UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee PhD
information technology
electrical engineering

DIETI UNINA

PhD student: Mirko Casale

ADAS virtual prototyping via component-based and model-based toolchains

Tutor: Stefania Santini

Cycle: XXXIX

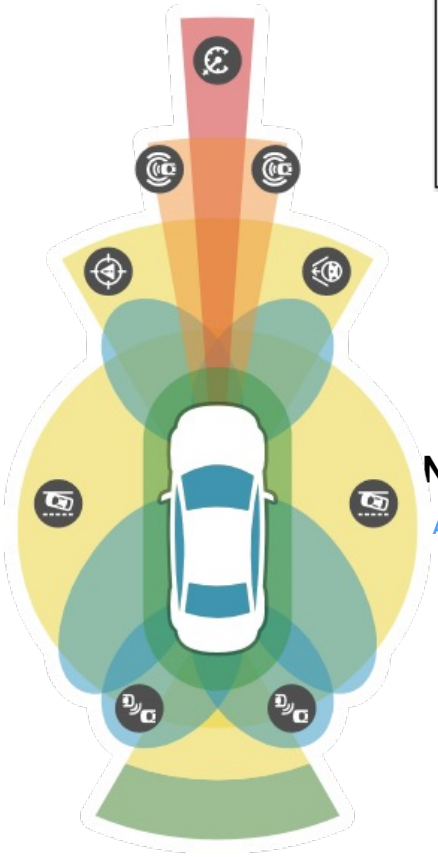
Year: Second

itee PhD
information technology
electrical engineering

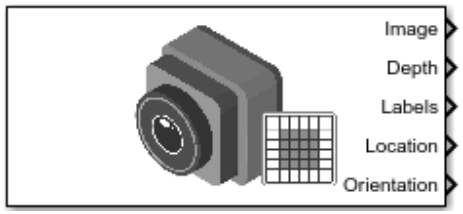
My background

- **Master Degree:** in Mechanical Engineering for Energy and Environment obtained from University of Naples – Federico II
- **Master Thesis:** Implementation of a quasi-dimensional model for the analysis and optimization of an aircraft ICE
- **Research Group:** DAiSYLab (Prof. StefaniaSantini)
- **PhD start date:** November 2023
- **Scholarship type:** No Scholarship

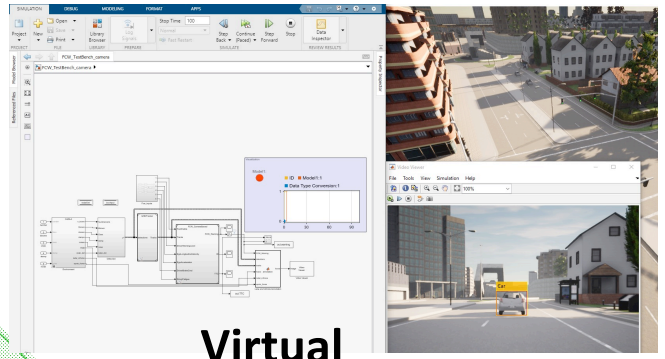
Research area:
ADAS Sensor modeling & Validation



ADAS Functionality



Component Modeling [1]



Virtual Testing

Component Design

Vehicle Testing

[1] Bouguet, J. Y. Camera Calibration Toolbox for Matlab. http://www.vision.caltech.edu/bouguetj/calib_doc

