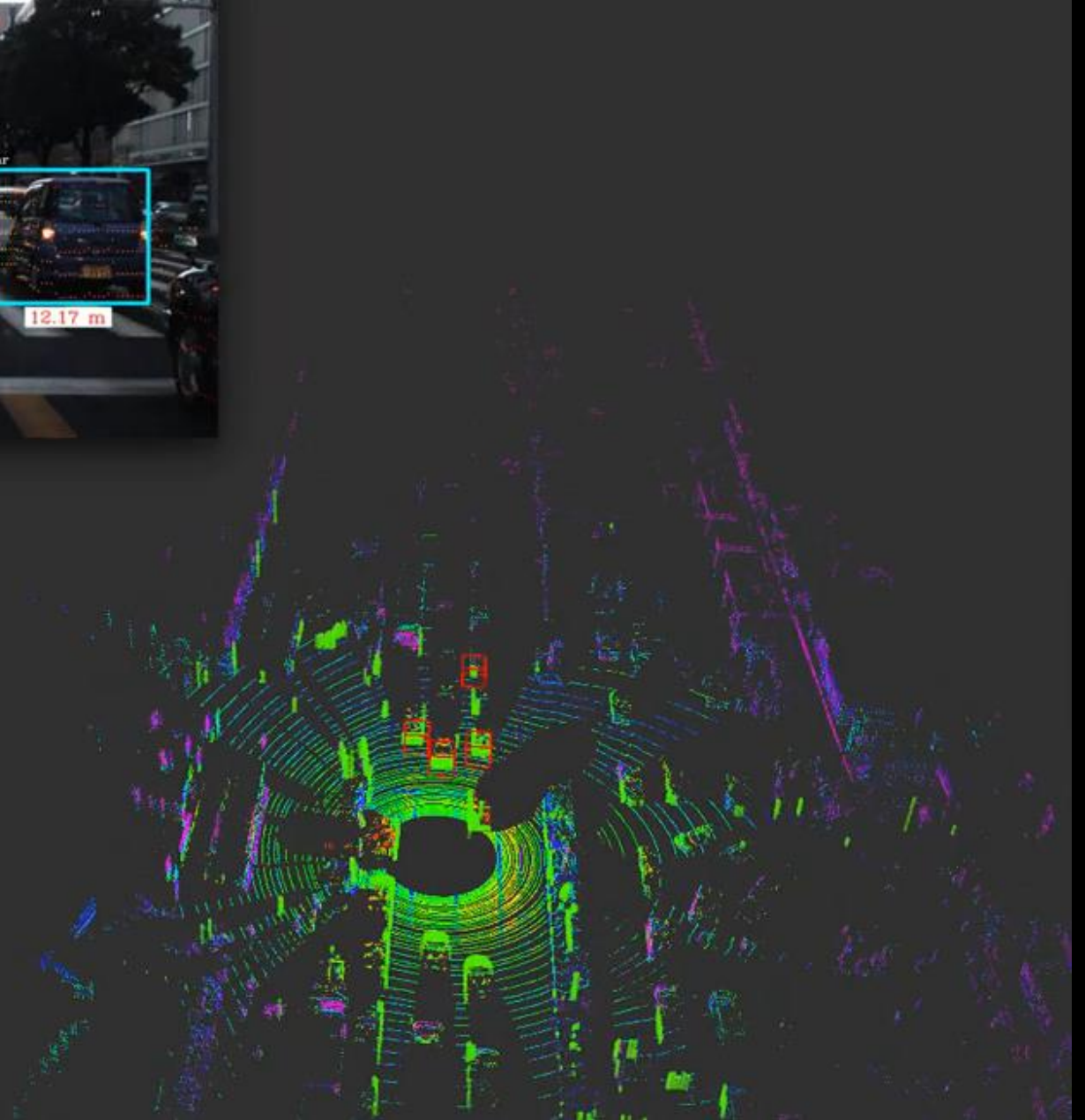
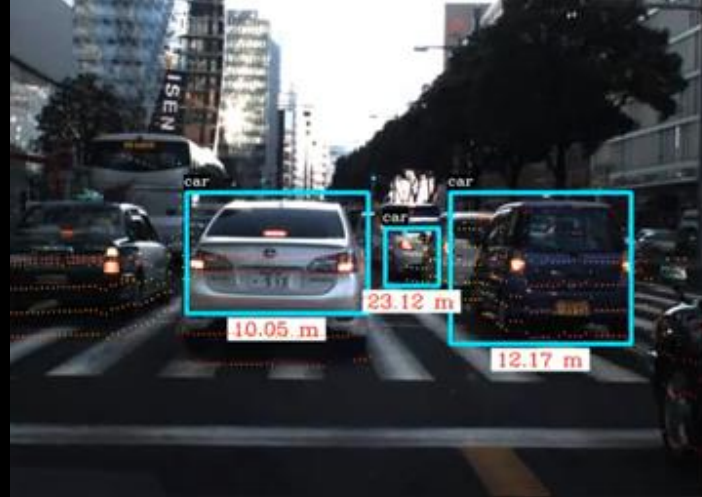
Intensity Image



