Adaptive modelling for automotive applications

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Abstract

Current engine control systems are commonly confided to fixed calibrations, with different maps for compensating temperature, pressure or aging variations. Exhaust emissions sensors present delayed and slow responses that makes impossible to control the engine during transients. On the other side, models suffer the problem of drift during its lifetime provoking undesired behaviour for an optimal control.

The current paper proposes to design simple models (analytical or maps) that catch the main dynamic properties of the studied variable with adaptive capabilities. The use of an optimal observer as Kalman filter and the integration of the model with some physical (or virtual) sensor open the possibility of correcting the performance of the model during the system life. Adaptive modelling approach allows using simple models since the online model fitting is able to cope with the modelling error; hence simple heuristic models can be used for replacing more complex physical-based models while guarantying similar performance.

The main advantages of the method are related to the simple way of obtaining a valid model where heuristic identification is enough while avoiding the adaptation of complex

Obtaining a dynamic and steady state reliable estimation of exhaust emissions allow implementing more advanced control strategies, such as Model Predictive Control (MPC), that is the key for the modern control structures that are being researched right now for internal combustion engines, but not commercially applied yet.

Finally, the strategy can be useful for sensor performance identification and also for calibration or system diagnosis.

The methodology is shown for the estimation of NOx concentration, which is needed for reducing NOx emissions on Diesel internal combustion engines and for SCR (selective catalyst reduction) diagnosis, but anyway the method is valid for other variables and for other kind of systems.