Towards an Omni-directional Sensing of a Large Dynamic Environment

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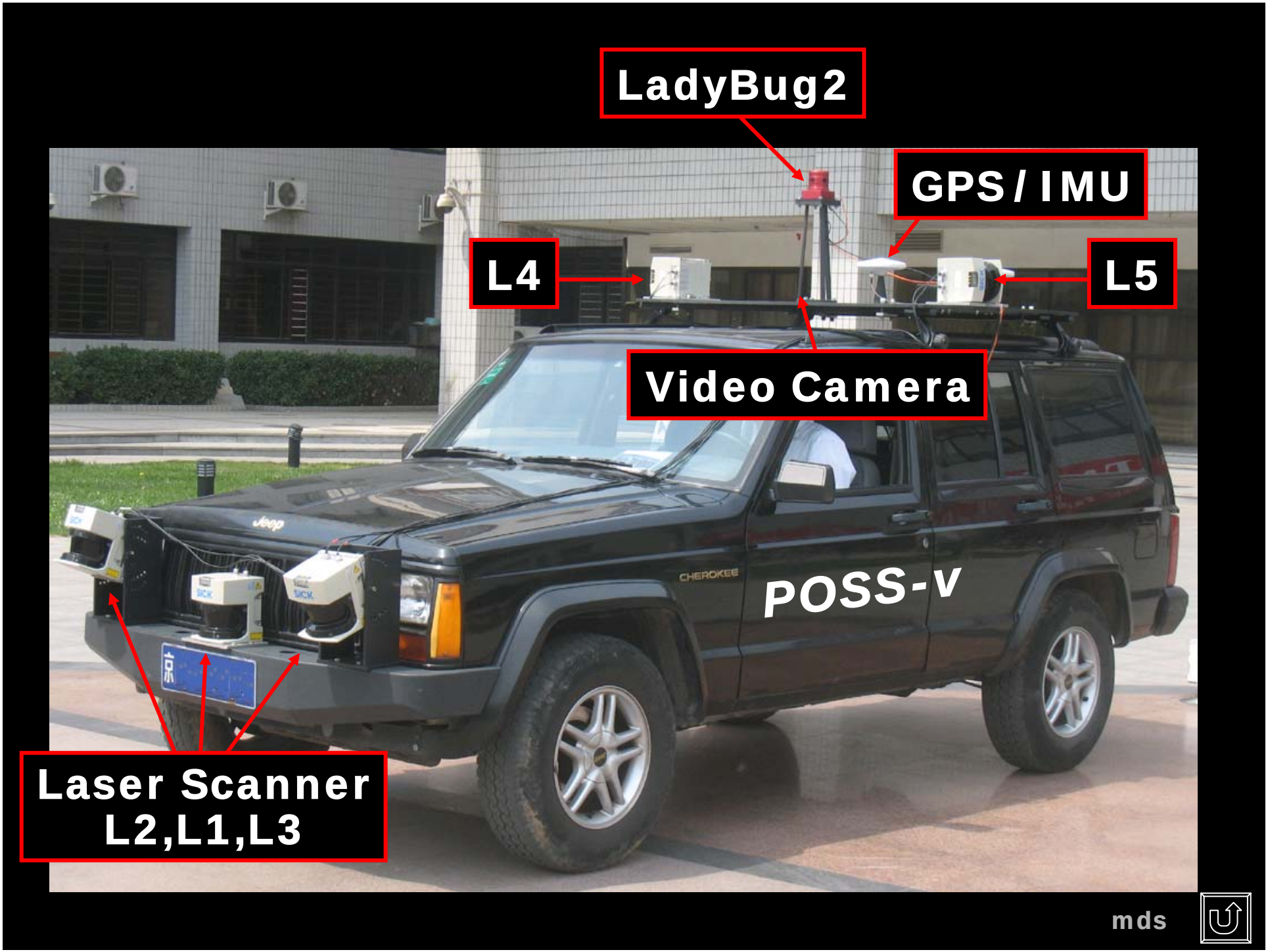

LadyBug2
GPS / IMU
L4
L5
Video Camera
POSS-V
Laser Scanner
L2,L1,L3
mds

Our Goal

We focus on the sensing technologies of intelligent vehicle.

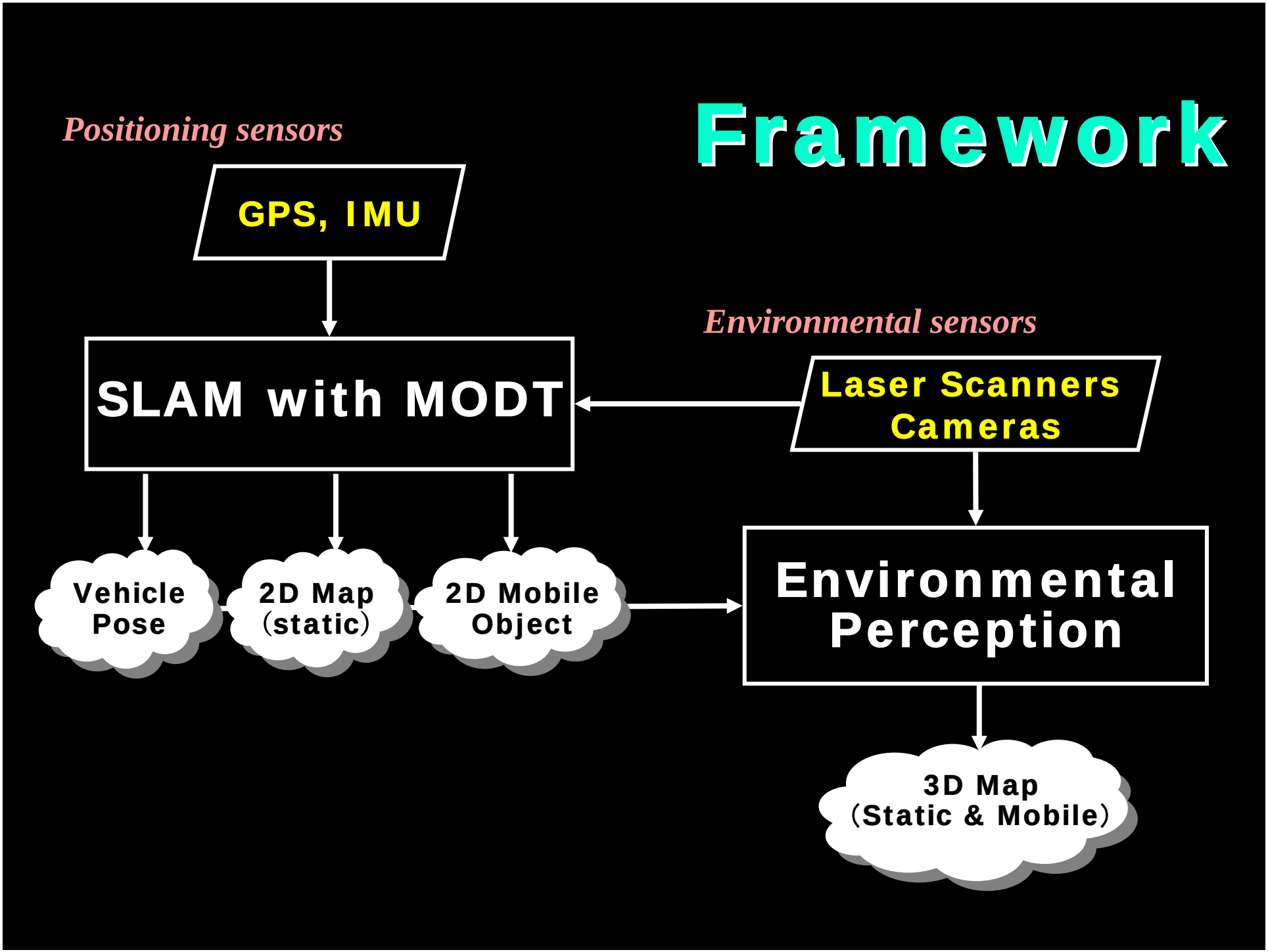
We want to develop an intelligent vehicle of **Omni-directional** eyes looking at the environment of both static and dynamic objects.

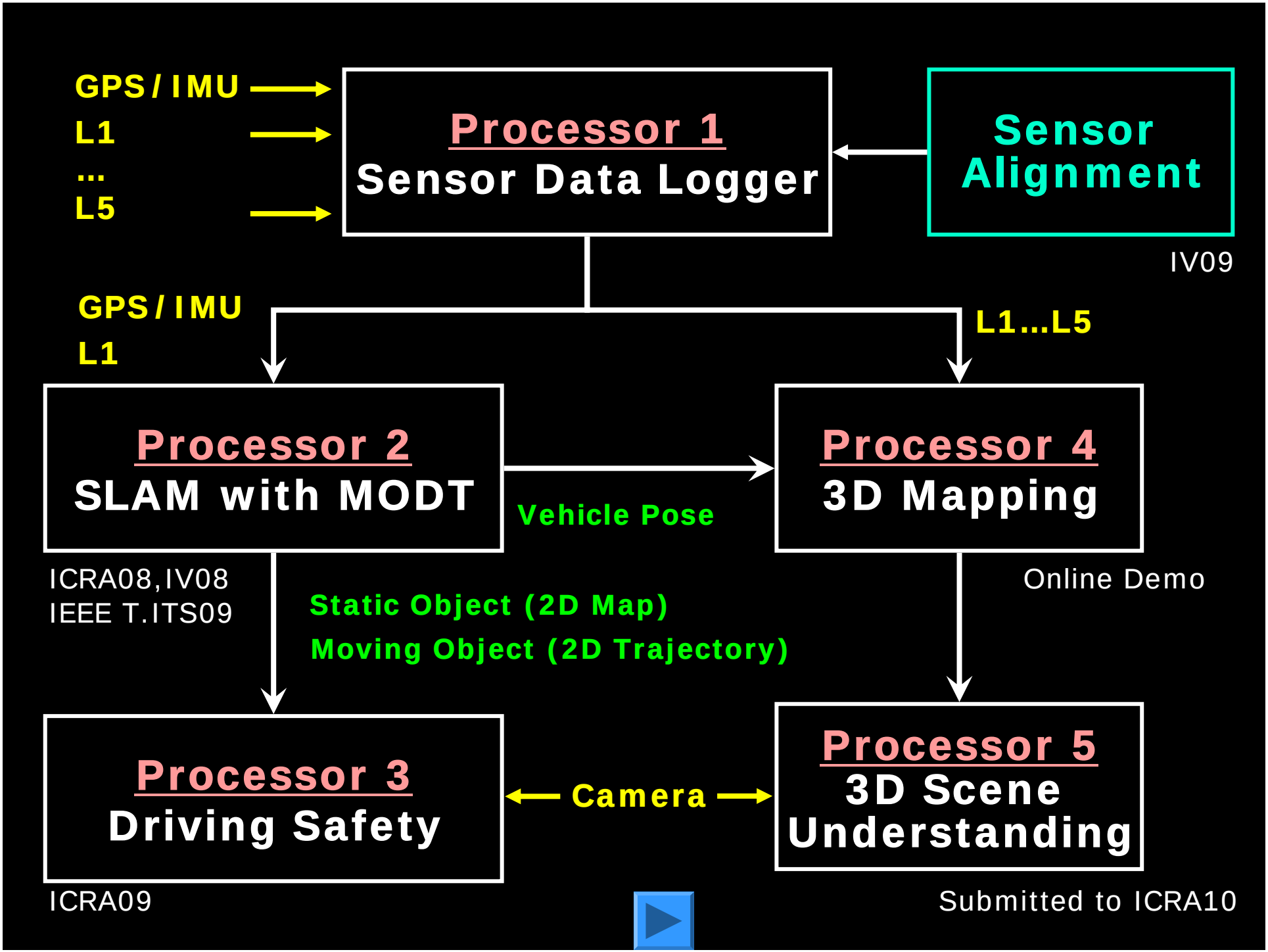
We want to **detect** the **moving objects** in the surroundings, and **track** their **states**, such as speed, direction, and size, so that dangerous situations can be predicted.

