Vehicle Propulsion Information Integration
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**Project Overview**

In the automotive area there are ever increasing demands from legislators and customers on low emissions and good fuel economy. In the process of developing and investigating new technologies, that can meet these demands, modeling and simulation have become important as standard engineering tools.

To improve the modeling process new concepts and tools are also being developed and a key point is the interplay between modeling and information fusion, using information from in-vehicle sensors, models of different complexity and time scales, and prior knowledge. Here a new formulation for multi-zone in cylinder models is depicted.

**Publications**


**Diesel and SI Modeling**

In Diesel and SI engine models it is often advantageous to have multiple zones. In the SI engine it can for example be used to track the temperature distribution which is important for e.g. models of ion currents. Because the combustion is rate controlled it is also essential for combustion models that the temperature is correctly modeled and therefore multi-zone models are used. The DAE formulation depicted here gives a new, flexible way to set up multi-zone models.

**Control Volume** (Theoretic model)

- State variables: \( p, T, V, x \)
- Composition
- Simulation model:
  \[ \begin{align*}
  a dp + b dT &= e \\
  c dp + d dT &= dQ + f
  \end{align*} \]

**Single Zone** (Traditional)

- Homogeneous distribution

**Theorem:**

If the gas is *Well Behaved*, then the Multi Zone DAE formulation has a unique solution as long as all zones have non-zero size.

\[ \sum dV_i = dV \]

\[ \text{Multi Zone DAE (New)} \]

\[
\begin{pmatrix}
0 & 1 & 0 & \cdots & 0 \\
\vdots & \ddots & \ddots & \cdots & \vdots \\
0 & \cdots & 0 & p & 0 \\
0 & \cdots & 0 & p & d_n \\
0 & \cdots & 0 & p & d_N \\
\end{pmatrix}
\begin{pmatrix}
dp \\
dV_1 \\
dT_1 \\
dV_N \\
dT_N \\
\end{pmatrix} =
\begin{pmatrix}
dV \\
e_1 \\
e_N \\
f_1 \\
f_N \\
\end{pmatrix}
\]

**Simulation model:** \( a, \ldots, f \) functions of state

- \( a dp + b dT = e \)
- \( c dp + d dT = dQ + f \)

**SI Engine**

Zone for Ion Current Modeling

**Diesel Engine**

Layered Air/Residuals

- Evaporated fuel, \( m_e \)
- Entrained air, \( m_a \)
- Combustion, \( m_b \)

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