



CISB

CENTRO DE
PESQUISA E INOVAÇÃO
SUECO-BRASILEIRO

5th Annual
Meeting

2015

November 9-13

Case in Autonomous Vehicles

Denis F. Wolf

University of Sao Paulo – LRM/ICMC/USP

Autonomous Vehicles at LRM/ICMC/USP

Research Interests

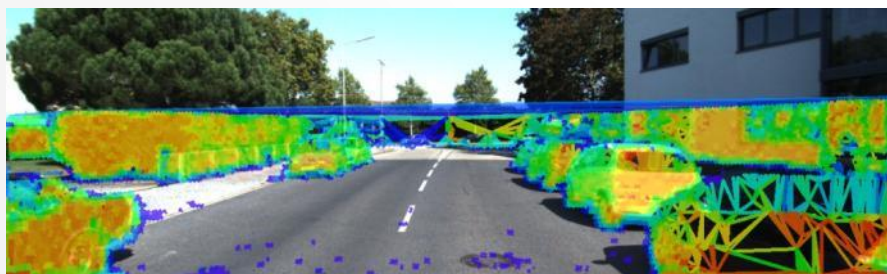
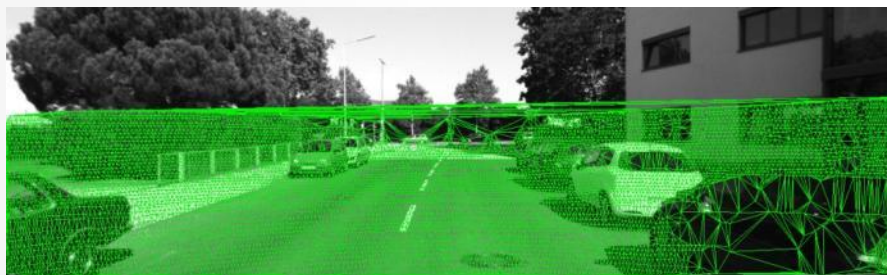
- **Perception**
 - Obstacle detection
 - People
 - Cars
 - Traffic Lights
 - Tracking of moving obstacles
 - Road detection
 - Sensor Fusion
- **Mapping**
 - Automatic lane-level mapping
 - Semantic mapping
- **Localization**
- **Control**
- **Decision Making**
- **Vehicle communication**
- **Driving assistance systems**



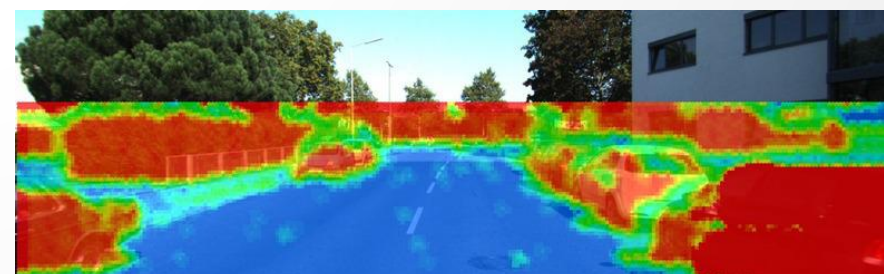
Obstacle and road detection



LIDAR + single camera

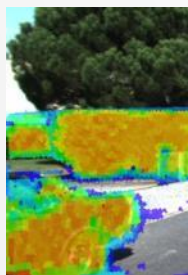
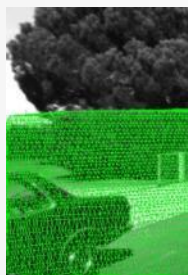


Stereo camera

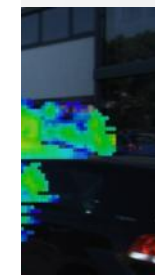
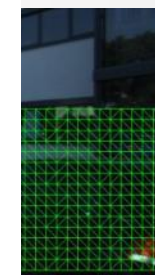


Shinzato et. Al. *Road Terrain Detection: Avoiding Common Obstacle Detection Assumptions Using Sensor Fusion*, IEEE Intelligent Vehicles Symposium – IV, 2014

