Road
student

TOP 10

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WINNER

N. project: L1-24 **category:** Road

Members: Martin Hofstetter **University:** Graz University of Technology

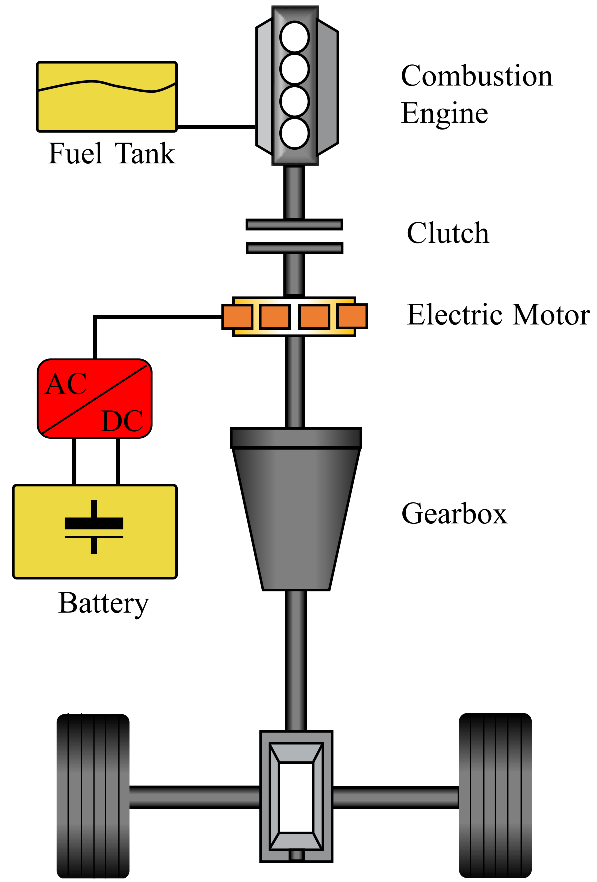
RA1 **Environment – Decarbonisation, Sustainability and Energy Efficiency**

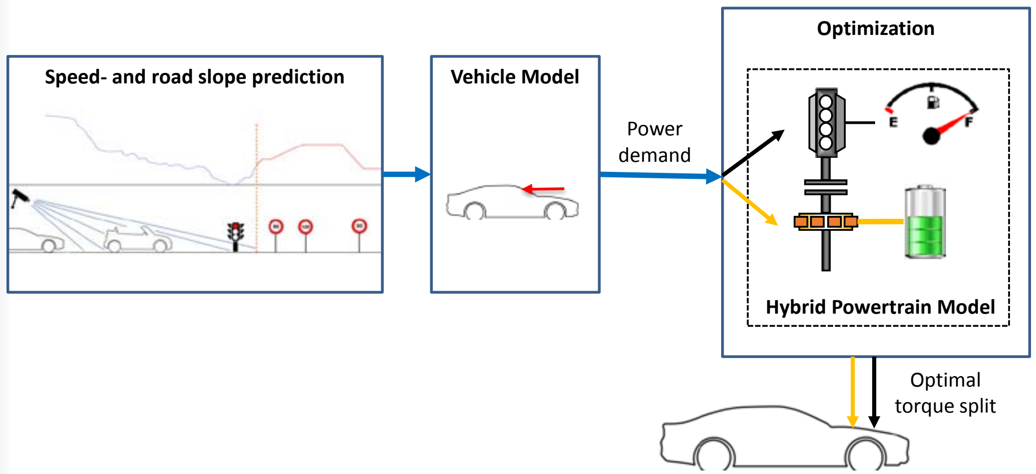
Key Characteristics: The fuel saving potential of PHEVs is presented as a function of the prediction horizon length • A Dynamic Programming optimization algorithm uses a quasi-static vehicle model to determine the optimal power distribution between both propulsion units • The proposed predictive operation strategy has remarkable potential in fuel savings •

Sensor Range Sensitivity of Predictive Energy Management in Plug-In Hybrid Vehicles

Hybrid vehicles are the most promising technology to reduce greenhouse gas emissions in the next decades combining local emission free electric propulsion with de facto unlimited range of fossil fuel powered vehicles.

