Control of a Driveline with a Slipping Clutch

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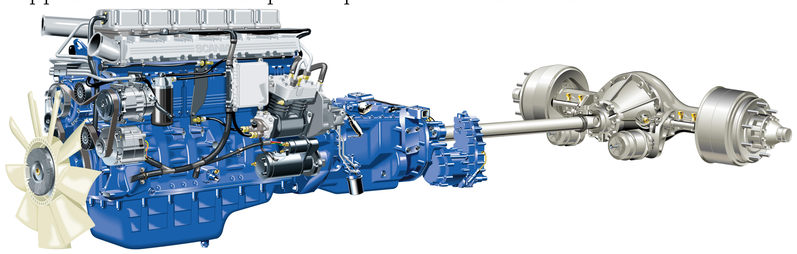
Integrated Powertrain Control

The behavior of a vehicle is not only controlled by the engine. There are several actuators available in a vehicles driveline (automatic clutch, Automated Manual Transmission (AMT),...) that can be used to affect the vehicle drivebility. By using these different actuators in an integrated manner with common control targets, performance and comfort benefits can be achieved. Scania acts as industrial partner in this project and supplies hardware and specific problem formulations.



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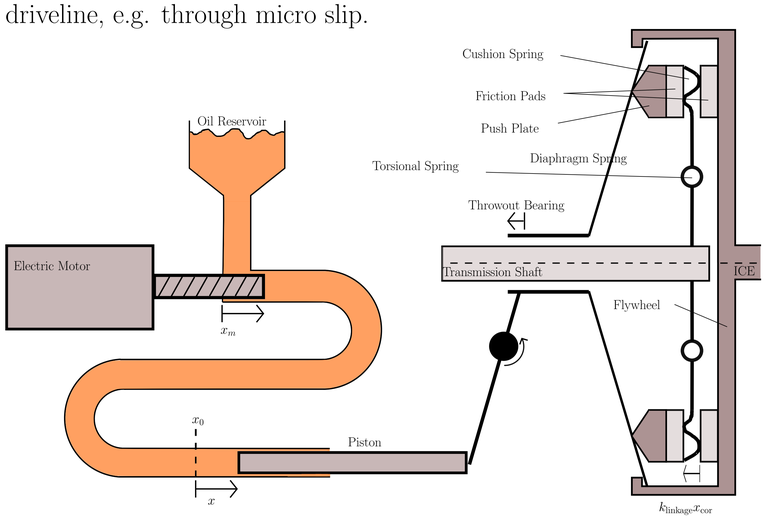
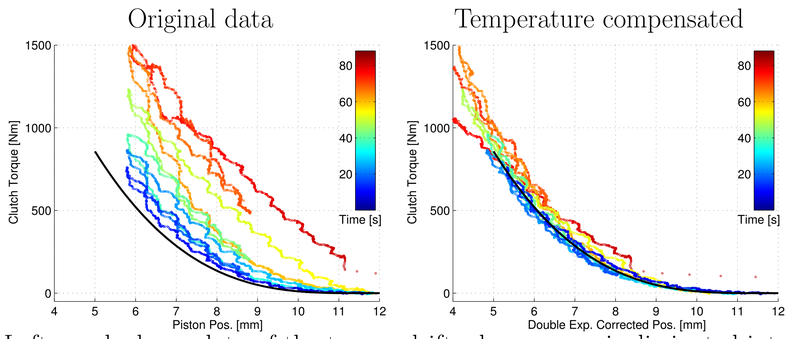
The use of an automatic actuator for the clutch gives new opportunities for controlling the engine and driveline. Several applications would benefit from advanced clutch control. For example start and stop strategies for heavy trucks can be employed and in addition clutch control can be utilized in AMTs to reduce the time for gear changes, which is a crucial parameter for preventing stall in heavy trucks during hill climbing. Furthermore it is possible to use clutch control to damp oscillations in the driveline, e.g. through micro slip.