Obstacle and road detection

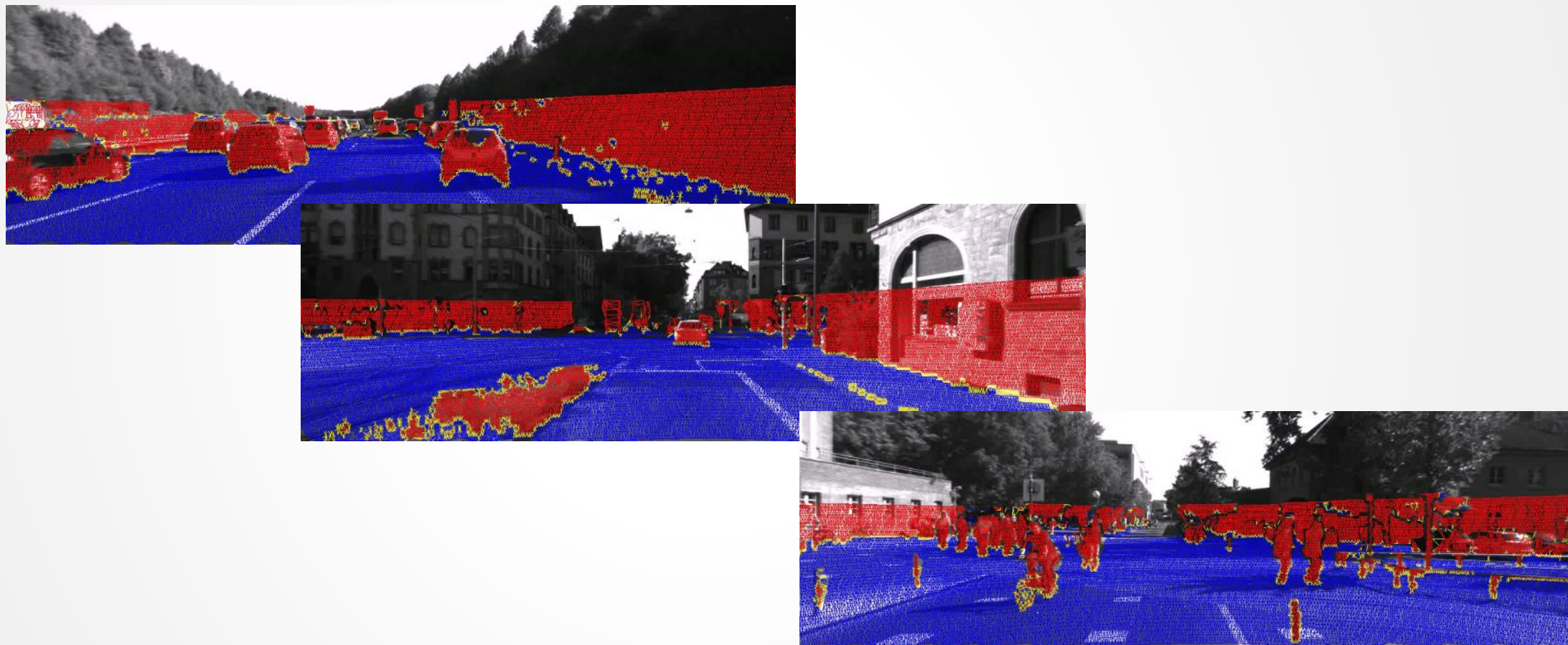


Parameters	GRES3D+VELO	GRES3D+Stereo
θ	77°	11.7°
σ	50.0	
λ	not required	$5px$
roi	not required	$width \times \frac{2}{3}height$
$green-threshold$	0.2	
$precision-degree$	5° (means 72 bins)	
β 's	0.08, 0.10, 0.12, 0.14, 0.16	
$global-origin-point\ g(u,v)$	$width/2, height - 50$	
offsets in $width$ of g	$-100, -50, 0, +50, +100$	



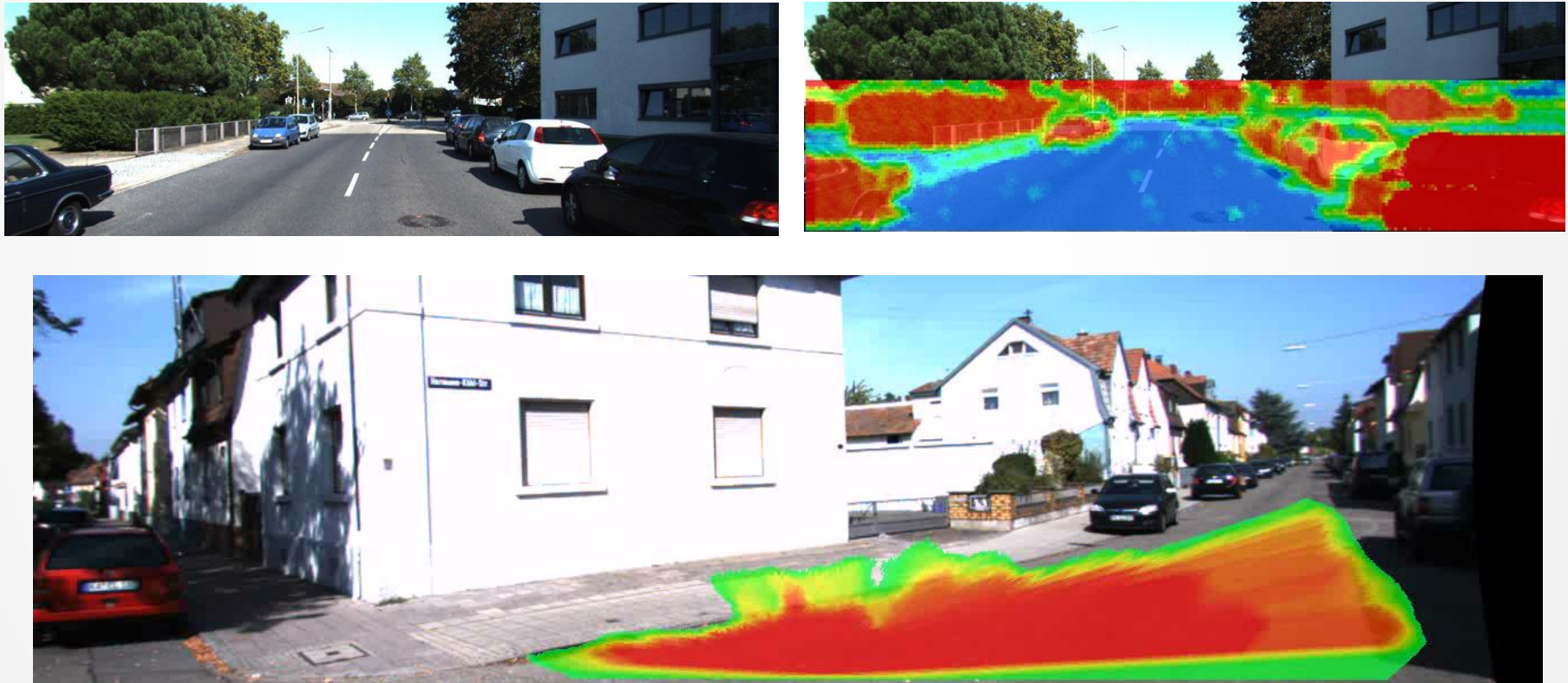
Perception

LIDAR-based obstacle and road detection



Shinzato et. Al. *Road Terrain Detection: Avoiding Common Obstacle Detection Assumptions Using Sensor Fusion*, IEEE Intelligent Vehicles Symposium – IV, 2014

Stereo vision-based obstacle and road detection



Shinzato et. Al. Road Estimation with Sparse 3D Points From Stereo Data,
IEEE Intelligent Transportation System Conference – ITSC, 2014.

