Modeling and Control of Advanced Turbocharged Engines

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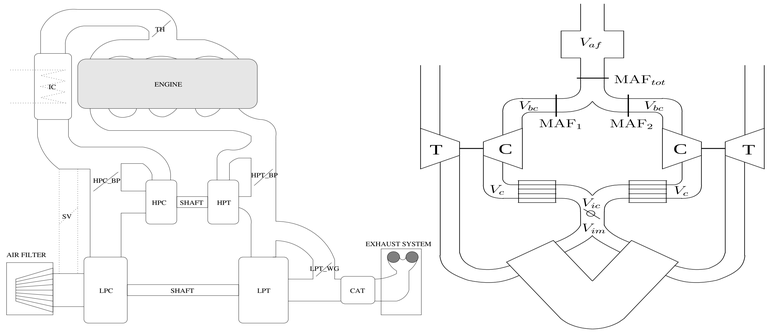
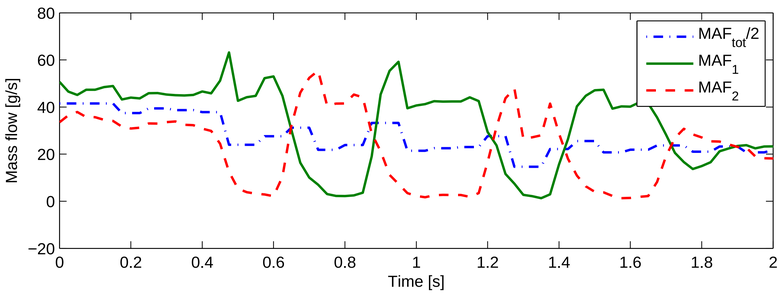
Project Background and Status

The ever increasing focus on fuel efficient vehicles forces the automotive industry towards more advanced engine concepts. Downsizing and turbocharging has been one possible solution. To still be able to provide the desired vehicle and engine behavior a single turbo is more often insufficient. This project focuses on modeling and control, of turbo systems with more than one turbo.

The third stage of the project has been devoted to initial measurements of a two stage turbo system on the common engine platform, and modeling efforts for surge, co-surge and choke. Choke modeling is especially motivated by two stage system, and co-surge[1] is a phenomenon, where a parallel twin turbo compressor system surges.

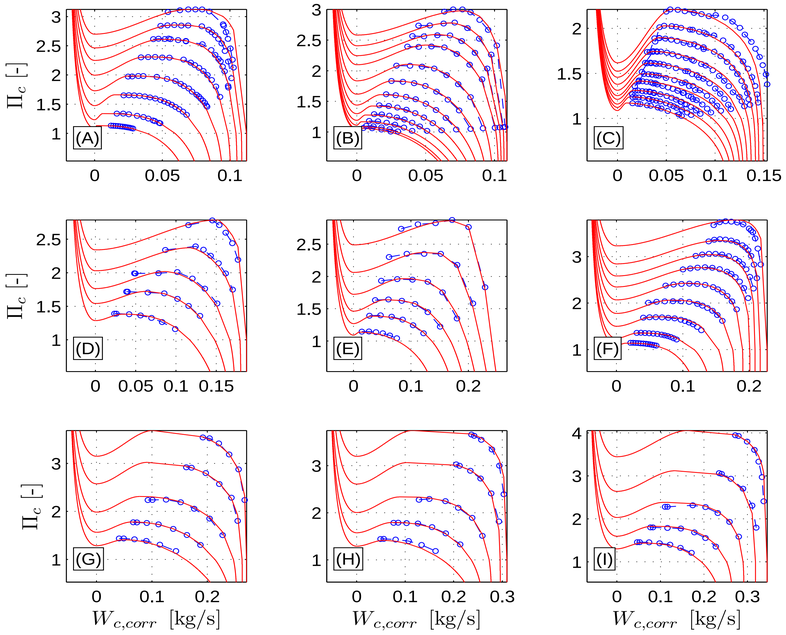
The work, therefore, evolves around component modeling capable of reproducing these phenomenons, and extended the available Mean Value Engine Model framework. The extended MVEM is suitable for investigation of both instability issues and control principles, for advanced turbocharged engines.