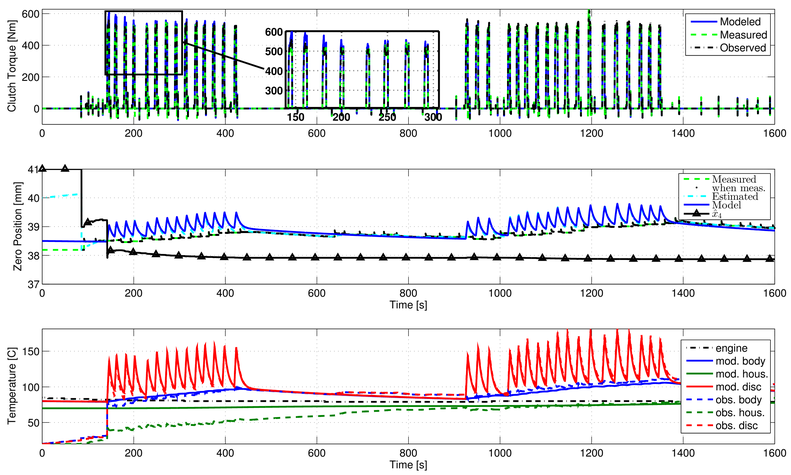


Clutch Model



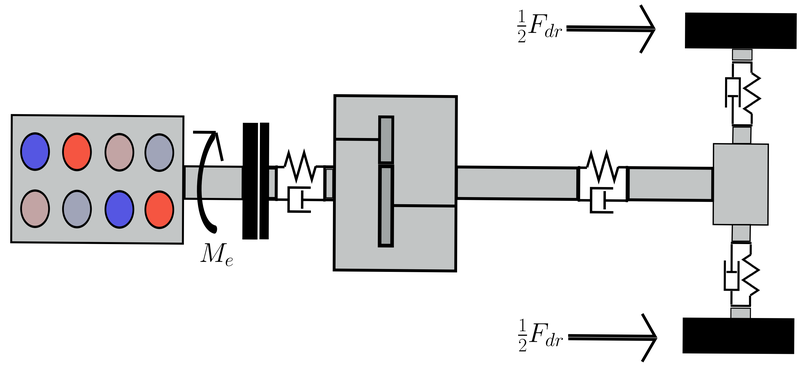
Left graph shows data of the torque drift when energy is dissipated into the clutch. Right graph shows the data after the position has been corrected for temperature effects using the clutch model developed in this project. The clutch model is a linear temperature model together with a linear thermal expansion.

Observer



An Extended Kalman Filter has been built in order to handle unknown initial values and wear. The observer can start to converge before the clutch is being slipped by using the available measurement of x_0, see figure to the left.

Driveline Model



Measurement from a Scania truck compared with open-loop simulation of the model. Driveline oscillations are modeled and capture both the amplitude and frequency of those seen in experimental data.

Future Work

The next step is to use the observer when developing a micro-slip controller. Micro slip is when the clutch is controlled to be slipping all the time, but with a very low slip in order to avoid over heating and unnecessary wear of the clutch.

Publications

Myklebust, A. and Eriksson, L. (2012a). Road slope analysis and filtering for driveline shuffle simulation. In *2012 IFAC Workshop on Engine and Powertrain Control, Simulation and Modeling*.

Myklebust, A. and Eriksson, L. (2012b). Torque model with fast and slow temperature dynamics of a slipping dry clutch. In *2012 IEEE Vehicle Power and Propulsion Conference*.

Myklebust, A. and Eriksson, L. (2013a). The Effect of Thermal Expansion in a Dry Clutch on Launch Control. In *7th IFAC Symposium on Advances in Automotive Control*.

Myklebust, A. and Eriksson, L. (2013b). Modeling and Estimation for Dry Clutch Control. *Licentiate Thesis*.

Myklebust, A. and Eriksson, L. (2013c). Modeling, observability and estimation of thermal effects and aging on transmitted torque in a heavy duty truck with a dry clutch. Submitted to *IEEE/ASME Transactions on Mechatronics*.