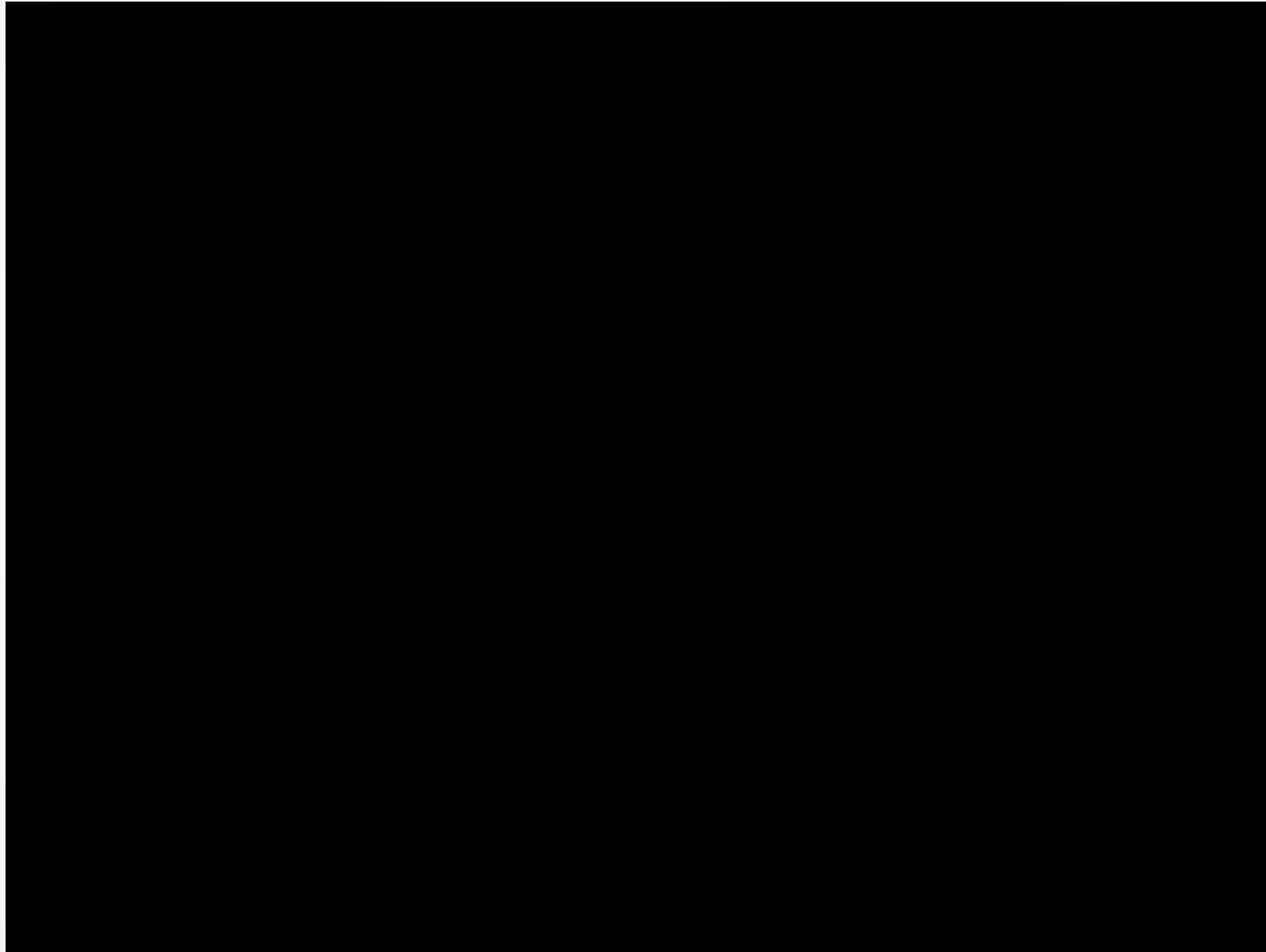
Perception

Detection and tracking of moving obstacles

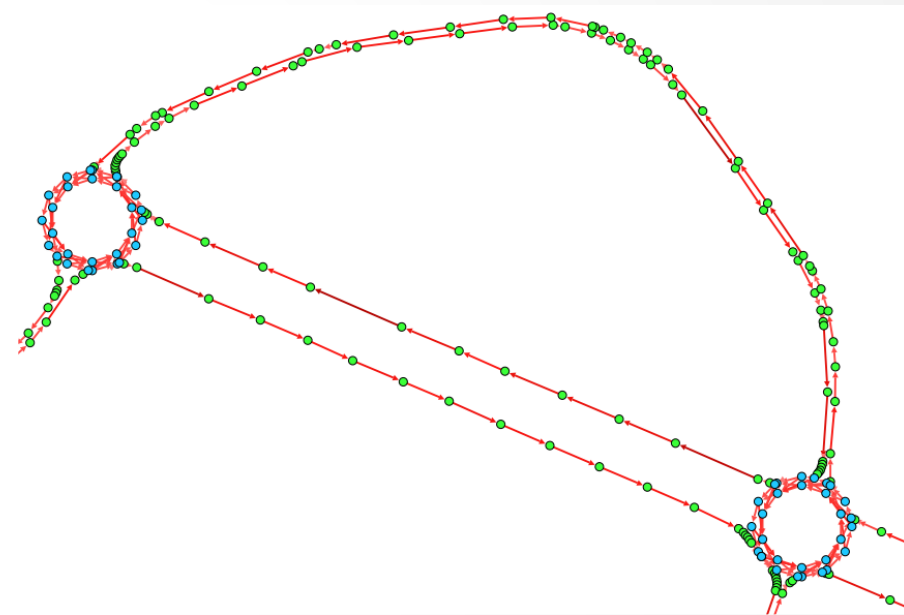


D. A. Ridel, P. Y. Shinzato and D. F. Wolf, Obstacle segmentation with low-density disparity maps, 7th Workshop on Planning, Perception and Navigation for Intelligent Vehicles, IEEE IROS, 2015