Compared to conventional hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs) have additional potential of improving fuel efficiency and reducing local emissions due to a higher battery capacity and the possibility to be recharged from external outlets. Energy management has a major impact on fuel consumption in both cases. In this study the fuel saving potential of PHEVs is presented as a function of the prediction horizon length. The driving route is assumed to be known a-priori, which is the case when using navigation systems. The prediction horizon is defined as the distance range within which the upcoming vehicle speed is known in detail. This represents a simplified model of on-board vehicle sensors, which are limited in distance range. Also speed limits and road inclination are used to roughly estimate the future speed. Based on the speed-related power demand estimation, the overall fuel consumption is minimized: a so called Dynamic Programming optimization algorithm uses a quasi-static vehicle model to determine the optimal power distribution between both propulsion units for every time step. The parallel hybrid drive train is according to a P2 lay-out, consequently the electric motor is situated between the gearbox and the internal combustion engine. The performed simulation study is based on a real world driving cycle consisting of urban, suburban and highway sections. The results suggest that the proposed predictive operation strategy has remarkable potential in fuel savings, compared to the investigated heuristic, rule-based strategy. Even when using very simple and easily available estimations only by upcoming speed limits, significant fuel savings can be accomplished.





2ND PRIZE

N. project: L1-28 **category:** Road

Members: Konstanze Winter **University:** Delft University of Technology

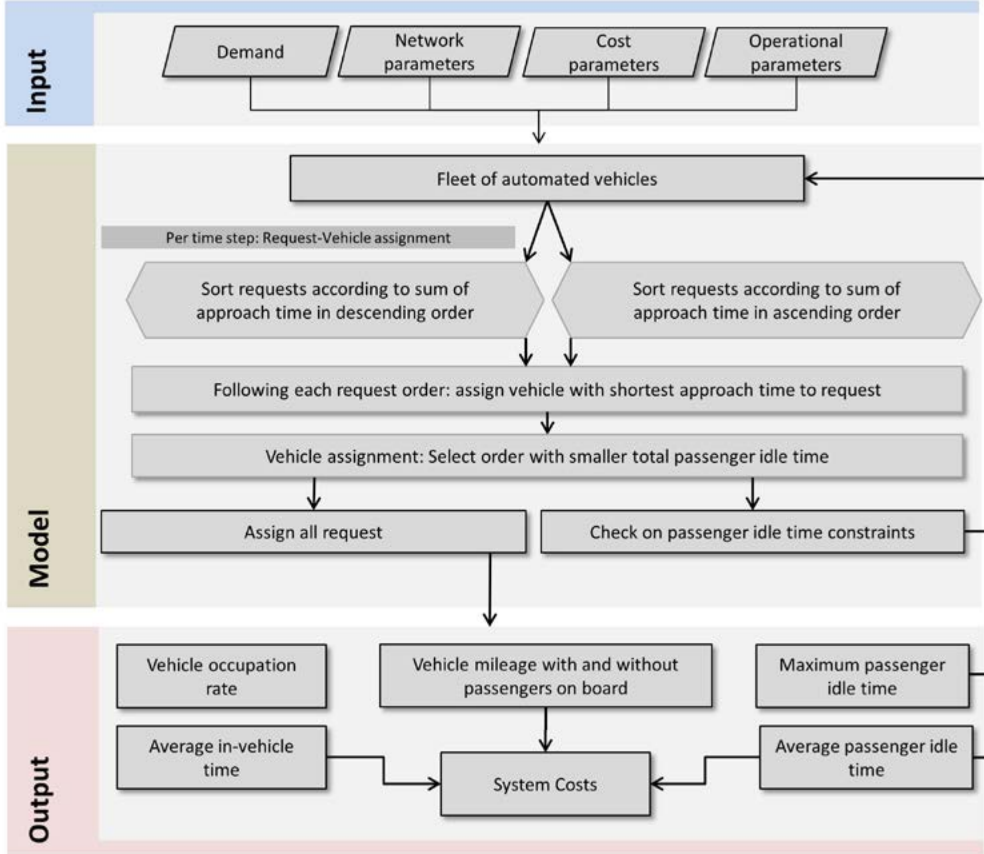
RA3 **Urban and Long-Distance People Mobility – Systems and Services**

