Electronics for safe, efficient electric vehicles

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For decades, futurists have been predicting that the use of electric vehicles (EVs) will overtake conventional vehicles, providing clean, green and cheap transport for all. Although increasing numbers of electric vehicles are being sold in Europe, the internal combustion engine still remains king of the road. EU-funded researchers are trying to change that, developing technology that promises to significantly improve the range and efficiency of EVs without compromising comfort or safety.

As battery and electric motor technology has advanced in recent years, manufacturers have started to produce more commercial electric vehicles, from buses to cars and bikes. But while sales are rising rapidly, there are still fewer than 100,000 purely electric vehicles on Europe's roads - compared with more than 250 million conventional vehicles, 90

% of which are passenger cars.

Several factors are holding back the electric vehicle market, despite its promises of cheaper transport, less noise, reduced fuel imports and lower emissions of CO2 and other pollutants.

"The most obvious barrier that explains the hesitation of consumers to choose an electric vehicle is the cost-performance ratio which is, compared to conventional vehicles, not very attractive," says Dr Volker Scheuch, a researcher at German automotive electrics group Intedis. "One of the drawbacks on the performance side is the short range of electric vehicles due to battery technology, which is still at the beginning of its evolution, and vehicle concepts that still use ideas from times when the economical use of resources was not really a topic."

Often, the design and many of the components of electric vehicles still borrow features from their conventional predecessors that may not be optimised for EV efficiency or safety. But simply optimising each component individually is not sufficient - the overall architecture and the interactions between components also need to be addressed if EVs are to meet their full potential.

Several new EV concept vehicles employ parallel motors - offering not only greater manoeuvrability and performance compared to more conventional single-motor designs, but also increased energy efficiency. However, controlling two motors at the same time safely is a considerable challenge, requiring a novel system architecture and a range of electronic devices, from sensors to control units.

The issue is being tackled by a team of researchers working under the direction of Dr Scheuch in the 'Safe and efficient electrical vehicle' (EFUTURE) project, which received EUR 4 million in funding from the European Commission. Their goal is to prepare the next generation of

electric vehicles by creating intelligent software that minimises energy needs while still being able to dynamically optimise decisions between safety and energy efficiency.

"Today's vehicles have a very high level of operational safety which needs to be kept for the electric generation," according to Dr Scheuch. "New challenges arise when more than one motor driving the wheels comes into play. This is what we investigated in EFUTURE - which additional requirements are to be met for two parallel front motors and how can they be implemented into a system safety concept."

Among other key innovations, the team implemented central decision units in such a way that motor controls are subject to redundancies in case of failures, based on the concept of "functional safety" - which means that any component or system must include the safe management of any likely operator errors, hardware failures or environmental changes.

The team were therefore able to demonstrate an electric prototype vehicle that is not only safe, but also more efficient. They have therefore achieved a potentially much longer range than most existing EVs, achieved 'virtually' through use of software alone.

Increasing the range - and attractiveness - of EVs

"We have therefore demonstrated the feasibility of creating a 'virtual range extender,' which has no hardware associated with it, by using new driver-assistance functions, founded on a lean architecture, while keeping a superior level of operational safety," Dr Scheuch explains.

Novel Advanced Driver Assistance Systems (ADASs) developed by the EFUTURE team include a green Autonomous Cruise Control system (Green ACC) that automatically adjusts vehicle speed depending on

traffic and road conditions while improving efficiency, and an "ECO mode" that coaches the driver to adopt driving habits that use less energy.

Less visible to drivers, but no less significant are other EFUTURE innovations such as an automatic Vehicle Observer sensor system to enhance safety, and a Torque Vectoring functionality that improves driving stability and comfort. Torque Vectoring also extends the Anti-Lock Braking' (ABS) and Electronic Stability Control (ESC) functions to normal driving, thereby extending the dynamic range of the vehicle.

"There are also functions not visible to the driver, such as the vehicle energy management system, and decision units that define trajectory and actuator control, which also contribute to the overall efficiency," Dr Scheuch says.

The project manager explains that one of the biggest challenges the team had to overcome was adapting a first-generation electric vehicle to meet the project requirements - exemplifying the problem of the use of legacy components based on systems used in conventional cars.

"To convert our architecture concept into hardware we substituted the core components with new ones: the vehicle control unit, the battery control unit, the battery and motors. Furthermore, we added a complete system for ADAS functionality (cameras and radar), and implemented an entirely new set of control software for all components. In short, we converted a very basic vehicle to a highly instrumented car full of innovative functions," Dr Scheuch says.

The prototype concepts and systems developed by the project partners, which includes the European Technical Centre of Tata Motors, are expected to find their way into future generation EVs.

"Many of the ideas of EFUTURE will be found in future products and services of the partners. The domain architecture of the vehicle controller, the algorithms, the Green ADAS functions, safety concepts and many more will be part of new research projects or are already part of new hardware products for future vehicles," the project manager says.

"The more innovative concepts for efficient driving exist, the higher the impact on the vehicle market in Europe, and EFUTURE is one part of it. Economically, we have shown a feasible way towards a higher EV range, thus enhancing consumers' acceptance of electrically driven cars - they will get more value for their money."

More information: cordis.europa.eu/projects/rcn/95487_en.html

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