Perception



Automatic lane-level semantic mapping



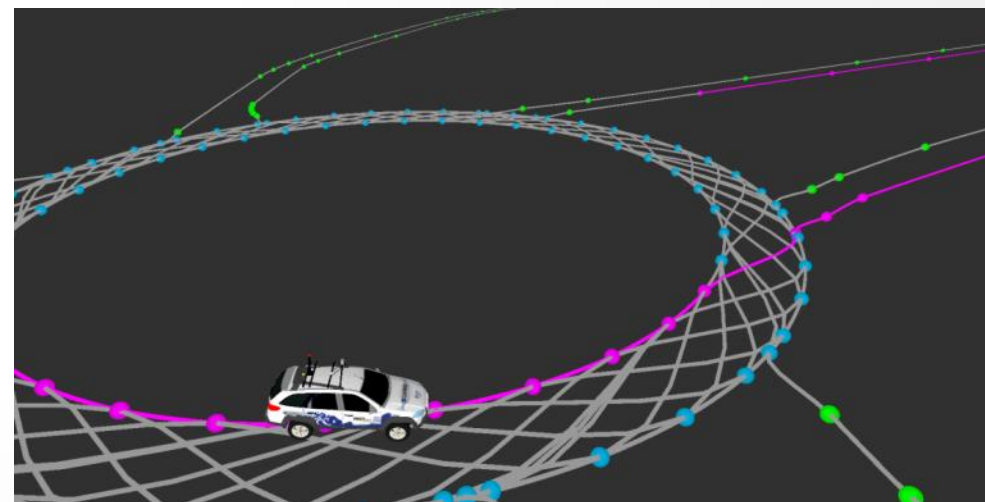
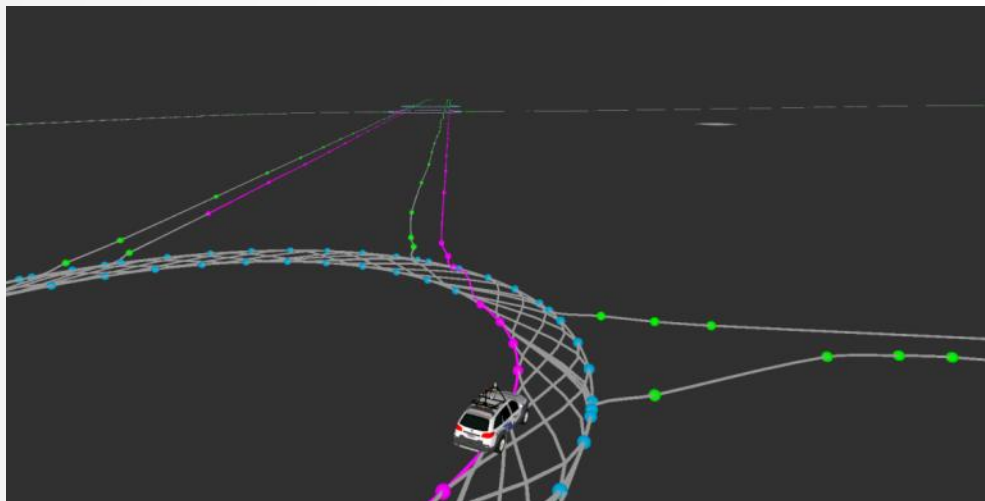
Zoccoler et al., Automatic Semantic Waypoint Mapping Applied to Autonomous Vehicles,
Latin American Robotics Symposium – LARS, 2014

Mapping

Automatic lane-level semantic mapping

Zoccoler et al., Automatic Semantic Waypoint Mapping Applied to Autonomous Vehicles,
Latin American Robotics Symposium – LARS, 2014

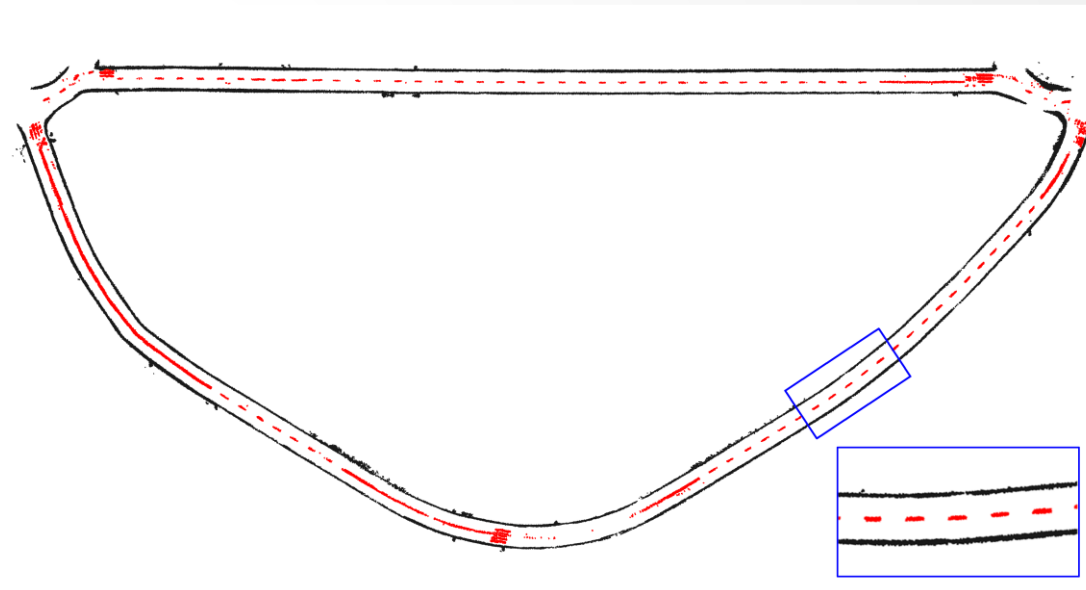
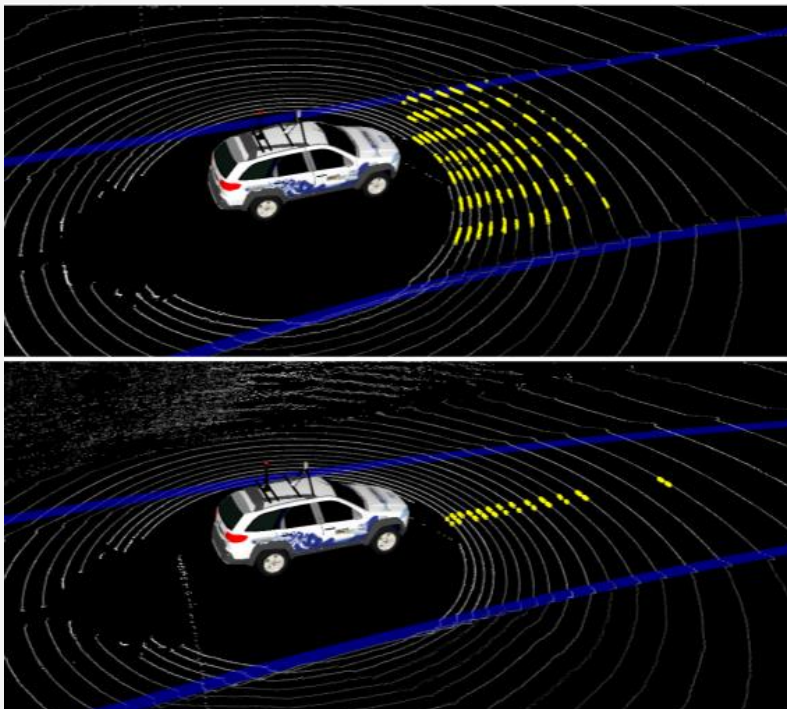
Automatic lane-level semantic mapping



