Automotive LIDAR-based strategies for obstacle detection application in rural and secondary roads

A solution derived from SOLCO project

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CRF – Infotelematic System

Berlin, 19th International Forum on Advanced Microsystems for Automotive Applications (AMAA 2015)

7-8 July 2015

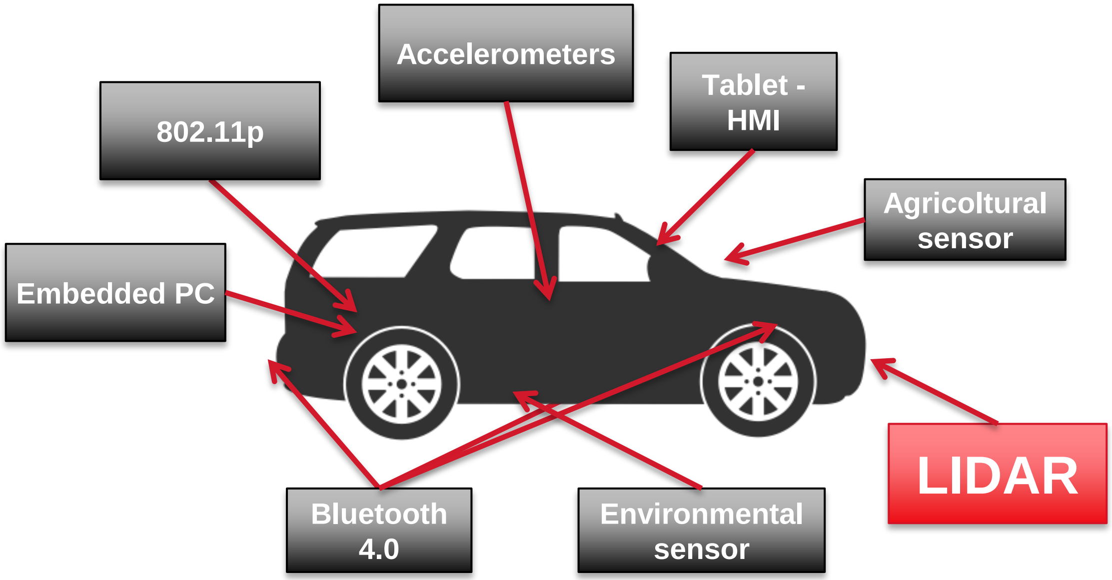
Index

- SOLCO – Project experience and agricultural scenario
- Problem definition
- Experimental setup
- Obstacle detection strategies: proposed solution
- Preliminary results
- Conclusions and next steps

SOLCO – Main project contents

SOLCO is a research project co-funded by the Public Authority Provincia Autonoma di Trento (Italy) focused on efficient mobility and safety in agricultural environment.

- Efficient mobility (CO2 reduction)
  - Logistic optimization
  - Real-time missions reorganization
- Safety
  - Rollover accidents
  - Dangerous conditions (obstacles, weather and terrain conditions)
  - VRU and obstacle detection



Problem definition

ADAS functions are designed for urban and extra-urban roads and highways.

Tests with LIDAR applied to ADAS in agricultural environment (fields) highlighted some **problems related to obstacle detection**:

1. Too many objects not categorizable (**unforeseen categories**)
2. Continuous **separation and re-aggregations of objects**
3. High **variability** in **the number of detected objects** and of relative **sizes**

Difficult to distinguish real obstacles on the vehicle path from background objects

How to isolate real obstacles?

Problem definition: roads classification

6 road types → 2 scenarios

Urban/Extra-Urban Scenario

Rural Scenario

Rural Scenario

Rural Scenario

Rural Scenario

Rural Scenario

Problem definition: main differences between scenarios

Feature	Rural Scenario	Urban/Extra-Urban Scenario
Obstacles	High variability of size Unpredictable behavior	Low variability of categories
Terrain /Carriageway	No lane delimitations Small width Uneven road surface	Lane delimitations Well defined lanes Regular road surface
Background	Highly variable background Frequent narrow curves Slope changes	High presence of buildings Geometric shapes
Roadside	No sidewalk Close walls and enclosures Few road signs	Presence of sidewalks or guardrails Many road signs
Geometry	Highly variable width of roads	Larger standardized width

