Abstract

In last decade, Hybrid Electric Vehicles (HEV) have emerged as real alternatives to engine-driven vehicles, in order to reduce fuel consumption and emissions. However, their market share is still limited, as their impact on global fossil fuel demand and CO_2 production. In parallel, the possibility of upgrading conventional vehicles to HEV is gaining interest. A research work on the development of a kit for converting a conventional vehicle into a Through-The-Road (TTR) Hybrid Solar Vehicle (HSV), performed at the University of Salerno, is presented in this thesis. The prototype implementation through the installation of flexible solar cells, an additional Lithium-Ion battery and two electrically driven wheel-motors on a FIAT Grande Punto is described in detail. In the proposed vehicle, the control of in wheel motors is performed via a designed Vehicle Management Unit (VMU). In order to develop an effective and safe control strategy for in wheel-motors to be implemented on the VMU, a precise real-time knowledge of the Driver Intention is required. In particular, a set of mathematical models using data measured only by the OBD gate are developed (active gear detection, wheel torque estimation) and integrated into a fuzzy logic model. A study on the interaction between the driver and the modified vehicle system is carried out and used to evaluate the effects on drivability of the actuation chain delays due to the use of low frequency data and non-linear combination effect of different actuator interaction. The implemented control strategies are presented in terms of fuel and costs savings and, in particular, the management of regenerative braking is investigated to maximize its benefits and make the whole system work in safe conditions. Moreover, a methodology for predictive maintenance of vehicles based on telemetry technologies is defined in order to predict failure events and suggest the actions needed to avoid them for the user safety improvement. Finally, a study on turbo-compressor models is presented. Engine downsizing and super/turbocharging is currently, together with hybrid systems, the most followed trend in order to reduce CO_2 emissions and increase the powertrain efficiency. A key challenge for achieving the desired fuel economy benefits lies in optimizing the design and control of the engine boosting system, which requires the ability to rapidly sort different design options and technologies in simulation, evaluating their impact on engine performance and fuel consumption. Starting from the dimensional analysis theory for turbomachinery and a set of well-known control-oriented models for turbocharged engines simulation, a novel scalable model is proposed to predict the flow and efficiency maps of centrifugal compressors and radial inflow turbines as function of their key design parameters. The proposed approach is validated on a large database of compressors and turbines for automotive boosting applications, and examples are given to illustrate how the characteristic curves can be scaled with key design parameters.