Summary of study & Training activities

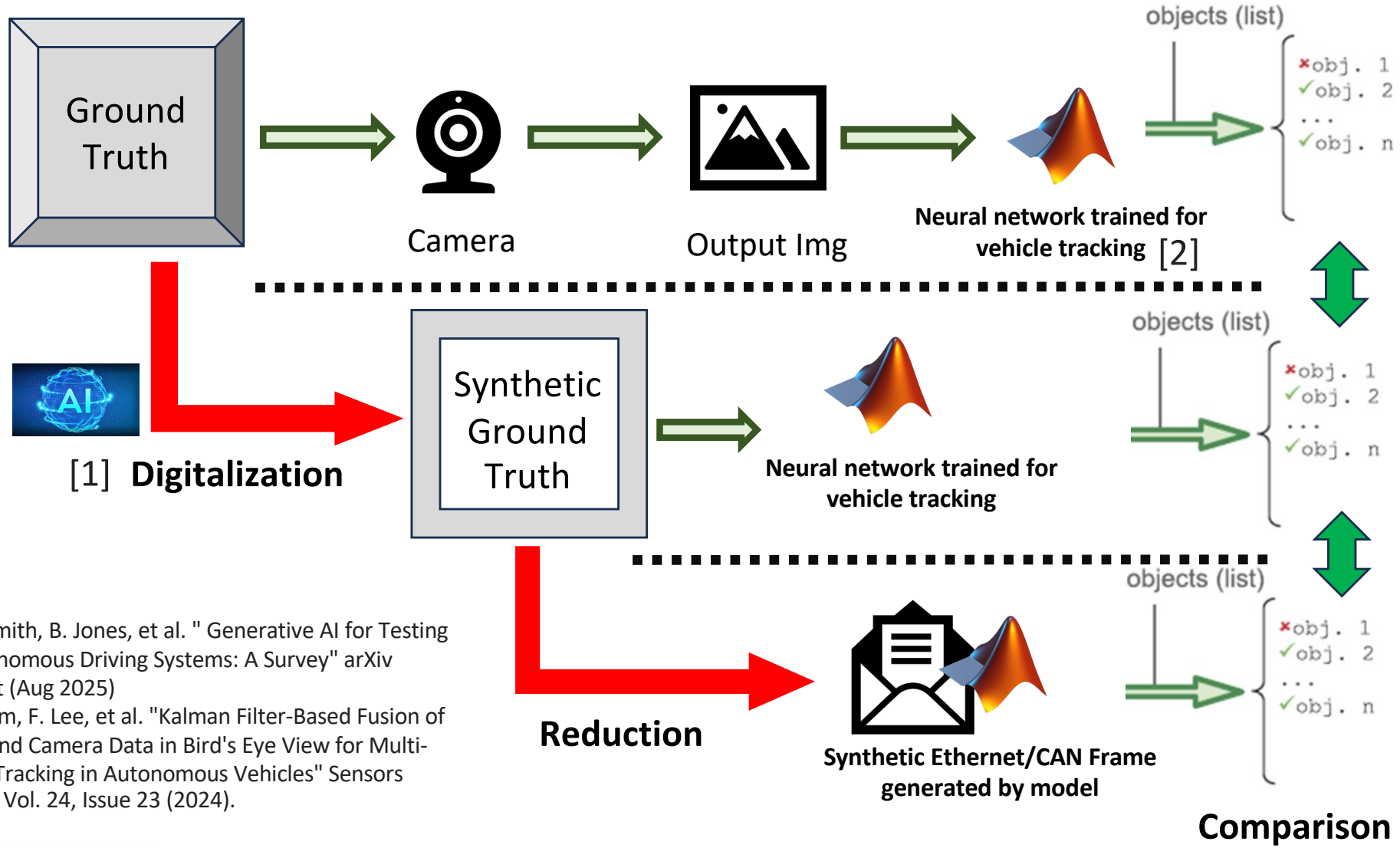
The focus of my first year was to contextualize the topic from an academic point of view in order to approach it in a rigorous and yet practical way by collecting notions of both, the specific topic and how or in what context scientific publications are made.

For this reason, various seminars and courses were attended, the most relevant of which include:

- **Courses:**
  - Advanced Control And Applications – Prof. G.Fiengo
  - Tecnologie Dei Sistemi Di Automazione – Dr. A. Petrillo
- **Seminars:**
  - Control of multi-agent systems with time delays: theory and applications - Dr. Gabor Orosz
  - Explainable Scientific Machine Learning: Theoretical and Practical Perspectives - SSN
  - IEE ITSS Italian Chapter Annual Meeting and PhD Award 2025 - IEEE

Research Activity: Virtual Testing Framework

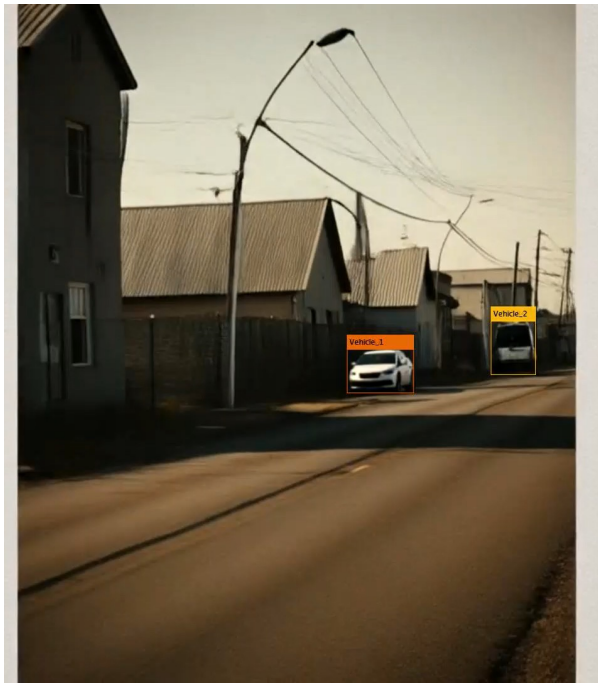
- **Problem Statement:** Lack of a shared and academically agreed framework for virtual validation and KPI measurement. [1]
- **Approach:** Proposal for a methodology that is based on the digitization of the virtual environment.