Experimental setup - testing and LIDAR specifications

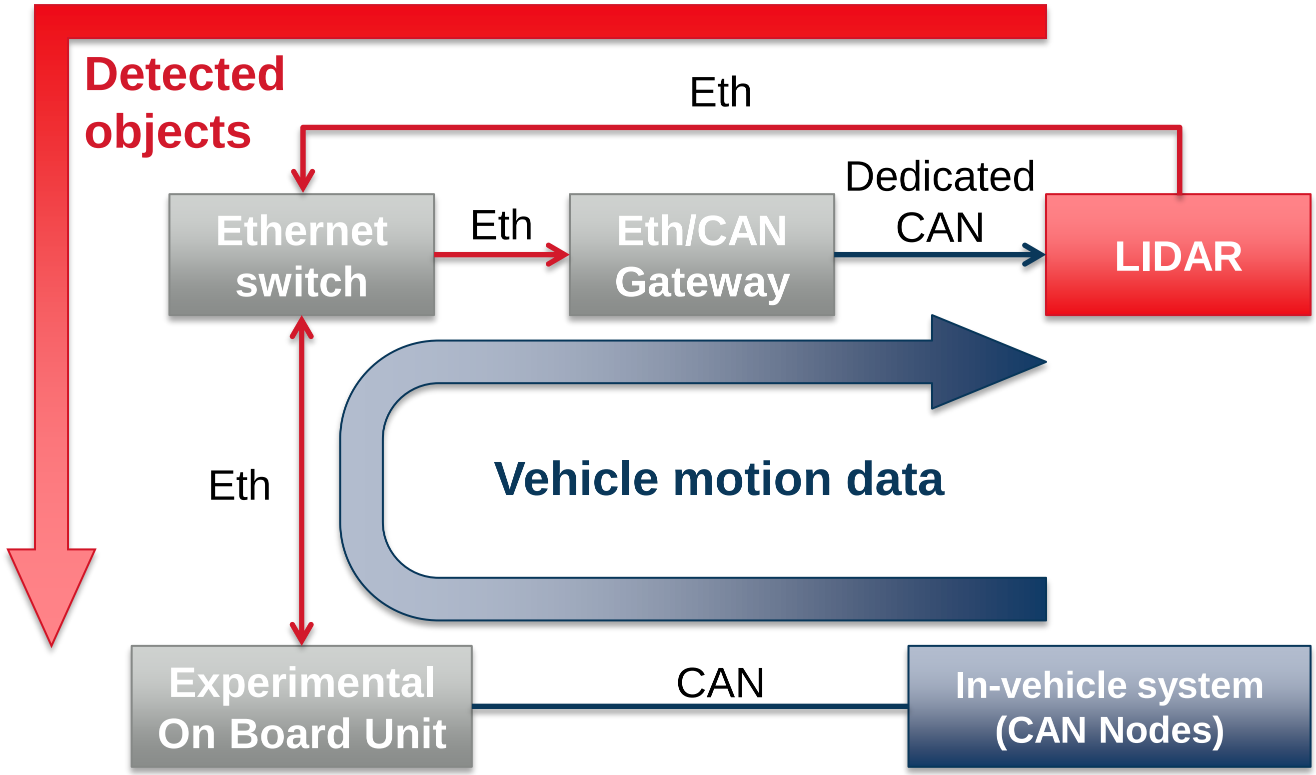
Main testing conditions:

- Target obstacle: pedestrian
- Position: center of available path
- Starting distance: 40m
- Vehicle motion: straight at 20km/h
- 6 road types

Main LIDAR specifications:

Feature	Value
Type	TOF-based 2D NIR LIDAR for automotive
Horizontal FOV	~ 145°
Vertical FOV	3.2° (average)
Horizontal resolution	≥ 0.25°
Distance resolution	≤ 100 mm
Range for objects	80 m
Scan rate	25 Hz (1 frame every 40 ms)

Experimental setup – Vehicle architecture



Data recording:

- By mean of specific SW on Experimental OBU
- Recorded files include all pre-processed output data – frame-by-frame object list