CNN Segments



Camera-LiDAR Calibration and Sensor Fusion



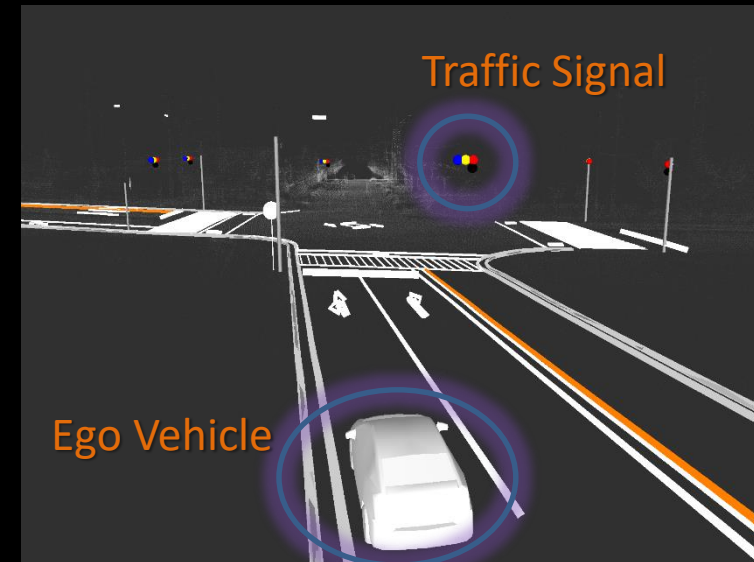
KITTI Dataset Plugin



