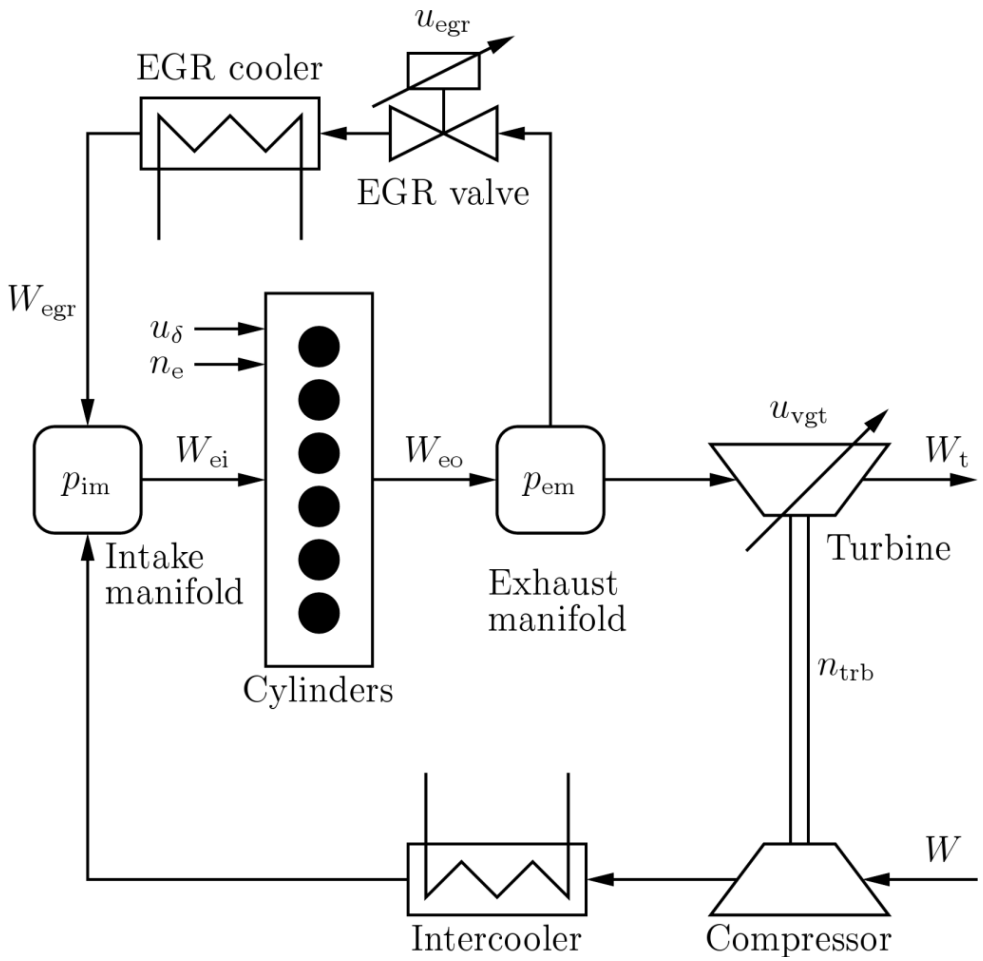
Virtual Sensors for Gas Flows in Heavy-Duty Diesel Engines



Project within ”Fordonsutveckling” (VINNOVA fast track – continuance of DNR 2006-00072)

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Content

FFI in short

FFI is a partnership between the Swedish government and automotive industry for joint funding of research, innovation and development concentrating on Climate & Environment and Safety. FFI has R&D activities worth approx. €100 million per year, of which half is governmental funding. The background to the investment is that development within road transportation and Swedish automotive industry has big impact for growth. FFI will contribute to the following main goals: Reducing the environmental impact of transport, reducing the number killed and injured in traffic and Strengthening international competitiveness. Currently there are five collaboration programs: **Vehicle Development, Transport Efficiency, Vehicle and Traffic Safety, Energy & Environment and Sustainable Production Technology.**

1. Executive summary

The research in the project has proceeded according to plan and the Ph.D. student defended his dissertation 2011-05-27. Within the project, both Ph.D. student and senior researcher part, 11 konferens contributions, technical reports and articles have been published and another 3 are under review.

2. Background

Transportation is of vital importance in the modern economy and a major part of these transportations are carried out by trucks, e.g., in Europe and United States road vehicles account for more than 70% of the inland freight transport. As a consequence, a major part of the emissions from the vehicular tra.c is from trucks. It is therefore necessary to reduce the emissions and fuel consumption.
Stricter emission legislations and customer demands on low fuel consumption drive the technical development of engines and force new solutions to be introduced. To cope with reduced emission limits on diesel engines, for example intake manifold throttle, exhaust gas recirculation (EGR), and variable geometry turbine (VGT) are introduced. This technical development, with increased system complexity and tightened requirements from customers and legislators, increase the demands on the control and diagnosis systems. Two examples of important quantities that significantly affect the emissions from diesel engines are: air to fuel ratio and EGR-fraction . The increased demands on the control and diagnosis systems, increase the required information quality. At the same time it is desirable to have as few and cheap sensors in the system as possible to keep the cost down. This has made estimation an important and active research area.