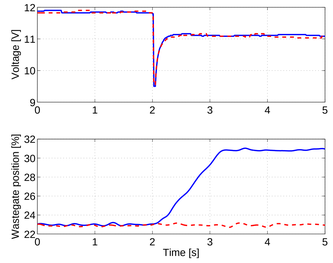
Compressor Performance Modeling

A compressor model has been developed[2]. It is capable of representing mass flow and pressure characteristic for three different regions: surge, normal operation as well as for when the compressor acts as a restriction. Different submodels have been investigated and methods to automatically parametrize the proposed model structure have been developed.



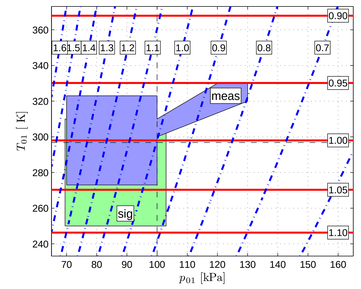
Boost Pressure Actuator Modeling

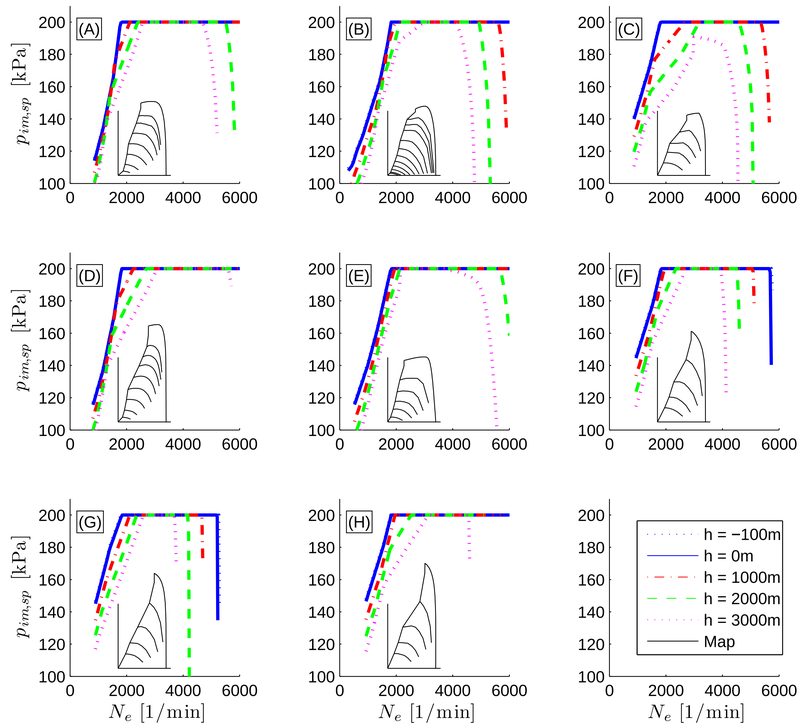
A physically motivated actuator model has been developed[3] for the pneumatic valves used to increase boost system flexibility in advanced turbocharged engines. Forces acting on the actuator system where modeled and a non linear compensator was developed to reject disturbances. The disturbance rejection using the compensator was proved for boost pressure both in a simulation environment as well as in the engine laboratory.



Investigation and Implications of Changes in Ambient Conditions for Control of Automotive Compressors

Turbo compressor performance is usually characterized by a map. This map describes the properties of the compressor. The goal with a map is to determine turbocharger performance so that it covers the full operating region of the compressor. However, when turbocharger performance is measured, the characteristics obtained are valid for the inlet conditions under which the measurements were conducted. To overcome this deficiency, different correction factors are applied to scale the performance variables to cover other inlet conditions.





[1] Modeling and Control of Co-Surge in Bi-Turbo Engines, Andreas Thomasson and Lars Eriksson, submitted to IFAC WC2011
[2] Surge and Choke Capable Compressor Model, Oskar Leufven and Lars Eriksson, submitted to IFAC WC2011
[3] Model-based boost pressure control with system voltage disturbance rejection, Ivan Criscuolo, Oskar Leufven, Andreas Thomasson and Lars Eriksson, submitted to IFAC WC2011