Martina Guerritore

LiDAR systems for assisted driving system in tramways

Tutor:
Prof. Mauro D'Arco

Co-Tutors:
Ing. Luigi Fratelli, PhD
Ing. Giuseppe Graber, PhD

Cycle: XXXVI

Year: II

My background

- MSc degree: Biomedical Engineering, Federico II University of Naples
- Research group: Electrical and Electronic Measurements
- PhD start date: 1st November 2020
- Scholarship type: *INPS - Dottorati INNOVATIVI – Intersettoriali, vertenti sulle tematiche dell'iniziativa "Industria 4.0"*
- Partner company: Hitachi Rail STS

Research field of interest: Context

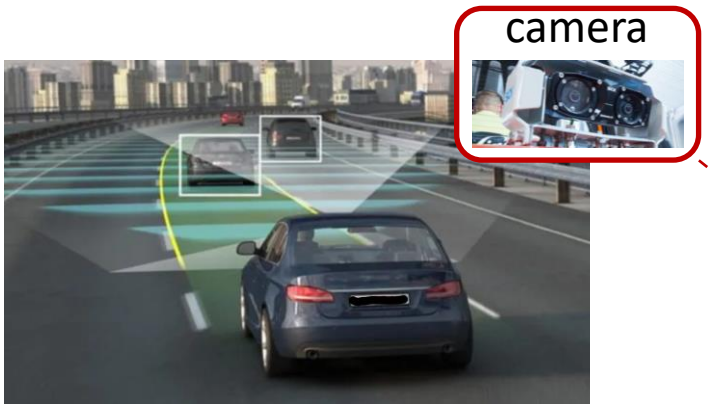
Assisted driving system for Tram

The trams are receiving significant attention because they:

- represent a sustainable solution for *zero-emission*
- are well integrated into the existing urban context

To support this expected spread of tramways, its safety and its integration into the urban area must be maximized.

Existing approach:



Disadvantages:
- 2D vision
- dependence on scene illumination

Research field of interest: proposed approach

We propose an assisted driving system based on the fusion of:

LiDAR
+
camera

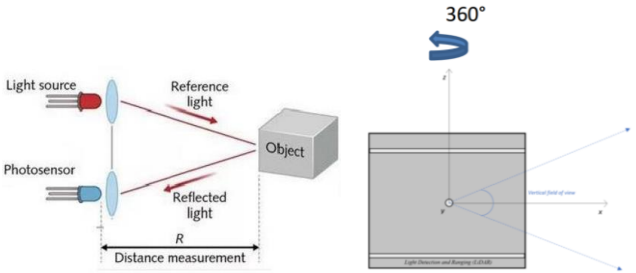
The proposed system provides:

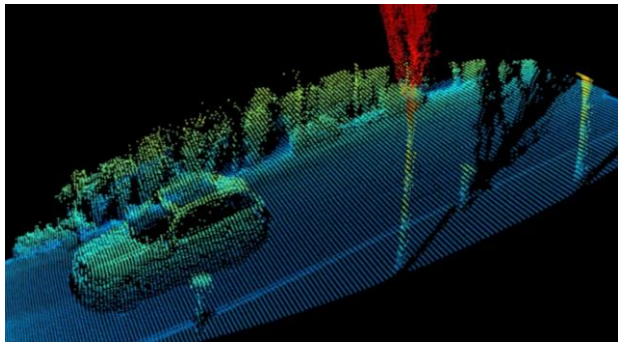
- Detection and tracking of moving objects in 3D
- Alerts the driver about possible dangers/obstacles

The focus of my Ph.D. program is LiDAR moving object detection and tracking

Light Detection And Ranging

is a technology, based on the transmission and reception of an impulse and giving back a points cloud with distance measurements of objects in the surrounding environment.