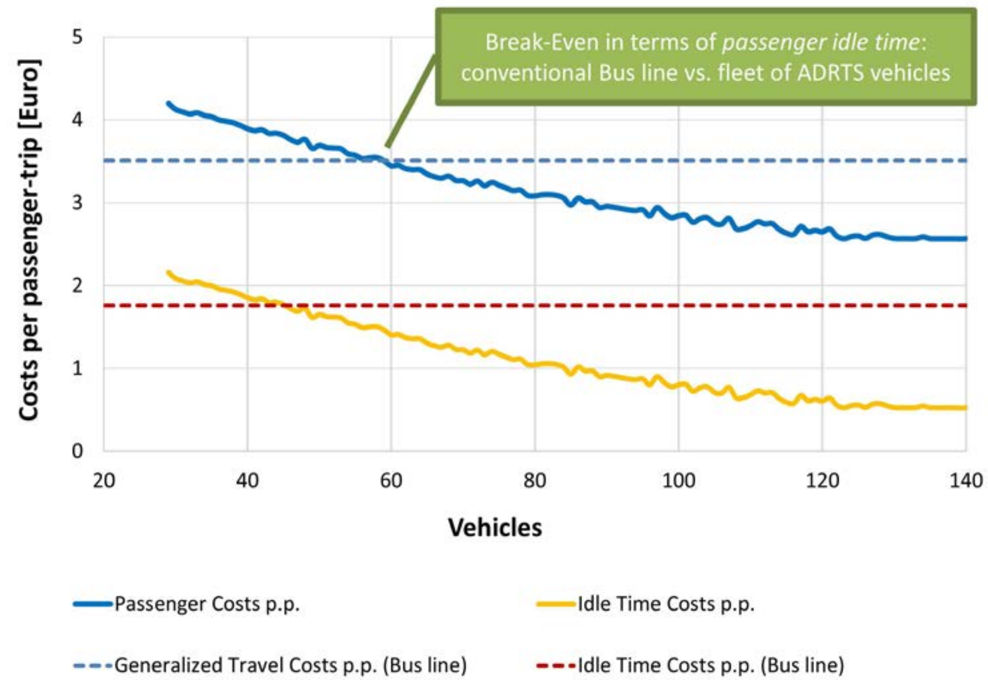
Key Characteristics: Simulation of a new mobility service for urban and regional public transportation operated by automated vehicles • The simulation tool determines for a certain demand the required fleet size and the overall driven kilometers while constraining the maximum passenger waiting time • The simulation output allows to estimate the operational and passenger costs and consequently to determine the optimum fleet size for obtaining minimum overall costs

Simulation of an Automated Public Transportation System

It is a challenge to improve public transportation in both densely populated cities and rural areas in terms of service, sustainability and financial feasibility. A solution approach are flexible demand-responsive transportation services.

