Sensor Alignment Towards an Omni-Directional Measurement using an Intelligent Vehicle

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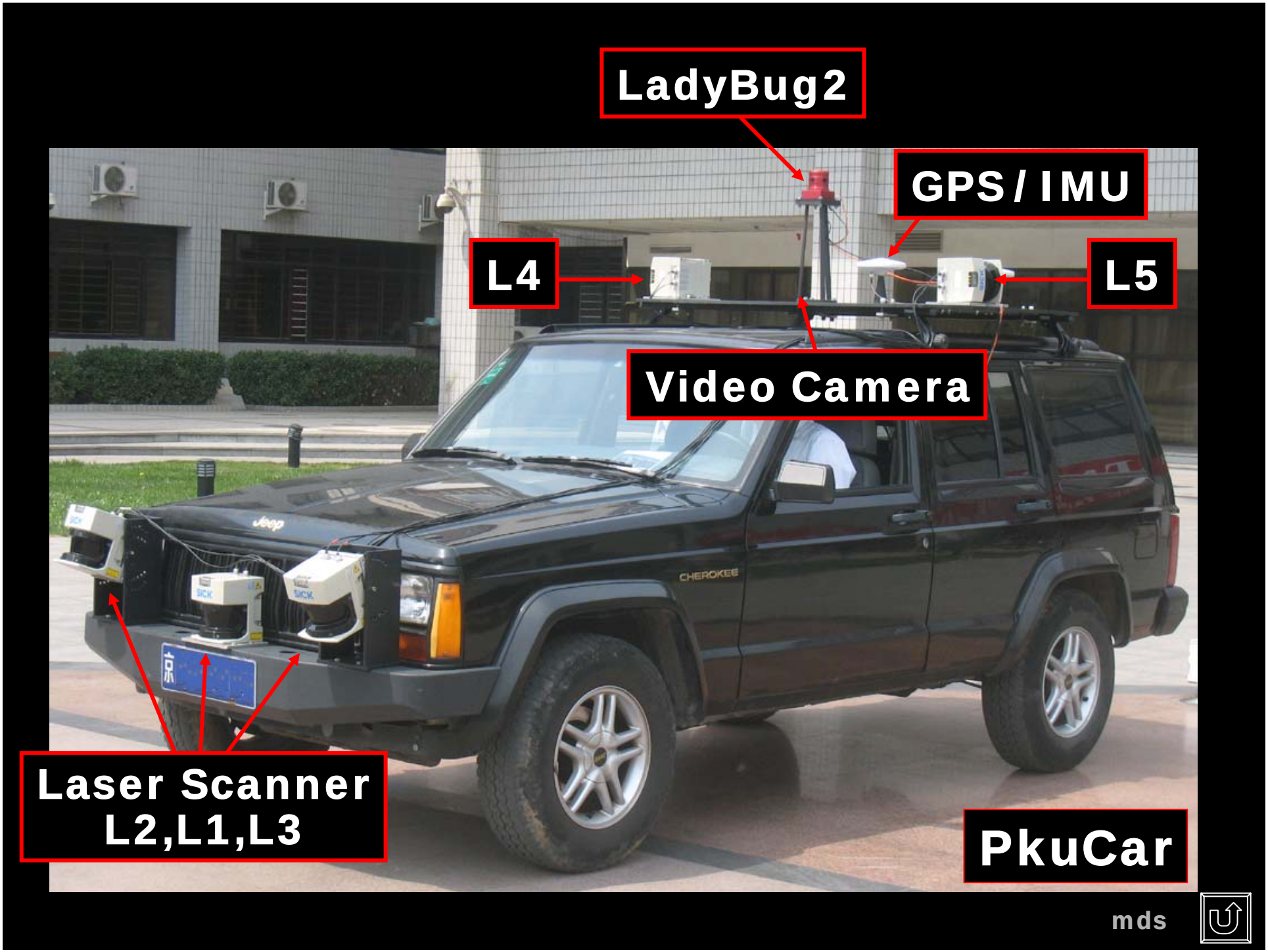

LadyBug2
GPS / IMU
L4
L5
Video Camera
Laser Scanner
L2,L1,L3
PkuCar
mds

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.

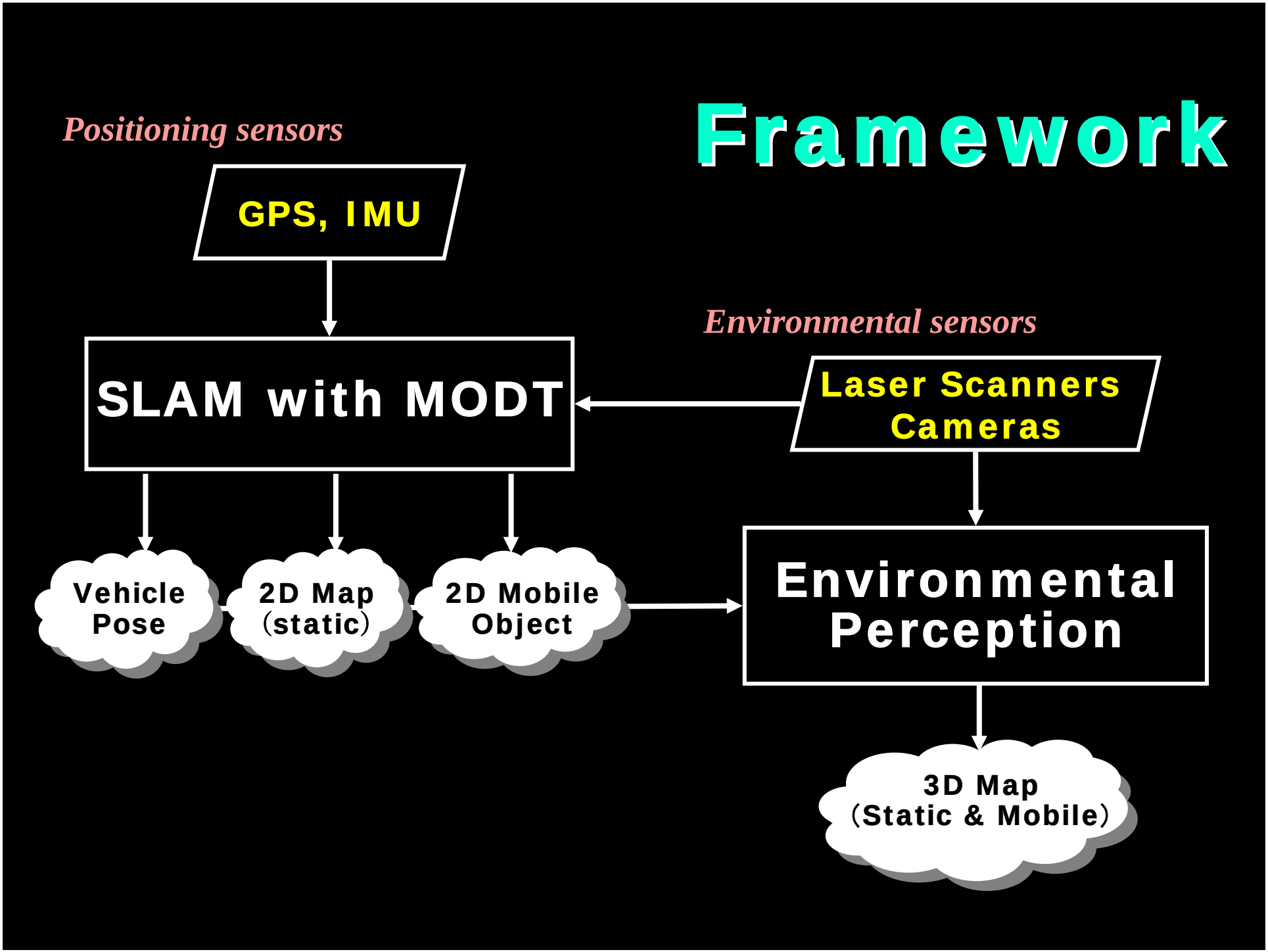
We want to **detect** the **moving objects** in the surroundings, and **track** their **states**, such as speed, direction, and size, so that dangerous situations can be predicted.

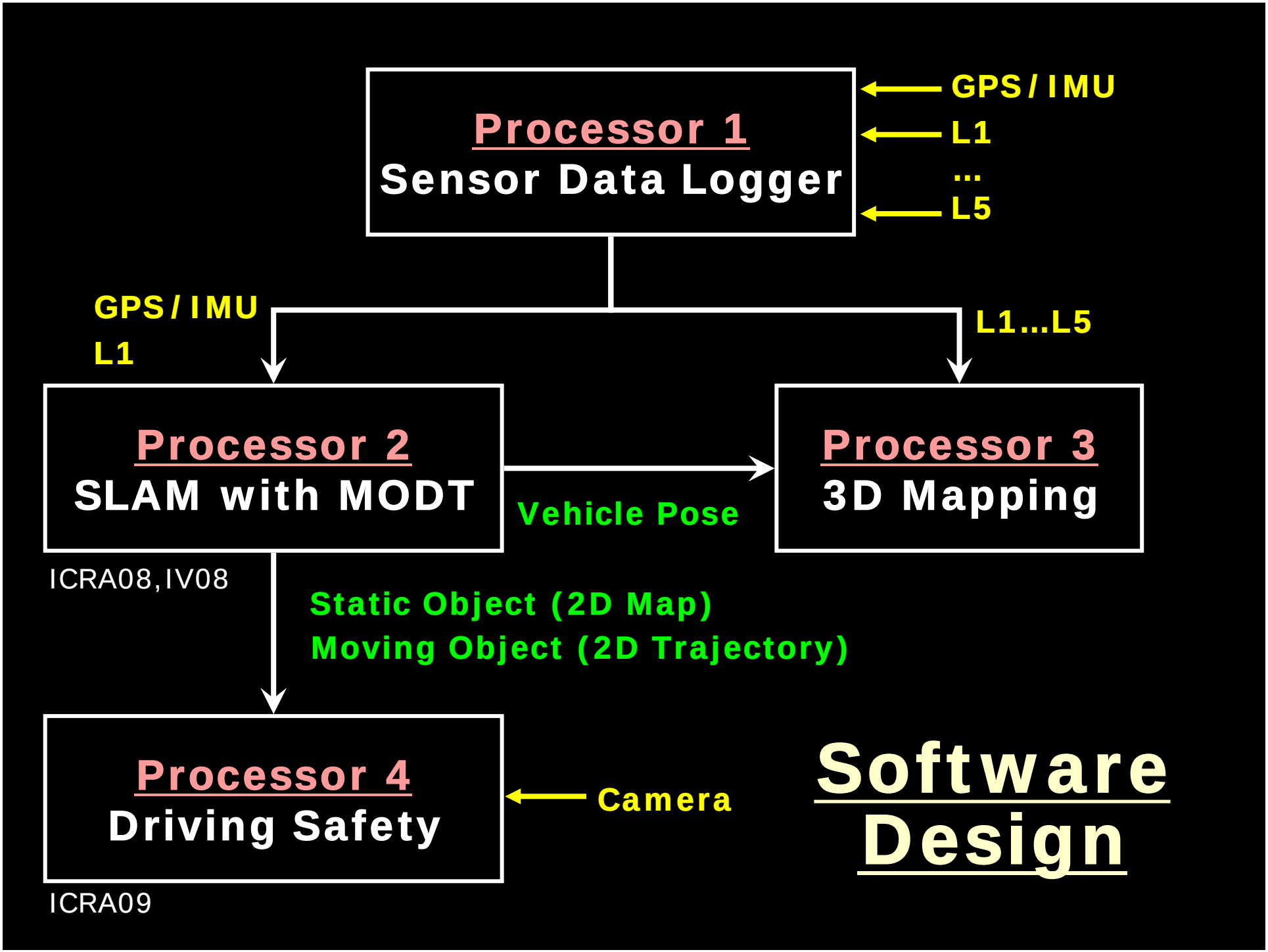
We want to **generate a 3D copy** of the dynamic urban scenery that contains both stationary objects, e.g. buildings, trees, road etc., and mobile objects, e.g. people, bicycles and cars.

