

# STUDENTS' ANNUAL ACTIVITY REPORT

## CYCLE XXXV YEAR 2019-2020

- Name and Surname            **Sara Luciani**
- Dottorato in                    **INGEGNERIA MECCANICA**
- Department                    **DIMEAS**
- Coordinator                   **Prof. Luca GOGLIO**
- Tutor                            **Prof. Andrea Tonoli**

- Macroarea

Lead-Acid batteries monitoring in medium and heavy commercial vehicles, estimation techniques for the State of Charge (SoC) and the State of Health (SoH) based on Artificial Neural Networks (ANNs).

- Short description of research activity (maximum 20 lines)

During recent years, the electrification of the vehicles has notified of an increasing interest, which prompted the researchers to develop new powertrain solutions and, to optimize the electrical components in the vehicle. Growing attention has been addressed to one particular subsystem, the battery. In the medium and heavy commercial vehicles, the battery usually provides the power necessary to start the vehicle, to the additional and permanent electrical consumers and the cabin systems during the overnight stops. Specifically, accurate monitoring of the State of Charge (SOC), as a function of the aging suffered by the battery, indicated by the State of Health (SOH), is of primary importance. In the commercial vehicles, this monitoring ensures that there is a sufficient level of the available energy such that the vehicle can start, extends the battery life and, finally, reduces the replacement interventions. Nevertheless, the SOC and SOH cannot be directly measured with sensors and must be estimated through indirect approaches. Among the existing method used to estimate these variables, the Artificial Neural Networks (ANNs) represents a promising solution since they are independent of the model and, at the same time, they guarantee an adequate level of accuracy.

The research goals are:

1. Design of algorithms for the estimation of the State of Charge and the State of Health for Lead-Acid batteries in commercial vehicles.
  2. Design of algorithm for the combined estimation of the State of Charge and the State of Health.
  3. Validation of these algorithms in a simulation environment.
  4. Deployment of the resulting algorithm on a real Battery Monitoring System (BMS) of a commercial vehicle and test in real operating conditions.
- Training activities carried out during the year (courses, seminars, etc.); for each activity specify the nature, duration, and location

### **Politecnico di Torino**

#### **Hard skills**

- 01LCPRV - Experimental modeling: costruzione di modelli da dati sperimentali (33h) 07/04/2020
- 01RGRV - Optimization methods for engineering problems (30h) 15/06/2020
- 01SFURV - Programmazione scientifica avanzata in Matlab (28h) 29/06/2020

#### **Soft skills**

- 01QORRO - Writing Scientific Papers in English (15h) 20/02/2020

Webinar: Online training Orbit Express (1h)

16/09/2020

### **IVECO**

- Webinar: Corso su reti LIN/CAN, 03/09/2020 -10/09/2020 (16h) e 08/10/2020

### **Formula Student Germany Academy**

- Webinar: Driverless Workshop 2020 (powered by Waymo), 29/08/2020 (11h) e 26/09/2020

- Possible participation in further research activities during the year (research projects and agreements)

Participation in the research activities investigated by the Interdisciplinary Laboratory of Mechatronics (LIM) on the design of algorithms to control and plan the trajectory in an electric racing vehicle participating in the Formula Student championship for the Driverless category.

Participation in the research activities investigated by the Interdisciplinary Laboratory of Mechatronics (LIM) on the design of algorithms to optimize the passenger's comfort in assisted and autonomous vehicles.

- Collaborations with companies during the year

IVECO, within the PhD topic.

- List of accepted papers

**Accepted for the publication:**

Luciani S., Bonfitto A., Amati N., Tonoli A. (2020, August). "Comfort-oriented design of Model Predictive Control in assisted and autonomous driving". In Proceedings of the ASME 2020 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC-CIE 2020), 22<sup>nd</sup> International Conference on Advanced Vehicle Technologies (AVT).

**Under peer-review process:**

Feraco S., Luciani S., Bonfitto, A., Amati, N., Tonoli A. (2020, November). "A local trajectory planning and control method for autonomous vehicles based on the RRT algorithm". 2020 AEIT International Conference of Electrical and Electronic Technologies for Automotive - Track 3 Advanced driver assistance systems and autonomous driving, safety and connectivity. IEEE.

Luciani S., Bonfitto A., Amati N., Tonoli A. "Model Predictive Control for comfort optimization in assisted and driverless vehicles". Advances in Mechanical Engineering

Date, 17/09/2020

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Signature of Tutor

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Signature of the Phd student

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The Coordinator