Obstacle detection strategies: proposed solution

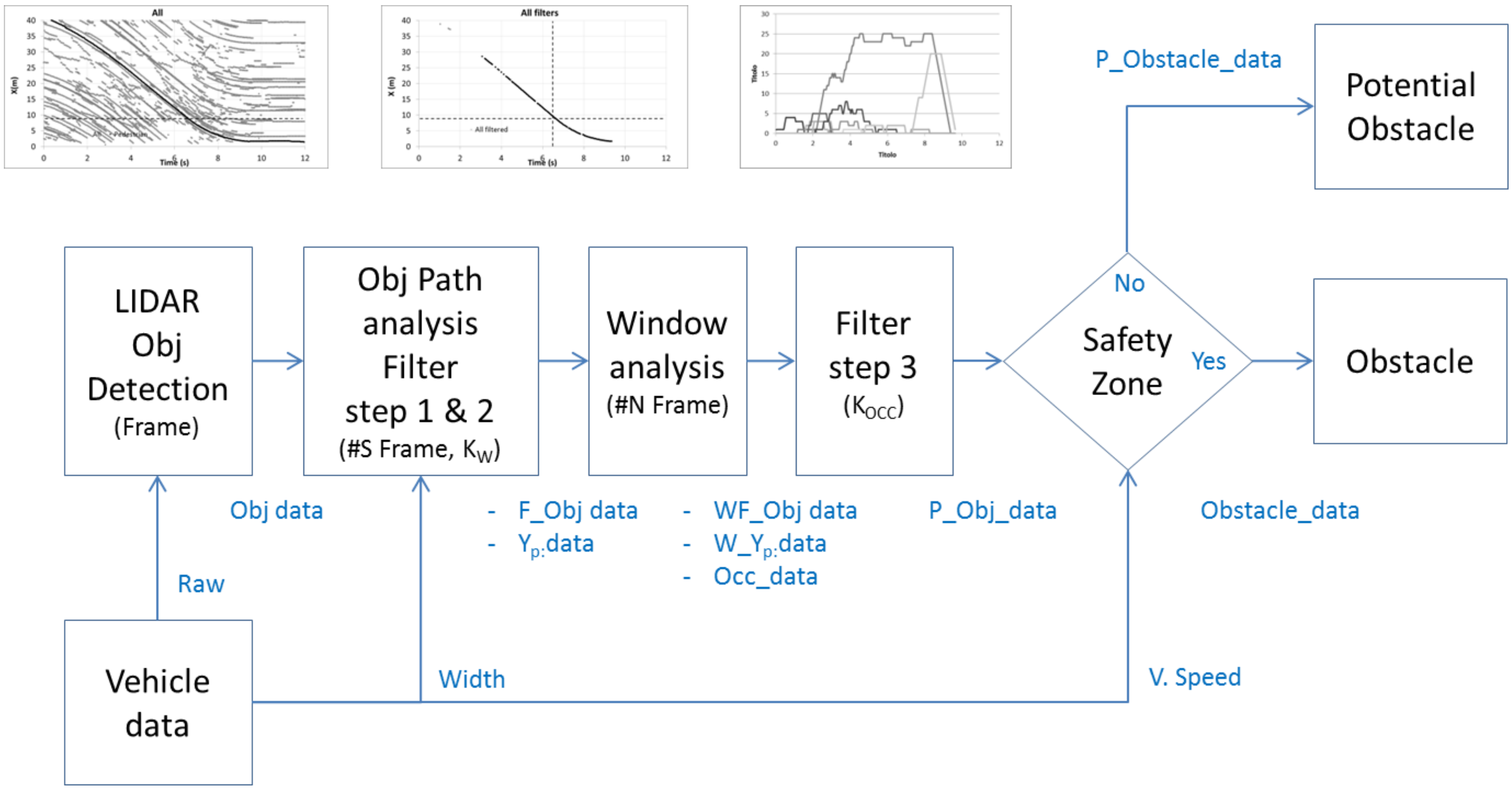
Proposed solution based on **post processing analysis on recorded** data for all 6 road types

Keep in mind **final goal** of **real-time implementation** = keep it simple!