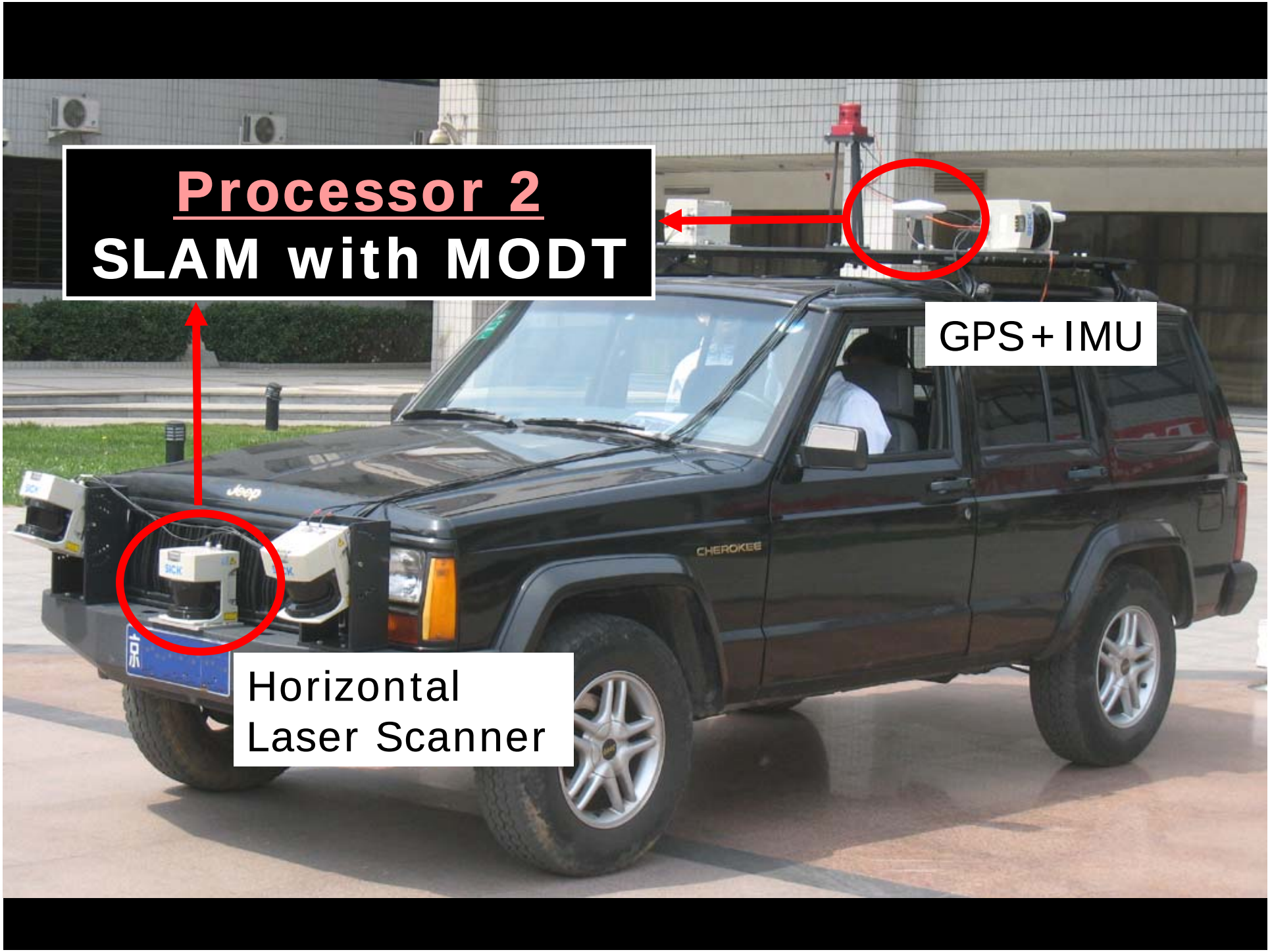
Key Issues

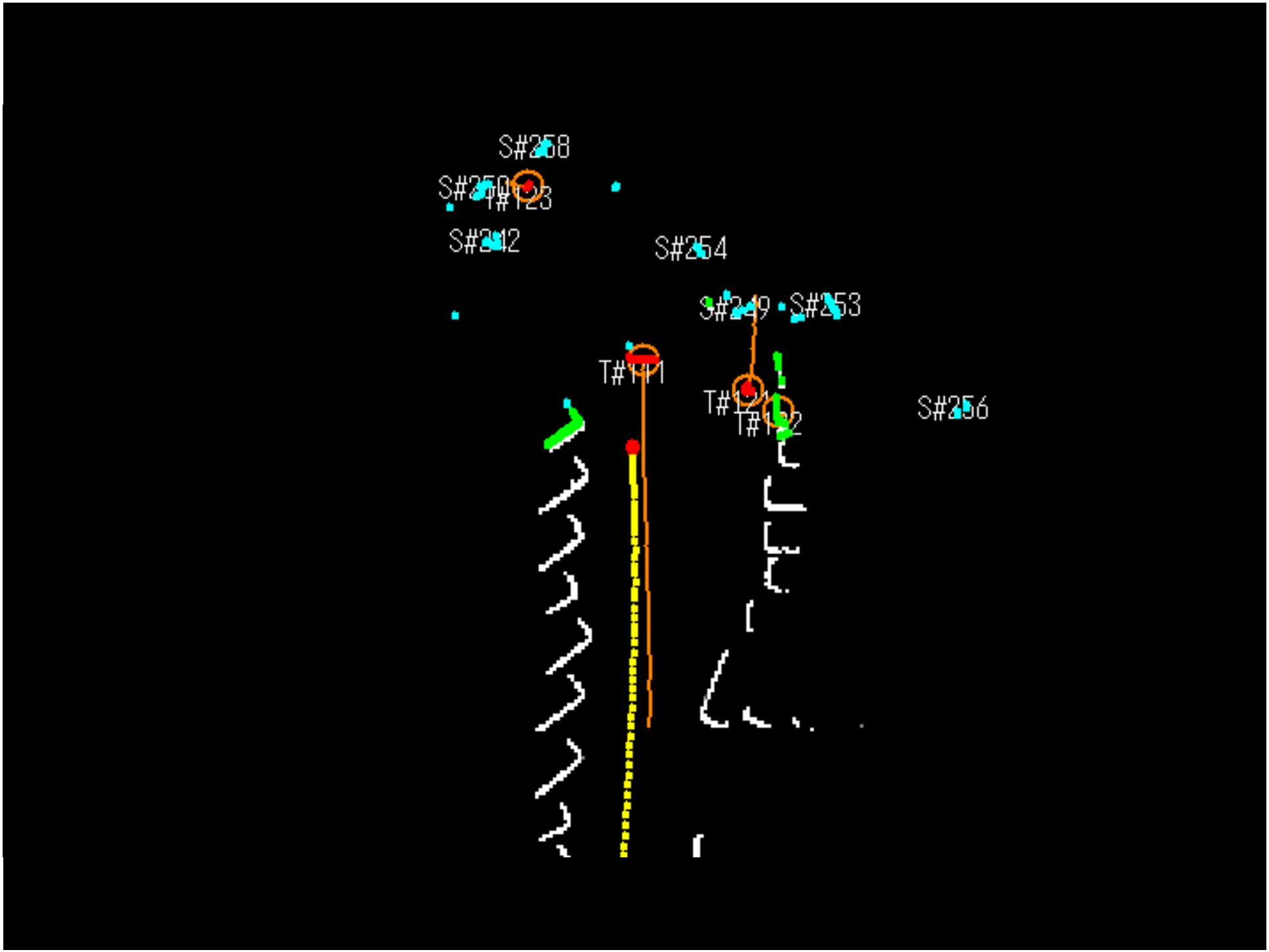
- Sensor Alignment
- Localization
- 3D Mapping
- Mobile objects' detection, tracking and classification