Research field of interest: Methodology

LiDAR moving object detection and tracking includes the following steps:

- Background filtering
- Clustering
- Classification of moving objects
- Tracking of moving objects

Major challenges:

- running in real time
- adaptability to any scene
- accurate results

Research field of interest: Experimental site and instruments set-up

San Giovanni (Naples, Italy)

1

(a) Street-view of the experimental site. (b) Set-up adopted to carry out the experiments

Urban Line (Naples, Italy)

2

(a) Research team. (b) Set-up adopted to carry out the experiments

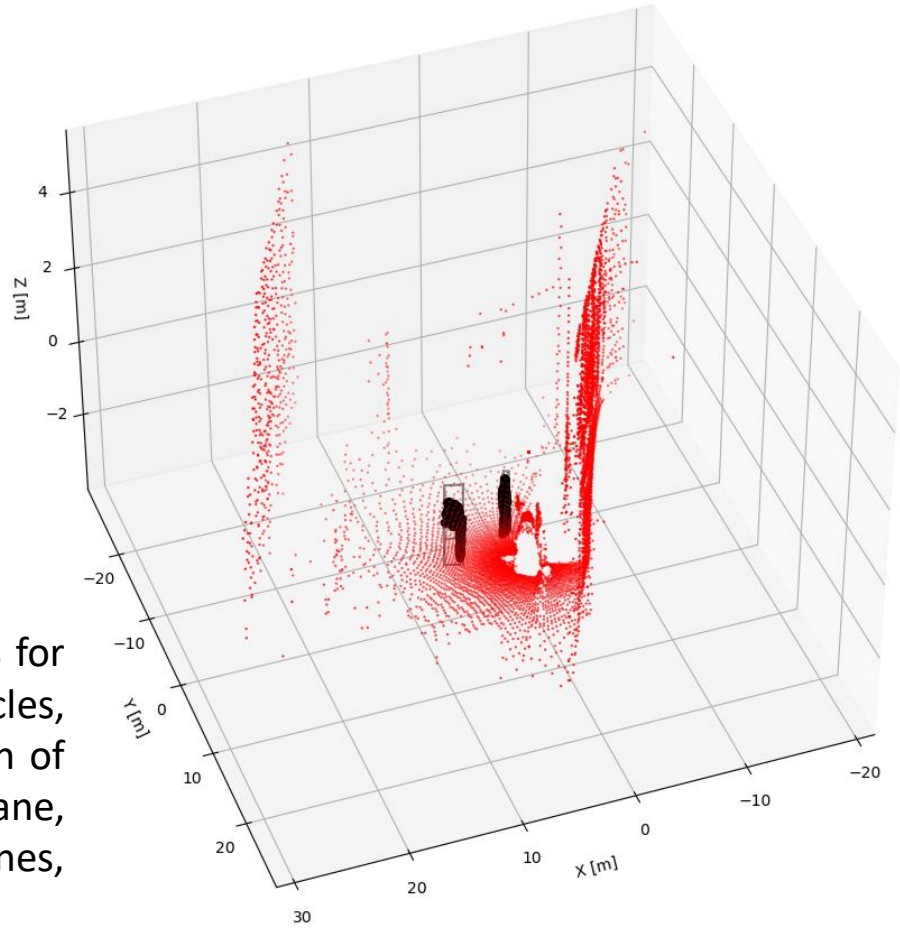
Research field of interest: result

Results obtained by applying the proposed methodology to the data obtained from the first experimental set-up:

Detection of moving objects
- *Background filtering*
- *Clustering*
- *Detection of double occurrences*