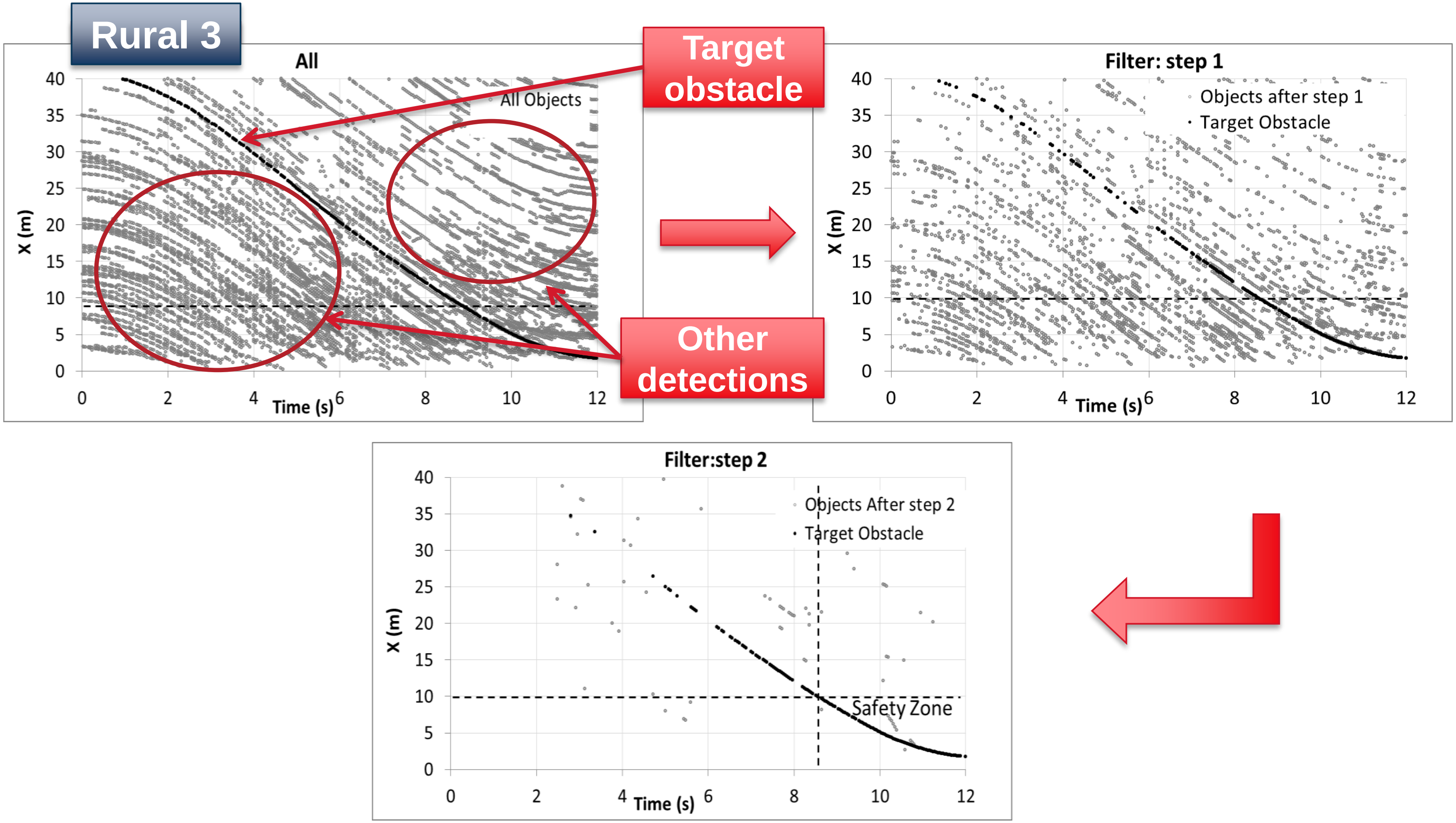
Most significant LIDAR output:

- List of detected objects;
- Set of properties for each object:
  - distance (x and y)
  - relative speed
  - size
  - if recognized, classification (*pedestrian*, *car*, *truck*, *bicycle*) or more general *unknown big* and *unknown small*;

