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Internal Combustion Engine - the Oldest Object of Mechatronic System Application?

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Abstract - An internal combustion engine (ICE) is subjected to many requirements considering environmental issues (pollutants and greenhouse-gas emissions, NVH issues), safety (active vehicle safety demands, especially sufficient acceleration avoiding risky maneuvers) and competitiveness (economy of driving - fuel consumption, fun to drive). Associated issues can have been solved during the last quarter of century only if mechatronic concepts for mixture formation, ignition, controlled combustion, gas exchange, super/turbocharging with boost pressure control and exhaust gas aftertreatment devices are combined as integral system consisting of mechanical devices and microelectronic components including sensors. Therefore, the design of lay-out and embedded control systems for ICE's have been one of the first application of mechatronic devices. The contemporary engines cannot be used without X-by-wire technologies more.

The list and functional description of those devices, both already used or being applied in the near future, is presented. The synergy and added quality of mechanical and electrical component interaction is stressed, demonstrating surprisingly high concentration of power in apparently small engine systems and necessity to cover it by smart combined electronic/mechanical devices.

Future possibilities of fully flexible ICE with model-based predictive and adaptive control and the potential to fulfill the expected demands are addressed. The methods suitable for ICE mechatronic systems development and control, namely close combination of dedicated experiments with simulation and SiL and HiL methods are described in connection to it. The arrangement of the development process using Design Assistance System DASY and selected examples of results showing the contributions of ICE full flexibility are presented.