Traffic Light Recognition using 3D Map Information

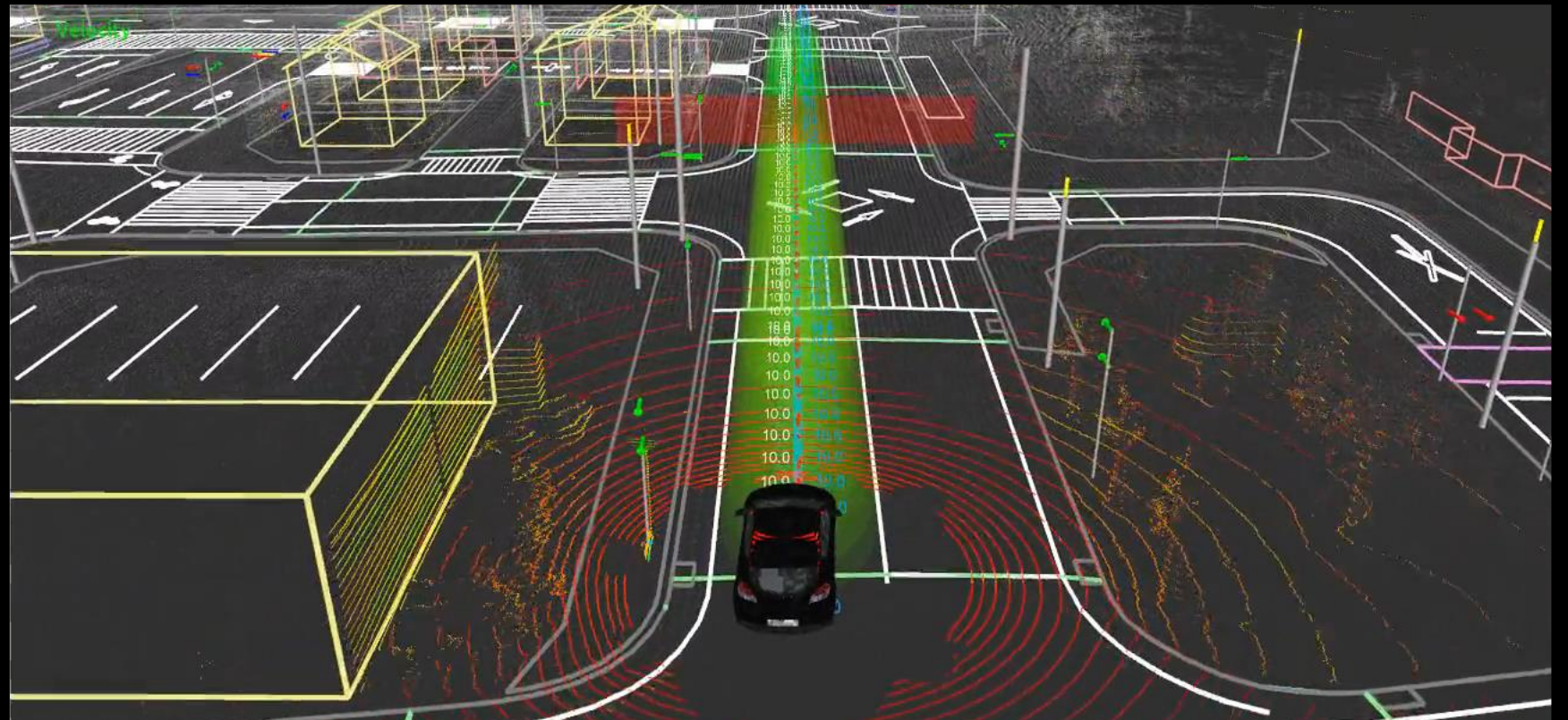


NO SIGNAL DETECTED