They can increase the comfort of public transportation for the urban population and be efficiently employed in sparely populated areas. However, traditional demand-responsive transport systems are costly and need to be subsidized when employed for public transport. With fully automated vehicles (AV) becoming operational, the question raises how they can be employed for efficient and effective mobility solutions integrated in transport systems. In this study the operation of a new mobility service for urban and regional public transportation operated by AV is simulated. The proposed transport system is defined as an Automated Demand Responsive Transport System (ADRTS), a demand responsive AV public transportation service providing individualized rides without fixed routes or timetables. Depending on vehicle capacity, requests for the ADRTS are combined in case they share the same pick-up and drop-off locations and are launched within a certain time window without inducing detours. Two case studies are simulated for the proposed ADRTS: a one-to-one case for approximately 3.700 requests and a many-to-many case consisting of 26 nodes for approximately 32.400 requests. The simulation tool determines for a certain demand the required fleet size and the overall driven kilometers while constraining the maximum passenger waiting time, which represents the customer service level. The passenger arrival process is considered to be stochastic and demand patterns for three node categories (station node, campus node and residential node) are specifically defined. The simulation output allows to estimate the operational and passenger costs and consequently to determine the optimum fleet size for obtaining minimum overall costs.





3RD PRIZE

N. project: L1-41 **category:** Road

Members: R. Vitolo, E. De Mattei, A. Luigi Pala, A. Pellegrino, N. Salamone, L. F. Vigna **University:** Politecnico di Torino

RA1 **Environment – Decarbonisation, Sustainability and Energy Efficiency**

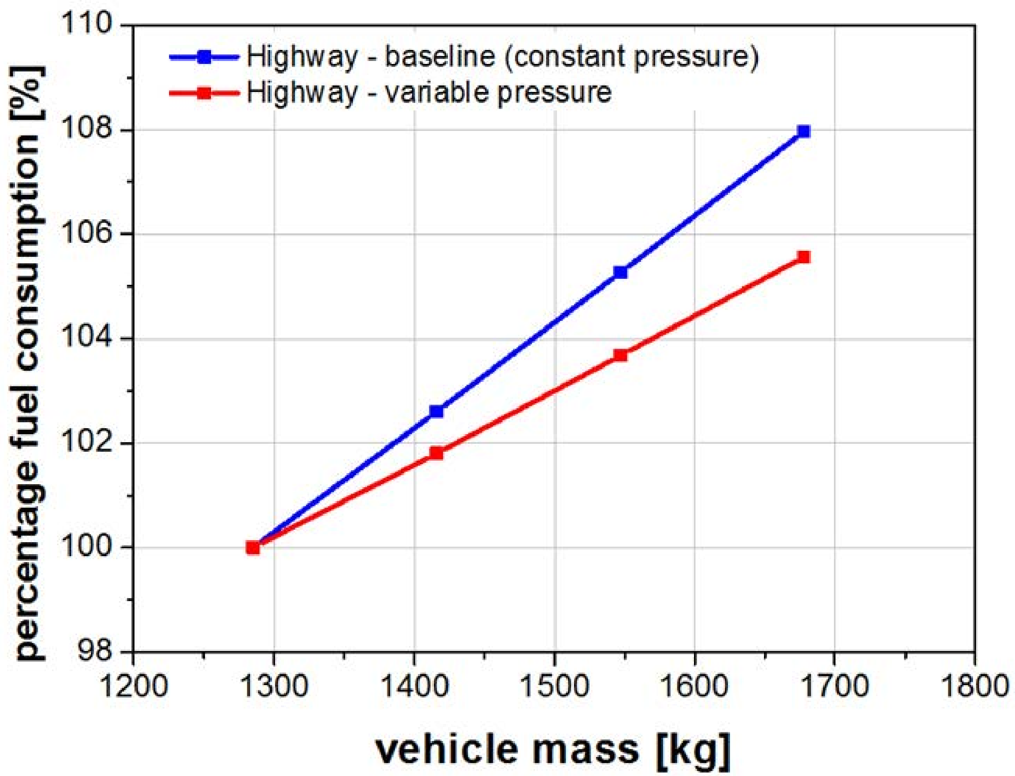
Key Characteristics: • Effect of tire pressure on fuel consumption and vehicle dynamics • Adaption of tire pressure to the vehicle working conditions • Design of a novel automatic central tire inflation system for passenger vehicles •