Zoccoler et al., Automatic Semantic Waypoint Mapping Applied to Autonomous Vehicles,
Latin American Robotics Symposium – LARS, 2014

Map-based localization

Curb and horizontal markings detection

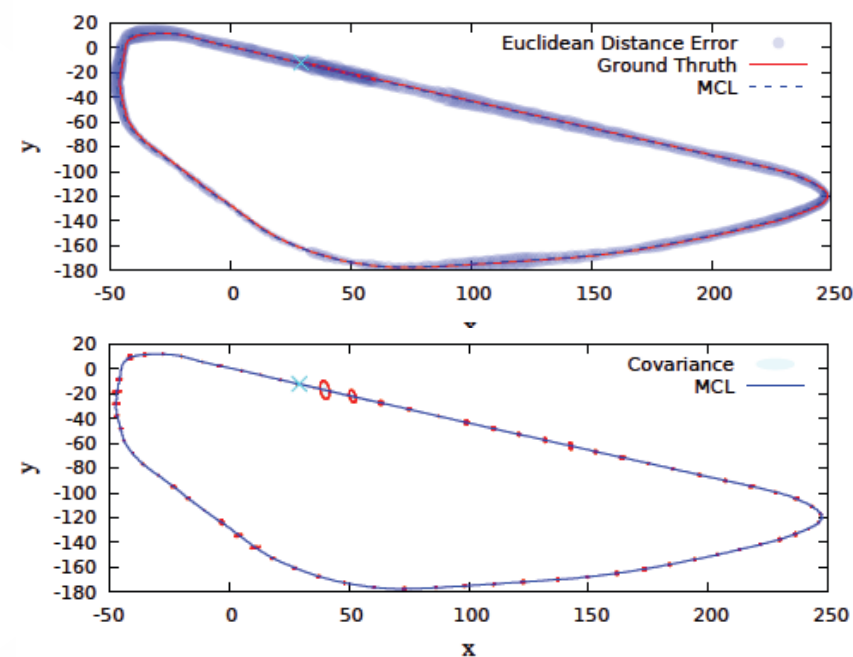
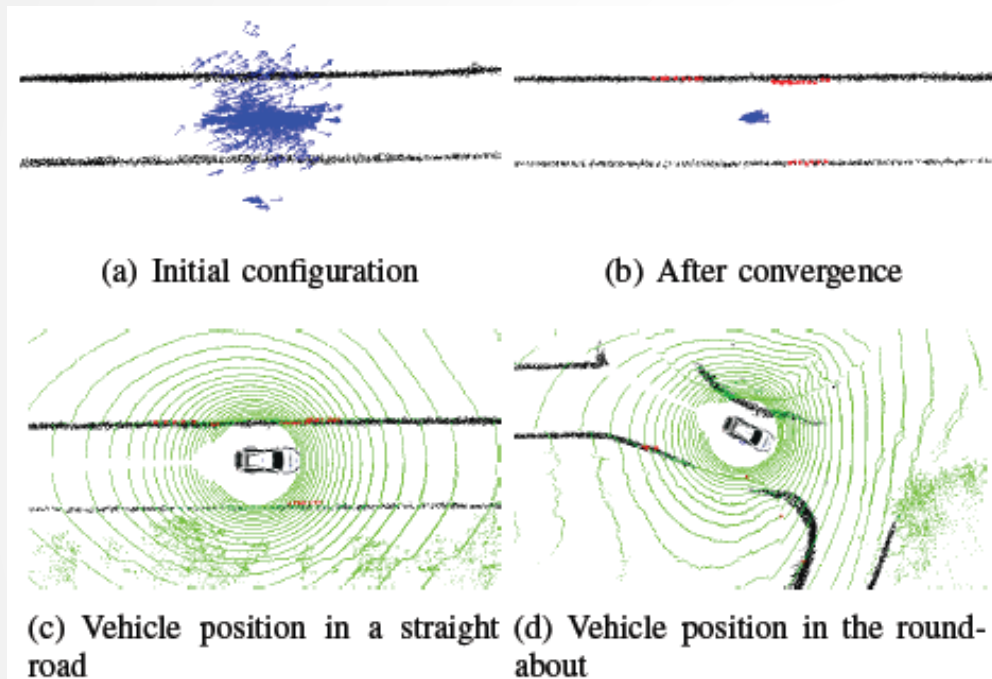


Hata et al., Robust Curb Detection and Vehicle Localization in Urban Environments,
IEEE Intelligent Vehicles Symposium – IV, 2014

Hata & Wolf, Road Marking Detection Using LIDAR Reflective Intensity Data for Vehicle Localization,
IEEE Intelligent Transportation System Conference – ITSC, 2014.

