PhD in Mechanical Engineering

Research Title: Torque vectoring for battery electric vehicles

Funded by	SILK-FAW

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Context of the research activity	The research develops in the framework of the cooperation between Politecnico di Torino and SILK FAW, a leader in high performance electric vehicles. Electric powertrains are characterised by a very high potential for improving the handling, stability, and drivability. This is due to the possibility to control the torque delivered by the electric motors in a much finer manner than what possible with a conventional powertrain. Additionally, the possibility to have powertrain configurations with two electric motors per axle allow unprecedented possibilities to control the vehicle (torque vectoring – TV). Torque vectoring can be exploited to improve the handling and to counterbalance the larger vehicle mass and powertrain inertias, typical of battery electric vehicles (BEV). This is particularly promising in high performance vehicles where handling and stability are essential for guaranteeing the safety in limit maneuvers or in low friction road conditions such as wet or snow. The possibility to control individually

	the torque leads to better exploitation of the tire with potential benefits also in terms of energy consumption. The knowledge in real time of the vehicle states such as the speed vector and side-slip angle are essential to fully exploit the potentialities of torque vectoring. Such variables can not be directly measured unless using expensive sensors. Virtual sensing based on artificial intelligence shows a very high potential to estimate such variables despite the broad variability of the road and other conditions.

Objectives	1) Development of modelling and control simulation systems to control vehicles with 1-4 e-motors. 2) Trade off analysis of model based controllers and controllers based on Artificial Intelligence. 3) Development of virtual sensing to estimate the non directly measurable vehicle states such as speed vector, side-slip angle and tire-ground contact forces. 4) Evaluate the Impacts of the investigated control strategies on the fuel economy.

Skills and competencies for the development of the activity	Knowledge of vehicle dynamics, electric machines, system modelling, control systems.