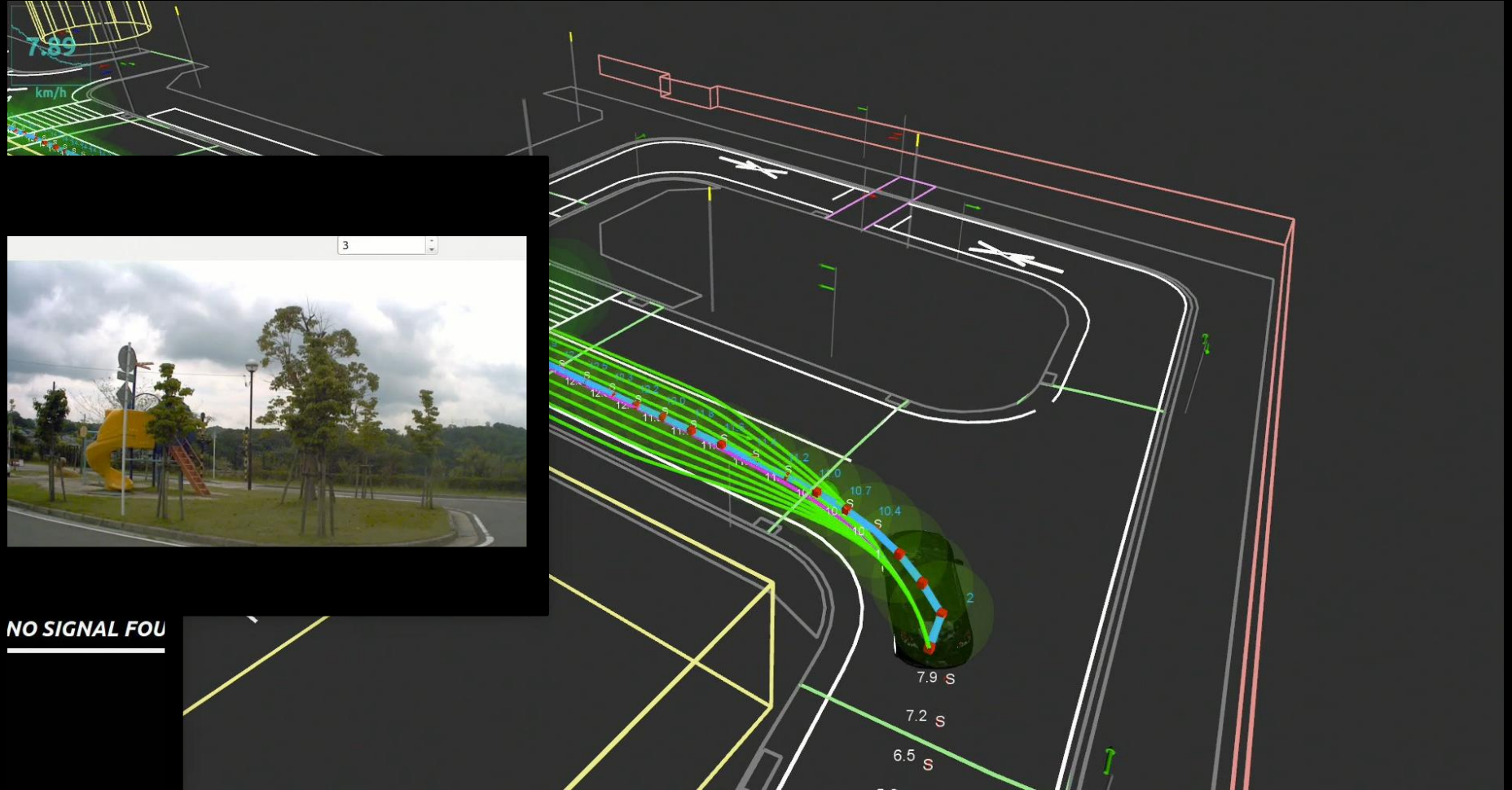




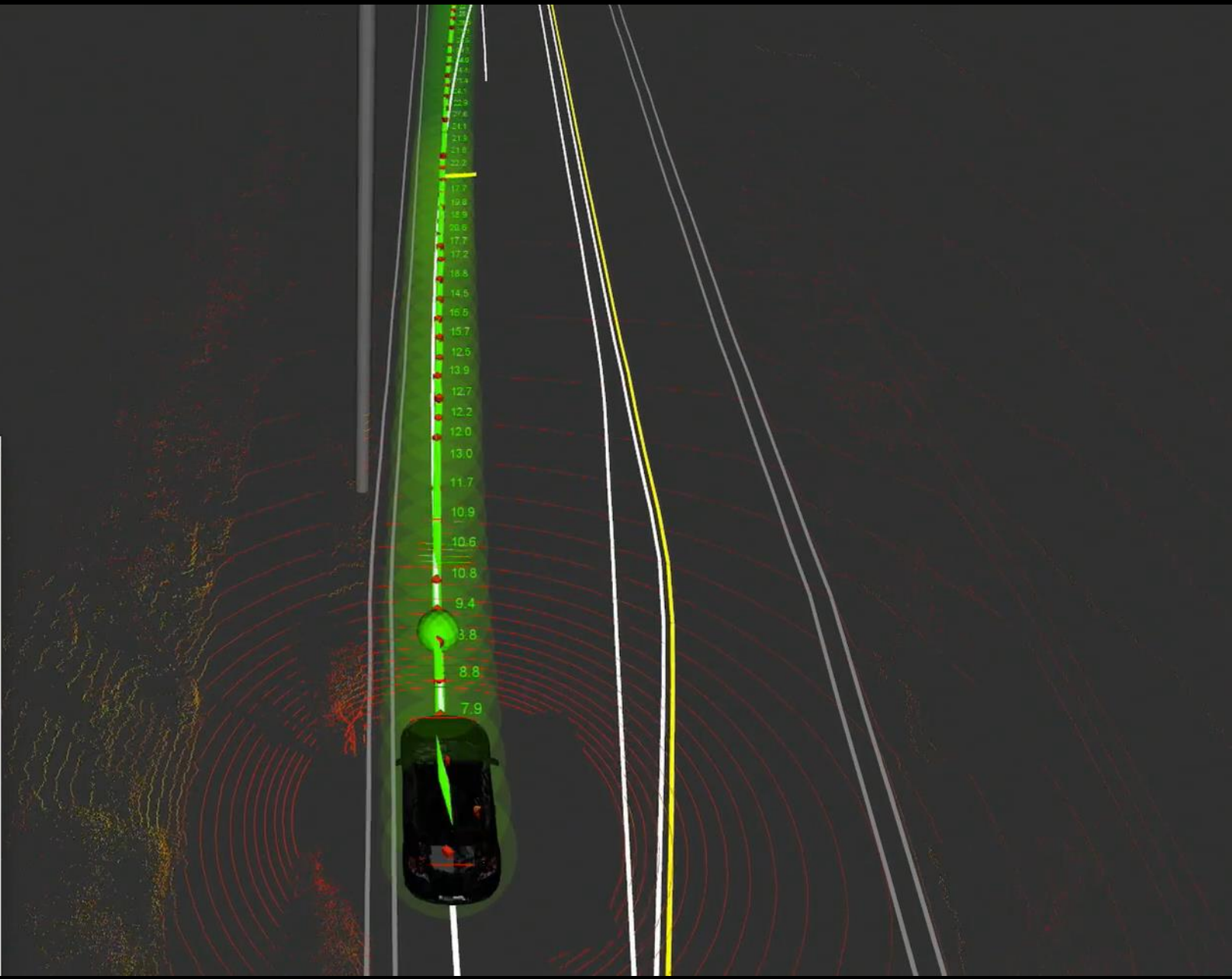
A* Search for Path Planning (Trajectory Generation)