Map-based localization

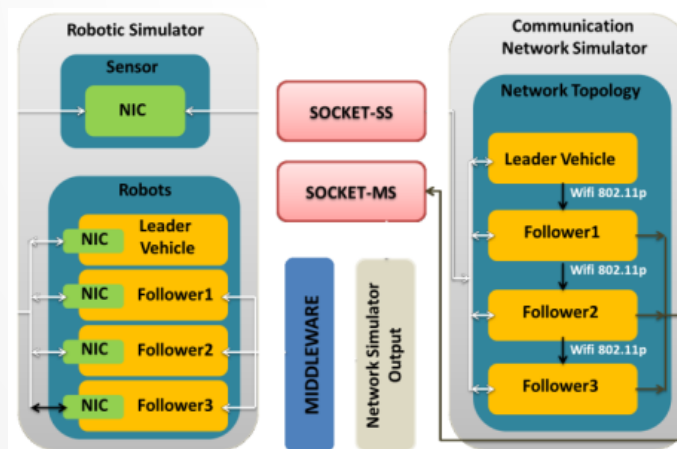
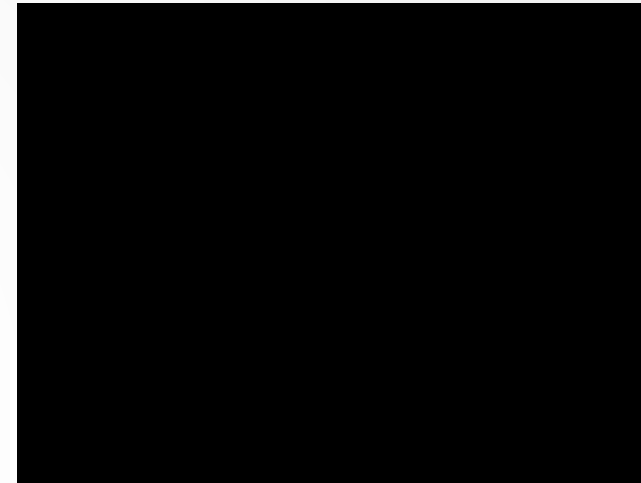
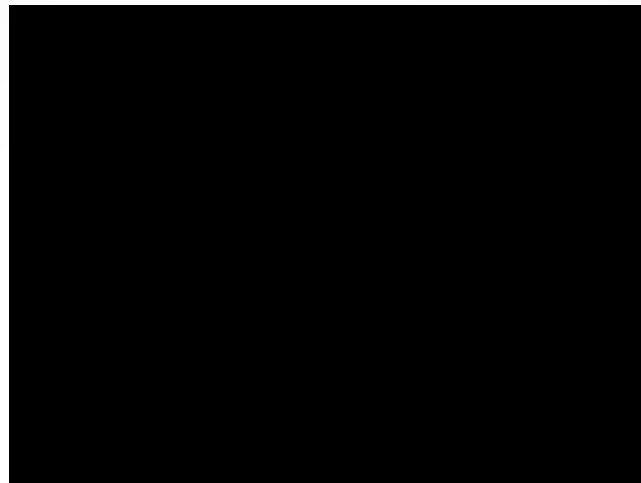
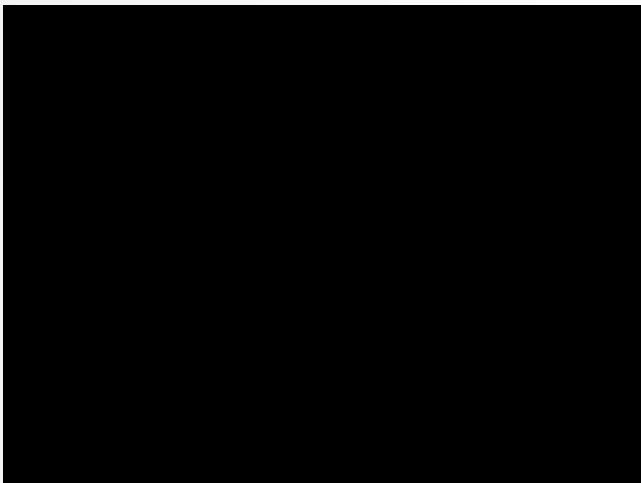
Real-time pose estimation



Hata et al., Robust Curb Detection and Vehicle Localization in Urban Environments,
IEEE Intelligent Vehicles Symposium – IV, 2014

Hata & Wolf, Road Marking Detection Using LIDAR Reflective Intensity Data for Vehicle Localization,
submetido ao IEEE Intelligent Transportation System Conference – ITSC, 2014.

Driving Assistance / Cooperative Vehicles



Gomez et. Al., Simulation Platform for Cooperative Vehicle Systems,
IEEE Intelligent Transportation System Conference – ITSC, 2014.