3. Objective

The project has had several objectives, to strengthen the collaboration between Scania and LiU and increase the overall competence at Scania in the area of estimation, especially gas flow estimation, to enable control and diagnosis of future heavy duty diesel engines with competitive operating cost while meeting the emission legislations.

4. Project realization

The project is executed as a Ph.D. project and the resulting dissertation was defended at Linköping University 2011-05-27, and work by senior researchers within engine modelling and control.

5. Results and deliverables

5.1 Delivery to FFI-goals

The program ”Fordonsutveckling” have as a goals to contribute to a global leadership within vehicular electronics and sotfware and to increase the competence in material and development methods.
This particular project has hade activities within engine control sysytems and software and has resulted in several scientific publications, e.g. a dissertation.

6. Dissemination and publications

The dissemination of results has primarily been conducted through scientific publications and presentations at conferences.

6.1 Knowledge and results dissemination

Beside attending national and international conferences, dissemination have been conducted by seminars at both the university and Scania.

6.2 Publications

Ph.D.

5 conference contributions:

1) ´Air mass-flow measurement and estimation in diesel engines equipped with EGR and VGT´, Erik Höckerdal, Lars Eriksson, Erik Frisk (2008) In: Electronic Engine Controls. Volume 2008-01-0992 of SAE Technical paper series SP-2159. SAE World Congress, Detroit, USA.
2) ´Observer Design and Model Augmentation for Bias Compensation Applied to an Engine´, Erik Höckerdal, Erik Frisk, Lars Eriksson (2008) IFAC World Congress. Seoul, Korea.
3) Samma till Reglermötet 2008, Luleå.
4) ´Model Based Engine Map Adaptation Using EKF´, Erik Höckerdal, Erik Frisk, Lars Eriksson (2010). Sixth IFAC Symposium on Advances in Automotive Control. München, Tyskland.
5) Samma till Reglermötet 2010, Lund.

2 articles:

1) ´Air mass-flow measurement and estimation in diesel engines equipped with EGR and VGT´, Erik Höckerdal, Lars Eriksson, Erik Frisk (2008) In: SAE Int. J. Passeng. Cars -- Electron. Electrl Syst., 1(1):393-402.

2) ´Observer Design and Model Augmentation for Bias Compensation with a Truck Engine Apllication´, Erik Höckerdal, Erik Frisk, Lars Eriksson (2009) In: Control Engineering Practice.

Licentiate thesis: ´Observer Design and Model Augmentation for Bias Compensation with Engine Applications´, Erik Höckerdal (2008) Department of Electrical Engineering, Linköpings Universitet.

Dissertation: ´Model Error Compensation in ODE and DAE Estimators with Automotive Engine Applications´, Erik Höckerdal (2011) Department of Electrical Engineering, Linköpings Universitet.

Under review are two additional papers, one conference contribution to CDC, Orlando Florida, 2011, and one journal article to IEEE Transactions on Industrial Electronics.

Senior part

1) ´Modeling and Control of Turbocharged SI and DI Engines´, Lars Eriksson (2007). In: Oil & Gas Science and Technology - Rev. IFP, 62(4):523-538.
2) ´Performance gains with EGR-flow inversion for handling non-linear dynamic effects in EGR VGT CI engines´, Johan Wahlström, Lars Eriksson (2007). Fifth IFAC Symposium on Advances in Automotive Control. Monterey, CA, USA.
3) ´Modeling and Control of Supercharged SI and CI Engines´, Lars Eriksson (2006). In: Proceedings of New Trends in Engine Control, Simulation and Modeling. IFP, Rueil-Malmasison, France.
4) ´Modeling of a Diesel Engine with Intake Throttle, VGT, and EGR´, Johan Wahlström, Lars Eriksson (2010) Department of Electrical Engineering, Linköpings Universitet.
5) ´Output Selection and its Implications for Model Predictive Control in Diesel Engines´, Johan Wahlström, Lars Eriksson (Submitted). To IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY.

7. Conclusions and future research

Another well functioning collaboration between Scania and LiU has been completed with a technical Ph.D. degree for the in the project employed Ph.D. student, Erik Höckerdal.

8. Participating parties and contact person

Scania CV AB (Publ), project manager Erik Höckerdal, authorized signatory Anders Lindberg.

Linköping University, department of electrical engineering, Lars Nielsen.

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