Bounding box fitting
- *Ellipse fitting*
- *Parameters estimation*

Multi-object tracking
- *Modelling objects kinematics*
- *Kalman filtering*

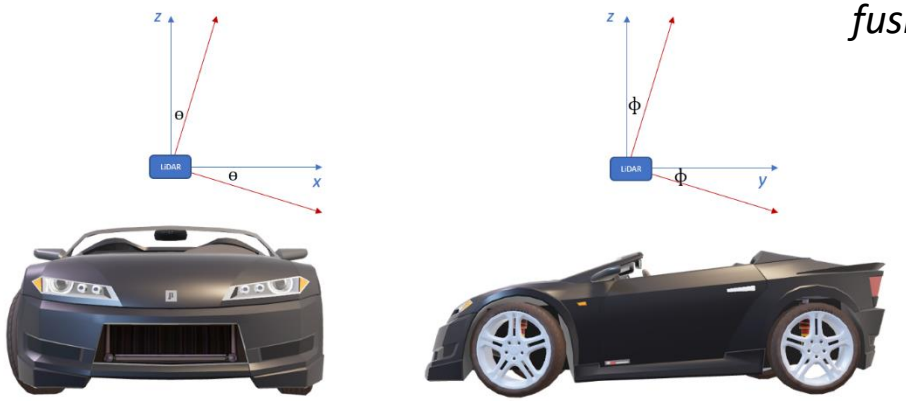


- Application in intelligent transportation systems for traffic monitoring operations as: detecting vehicles, pedestrians, or suspicious obstacles by a section of interest, measuring the speed of a vehicle in a lane, checking vehicles allowed to restricted zones, estimating travel times, traffic densities, etc.

Intended Contributions: overview

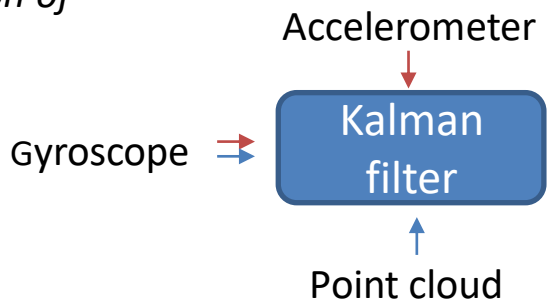
Before of applying the proposed methodology to the data obtained from the second experimental set-up , is important to solve self-alignment problem of moving LiDAR sensor.

- Problem: LiDARs are mounted on a self-driving vehicle or are used for road monitoring. However, there may be deviation angles between the Main and Sensor reference systems due to errors in installation, vibration, and others.
- Target: The sensor calibration method aims to estimate the angular deviations by avoiding use of the accelerometer and compensate them for more accurate measurements.



Description of the Main coordinate system (blue) and Sensor Coordinate system (red).
Left: front of view. Right: side of view

Existing and proposed approach are based on the fusion of



Disadvantages:

- knowledge of external acceleration
- accelerometer is sensitive to vibration.

Intended Contributions

- To validate the proposed solution for solving self-alignment problem of moving LiDAR sensor
- To apply the proposed methodology to the data obtained from the second experimental set-up.

Products

[-1]	Estimation of Euler angles via gyroscope and point cloud for self-alignment of moving and/or static LiDAR sensor. Word in progress – in validation
[j2]	Real-Time Detection and Tracking of Moving Objects using Roadside LiDAR Sensors. M. D'Arco , L. Fratelli, G. Graber and M. Guerritore Submitted to Sensor MDPI
[c3]	Application Scenarios for Gait Analysis with Wearable Sensors and Machine Learning. Mauro D'Arco, Martina Guerritore, Annarita Tedesco. Accepted by IMEKO TC4 International Symposium
[j4]	D'Arco, M.; Guerritore, M. Multi-Sensor Data Fusion Approach for Kinematic Quantities. Energies 2022, 15, 2916. https://doi.org/10.3390/en15082916 Published

Summary of study activities

- **PhD School**:

  PhD Excellence School "I. Gorini" 2022 - *winner of BEST PROJECT AWARD*

  XR Spring School 2022 - eXtended Reality Spring School 2022

- **Courses borrowed from MSc curricula:**

  Sensori per applicazioni biomediche, Prof. Egidio De Benedetto

- Reviewer for the journal "Scientific Reports"

Thank you for your attention