Autonomous Navigation

Autonomous vehicle project evolution



July 2011
Work begins



May 2012
Drive by wire

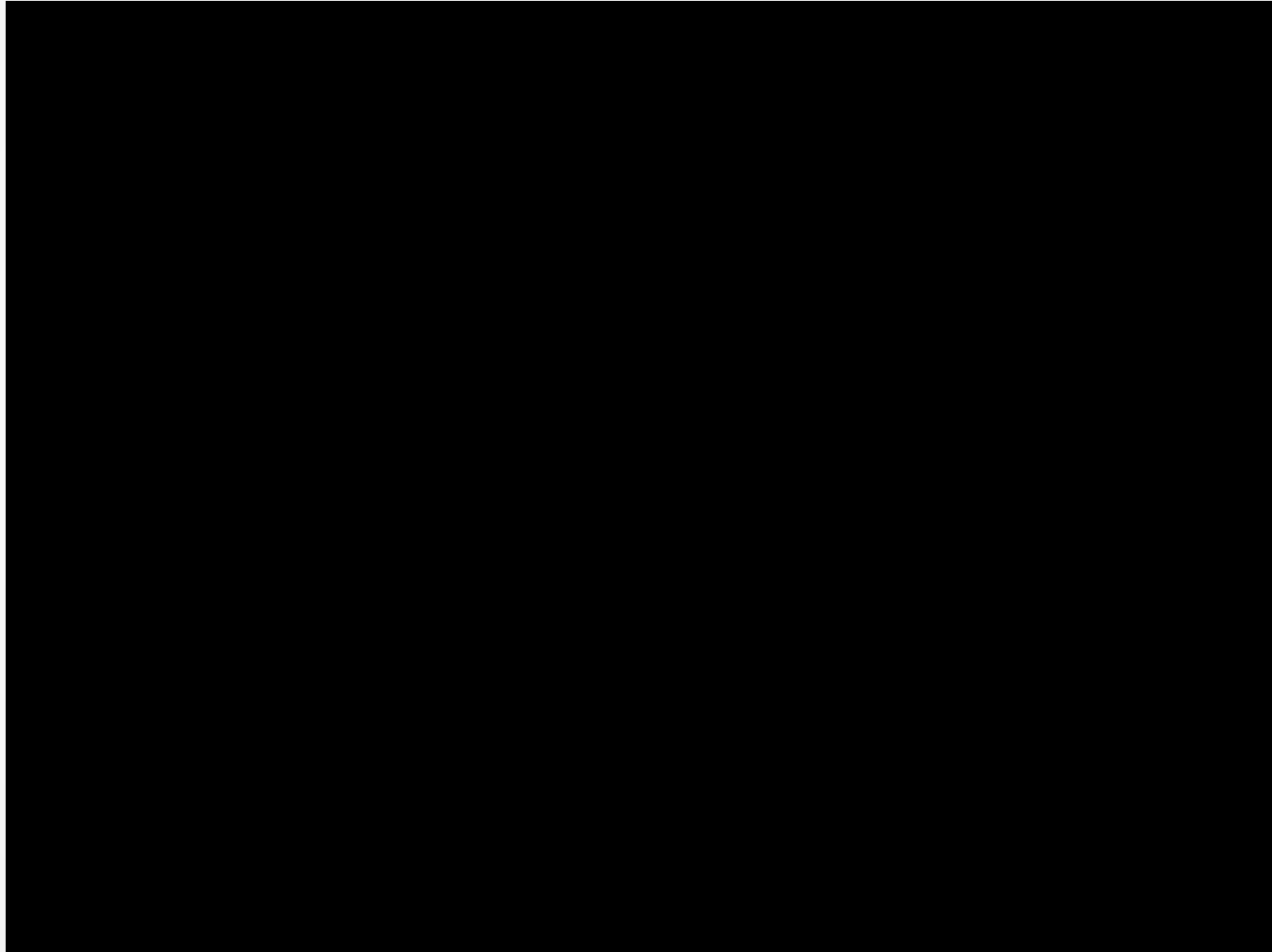


Sep 2012
Autônomo

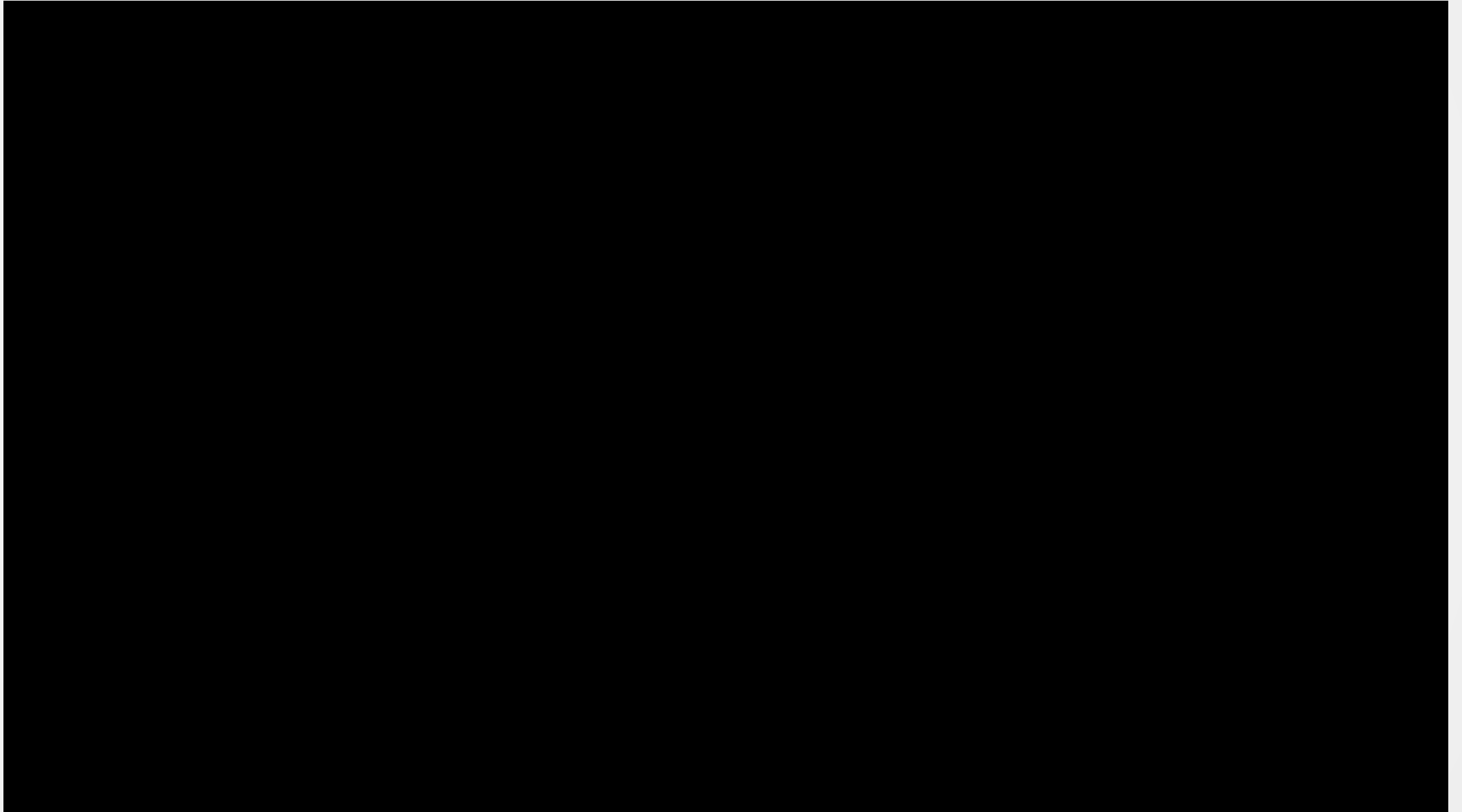


Oct 2013
In the city streets

Autonomous Navigation