State Lattice for Path Planning (Trajectory Generation)



Pure Pursuit for Path (Waypoints) Following



Task Trace Tool (Ftrace)

Runtime Manager

```
roscore http://autoware1:11311/
auto-starting new master
process[roscpp-core-1]: started with pid [7385]
ROS_MASTER_URI=http://autoware1:11311/
setting /run_id to cf579604-5ae7-11e6-802c-7824af4367a0
process[rosout-1]: started with pid [7415]
started core service [/rosout]

ROSドキュメント
autoware@autoware1: /home/iwasaki/Autoware/ros
Exception in thread ftrace_cont:
Traceback (most recent call last):
  File "/usr/lib/python2.7/threading.py", line 810, in __bootstrap_inner
    self.run()
  File "/usr/lib/python2.7/threading.py", line 763, in run
    self.__target(*self.__args, **self.__kwargs)
  File "/home/iwasaki/Autoware/ros/src/util/packages/runtime_manager/scripts/pro
c_manager.py", line 182, in get_ftrace_cont
    self._filterNodePid(pids)
  File "/home/iwasaki/Autoware/ros/src/util/packages/runtime_manager/scripts/pro
c_manager.py", line 164, in _filterNodePid
    f.close()
IOError: [Errno 22] Invalid argument

ftrace disconnected
[sched_setscheduler] pid=8072, priority=SCHED_OTHER
[sched_setscheduler] pid=8104, priority=SCHED_OTHER
[sched_setscheduler] pid=8376, priority=SCHED_OTHER
[sched_setscheduler] pid=8379, priority=SCHED_OTHER
[sched_setscheduler] pid=8380, priority=SCHED_OTHER
[sched_setscheduler] pid=8456, priority=SCHED_OTHER
[sched_setscheduler] pid=8503, priority=SCHED_OTHER
```

Runtime Manager

Quick Start Setup Map Sensing Computing Interface Database Simulation Status Topics

```
top - 17:40:52 up 1 day, 5:19, 13 users, load average: 0.28, 3.16, 3.78
Tasks: 363 total, 1 running, 360 sleeping, 0 stopped, 2 zombie
%Cpu0 :  0.0 us,  0.0 sy,  0.0 ni,100.0 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
%Cpu1 :  0.0 us,  0.0 sy,  0.0 ni,100.0 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
%Cpu2 :  8.3 us,  0.0 sy,  0.0 ni, 91.7 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
%Cpu3 :  0.0 us,  0.0 sy,  0.0 ni,100.0 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
%Cpu4 : 16.7 us,  0.0 sy,  0.0 ni, 83.3 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
%Cpu5 :  0.0 us,  0.0 sy,  0.0 ni,100.0 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
%Cpu6 :  0.0 us,  0.0 sy,  0.0 ni,100.0 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
```

System Monitor Ftrace ROSBAG RViz RQT

CPU	Usage
CPU0	0.0%
CPU1	0.0%
CPU2	8.3%
CPU3	0.0%
CPU4	16.7%
CPU5	0.0%
CPU6	0.0%
CPU7	0.0%
Memory	1GB/31GB(6%)

AutoWare

To disable this check run with `--no-wm-check` (though that is not advised, since it will probably produce faulty results).

```
Initializing...
Buffer size adjusted to 4096 from 4096 frames.
Opened PCM device default
Recording on device default is set to:
1 channels at 22050Hz
Capturing!
X Error: BadAccess (attempt to access private resource denied)
Bad Access on XGrabKey.
Shortcut already assigned.
X Error: BadAccess (attempt to access private resource denied)
Bad Access on XGrabKey.
Shortcut already assigned.
X Error: BadAccess (attempt to access private resource denied)
Bad Access on XGrabKey.
Shortcut already assigned.
X Error: BadAccess (attempt to access private resource denied)
Bad Access on XGrabKey.
Shortcut already assigned.
```