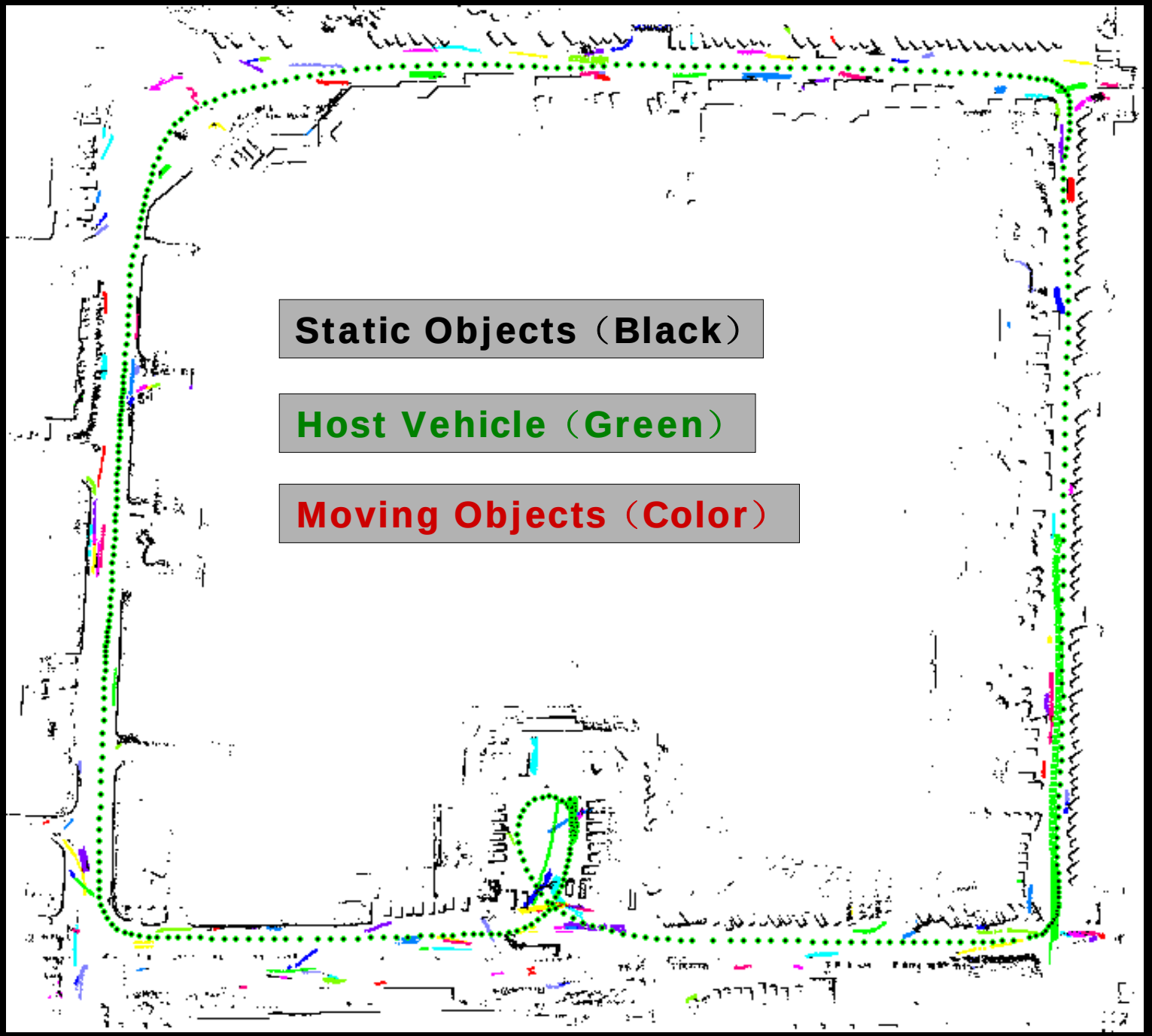
Framework


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)

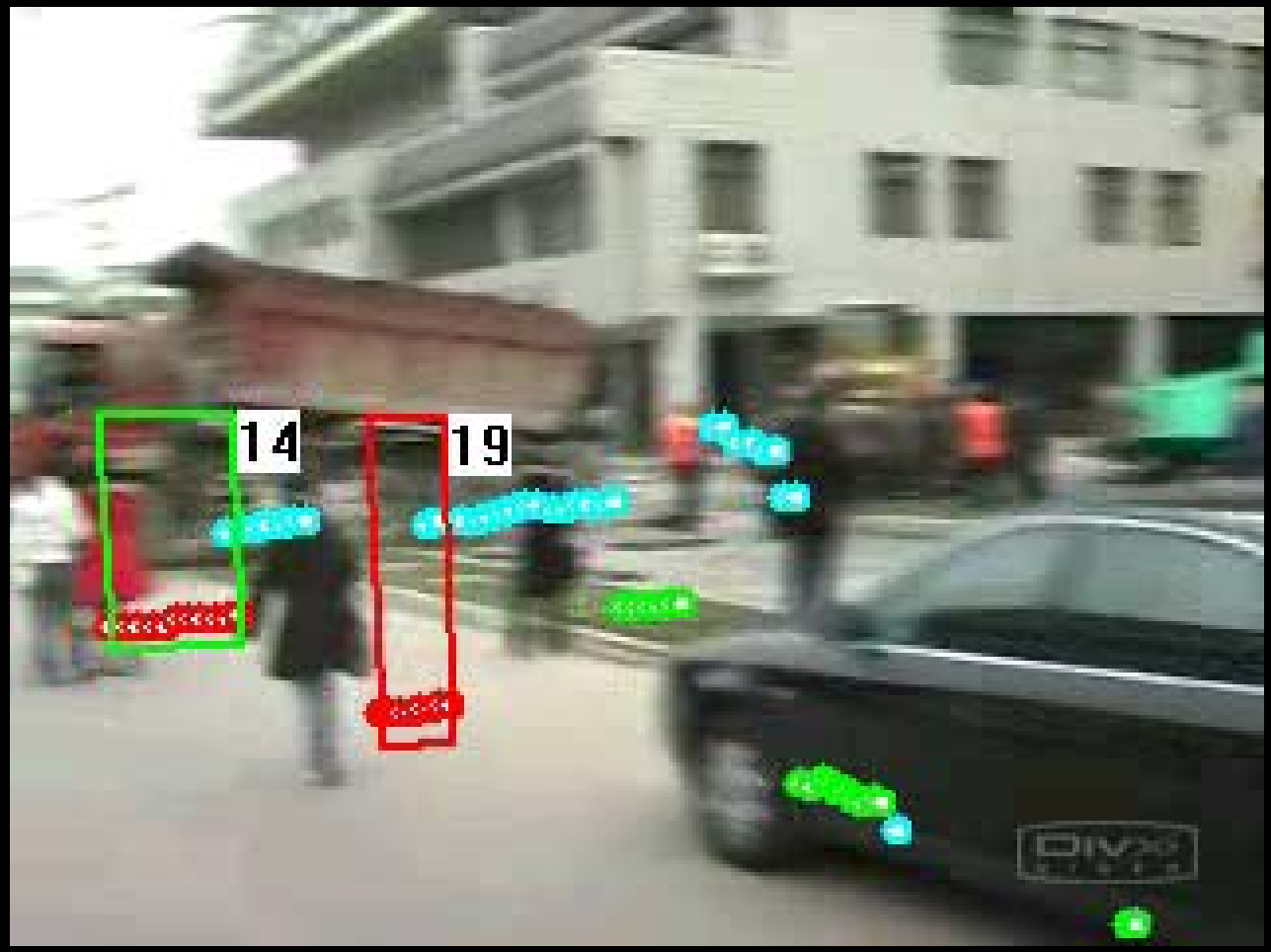

Processor 1
Sensor Data Logger
GPS / IMU
L1
...
L5
GPS / IMU
L1
L1...L5
Processor 2
SLAM with MODT
Vehicle Pose
Processor 3
3D Mapping
ICRA08, IV08
Static Object (2D Map)
Moving Object (2D Trajectory)
Processor 4
Driving Safety
Camera
ICRA09
Software Design