We want to **generate a 3D copy** of the dynamic urban scenery that contains both stationary objects, e.g. buildings, trees, road etc., and mobile objects, e.g. people, bicycles and cars.

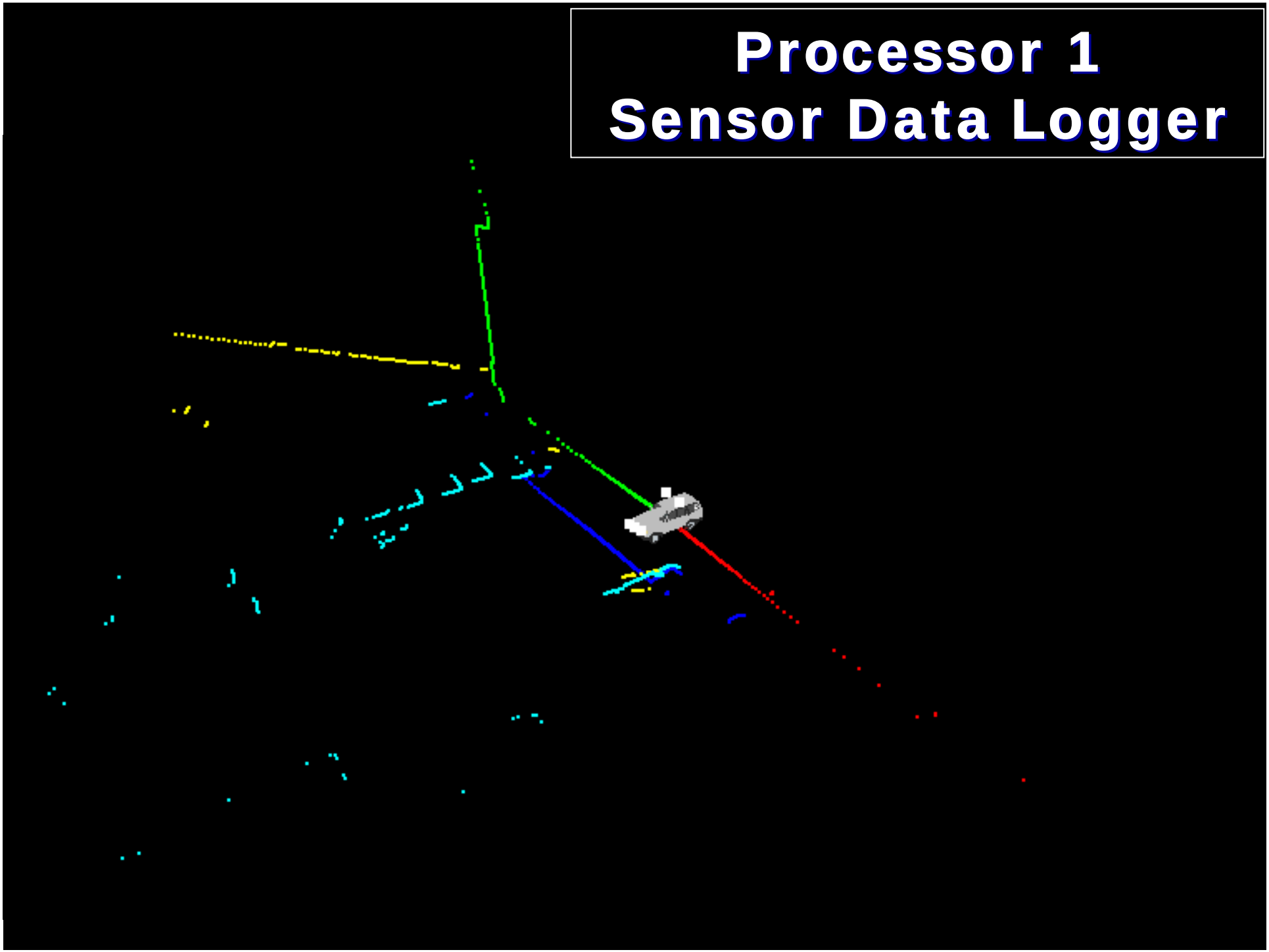
Key Issues

- Sensor Alignment
- Localization
- 3D Mapping
- Mobile objects' detection, tracking and classification
- Scene understanding

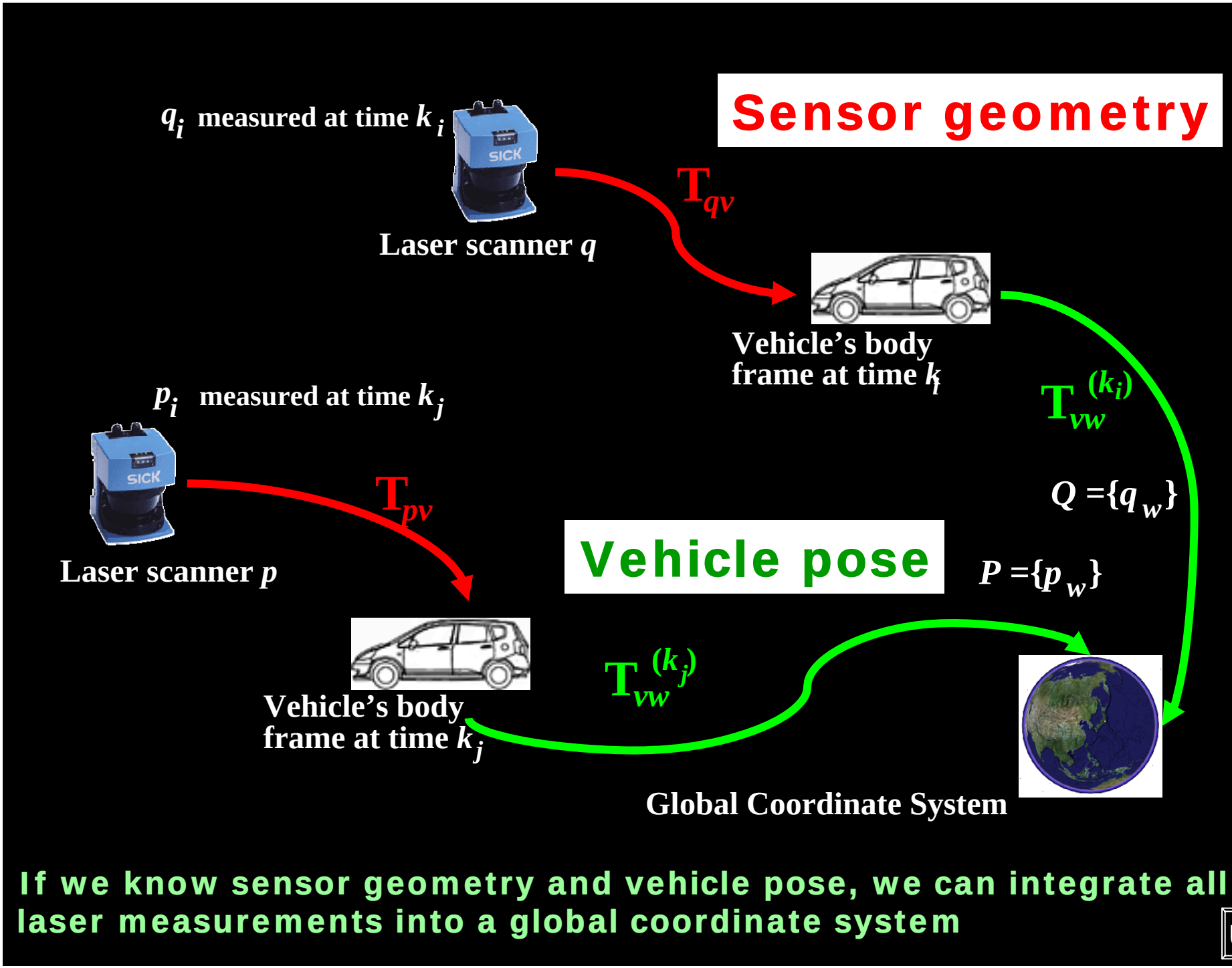

Framework
Positioning sensors
GPS, IMU
SLAM with MODT
Environmental sensors
Laser Scanners
Cameras
Vehicle Pose
2D Map (static)
2D Mobile Object
Environmental Perception
3D Map (Static & Mobile)


GPS / IMU
L1
...
L5
Processor 1
Sensor Data Logger
Sensor Alignment
IV09
GPS / IMU
L1
L1...L5
Processor 2
SLAM with MODT
Vehicle Pose
Processor 4
3D Mapping
ICRA08, IV08
IEEE T.ITS09
Online Demo
Static Object (2D Map)
Moving Object (2D Trajectory)
Processor 3
Driving Safety
Camera
Processor 5
3D Scene Understanding
ICRA09
Submitted to ICRA10