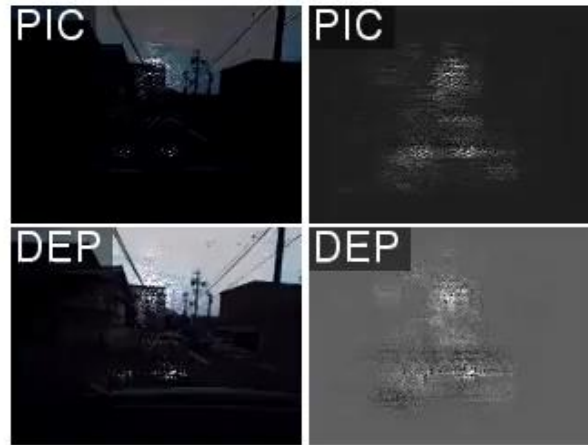
Automan

<https://www.automan.ai>

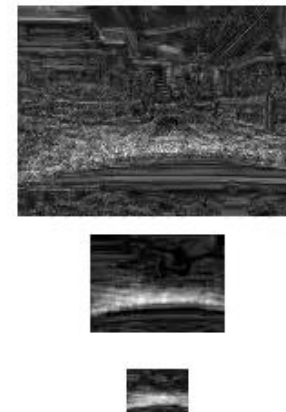
Input



Saliency



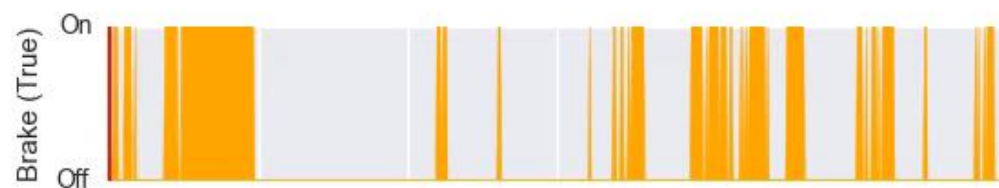