Processor 2
SLAM with MODT
GPS + IMU
Horizontal
Laser Scanner


S#258
S#250
T#123
S#242
S#254
S#249
S#253
T#111
T#121
T#122
S#256


Static Objects（Black）
Host Vehicle（Green）
Moving Objects（Color）

Fusion with Video

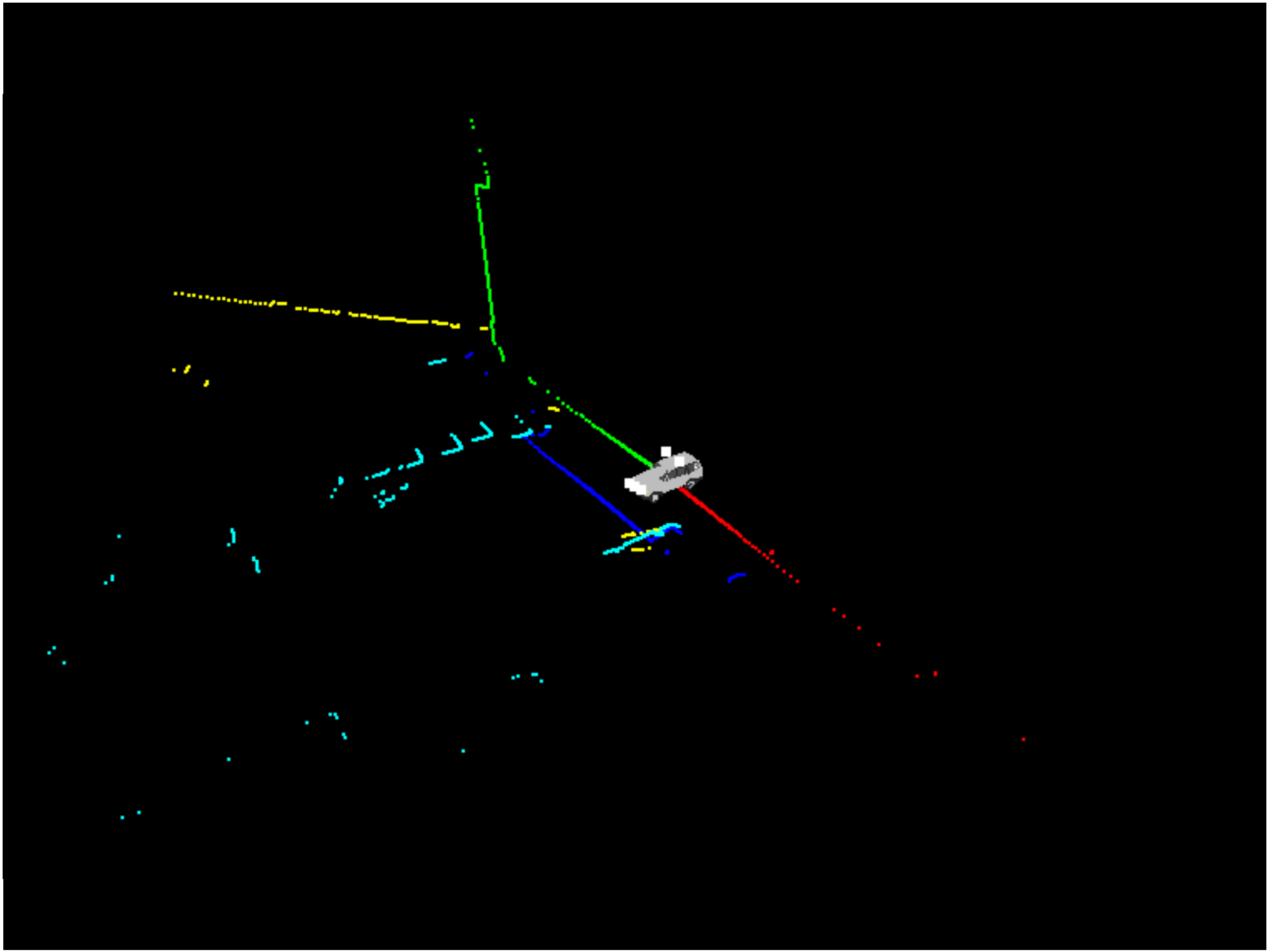


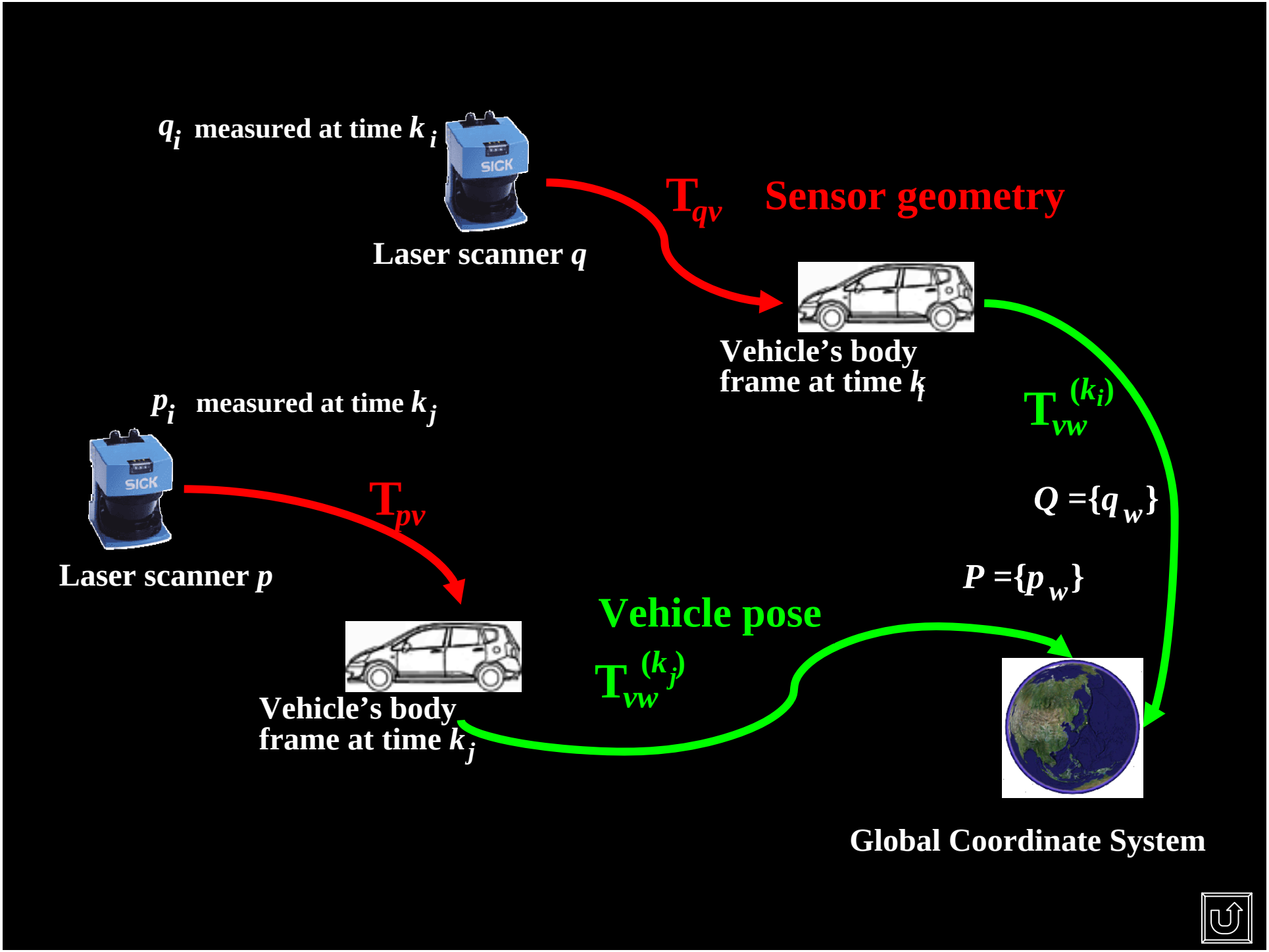
Objects

- person
- bicycle
- group
- car

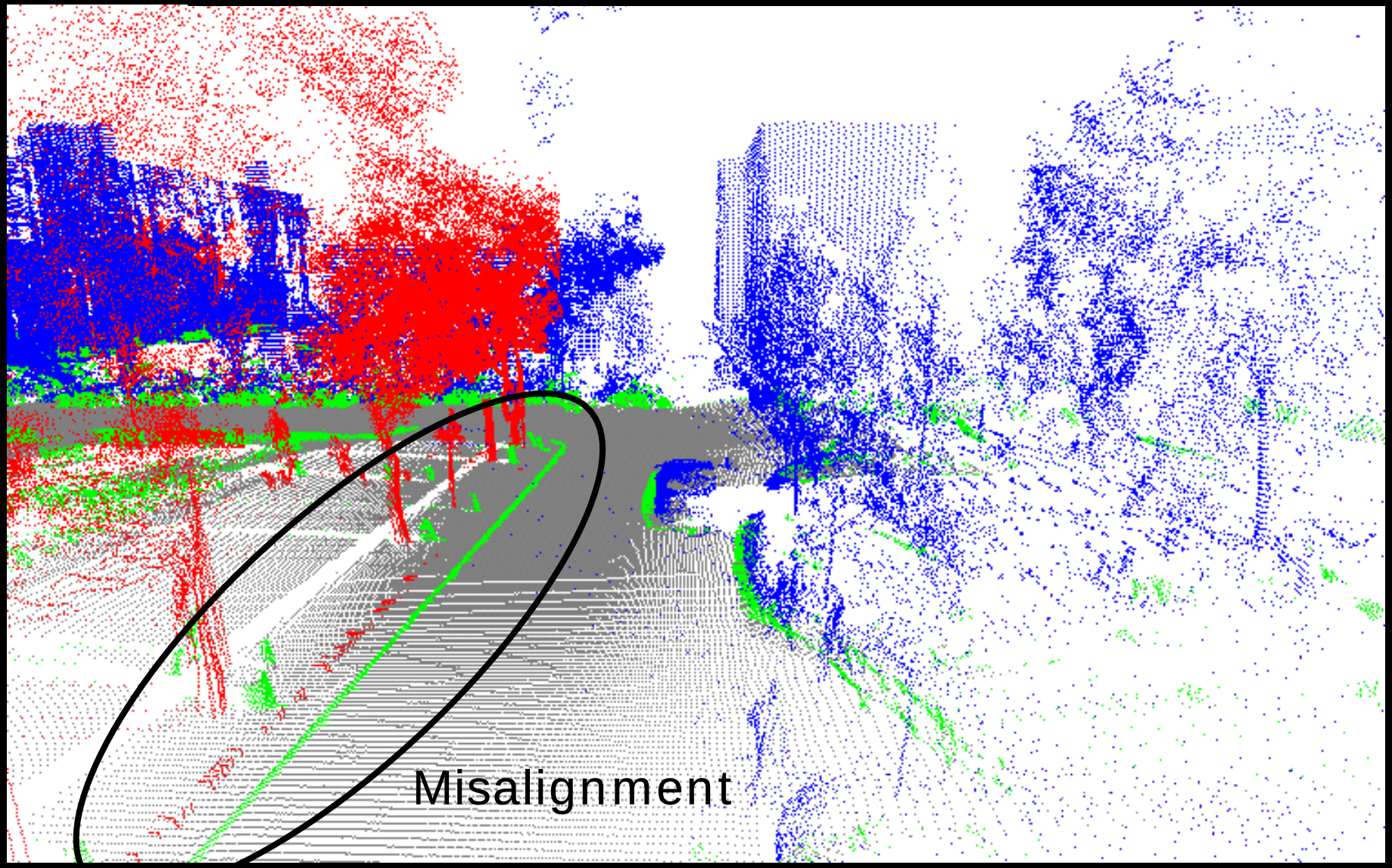
Laser Points

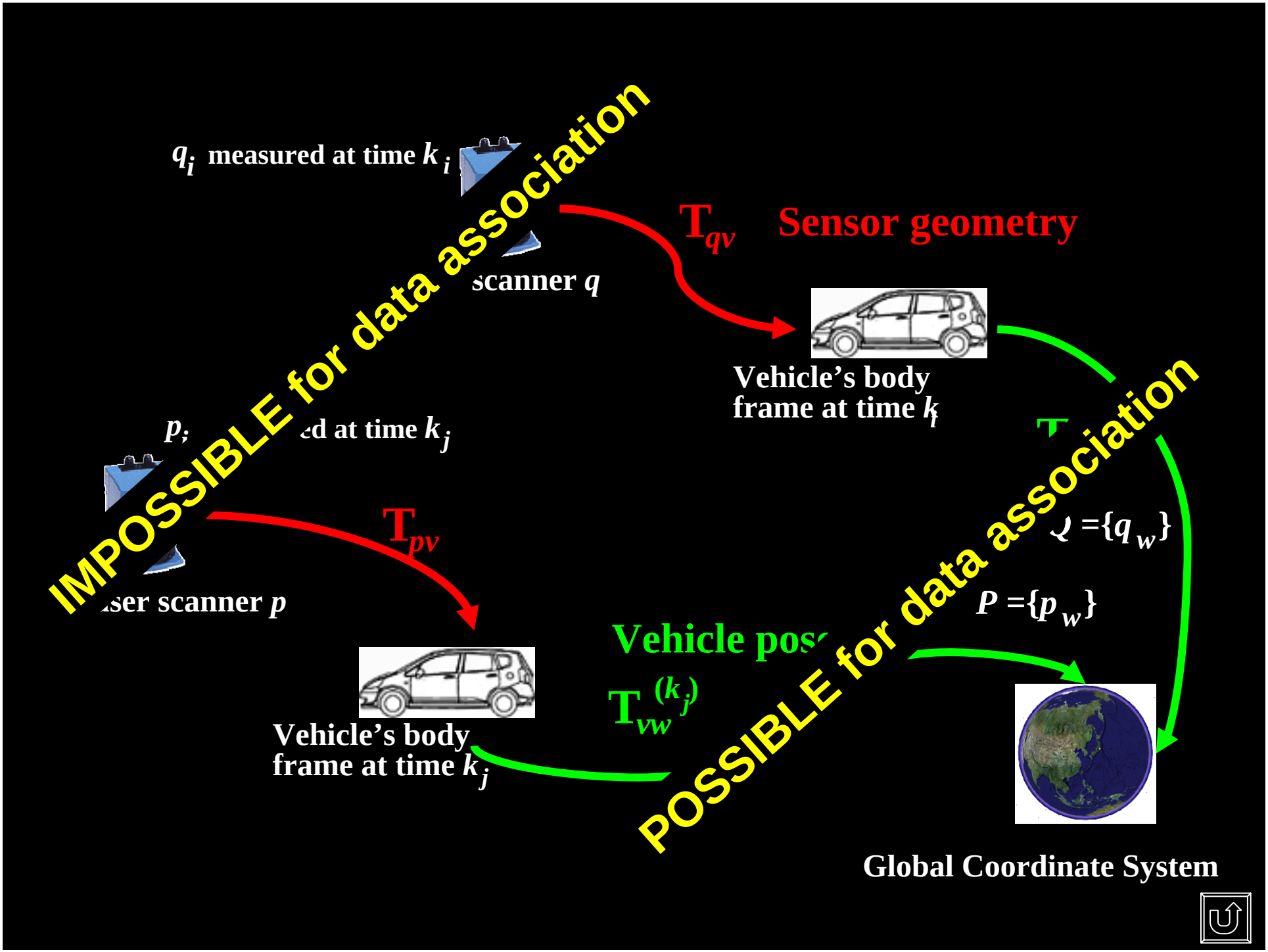
- moving
- seed
- group




q_i measured at time k_i
Laser scanner q
T_{qv}
Sensor geometry
Vehicle's body frame at time k_i
$T_{vw}^{(k_i)}$
$Q = \{q_w\}$
p_i measured at time k_j
Laser scanner p
T_{pv}
$P = \{p_w\}$
Vehicle pose
$T_{vw}^{(k_j)}$
Vehicle's body frame at time k_j
