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The role of dynamics and control in cutting vehicle CO_2 emissions

There are only two ways of cutting CO_2 emissions from road vehicles: either i) by eliminating carbon from the propulsion source, or ii) by dramatically improving vehicle efficiency. Adopting either of these options affordably is by far from easy. This plenary lecture will focus on areas of vehicle technology where dynamics and control can be used expediently to improve vehicle efficiency for conventionally powered vehicles, Hybrid Electric Vehicles (HEV), and (battery) Electric Vehicles (EV). For example, in both conventionally-powered vehicles, and HEV, there are significant benefits of closed-loop combustion control to improve engine thermal efficiency and performance using different fuels. The state of indirect cylinder pressure sensing will be discussed. Another application where significant fuel economy improvements are possible in IC engines, is to replace the liquid cooling with evaporative cooling a novel approach to control two-phase spray evaporative cooling will be outlined. Yet another area for CO_2 emission reduction for HEV is the adoption of advanced Range Extender concepts. And a final example (where a novel optimal control approach will be discussed) is optimal flywheel-based kinetic energy recovery that offers durable vehicle range extension for both EV and HEV. In summary, a broad overview will initially be given of areas where dynamics and control alone can engender significant improvements in vehicle efficiency. Some of the realizable benefits and implementation challenges will be examined for the topics mentioned.

Recent Publications

1. S Jafari J F Dunne, M Langari Z Yang, J-P Pirault, C A Long and J Thalackottore Jose (2018) Control of spray evaporative cooling in automotive IC engines. ASME Journal of Thermal Science and Engineering Applications 10(4):1-11.
2. C Bennett J F Dunne, S Trimby and D Richardson (2017) Engine cylinder pressure reconstruction using crank kinematics and recurrently-trained neural networks. Journal of mechanical systems and signal processing 85:126-145.
3. J F Dunne and L A Ponce Cuspinera (2015) Optimal gear ratio planning for flywheel-based kinetic energy recovery systems in motor vehicles. ASME Journal of Dynamic Systems Measurement and Control. 137(7):071012.

Biography

Julian F Dunne is a Professor of Mechanical Engineering at the University of Sussex, UK. His expertise is in Dynamics and Control, with application interests in low emission vehicles, in particular, noise and vibration prediction for 'light-weighted' vehicles; control of combustion in downsized engines; evaporative cooling of Hybrid Electric Vehicle engines; kinetic energy recovery systems; and novel power generators. His special application interest is on efficient Range Extenders for Hybrid Electric Vehicles. He currently leads the 36-strong Dynamics, Control, and Vehicle Research Group at Sussex University. He has 78 refereed publications, and is an Editorial Board Member of three journals: *The Journal of Sound and Vibration, Vehicles, and Journal of Autonomous Intelligence*. His research has been externally-funded by the EPSRC, the EU, the UK Government, and Jaguar Land Rover. He has also received very significant support from Ford, Ricardo, and Denso (the Toyota subsidiary). In 2012, he has organized a very successful 2-day International Symposium at the University of Sussex on the Computational Modeling and Analysis of Vehicle Body Noise and Vibration.

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