Network



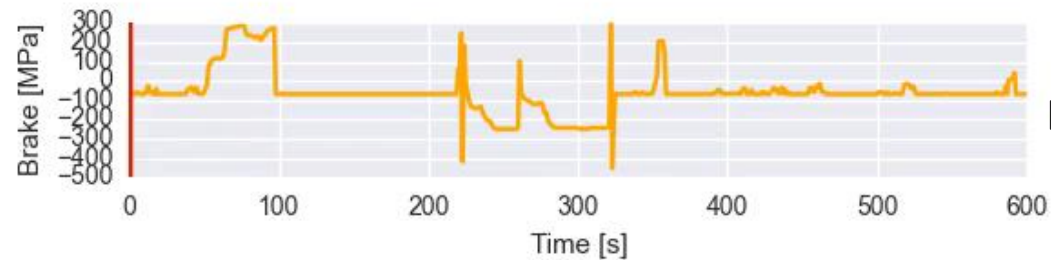
*Brake
or
Not to Brake?*



DNN Prediction

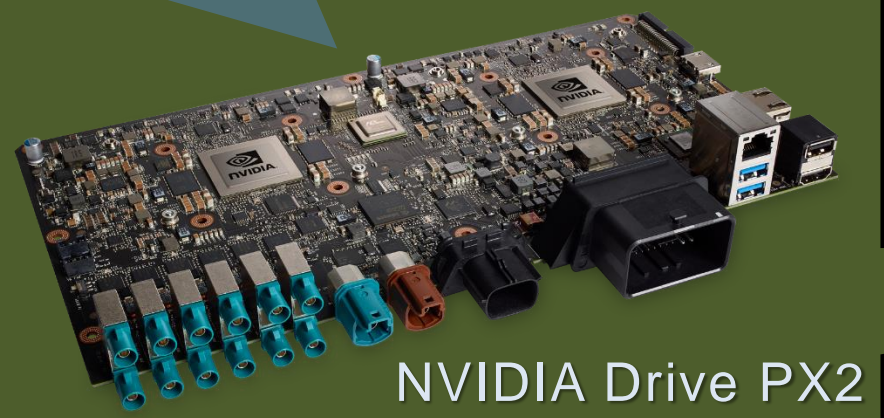
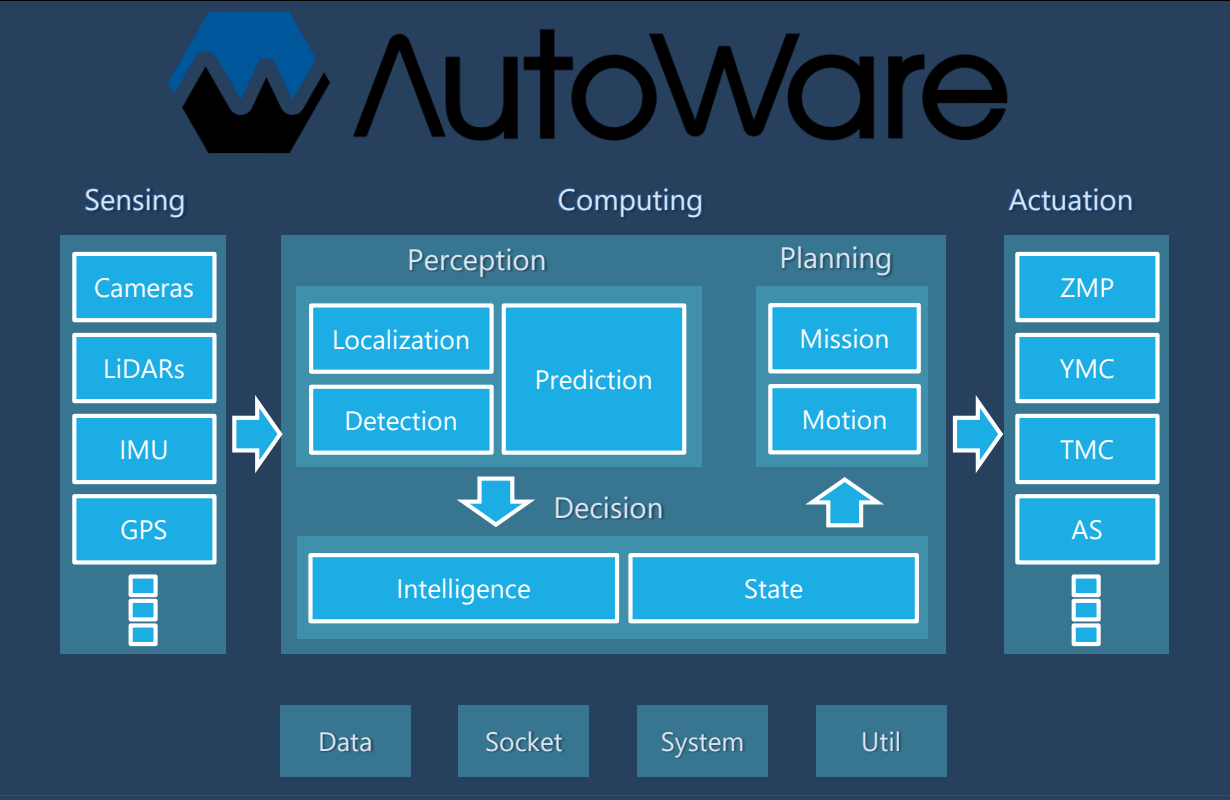


