Doctoral Dissertation
Doctoral Program in Energetics (XXXIV Cycle)

Hybrid and Electric Vehicles Optimal Design and Real-time Control based on Artificial Intelligence

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Summary

Electrification of on-road vehicles is one of the most recognized technology transformations worldwide and is nowadays pushing the world towards new mobility scenarios. New national and international regulations have born which introduce restrictions for conventional vehicles and set goals for green mobility. The infrastructure is evolving to welcome charging devices, zero-emissions are required to drive within specific city centers, stops are occasionally imposed to “old” vehicles in case of high pollution periods. Many resources are being worldwide invested into the research and development of innovative technologies for electrified vehicles, similarly to what happened for fuel-based vehicles.

An outstanding progress has occurred also to computer systems during the last years. Specifically, the improvement of the computational power achieved by newest processors has promoted the possibility of establishing new connections between engineering and informatics. Amongst all, techniques based on Artificial Intelligence (AI) have seen a spread in their application to very different engineering fields, such as robotics, computer vision, semantics, etc.

In the present dissertation, a journey into the optimization of the design and the real-time control of electrified vehicles through computer-assisted simulation is made which aims at demonstrating some of the potentials enclosed in AI-based approaches. Different techniques have been analyzed and their performances have been thoroughly discussed to provide the reader with a clear view of the integration of AI into the research about electrified vehicle technologies. Hybrid powertrains have been taken into account among the variety of electrified powertrains to be possibly analyzed (hybrid, fuel cell, full electric). The availability of different and multiple power sources within the same driveline introduces complexity both when the optimal design and the optimal real-time control are investigated. A demanding test case has hence been selected to stress AI systems.