Processor 1
Sensor Data Logger



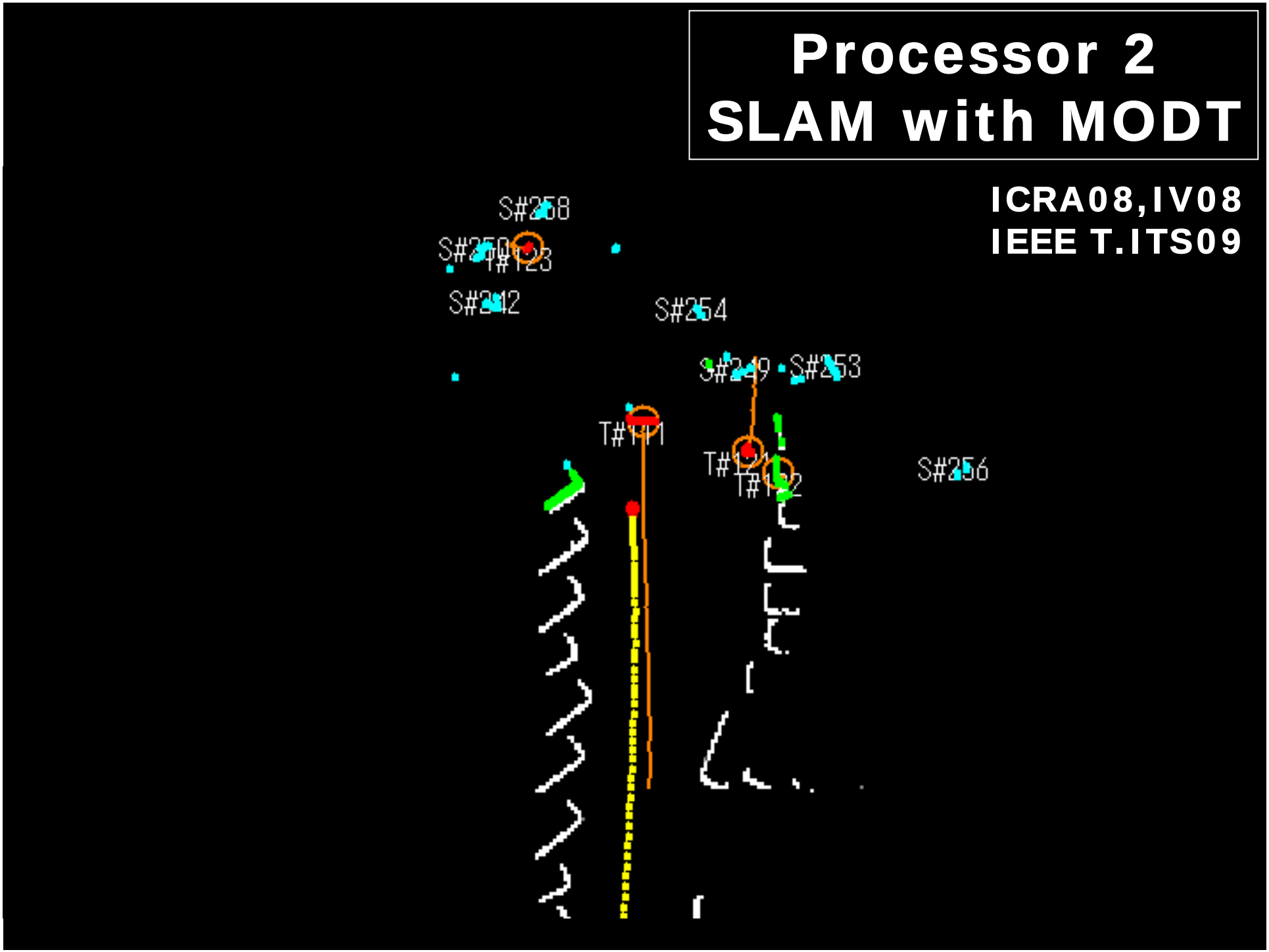
Sensor geometry



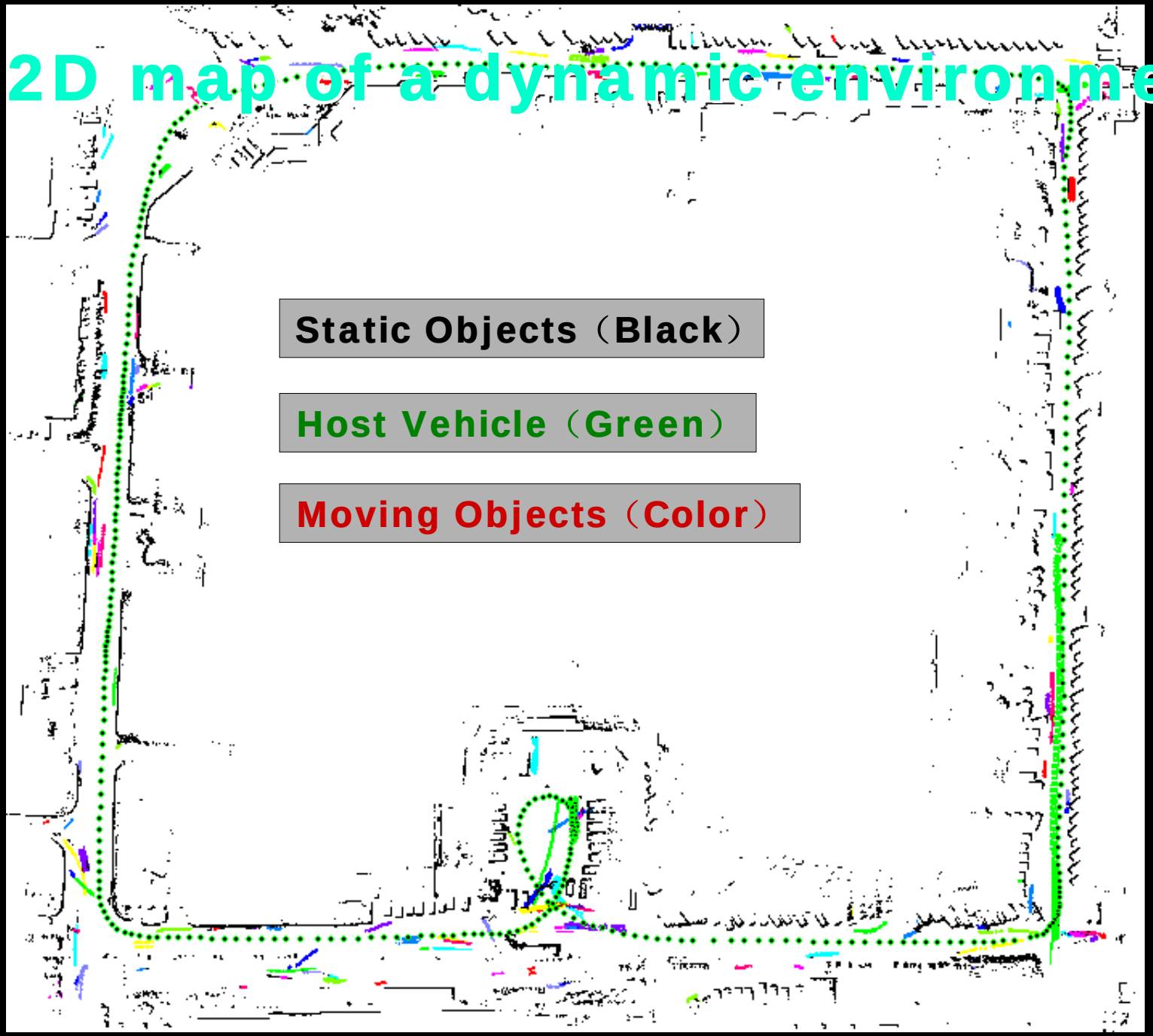
If we know sensor geometry and vehicle pose, we can integrate all laser measurements into a global coordinate system

Processor 2
SLAM with MODT

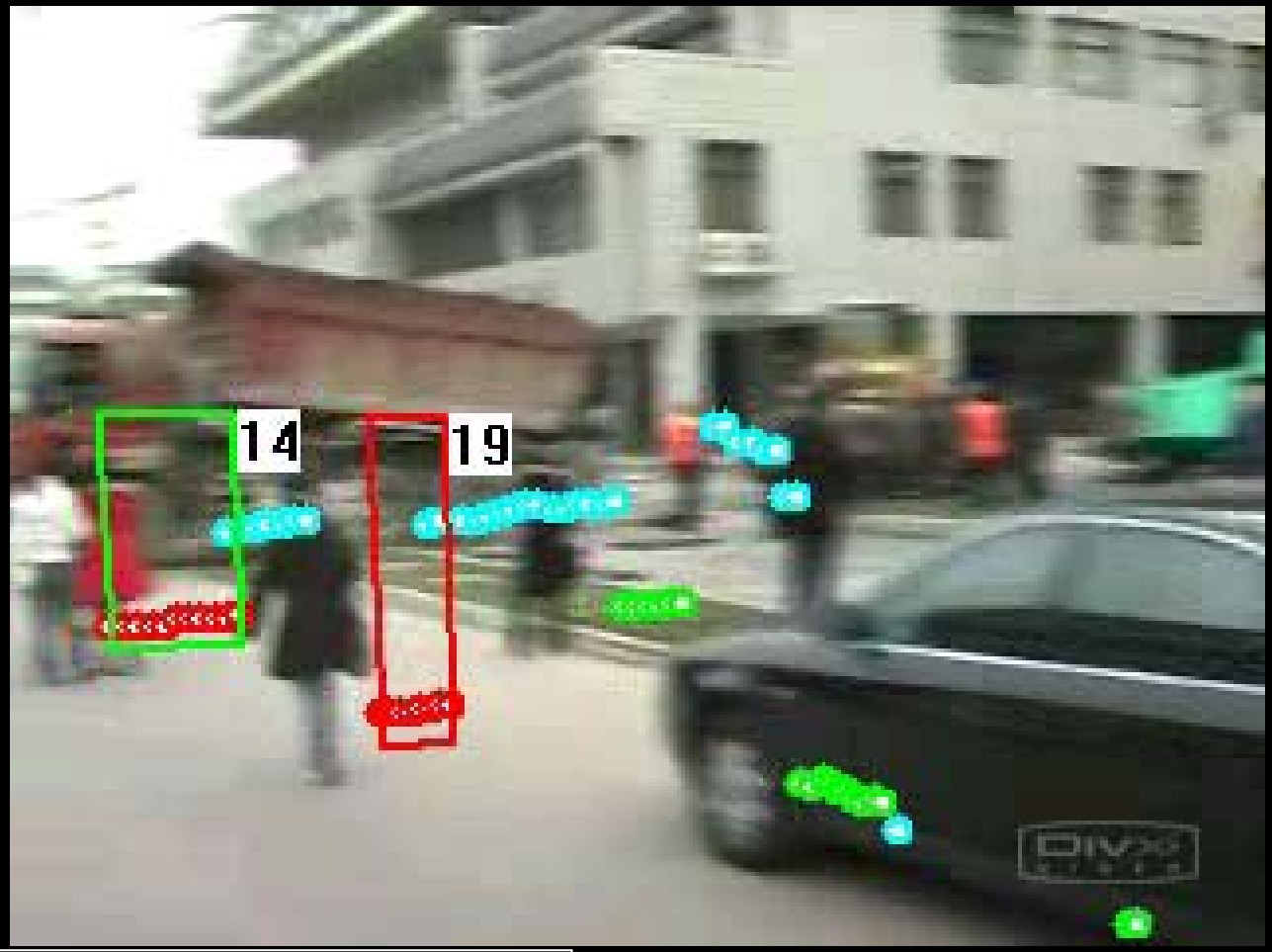
ICRA08,IV08
IEEE T.ITS09



A 2D map of a dynamic environment



Classification of Mv. Obj. [ICRA09]