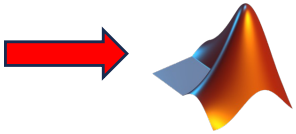
[1] A. Smith, B. Jones, et al. " Generative AI for Testing of Autonomous Driving Systems: A Survey" arXiv preprint (Aug 2025)

[2] E. Kim, F. Lee, et al. "Kalman Filter-Based Fusion of LiDAR and Camera Data in Bird's Eye View for Multi-Object Tracking in Autonomous Vehicles" Sensors (MDPI), Vol. 24, Issue 23 (2024).

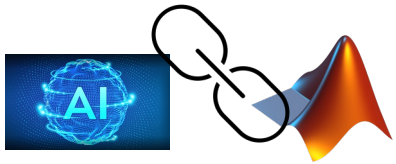
Research Activity: Detection of vehicles on the synthetic source



Ground truth



Matlab : Neural network trained for vehicle tracking



- **Contribution:** Vehicles detection in a synthetic image AI generated to reproduce a real environment.
- **Methodology:** Application of a trained neural network in vehicle recognition to image sequence.
- **Result:** Convincing data for the validation of the approach behind the proposed framework.

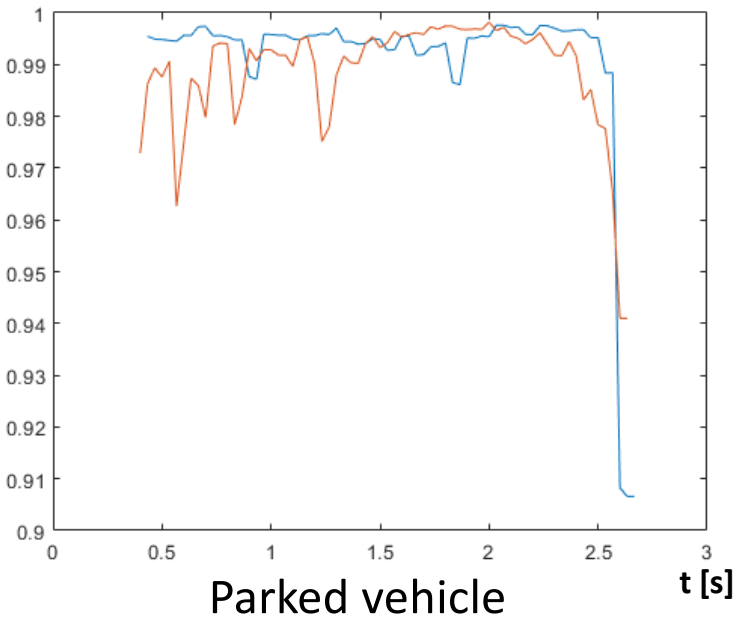
[1] Wojke, Nicolai, Alex Bewley, and Dietrich Paulus. "Simple online and realtime tracking with a deep association metric." In 2017 IEEE international conference on image processing (ICIP), pp. 3645-3649.
[2] Du, Yunhao, Zhicheng Zhao, Yang Song, Yanyun Zhao, Fei Su, Tao Gong, and Hongying Meng. "Strongsort: Make deepsort great again." IEEE Transactions on Multimedia (2023).

Research Activity: Data comparison

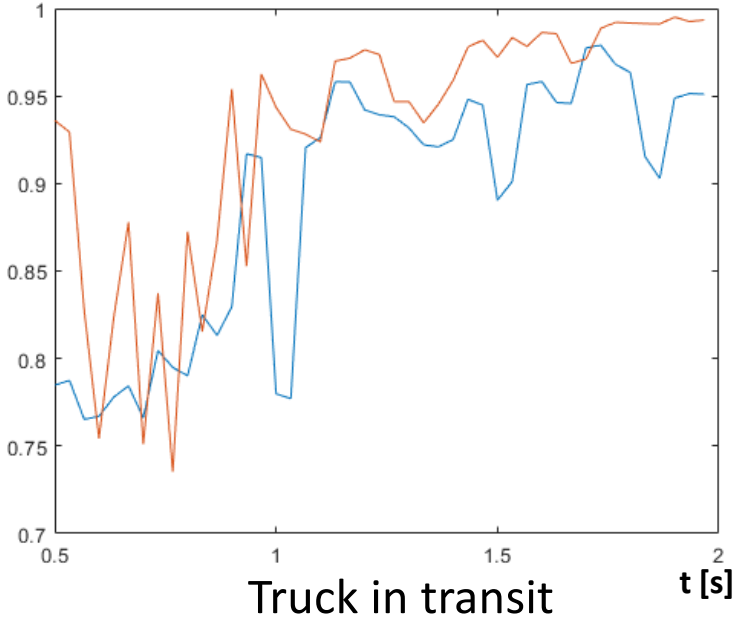
Detection accuracy [%]