Global Coordinate System

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

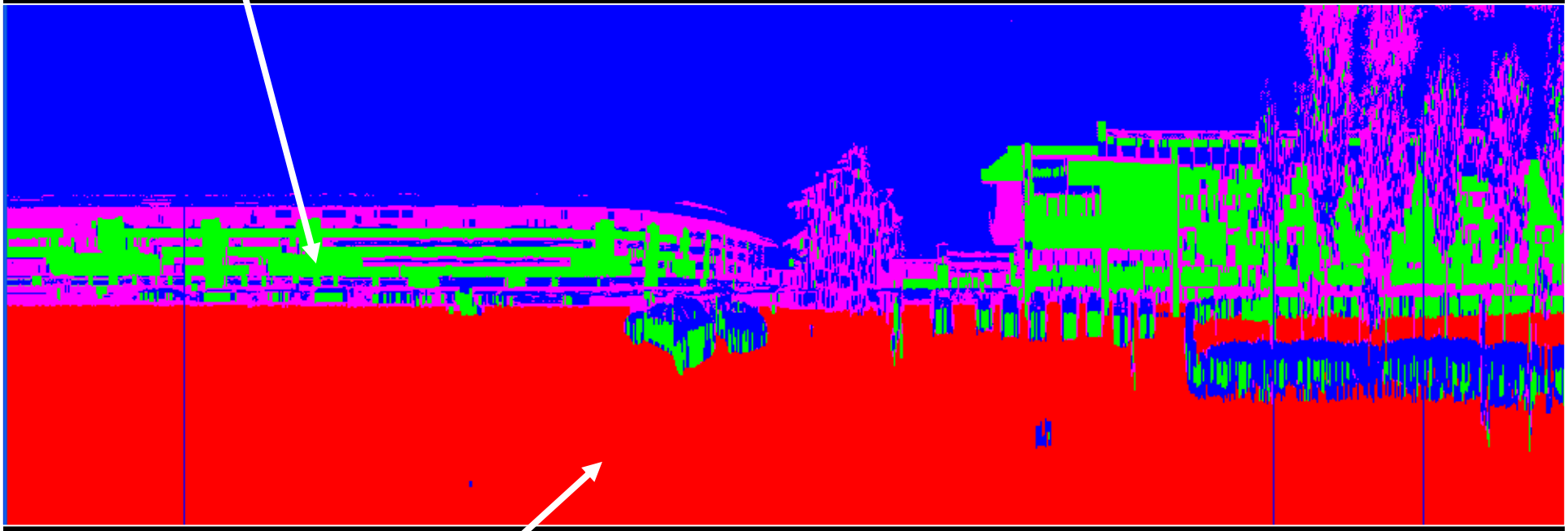



q_i measured at time k_i
scanner q
IMPOSSIBLE for data association
T_{qv} Sensor geometry
Vehicle's body frame at time k_i
p_j
ed at time k_j
ser scanner p
T_{pv}
$Q = \{q_w\}$
$P = \{p_w\}$
Vehicle pos
$T_{vw}^{(k_j)}$
POSSIBLE for data association
Vehicle's body frame at time k_j
Global Coordinate System

Sensor Calibration

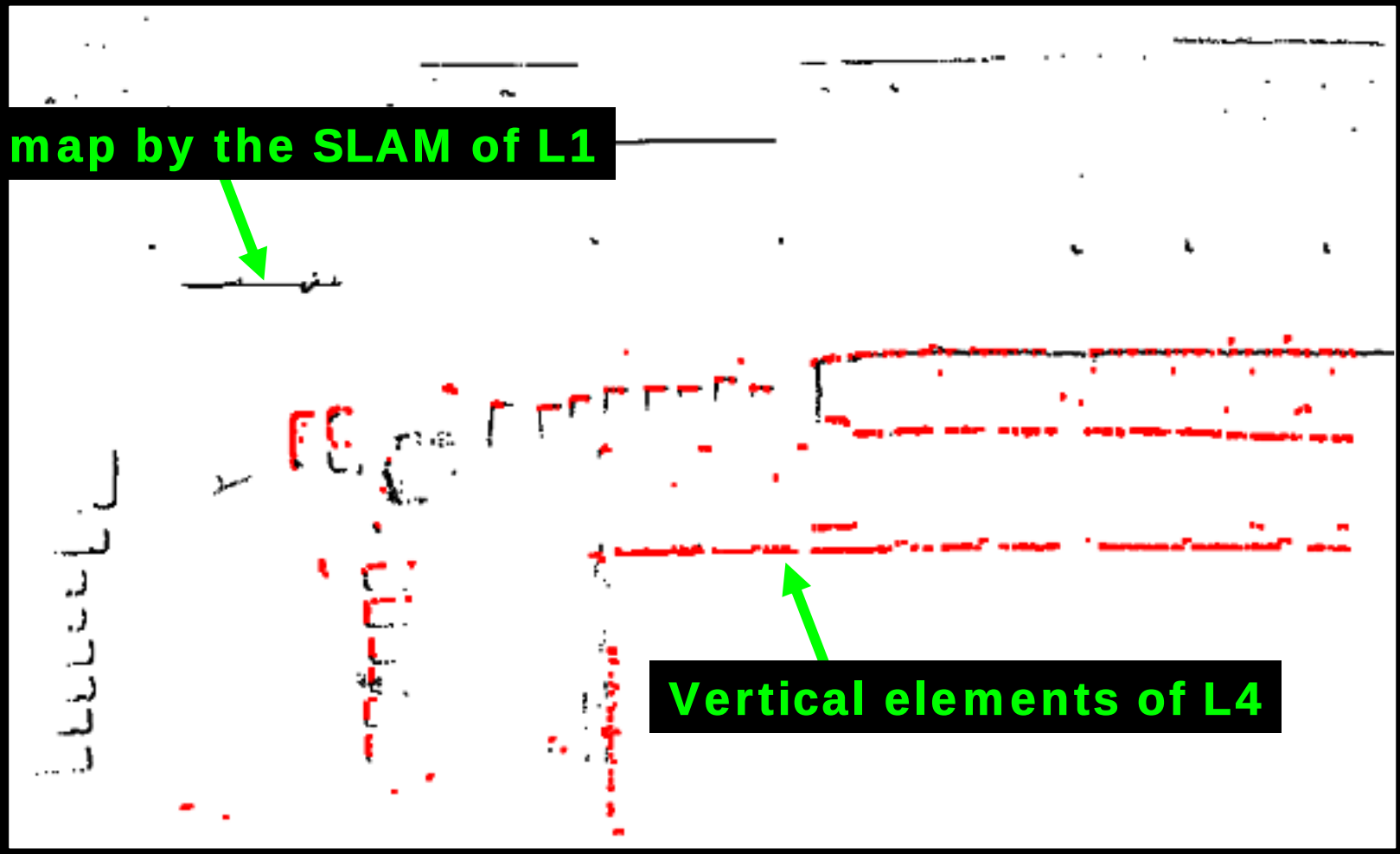
- Sensor geometries are calibrated by minimizing the displacement between geo-referenced data sets of **non-rigid geometry**
- Two sequential steps
  - Horizontal Registration
  - Vertical Registration