Objects

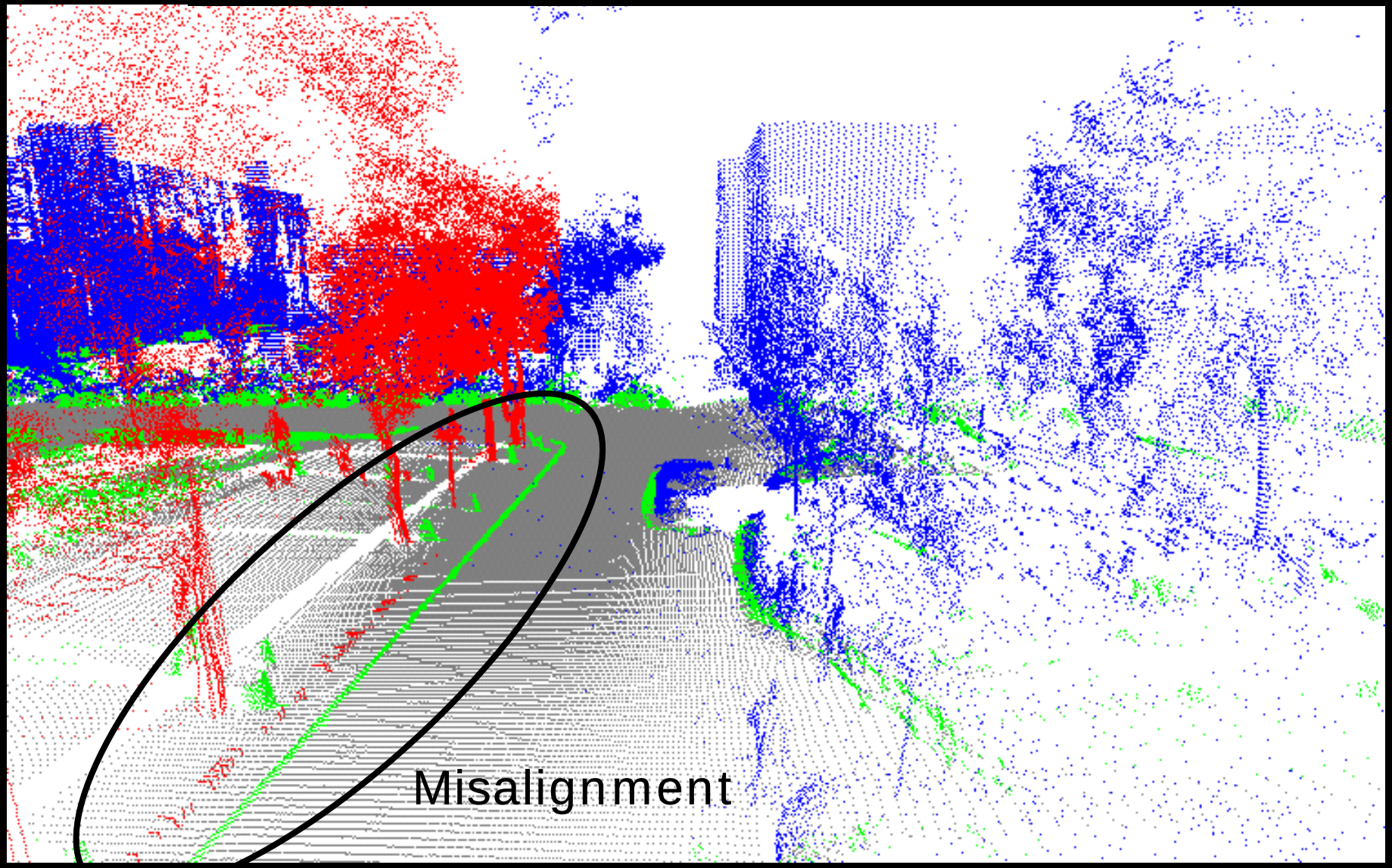
- person
- bicycle
- group
- car

Laser Points

- moving
- seed
- group

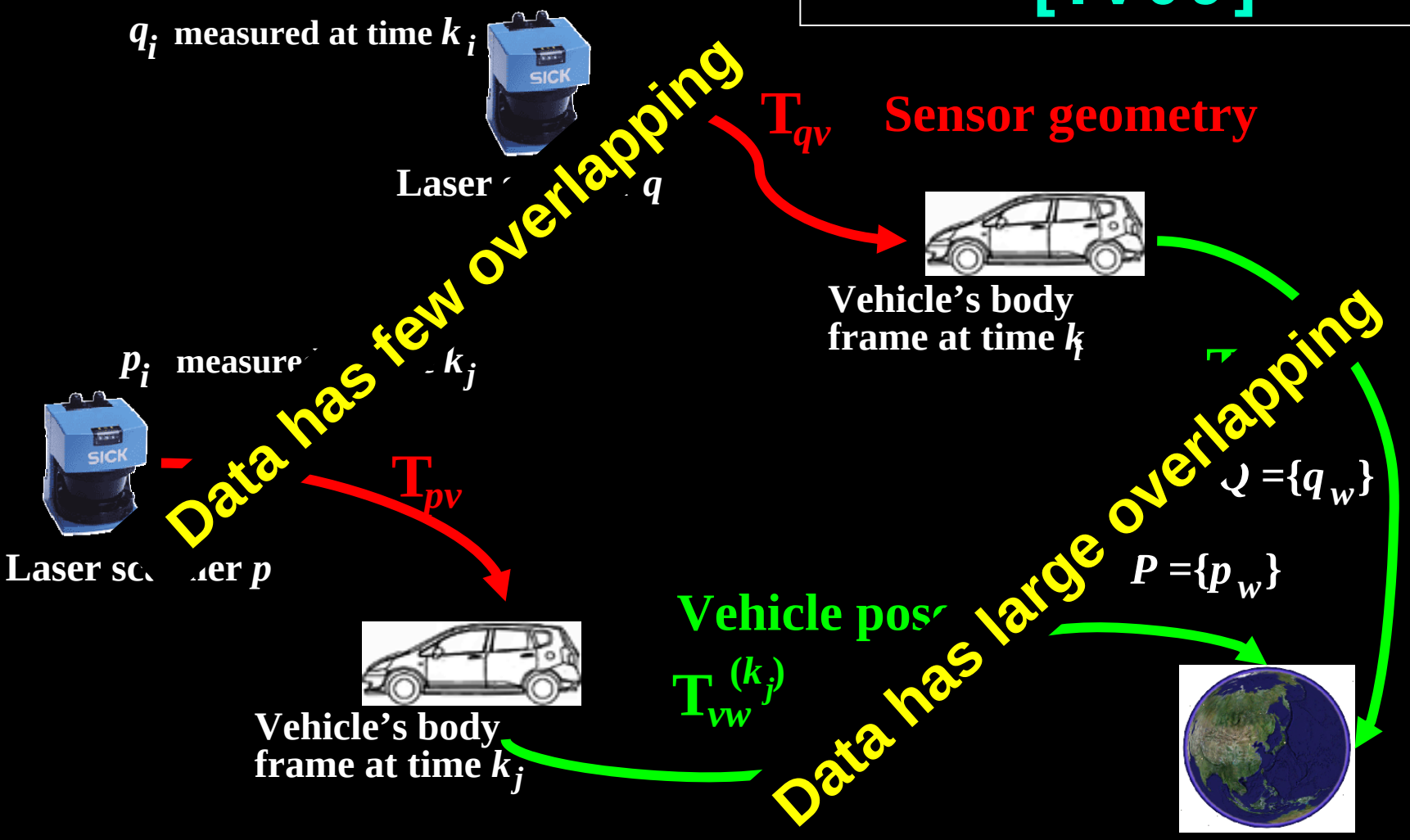
Processor 3
Driving Safety

A single object might be measured by different sensors at different time instance



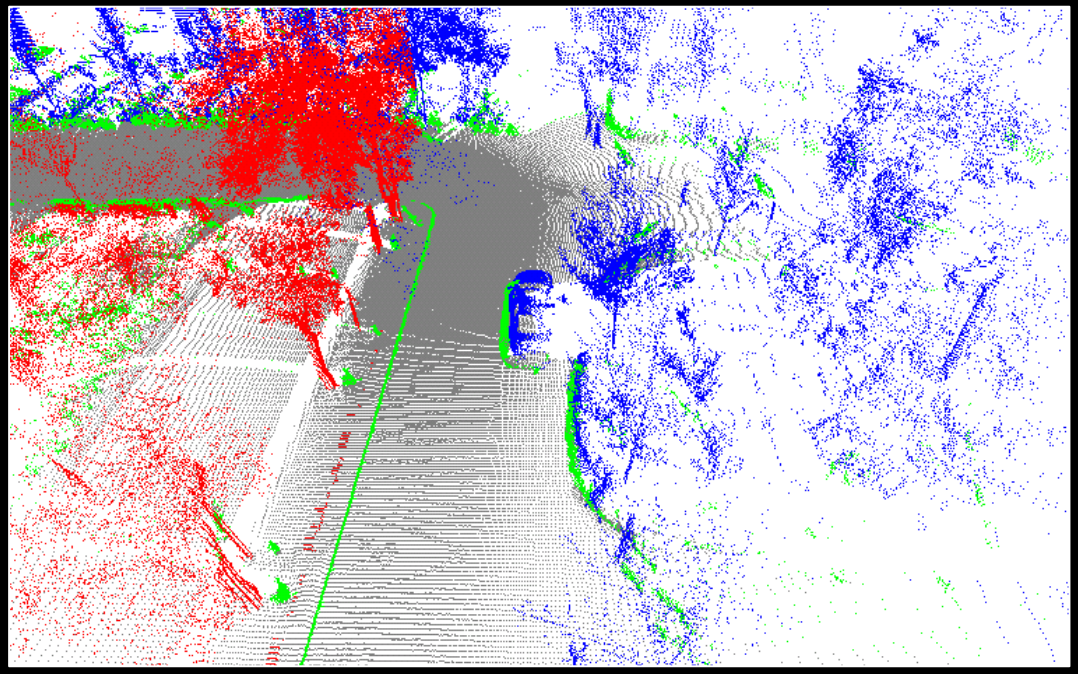
Colors represent for different sensor data

Sensor Alignment [IV09]

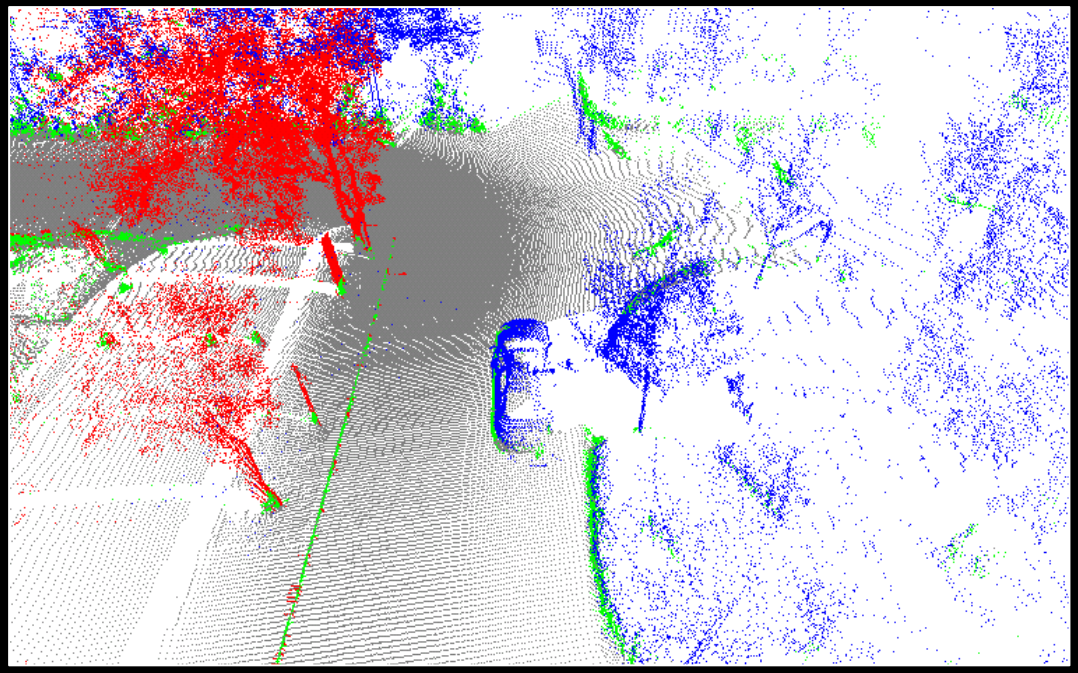


Sensor geometries are calibrated by minimizing the displacement between the geo-referenced data sets in horizontal and vertical levels