Obstacle detection strategies: proposed solution

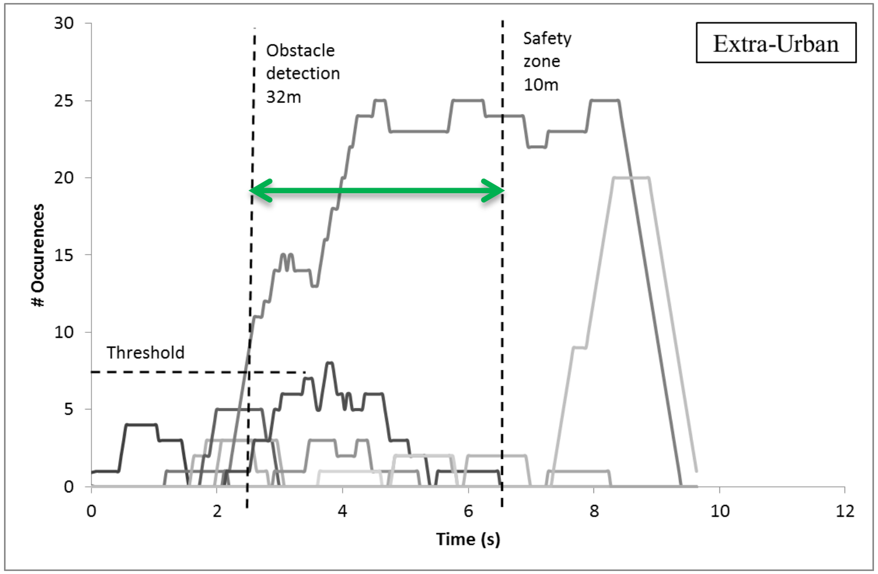


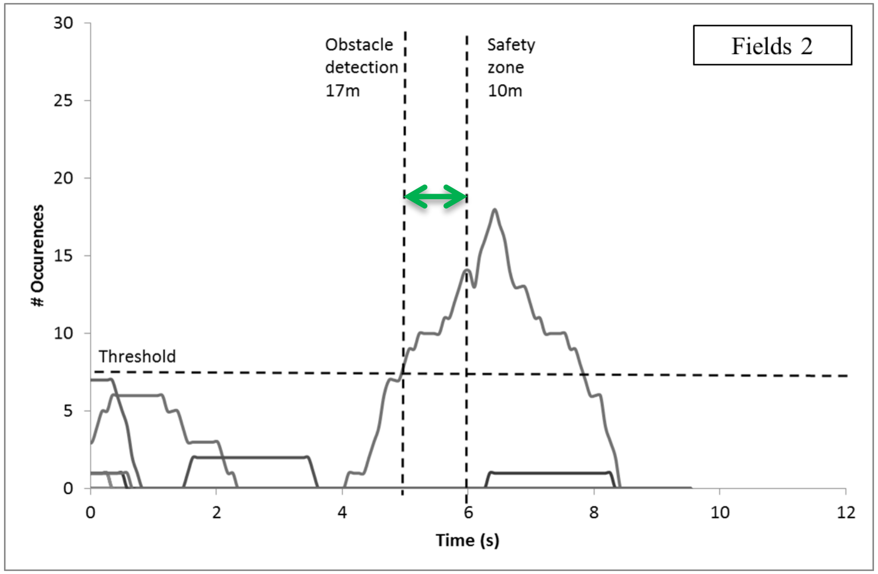
Preliminary results



The first two-step filtering already cleans a lot of noise, but still undesired objects remain

Preliminary results





As the road type complexity increases, the potential obstacles is isolated at a smaller distance

Real obstacle is recognized before the Safety Zone in all the road types

Conclusions and next steps

Conclusions:

- Differences between rural and urban/extra-urban roads influence the object detection performances
- The proposed algorithm can isolate the real obstacle from background in all tested road types
- The more complex the road type, the later the isolation of the real obstacle
- The real obstacle is always recognized before the Safety Zone

Next steps:

- Consider more testing configurations (obstacle size and position, its dynamic state, ego vehicle speed and distance of obstacle)
- Assessment of real-time performances
- Fine tuning of parameters

Thanks for your attention…

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