Vertical elements → Horizontal registration

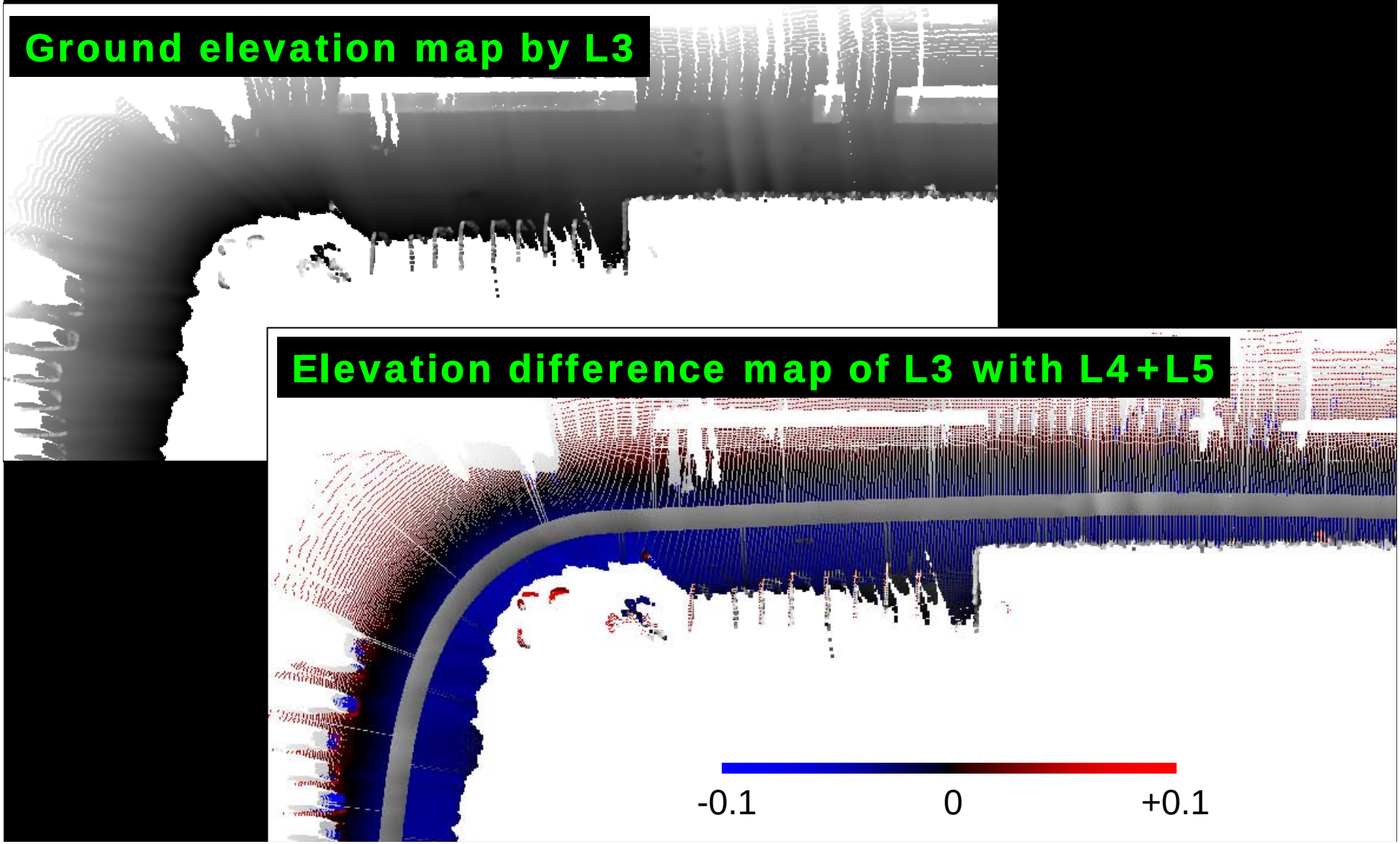


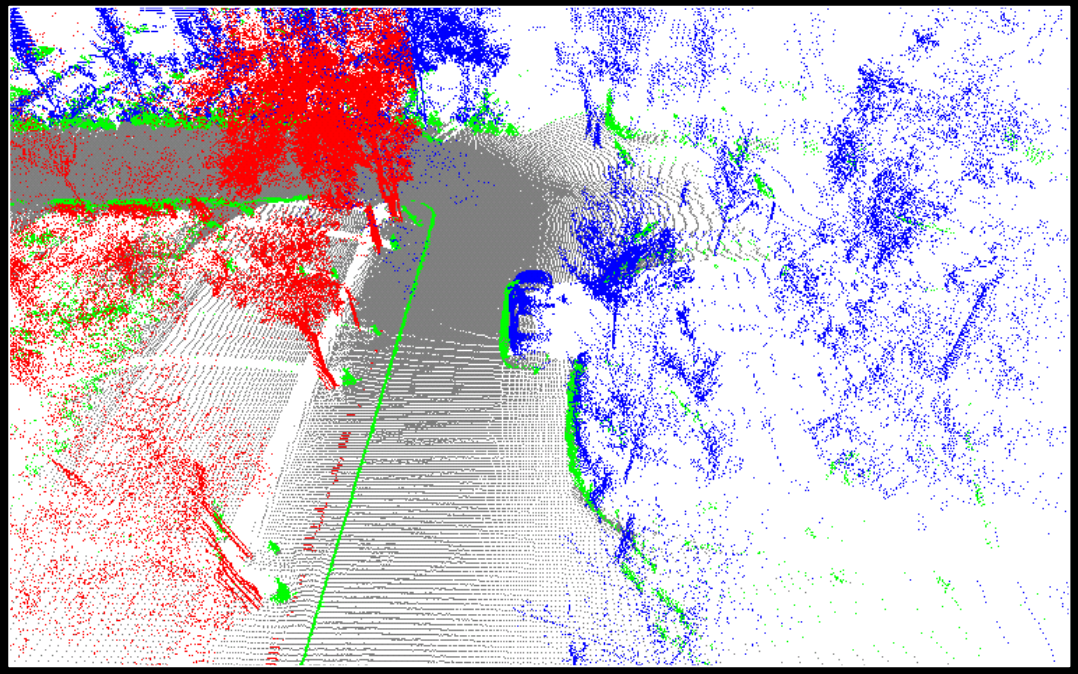
Ground data → Vertical registration

Horizontal Registration

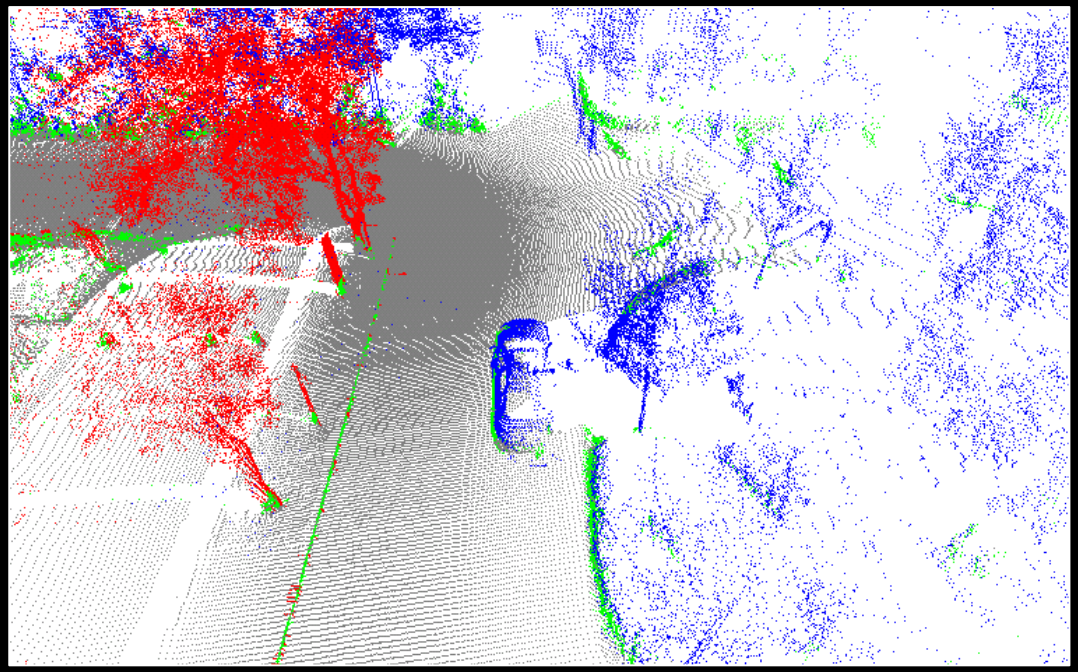


Vertical Registration