Results [IV09]

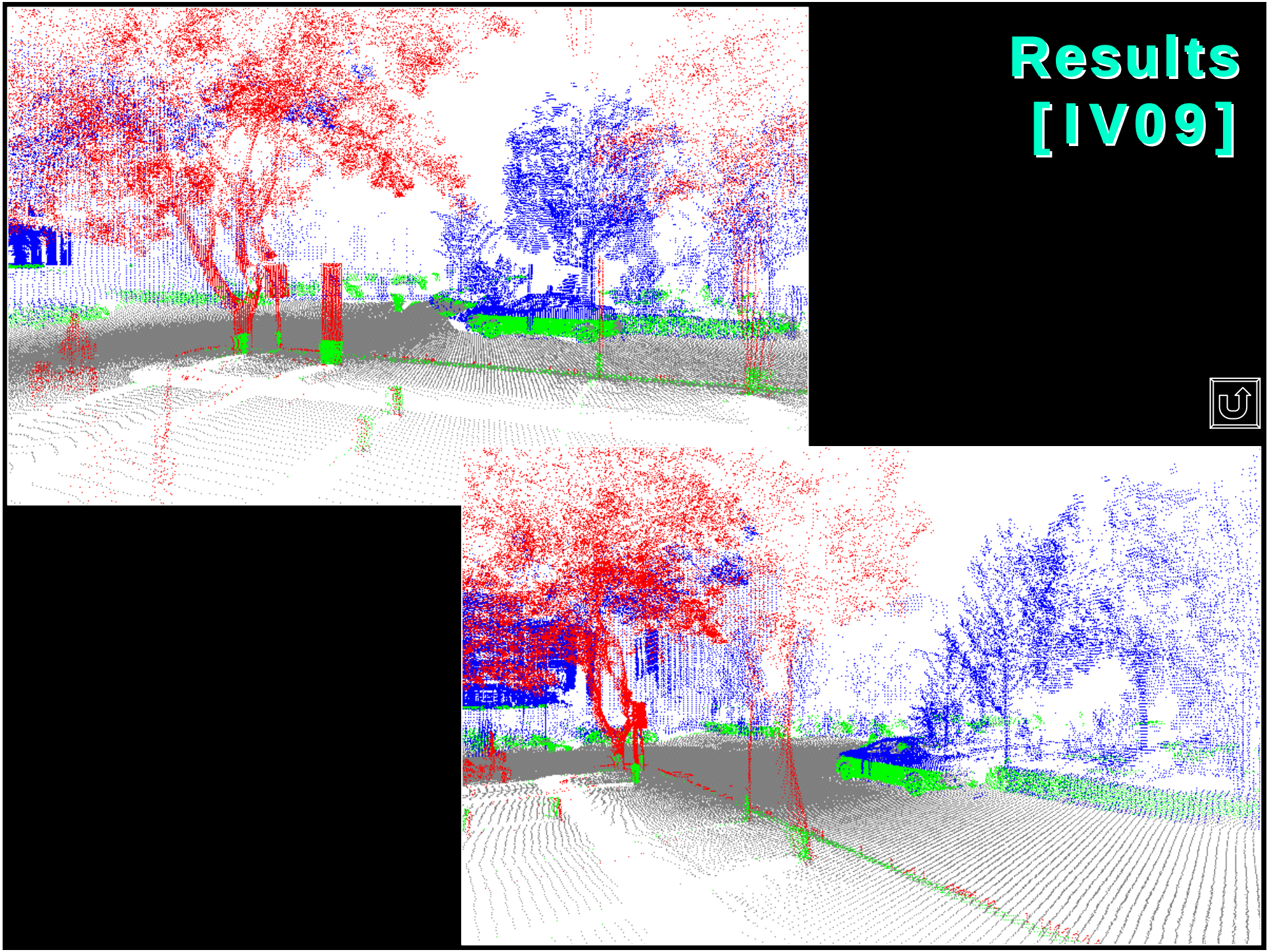


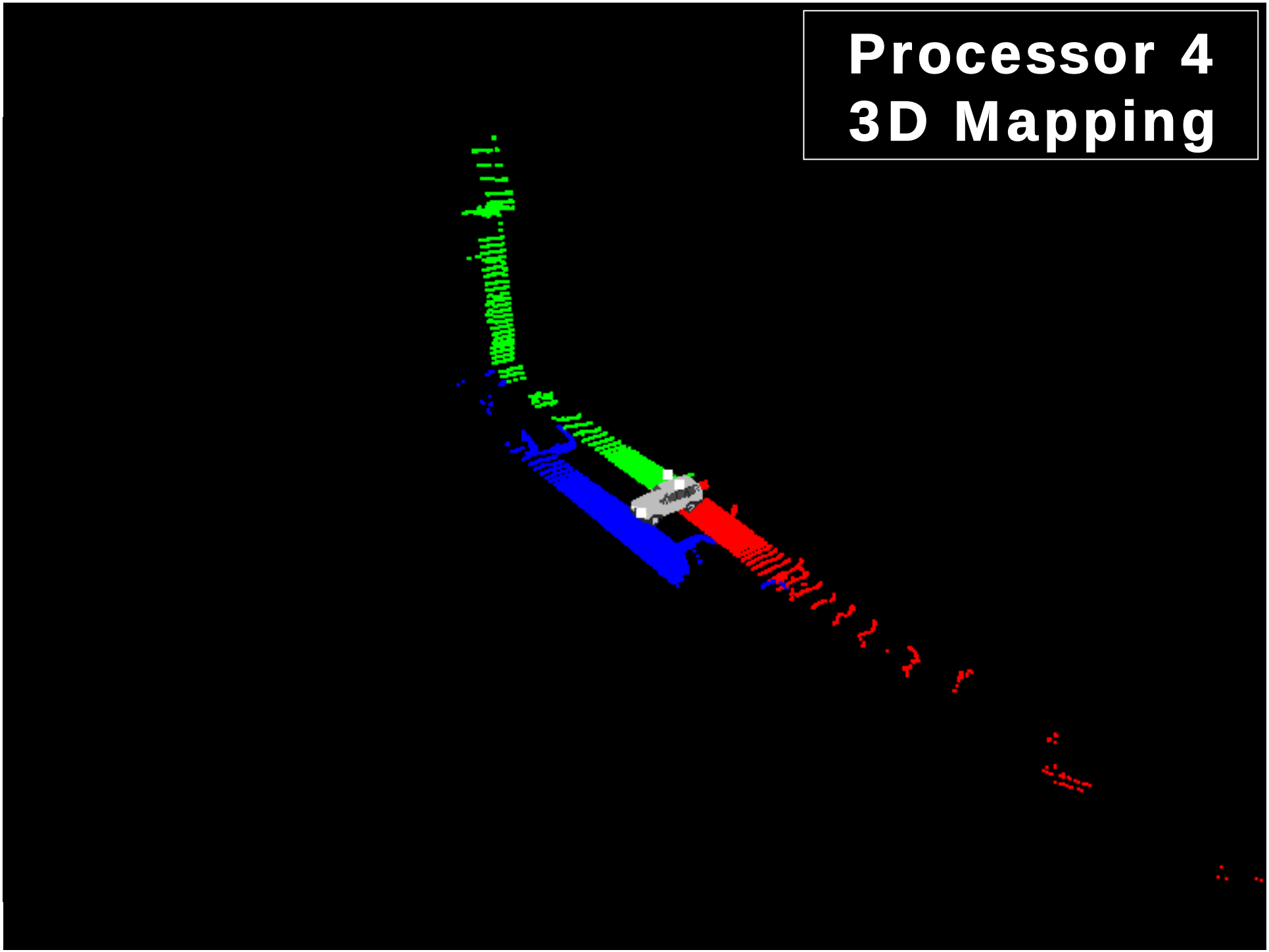
Before
Sensor Alignment