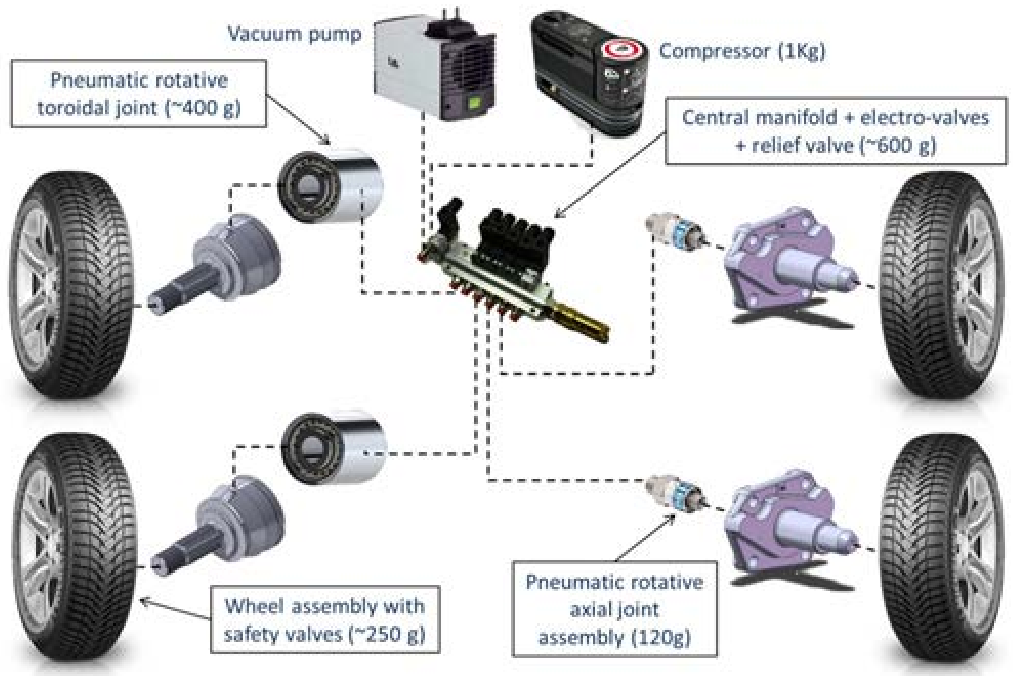
Automatic control of tire pressure on passenger vehicles

Tire inflation pressure has a critical impact on rolling resistance and its influence on vehicle fuel economy and CO2 emissions is huge due to the low attention paid by drivers to tire maintenance.

Safety, comfort and tire life are also negatively affected by incorrect tire inflation. Simulations show that maintaining the tire pressure to the nominal value would reduce fuel consumption up to 2%, taking into account that most of the circulating passenger vehicles present tires under-inflated at 75% of the nominal value. Further advantages can be obtained varying pressure according to the vehicle working conditions: adapting inflation pressure to current vehicle mass could produce fuel benefits up to 1.6% on NEDC and 2.4% in highway driving, while varying pressure during tire warm-up could reduce CO2 emissions by 0.53 gCO2/km (-0.38%) on a cold-start NEDC. This advantage may be obtained maintaining the tire pressure within a narrow range of 0.8 bar around the reference value (2.2 bar). According to our simulations and on-track tests, this would not produce significant effects on the vehicle longitudinal and lateral dynamic response. To address these issues, the present study proposes an on-board electro- pneumatic system for the automatic control of tire inflation pressure. The design focused on the reduced impact that the product should have on the standard production process of vehicles subsystems and assembly. A highly fail-safe layout has been produced which allows to isolate the tire when the system is not actuated and to limit in any case the minimum in-tire pressure through very simple and robust mechanical actions. The system has been produced as a prototype and tested on a static test bench.

Next studies will be dedicated to improve the system to further facilitate on-board integration and manufacturing processes. Combining the results obtained from the analysis of fuel economy and vehicle dynamics, an algorithm will be defined to calculate the optimal tire pressure.





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