Autonomous Navigation



Autonomous Navigation

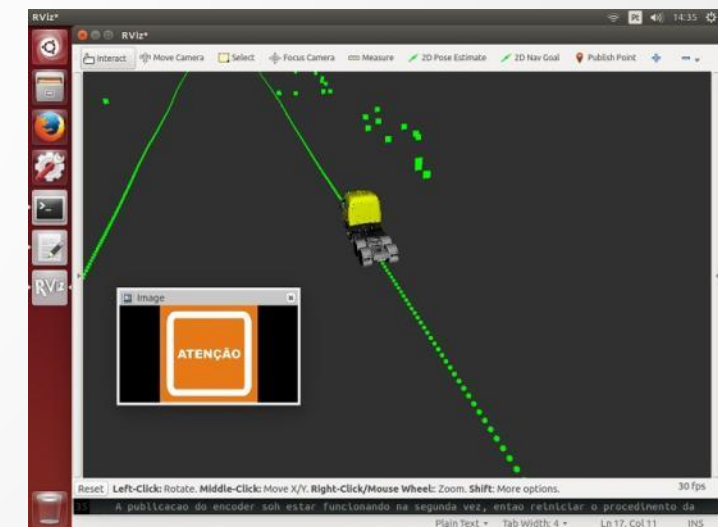
Autonomous Truck (cooperation with Scania)



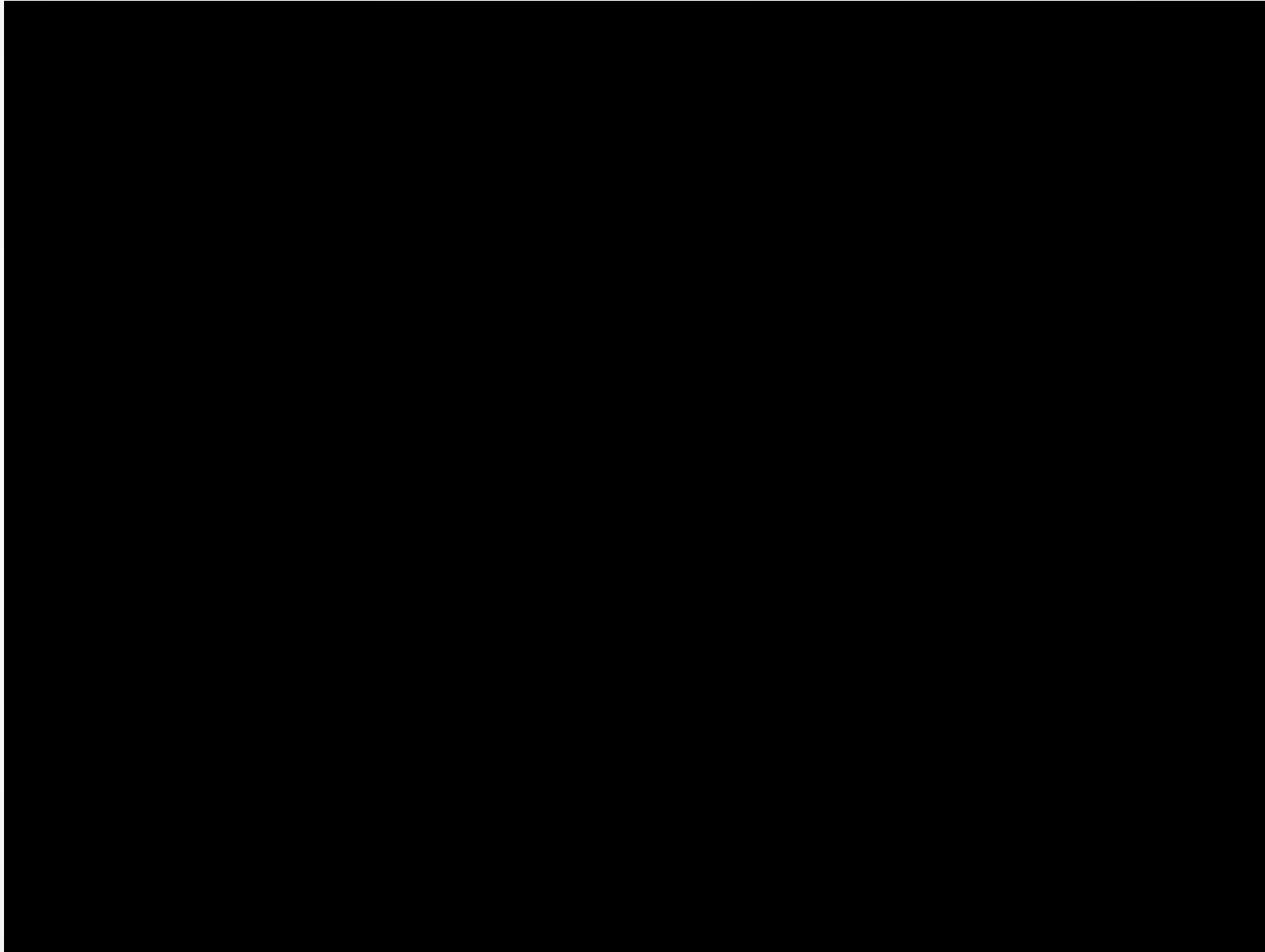
GPS

Stereo camera

Radar



Autonomous Navigation



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