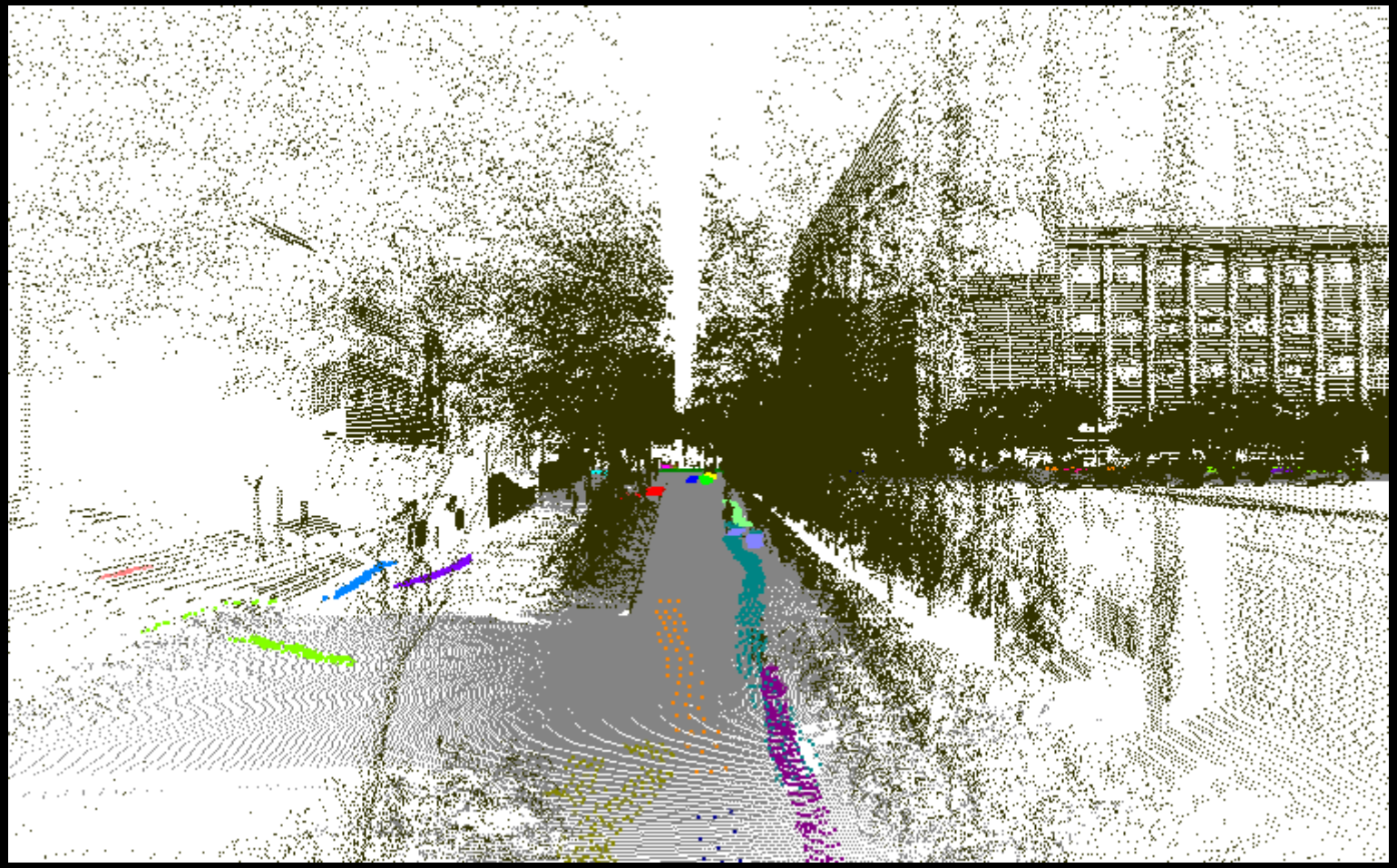


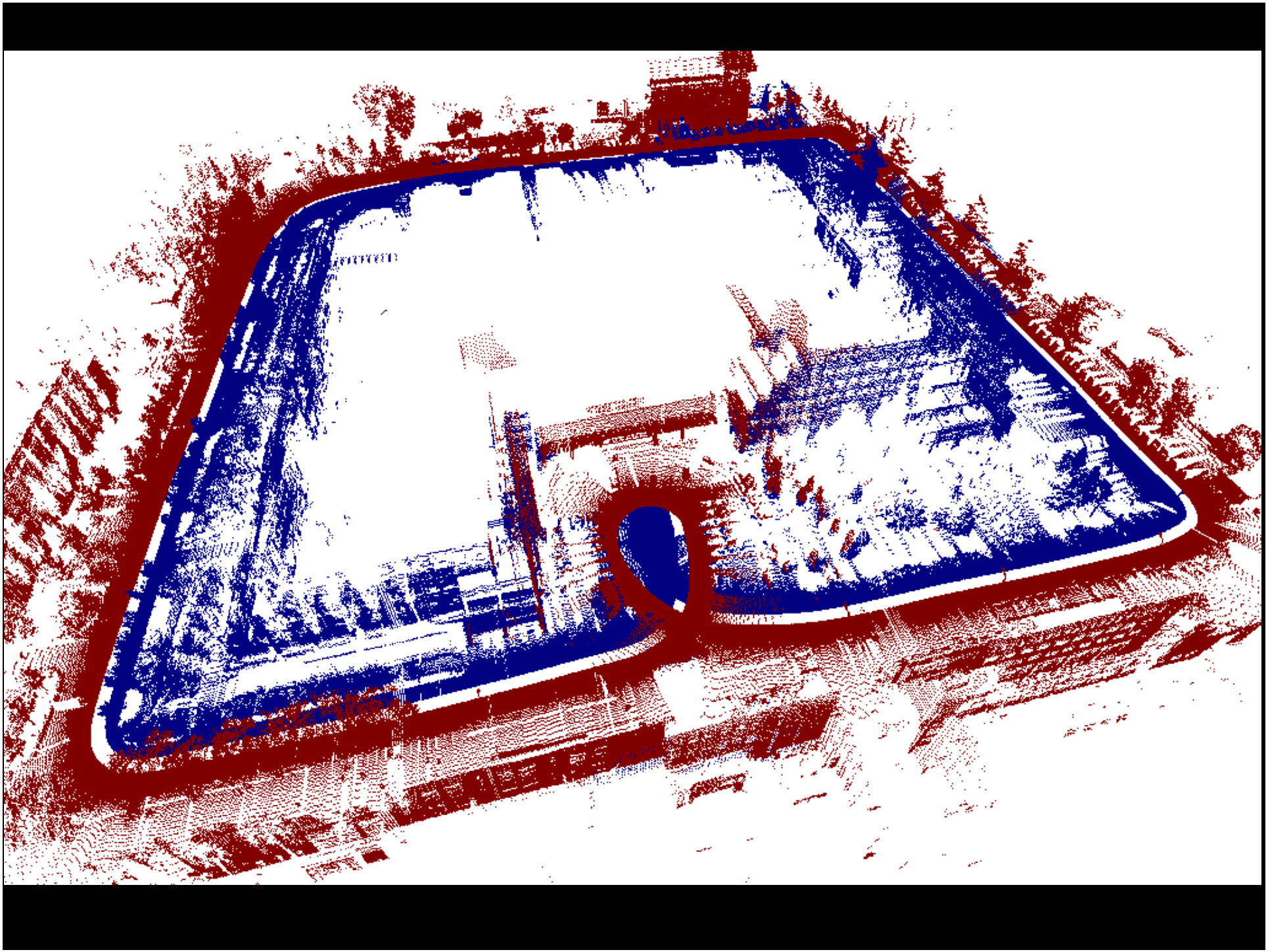
After
Sensor Alignment

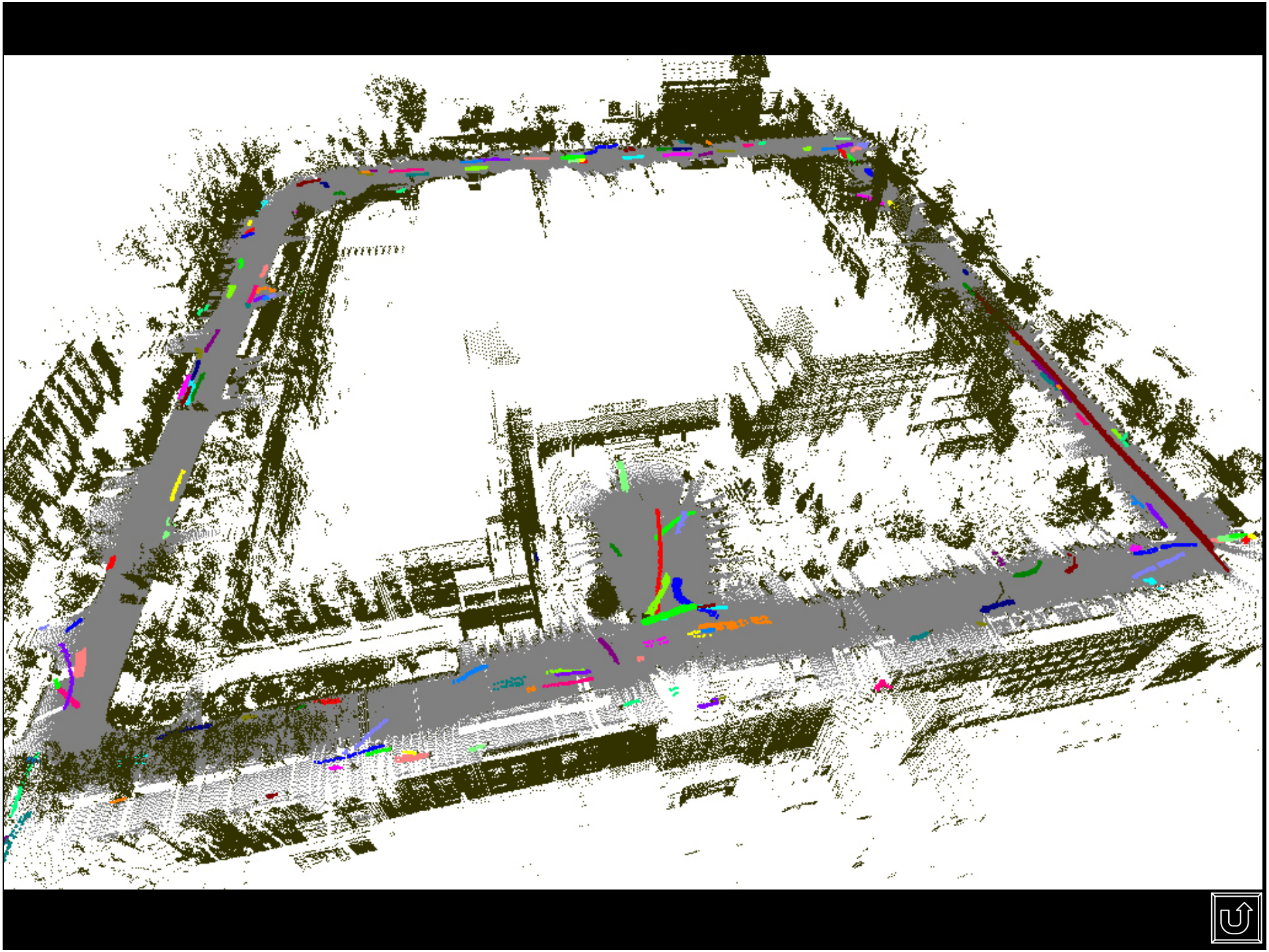
Results [IV09]



