« EMR and control of Hybrid Electric Trucks »

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Within the CE2I Program supported by the European Union through ERDF funding
Hybrid electric trucks
- most of delivery trucks, buses and long-haul trucks cannot be pure electric
- pure thermal (diesel) trucks will be forbidden in urban centres
- hybridation of trucks require an important investment cost
- more efficient technology have to be develop to face this challenge

Hybrid electric trucks and CE2I « e-drive »
- more efficient and smart « e-drives » for hybrid electric trucks
- a delivery hybrid truck as a reference
- comparison of different innovative technologies
- supplementary energy saving using the CE2I “e-drive” ?
Real delivery truck [Hofman 2008]
Mass - 7258 kg
ICE - 205 kW
(Electric Drive – 58 kW)

Complete vehicle simulation for a standard driving cycle
1. Pure diesel truck
2. Parallel hybrid with CVT (Continuous Variable Transmission)
3. Series-Parallel hybrid with DPG (Double Planetary Geartrain)
4. Series-Parallel hybrid with EVT (Electric Variable Transmission)
5. Parallel & Series Parallel hybrid with CE2I “e-drive”?
1. **EMR and control of the CVT-based hybrid truck**
   - EMR and control
   - Energy Management Strategy
   - Results

2. **EMR and control of other hybrid trucks**
   - EMR and control
   - Energy Management Strategy
   - Results

3. **Conclusion & Perspectives**
« EMR and control of the CVT-based hybrid truck »
« EMR and control of hybrid electric trucks »

- CVT principle -

Classical Manual Gearbox

Efficiency: 92%

Continuous Variable Transmission

Efficiency: 85%
« EMR and control of hybrid electric trucks »

- EMR and Control -

EMR’16, Hanoi, June 2018
For comparison: an optimal strategy is required. The Dynamical Programming is used, but a “backward model” is needed and EMR uses a forward model.
Assumptions:
ideal control / velocity known in advance (derivative computation)

Dynamic programming (off-line iterative method)
from a reference velocity \( v_{het-ref} \)
in a discretised time
all possible control inputs \( (T_{ice-ref}, K_{cvt}, k_{bk}) \) are tested
solution = control input evolutions for the smallest fuel consumption
EMR and control of hybrid electric trucks

Simulation Results

- Velocity (km/h)
- Transmission ratio
- SoC
- ICE power (kW)
- Electric power (kW)

Diesel truck
- 18.4 L/100km
- 16.6 L/100km
- -10.8 %

CVT hybrid truck

EMR’16, Hanoi, June 2018
DPG-based and EVT-based Hybrid trucks
« EMR and control of hybrid electric trucks »

- DPG-based HEV-

DPG hybrid truck
14,5 L/100km
-19,8 %
Specific design for this reference truck

EMR and control of A EVT-based hybrid car [Cheng 2012]
« EMR and control of hybrid electric trucks »

- Comparison of hybrid trucks -

Protocol

Energetic Macroscopic Representation and control of each vehicle
Simulation using Matlab-Simulink © for a UDDS driving cycle
Optimal energy management using Dynamic Programming

Pure Diesel truck reference

CVT-based Hybrid truck

Energy saving 10%

DPG-based Hybrid truck

Energy saving 20%

EVT-based Hybrid truck

Energy saving ?? (in progress)
« Conclusion & Perspectives »
**CE2I e-drive:**
20-phase machine + integrated GaN converters

**Protocol**
When the first CE2I prototype of 50 kW will be tested
A simulation model will be included in the previous simulation models
The energy savings due to the CE2I “e-drive” will be defined