Synthetic input

Original input



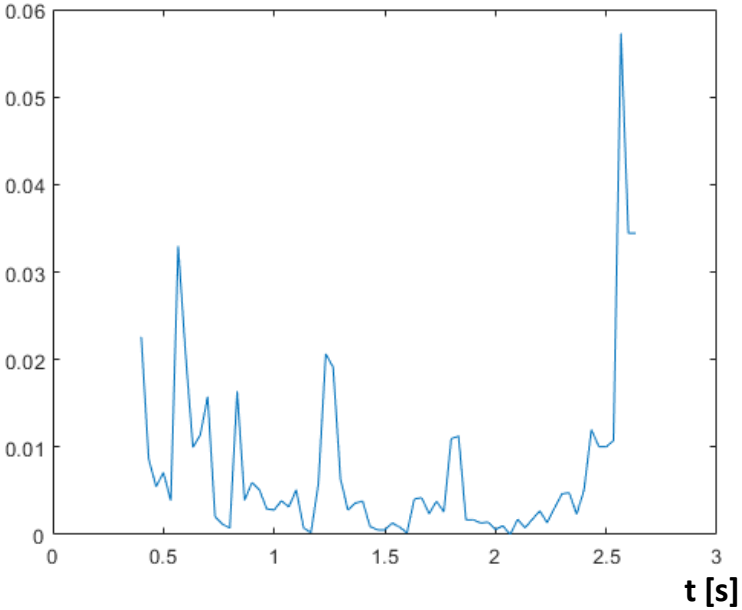
Parked vehicle

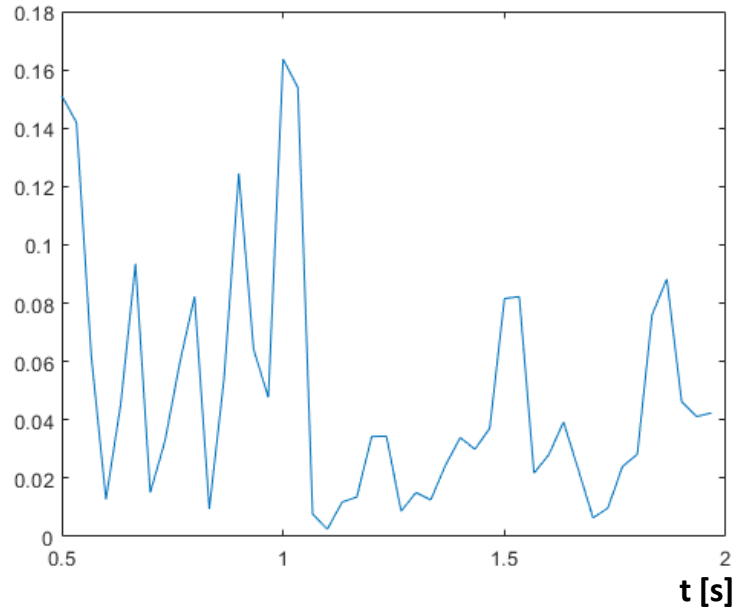


Truck in transit

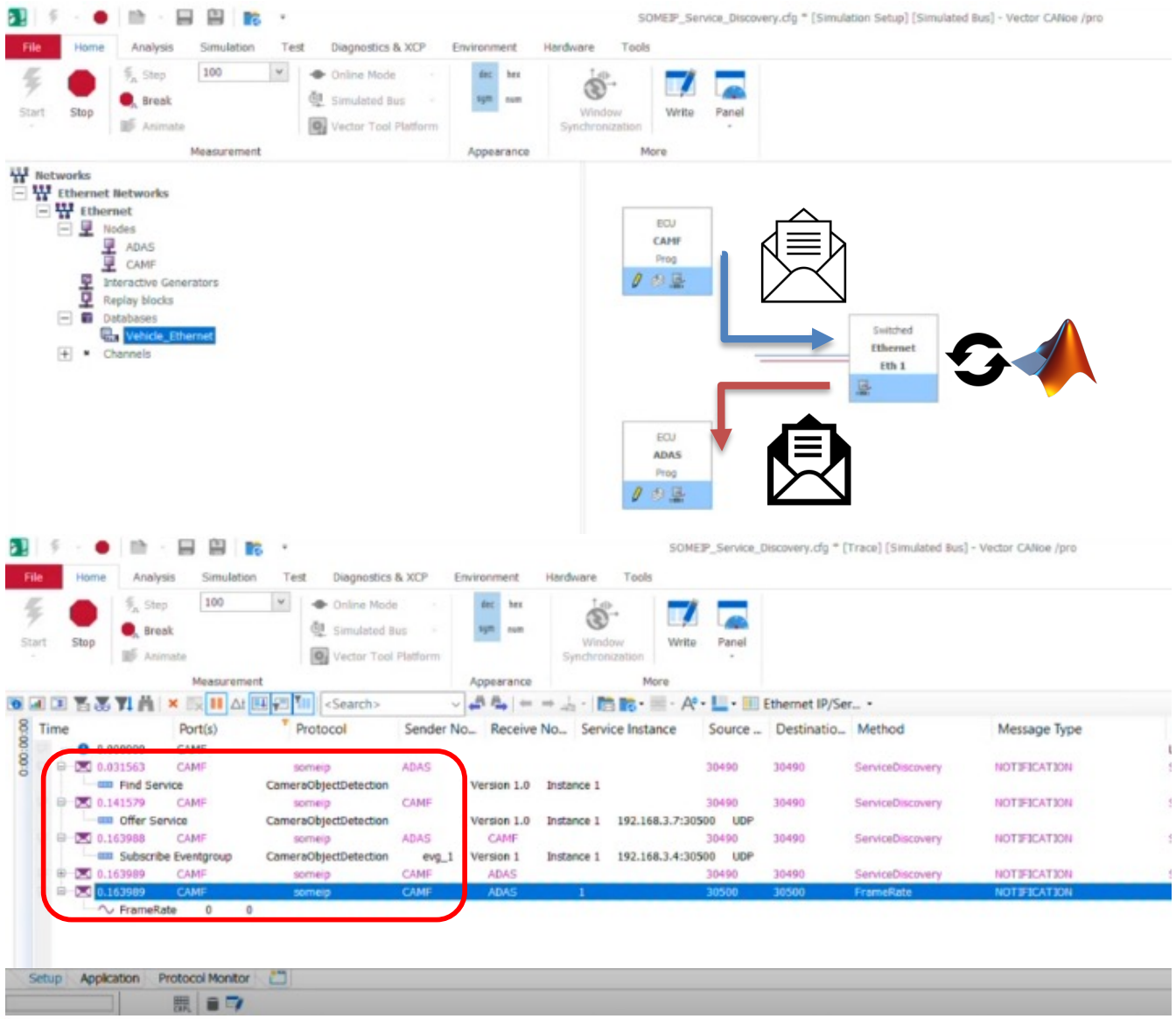
Absolute error [%]

Synthetic vs Real





Research Activity: Measurement/Simulation Setup



- **Objective:** Construction of a simulation environment for object detection on commercial measurement software.
- **Methodology:** Generation of data packets modified to contain object detection information using the SOME IP protocol
- **Result:** Being able to validate ADAS functionality without using images really captured by the camera.

Study and Training Activities – Credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	1.4	8.6	0	10
Bimonth 2	0	1	9	0	10
Bimonth 3	6	1.1	2.9	0	10
Bimonth 4	0	0	10	0	10
Bimonth 5	0	1	9	0	10
Bimonth 6	6	1	3	0	10
Total	12	5.5	42.5	0	60
Expected	10 - 20	5 - 10	30 - 45	0 – 4.8	

Next Year

- Q1) Parametric Model Finalization Complete the optimization and calibration of the mathematical models. Define the key metrics for efficiency (computation time) and robustness (detection accuracy).
- Q2) Intensive Experimental Validation Execute testing campaigns to systematically compare the model's output data with that of a real ADAS camera (Ground Truth), utilising complex driving scenarios.
- Q3) Analysis and Thesis Demonstration Statistically elaborate the results to demonstrate functional equivalence and the reduction in testing costs/time. Draft the central chapters of the dissertation (Methodology and Results).
- Q4) Writing and Publication Conclude the writing of the dissertation. Prepare and submit an article to a high