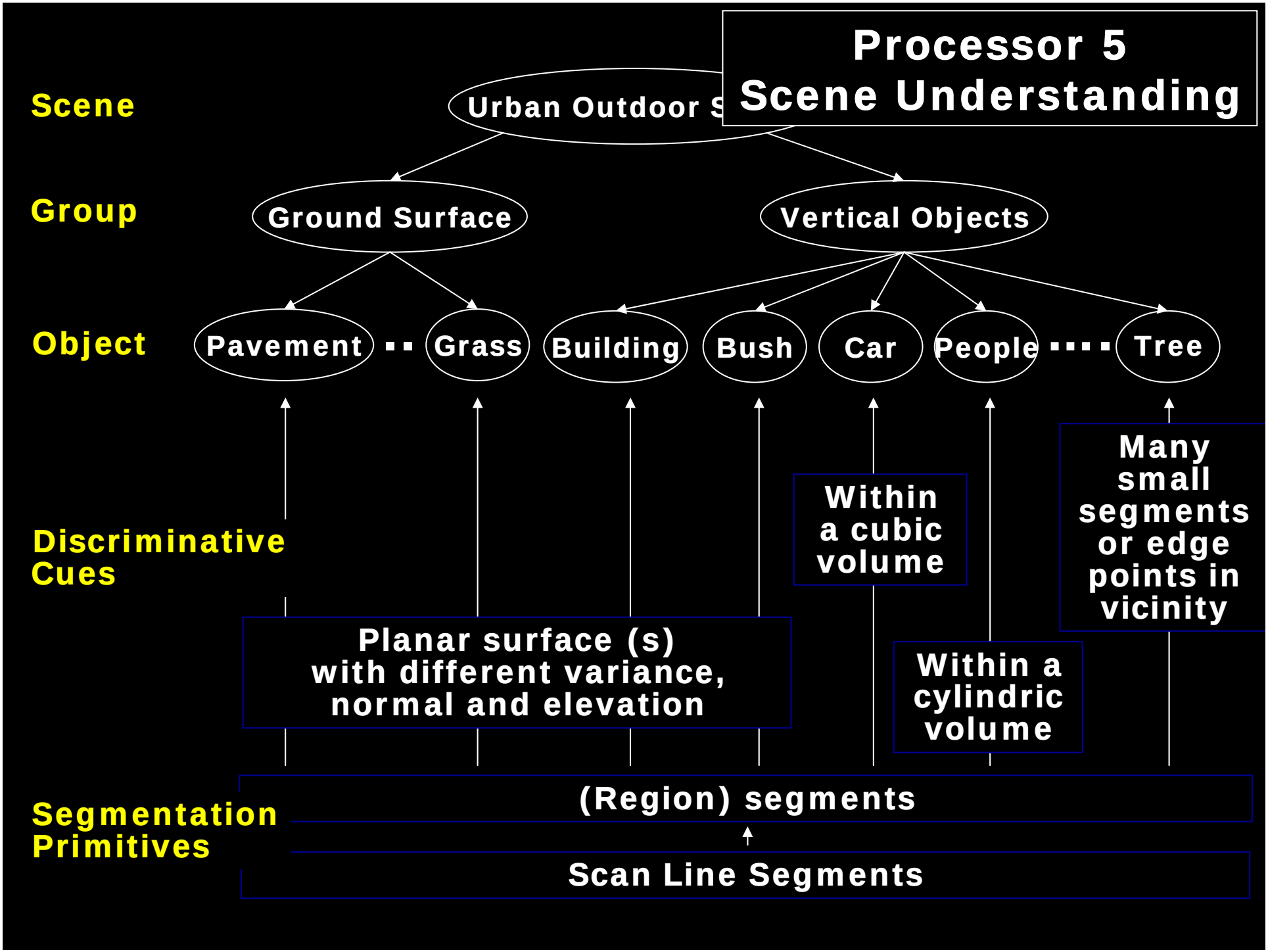

Processor 4
3D Mapping

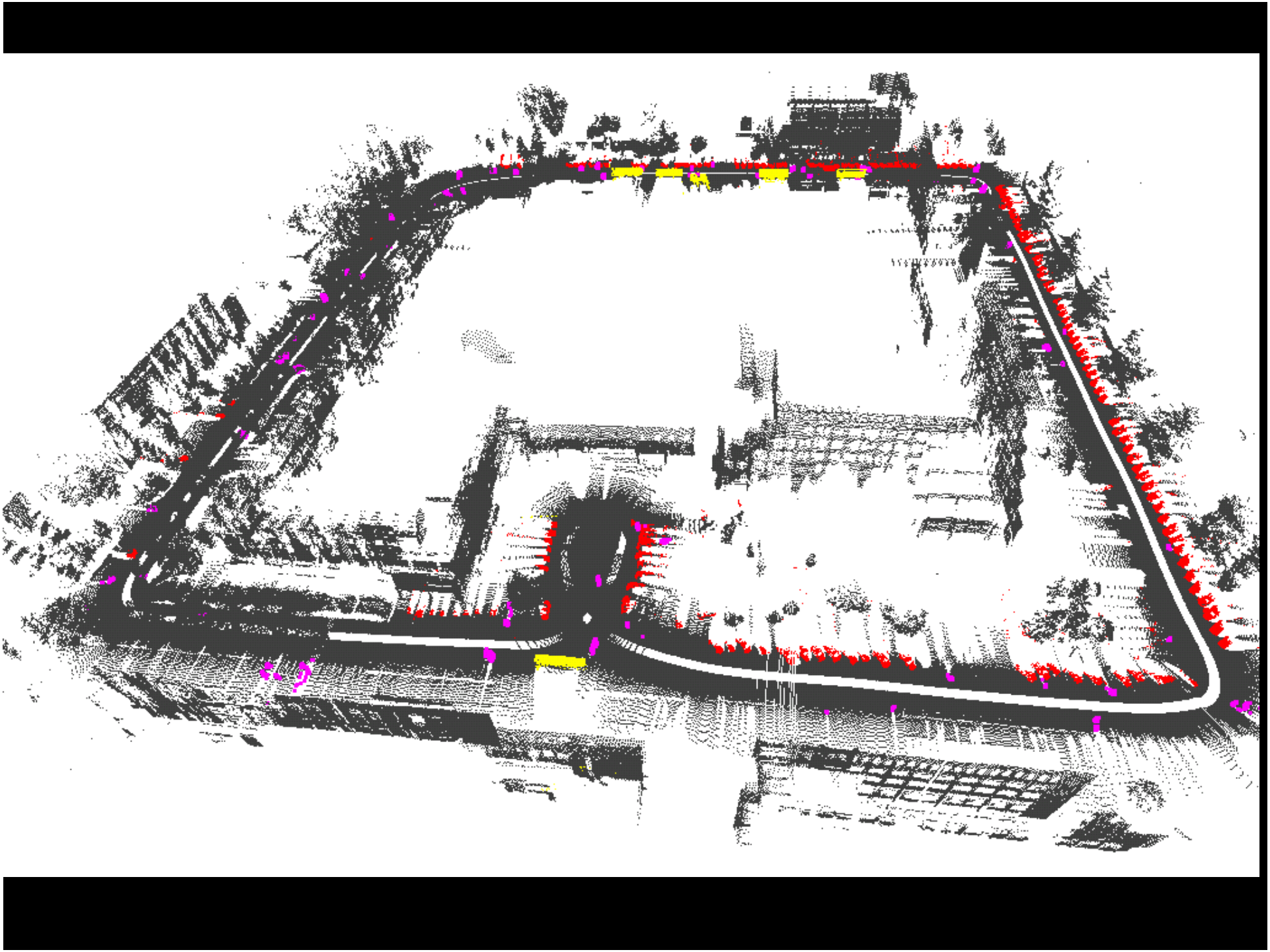


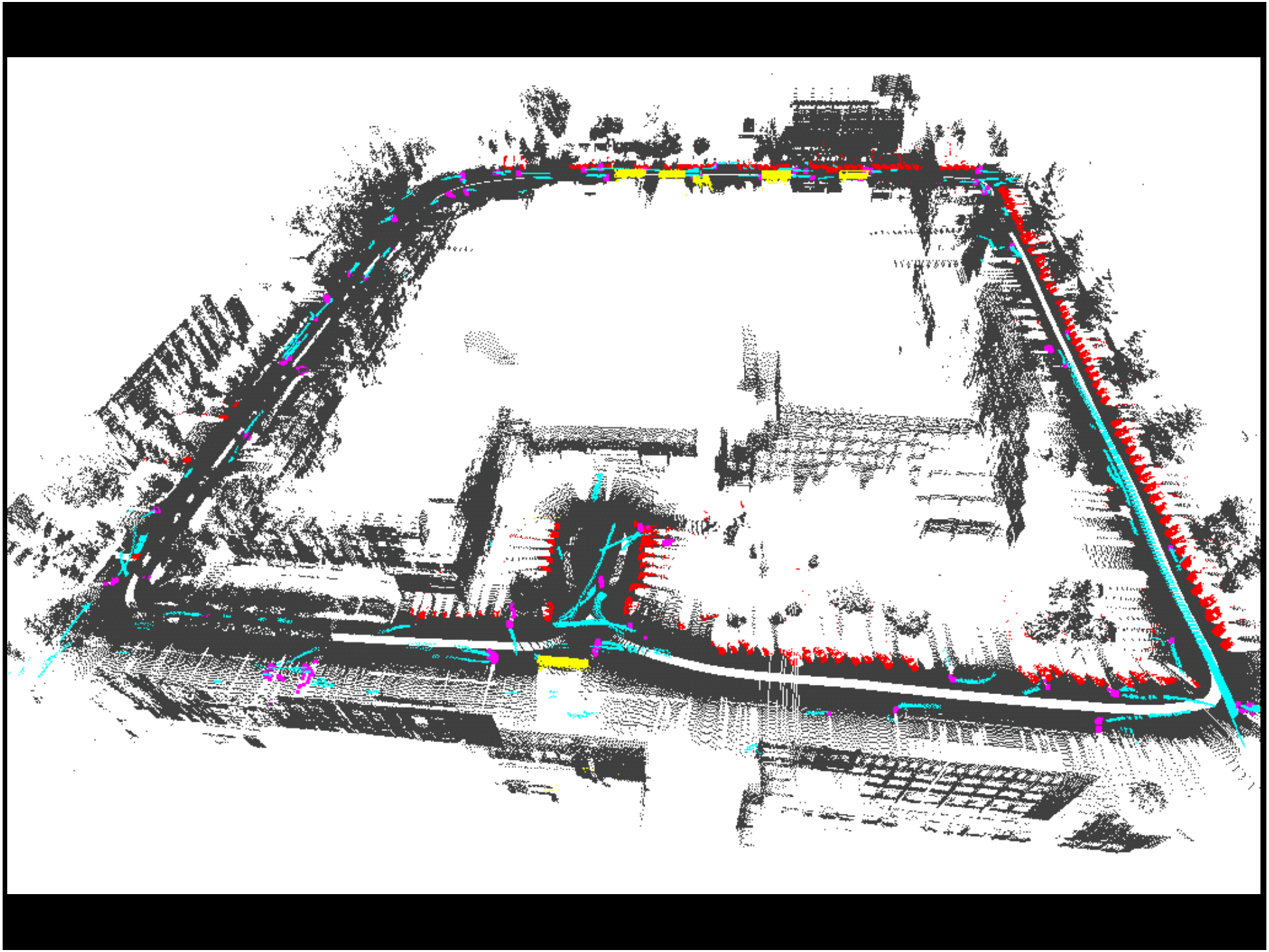


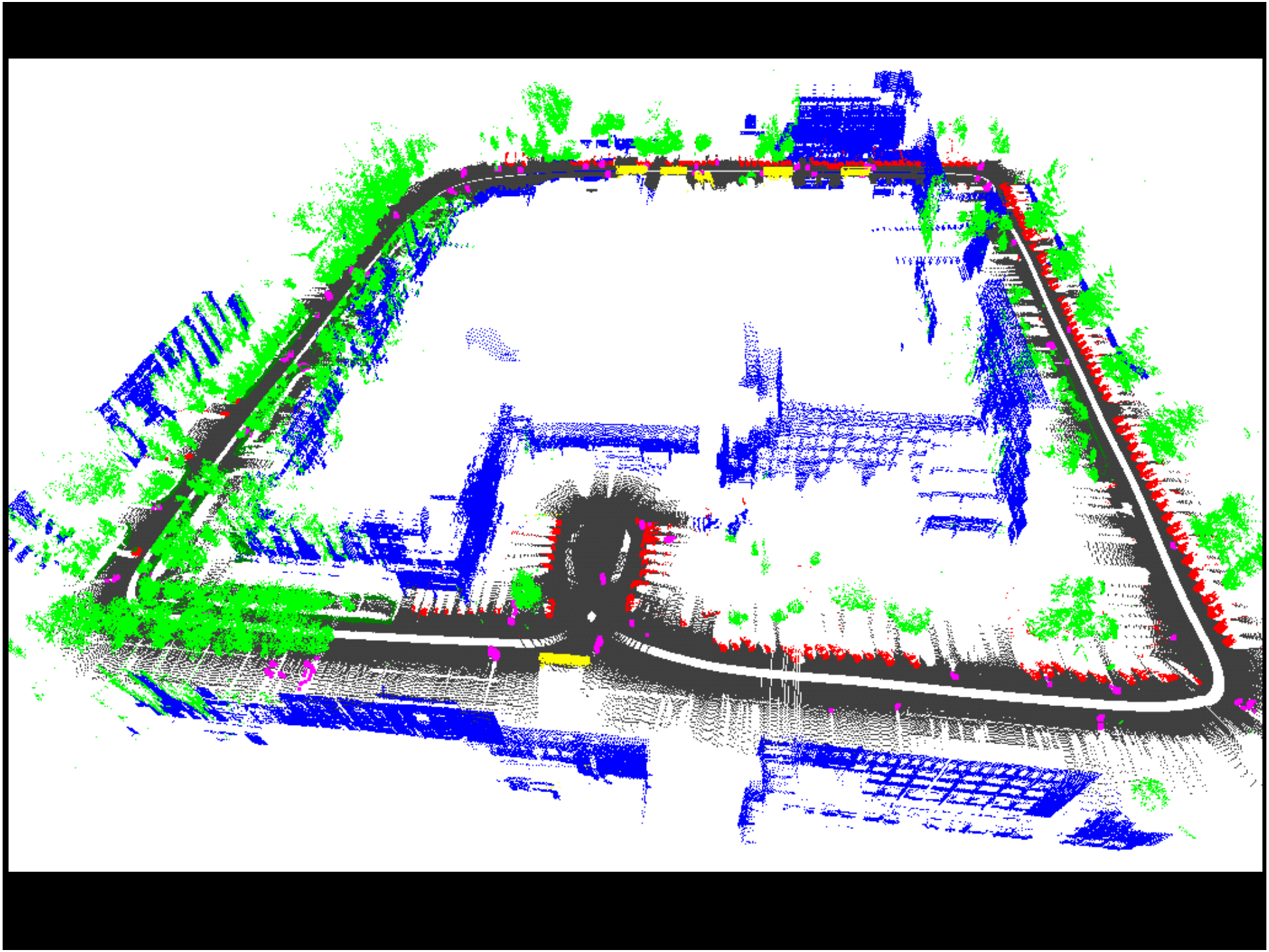


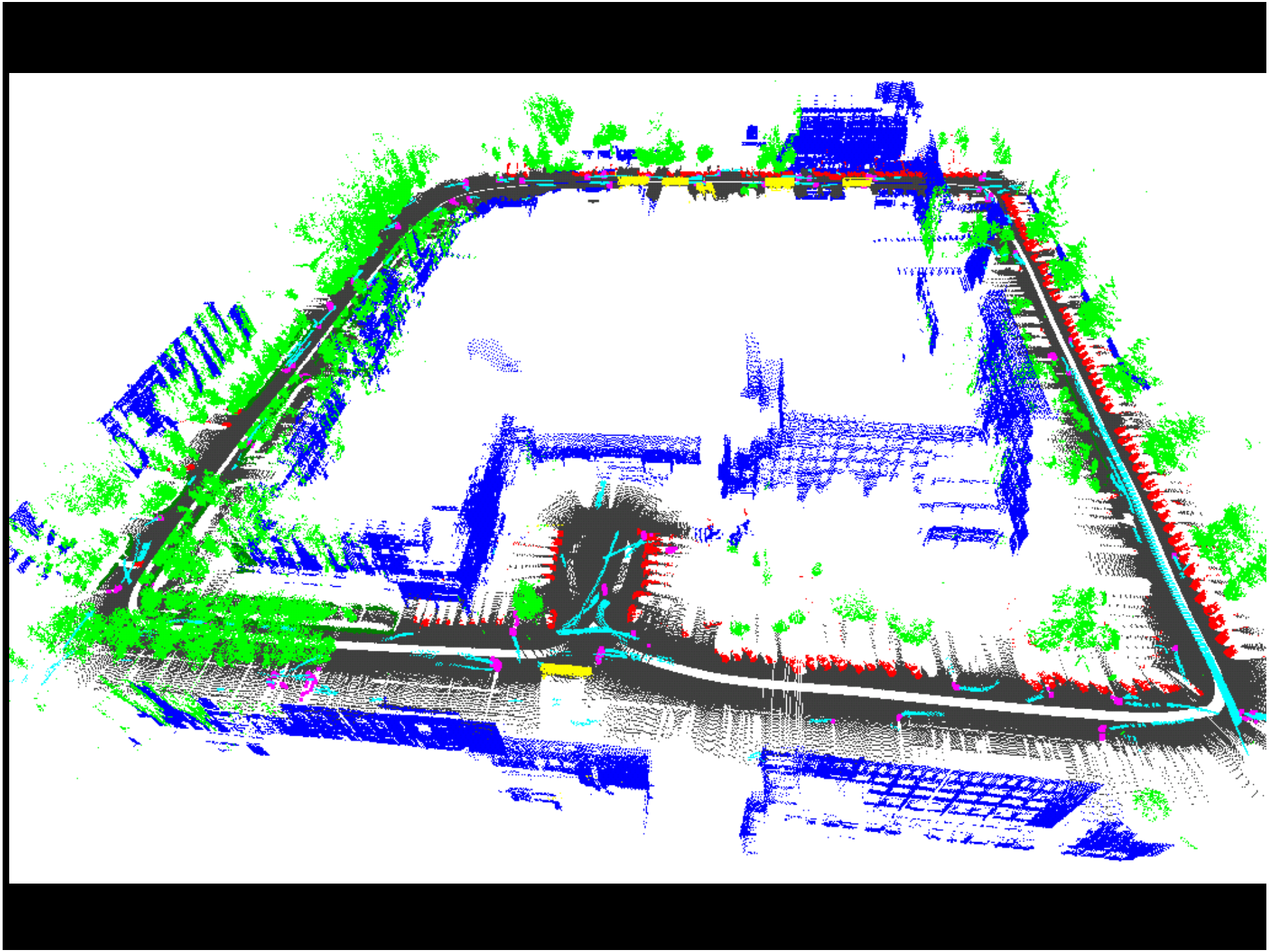
On-vehicle Demonstration

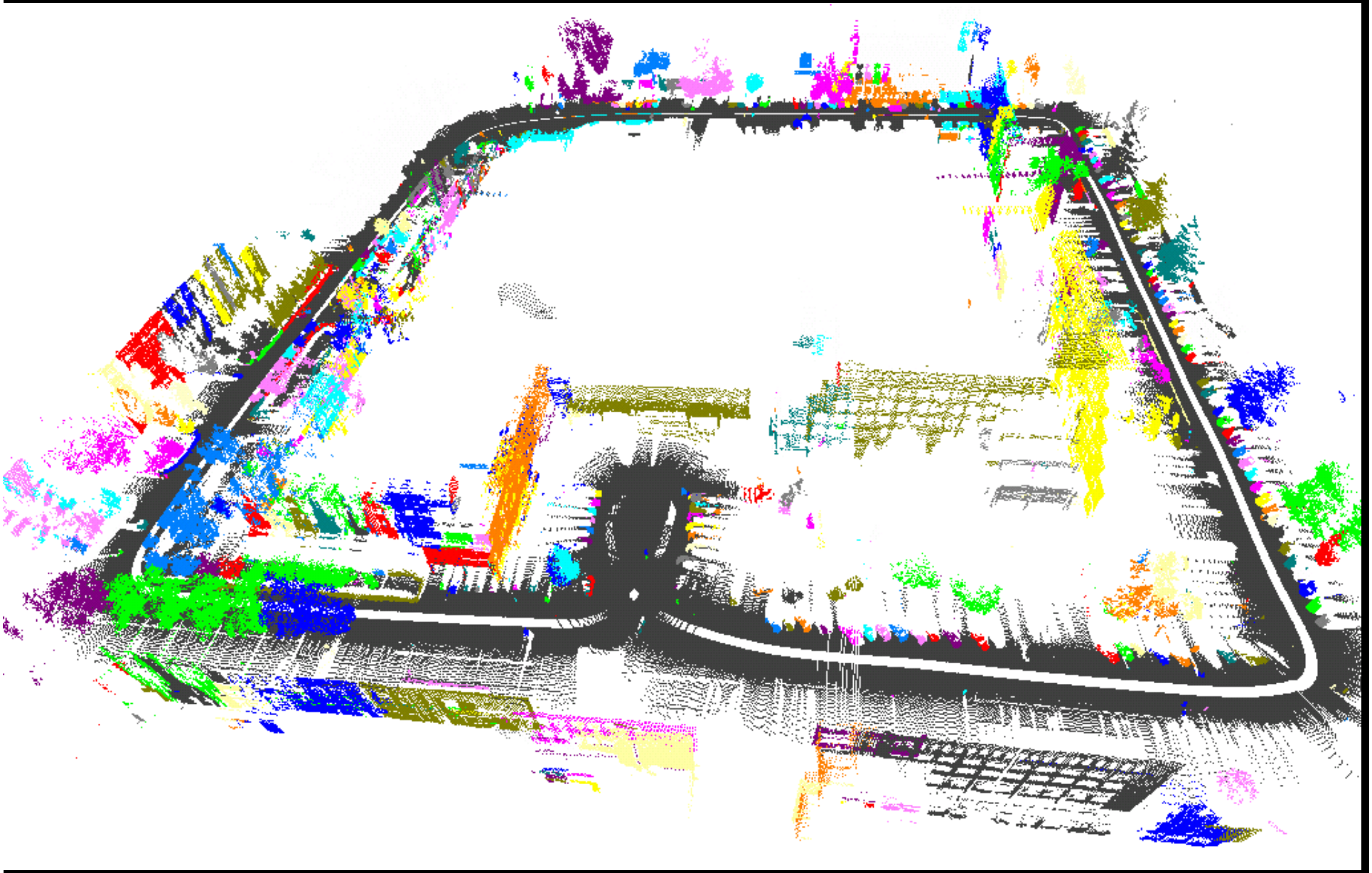

Processor 5
Scene Understanding
Scene
Urban Outdoor S
Group
Ground Surface
Vertical Objects
Object
Pavement
Grass
Building
Bush
Car
People
Tree
Discriminative Cues
Planar surface (s) with different variance, normal and elevation
Within a cubic volume
Within a cylindric volume
Many small segments or edge points in vicinity
Segmentation Primitives
(Region) segments
Scan Line Segments











Thank You!

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