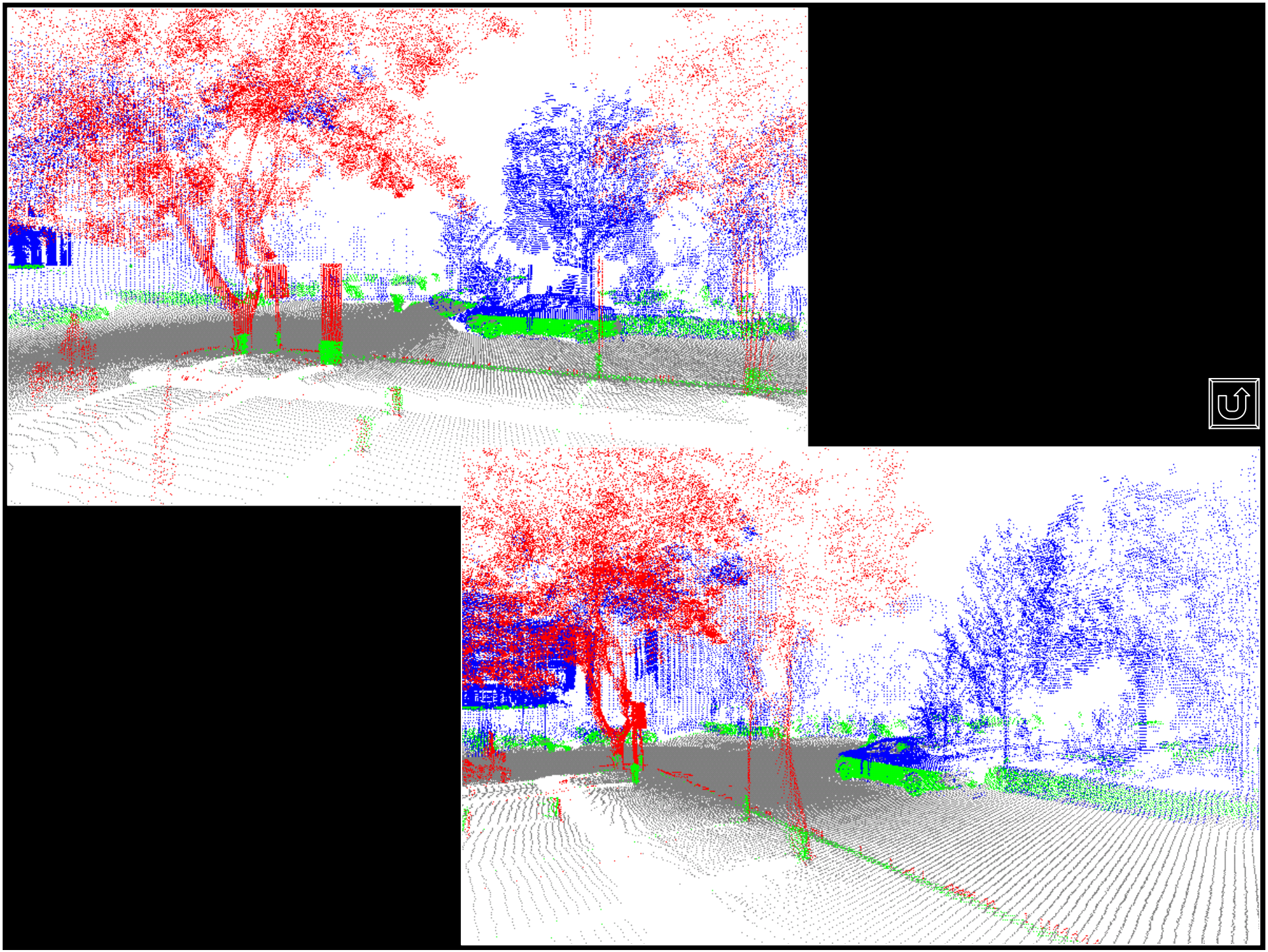


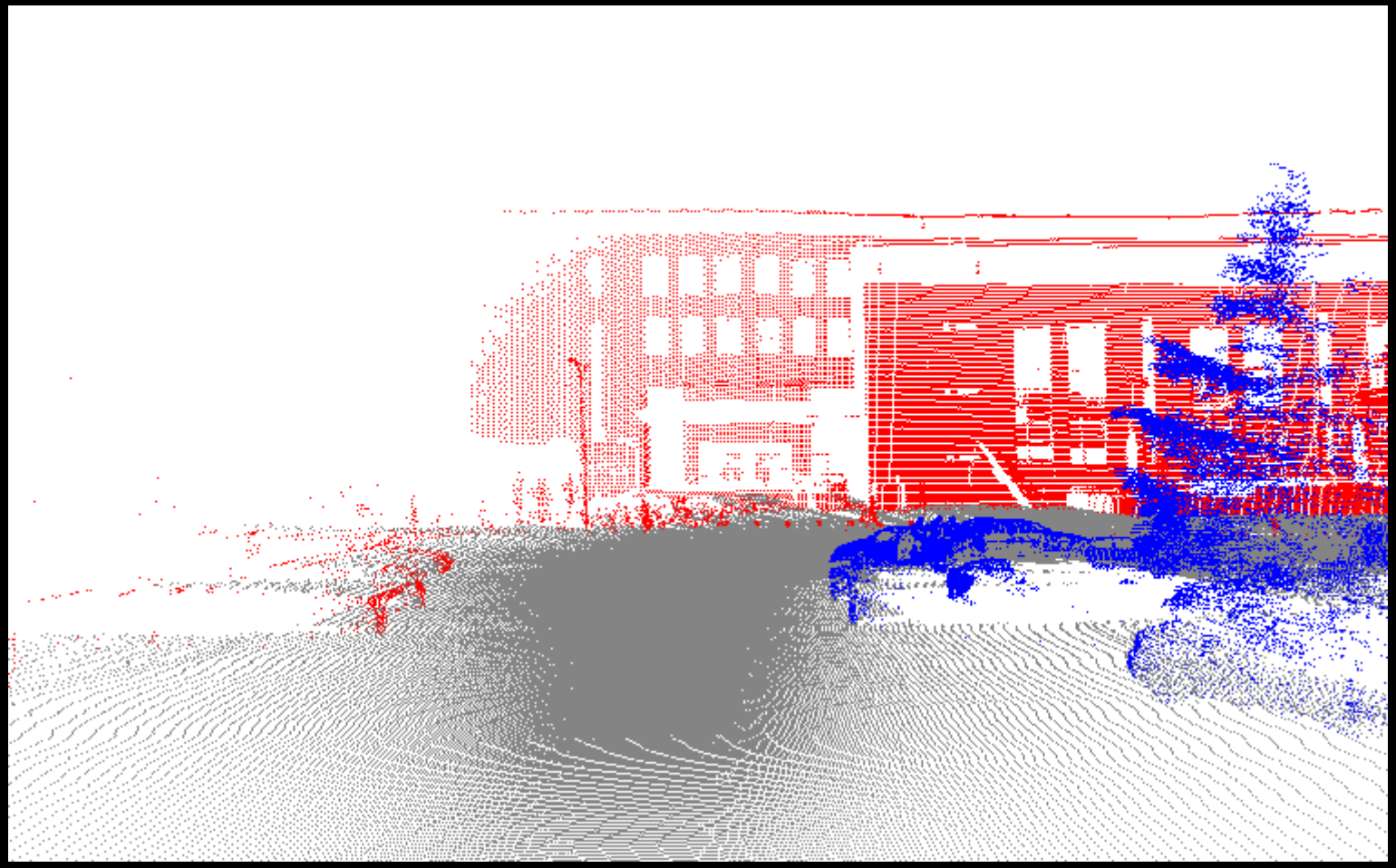


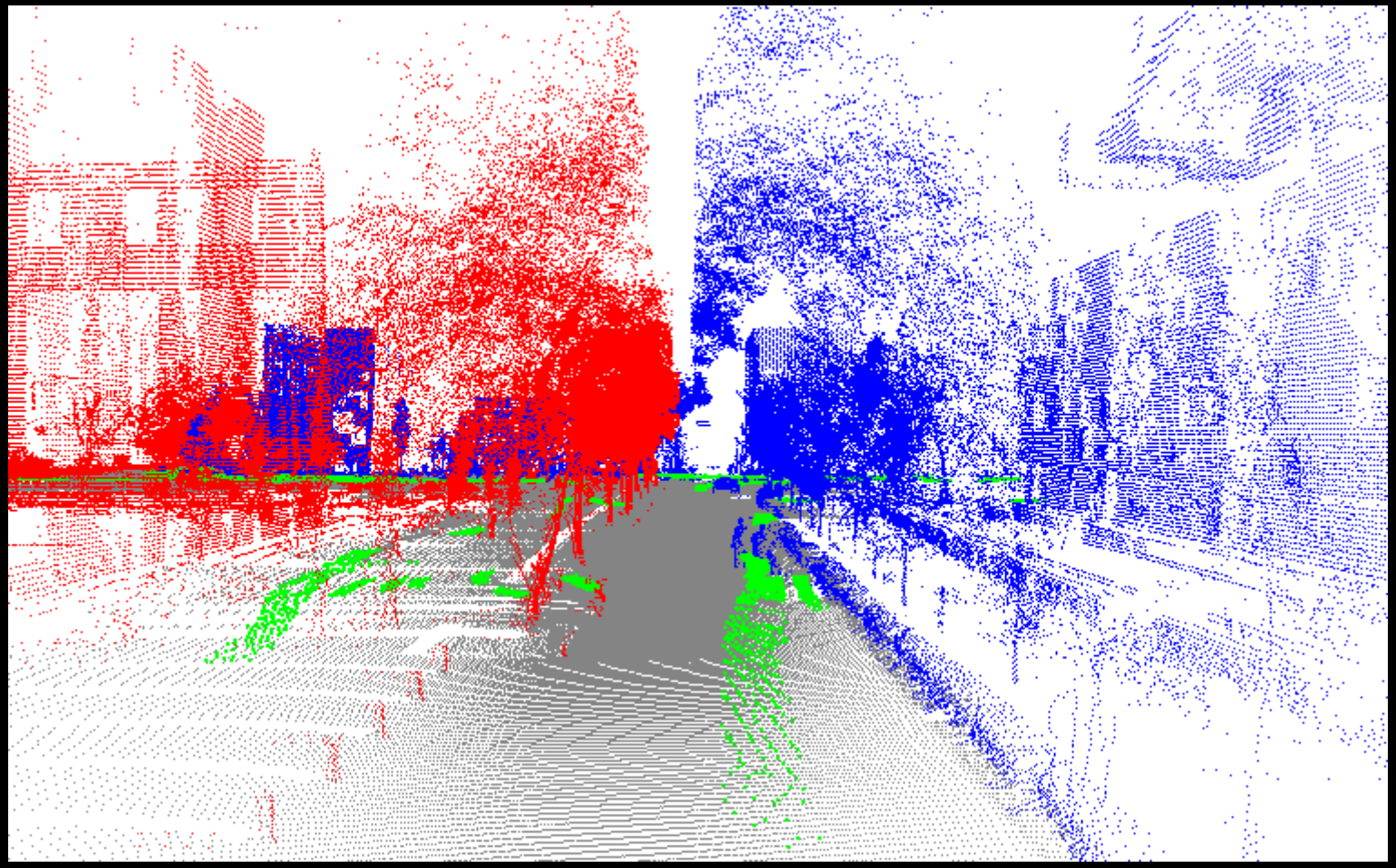
before

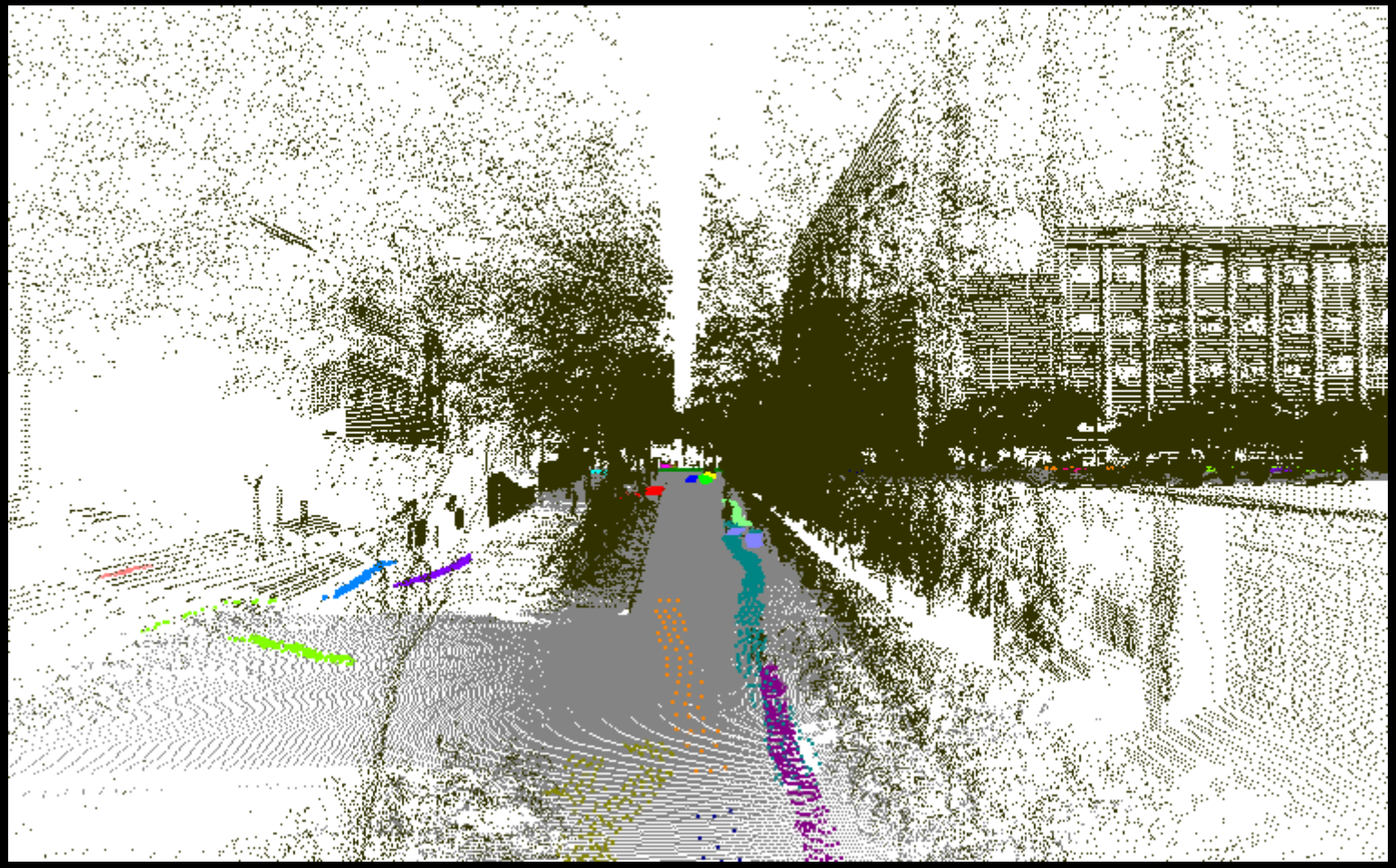


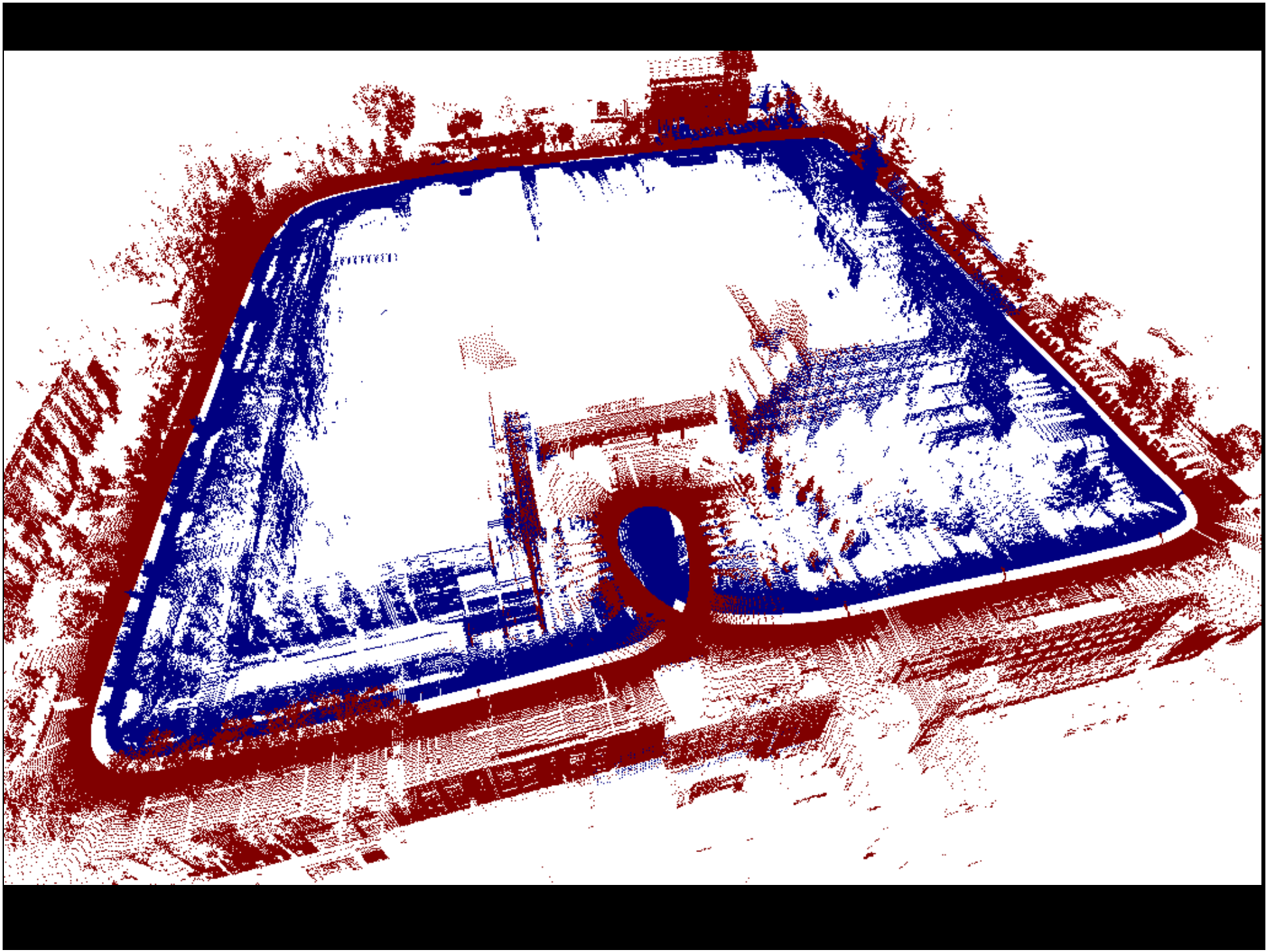
after

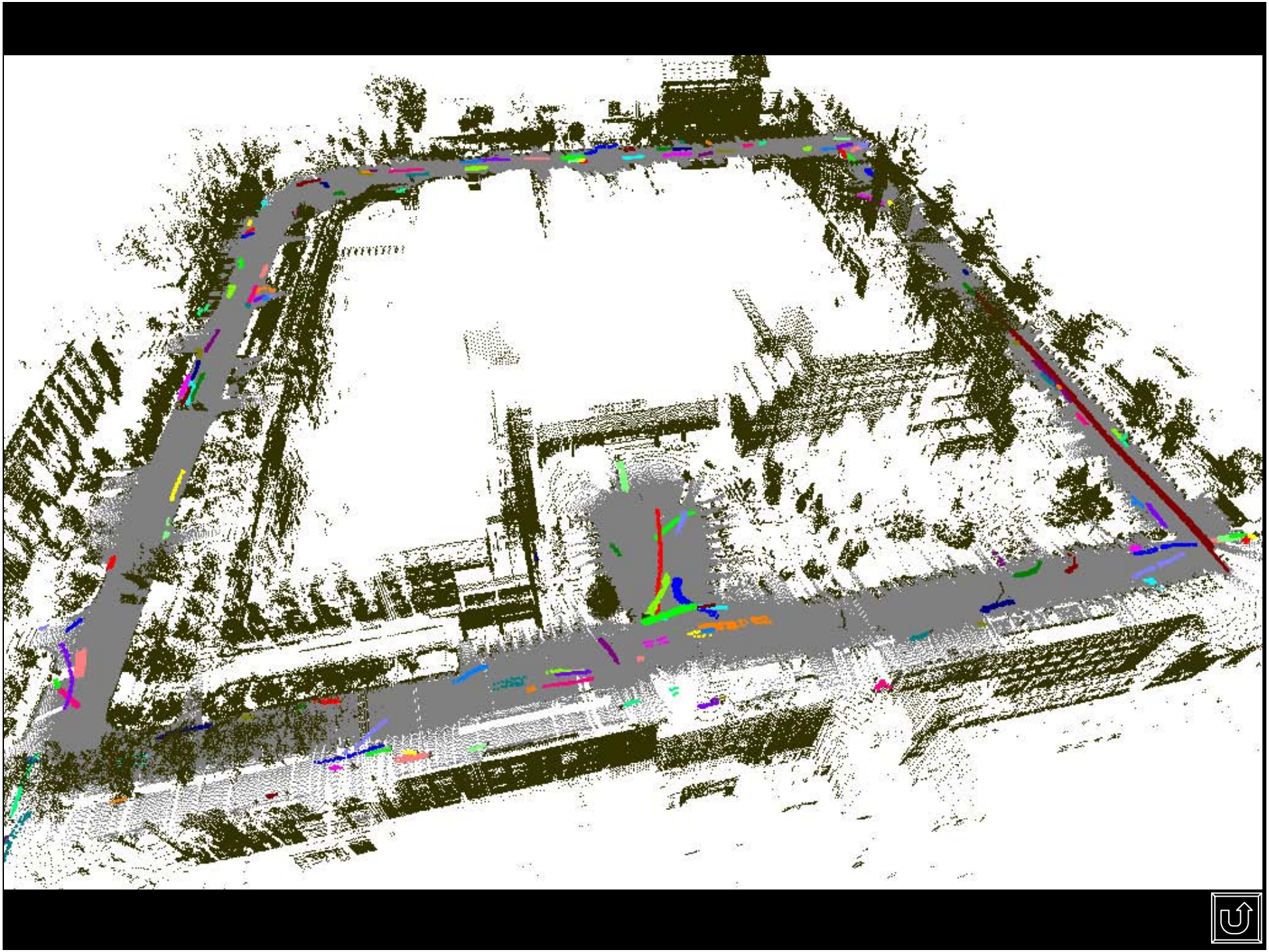












Conclusion

- Towards an intelligent vehicle of Omni-directional eyes looking at the environment of both static and dynamic objects.

Welcome to our demonstration!

Thank you !

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