Ph.D. in Information Technology: Thesis Defenses

March 1st, 2021
online by Teams – at 8.30

Stefano DATTILO – XXXIII Cycle

Analysis and control design of advanced suspension systems

Supervisor: Prof. **Sergio Savaresi**

Abstract:

This dissertation deals with the technological analysis, modeling, and control design of advanced suspension systems for automotive applications. The suspension is fundamental for the well-being of vehicle passengers: it must ensure an adequate level of road disturbance filtering, and it must preserve the tire-road contact. For these reasons electronically controllable suspensions are subject of intensive research in both academy and industry.

The main objective of this thesis consists in the analysis of the most promising state-of-the-art suspension technologies already available on the market, and in the design of control algorithms targeted to comfort and safety improvement. The cutting-edge suspension technology is currently represented by: Multichamber suspension: it is a semi-active suspension able to modulate both damping and stiffness coefficients at high frequency. In this dissertation, a mathematical model is developed and validated through test-bench experiments, then comfort-oriented control algorithms are proposed. Proactive suspension: it is a semi-active suspension technology, with short-term active capability, and energy-recuperation feature. Here, a mathematical model of the system is proposed and validated, then a comfort-oriented, and a safety-oriented algorithms are designed and validated in an advanced vehicle dynamic simulator. Hydro-pneumatic suspension: this type of architecture allows to change the system equilibrium position by injecting fluid in the suspension. We designed a load-leveling control algorithm, and we experimentally validated it in two different scenarios: a front-axle-suspension for small size agricultural tractor, and a fully suspended tractor cabin.

Gianluca SAVAIA – XXXIII Cycle

Modeling, control and automatic calibration of a semi-active suspension system for high-performance cars

Supervisor: Prof. **Sergio Savaresi**

Abstract:

The main objective of this thesis consists in developing intelligent algorithms which can enhance the comfort of high-performance cars. This class of vehicles is equipped with cutting-edge technology, in terms of sensors and actuators, which is not yet fully exploited in its potential and has considerable leeway for scientific research.

This thesis focuses on a semiactive suspension system which plays the main role among electronic controllers in shaping the desired vehicle dynamics, and it is responsible for the comfort and handling performance of the vehicle. The driver and the passengers are very sensitive to this system and it is therefore of utmost importance to have a good understanding of its building blocks in order to deliver the best possible performance. First, I present testbench experiments on the damper and a control-oriented model which can describe its behavior. Afterwards, I propose a set of control strategies for the control of the vertical dynamics which can significantly improve performance with respect to state-of-the-art algorithms; the proposed logics have been validated on a sports-car and the performance evaluated subjectively by a professional test driver and objectively by means of the on-board sensing units. Finally, I investigated an automatic calibration framework based on advanced machine learning techniques which can find the optimal calibration of the control parameters directly on the vehicle via iterative experiments; the proposed methodology has been validated on a production vehicle equipped with a proprietary software, and it has been shown to rapidly converge to the optimal calibration within a few experiments.

PhD Committee

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