Solutions for better fuel efficiency of Heavy Duty Trucks

Volvo achievements in the CONVENIENT project

The Volvo Demonstrator

Goal

1. **Optimal control**: develop a model based optimal controller ("Model Predictive Controller") that minimizes fuel consumption based on predicted road topology for the

   - Cooling system and battery
   - Vehicle kinetic energy (Predictive Speed Controller)

2. **HMI**: display for predictive speed control

3. **Aerodynamics**: develop functionality for automatic adjustable side deflectors and roof deflectors.

4. Prove FC gain in simulation

5. Prove functionality in a prototype truck with rapid prototype system (dSpace Autobox)

Let T denote the prediction horizon. Then minimize
$$J = q_a \int_0^T Q_a(s)ds - q_b E_b(T) - q_c E_c(T)$$
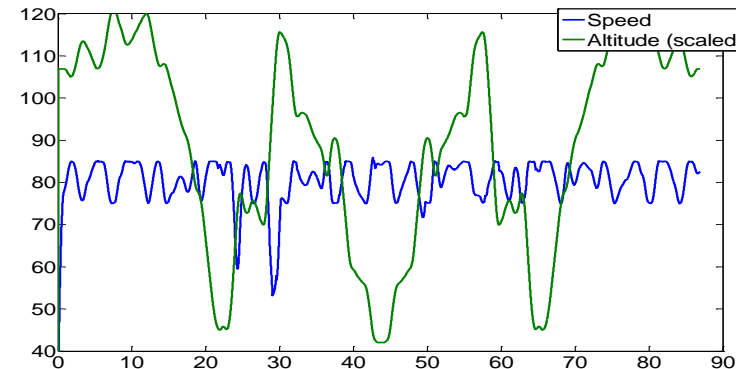under the restrictions
$$\int_0^T v(s)ds \geq \int_0^T v_{ref}(s)ds$$
$$v_{ref} - \Delta v \leq v \leq v_{ref} + \Delta v$$
plus energy storage and actuator constraints.

Achievements

Speed Controller

- FC gain proven in Simulation (~5%)
- Proven functionality in truck
- Validated vehicle model
- Prediction algorithm proven in simulation and in truck.

Cooling and Battery System

- Final version tested in simulation (~1%)
- Preliminary version tested in truck

HMI: Functionality tested in truck

Aerodynamics

- Controllable roof deflector (0-2%) and side deflector (0.5-1%) proven in simulation.
- Roof deflector functionality proven in truck.