Driving School Teacher



Driving School Teacher (details)b

NVIDIA – AutonomouStuff – Tier IV



NVIDIA Drive PX2

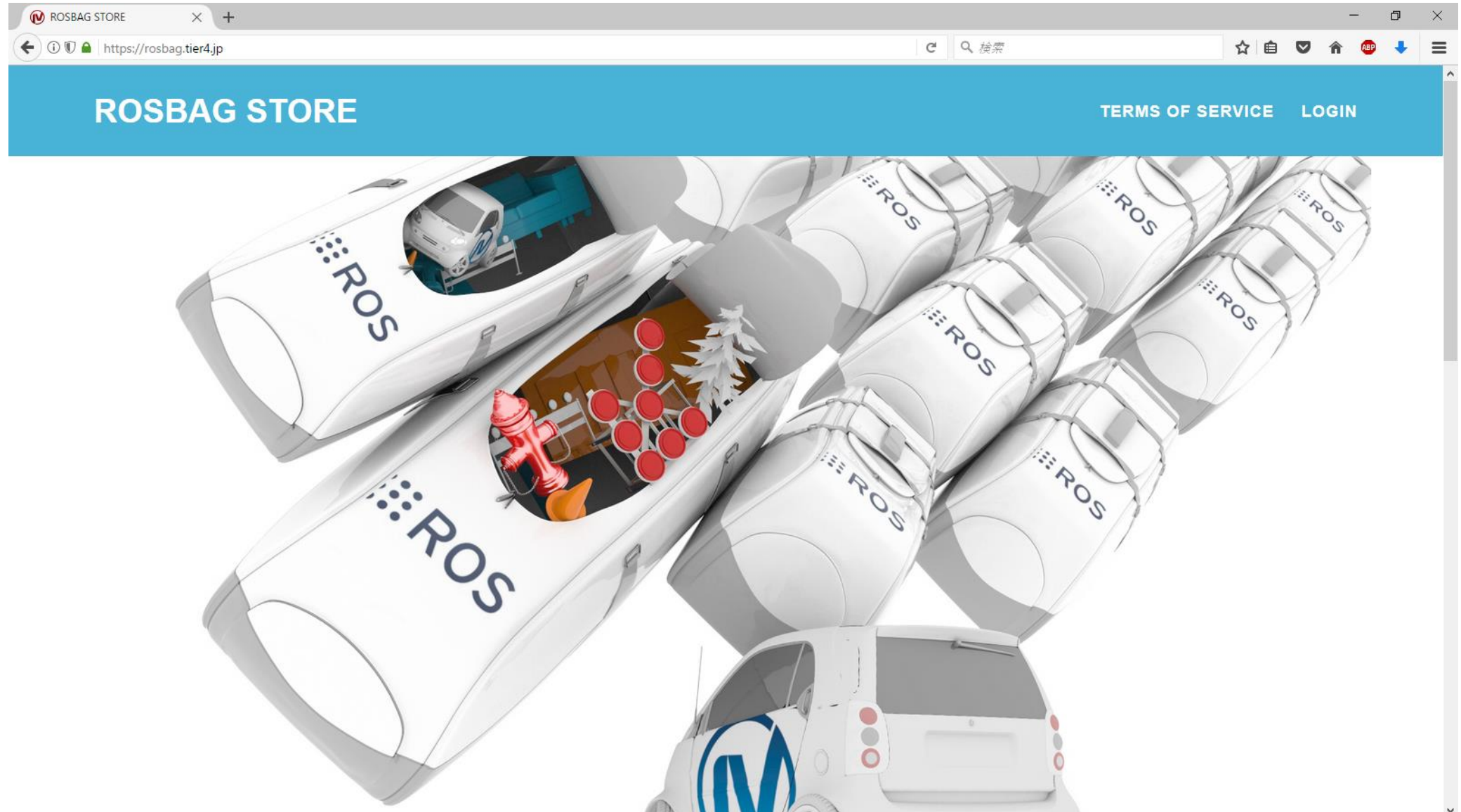


AutoWare

<https://github.com/CPFL/Autoware>

ROSBAG STORE

<https://rosbag.tier4.jp>



```

roscore http://autoware:11311/
... logging to /home/aohsato/.ros/log/02125f4e-9eb6-11e7-82a5-0242fd77032c/roslaunch-autoware-27842.1
og
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://autoware:40151/
ros_comm version 1.12.7

SUMMARY
=====

PARAMETERS
* /rostdistro: kinetic
* /rosversion: 1.12.7

NODES
auto-starting new master
process[master]: started with pid [27858]
ROS_MASTER_URI=http://autoware:11311/

setting /run_id to 02125f4e-9eb6-11e7-82a5-0242fd77032c
process[rosout-1]: started with pid [27890]
started core service [/rosout]
^[[1;5A

```

```

终端
/home/aohsato/workspace/Autoware/ros/src/util/packages/runtime_manager/scripts/runtime_manager_dialog
.py:2829: wxPyDeprecationWarning: Call to deprecated item.
wx.InitAllImageHandlers()
loading param.yaml
loading qs.yaml
loading setup.yaml
loading map.yaml
loading sensing.yaml
loading computing.yaml
loading interface.yaml
loading data.yaml
loading simulation.yaml
loading status.yaml
loading topics.yaml

```

Runtime Manager @autoware
9月21日(木) 03:29:43

Quick Start | Setup | Map | Sensing | Computing | Interface | Database | Simulation | Status | Topics

Map
Ref

Sensing
Ref

Localization
Ref

Detection
Ref

Mission Planning
Ref

Motion Planning
Ref

Android Tablet

Oculus Rift

Vehicle Gateway

Cloud Data

Auto Pilot

ROSBAG

RViz

RQT

0.0%
CPU0

0.0%
CPU1

0.0%
CPU2

0.0%
CPU3

0.0%
CPU4

0.0%
CPU5

0.0%
CPU6

0.0%
CPU7

top (9.1%CPU)
/sbin/init (0.0%CPU)
[kthreadd] (0.0%CPU)
[kworker/0:0H] (0.0%CPU)
[kssoftirqd/0] (0.0%CPU)

2GB/31GB(7%)
Memory

