PROJECT

HEMIS

Electrical powertrain HEalth Monitoring for Increased Safety of FEVs

Funding: European (7th RTD Framework Programme)

Duration: Jun 2012 - Feb 2015

Status: Complete with results

Total project cost: €2,924,470

EU contribution: €2,000,000

Call for proposal: FP7-2012-ICT-GC

CORDIS RCN : 104132

Background & policy context:

To achieve the aims of reducing energy consumption and CO2 emissions, Fully Electric Vehicle (FEV) needs to reach significant market shares. However, the advent of FEVs in mass production presents new challenges to automotive manufacturers due to the immaturity of the new building blocks, which can reduce FEV's safety and reliability. Among them, is the electric powertrain: i.e. electric traction motors and power electronics controller.

Another factor to be taken into account is electromagnetic interference due to the switching technology of power electronics. Furthermore, power electronics and the circulation of high currents from the battery to the motor will emit additional electromagnetic fields (EMF), including Low Frequency (LF) emissions not covered within the current automotive EMC standards.

Objectives:

The HEMIS project has two major objectives. The first one is to design a Prognostic Health Monitoring System (PHMS), which will sense key physical characteristics related to the health state of the powertrain and the emitted EMF. Based on this information, the PHMS will be able to provide a failsafe state, enhancing public's confidence on the safety and reliability of FEVs. PHMS will also predict the remaining useful life of the equipment, thus enabling enhanced maintenance and reduction of costs, due to acquired knowledge of failure mechanisms. The result of this multidisciplinary research will be a working prototype.

The second objective is to provide the manufactures of FEVs with design guidelines regarding EMC and the impact of EMF (including LF emissions) on human health. The research will also result in EMC/EMF testing guidelines for FEV manufacturers, which are expected to be incorporated as a part of emissions standards. Thus, HEMIS will help to counter fears amongst some sectors of the population about EMF exposure in FEVs.
With the proposed approach, HEMIS directly addresses the objective GC-ICT-2011.6.8 ICT for fully electric vehicles g).

Methodology:

Work Packages

WP1: Coordination and management
WP2: PHA and RAMS apportionment of the FEV
WP3: Identification of the causes of degradation of the motor and the control, and their consequences
WP4: Monitoring of the physical characteristics of the motor and control and prediction of their RUL
WP5: Analysis and measurement of EMC characteristics and health impact of EMF
WP6: Identification of hazard limits and design and implementation of on-board monitoring systems
WP7: Verification of the on-board monitoring systems for the fail safe transition

WP8: Dissemination and exploitation

WP1: Coordination and management
This work package deals with all the management aspects of the project and the monitoring of the progress towards the ultimate objectives, identifying shortcomings and recommending remedial action when necessary.

WP2: PHA and RAMS apportionment of the FEV
This work package is devoted to the definition of the architecture of a generic full electric vehicle. This allows undertaking the RAMS analysis of the vehicle and the RAMS apportionment, which in turn define the requirements of the powertrain and the HEMIS PHMS.

WP3: Identification of the causes of degradation of the motor and the control, and their consequences
This work package is responsible for defining the causes of degradation of the motor and the control, as well as the analysis of the effects and criticality of the different failure modes of these subsystems. A review of the available literature on the reliability of the electrical machine and its associated control was carried out in order to identify the nature, causes and prevalence of likely failure modes.

Deliverable D3.1 summarizes the failure modes of the powertrain and the analysis on their effect and criticality. In addition, their contribution to the hazards identified in WP2 is represented by means of Ishikawa diagrams. Possible methods for monitoring the health of the electrical machine and the control are also noted, as an input to WP4. The powertrain architecture is documented in deliverable D3.2.

WP4: Monitoring of the physical characteristics of the motor and control and prediction of their RUL
The aims of this work package are to identify which physical characteristics are most appropriate to monitor the performance of the powertrain and to define prognostic algorithms able to deal with the associated hybrid data in

Parent Programmes:

FP7-ICT - Information and Communication Technologies

Institute type: Public institution

Institute name: European Commission

Funding type: Public (EU)

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Asociacion Centro Tecnologico Ceit

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EU Contribution: €404,132

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Technologies:

Road vehicle design and manufacturing
Prognostic health monitoring system (PHMS)

Development phase: Research/Invention

Key Results:

So far the following objectives have been achieved

• A generic architecture for FEVs, representing the common features of electric vehicles has been defined. The architecture is focused on the electrical powertrain and takes account of vehicles that may purely battery powered or equipped with range extenders. Results have been compiled in the deliverable D2.1.
• The main hazards of the FEV for the driver and passengers have been identified, including hazards related to EMC issues within the vehicle. Every hazard has been classified using the ISO 26262 risk criteria. Results have been compiled in the deliverable D2.1.
• The RAMS analysis of the FEV which consists of a Fault Tree Analysis (FTA) and a Failure Mode, Effect and Criticality Analysis (FMECA) have been carried out concluding hazard mitigation techniques. Results are gathered in the deliverable D2.1.
• A representative mission profile has been identified, representing average physical and operational characteristics of the vehicle networks. Results have been compiled in the deliverable D2.1.
• The expression of the core hazard limit has been defined as a function of the functional elements reliability (the failure rate), and the characteristic of the monitoring system. The HEMIS project is broken down into eight work packages (WPs) that will lead to the completion of the ultimate goals of the project. Additionally, test cases of the monitoring system have been defined following the requirements of the ISO 26262. Results have been compiled in the deliverable D2.2.The failure modes of the powertrain defined in WP3 have been assessed in order to identify the most relevant ones considering their effect and frequency.
• Some physical characteristics have been preselected to monitor the heath of the powertrain. They will be assessed considering the accuracy and reliability of their measurement, as well as the cost of the sensors and the feasibility of their integration in a commercial powertrain.
• A literature study of the empirical and physical models of motor bearing degradation and electrolytic capacitors degradation has been performed. As a result of the investigation, it has been proposed to model the capacitor degradation process by using: i) the Arrhenius Law for the representation of the effect of the temperature on the capacitor lifetime, II) exponential laws for the representation of the effects of the capacitor degradation on the ESR and capacity measurements and iii) e

Documents:
D1.2.1First periodic Report - Publishable Summary (Final report)

STRIA Roadmaps: Transport electrification, Vehicle design and manufacturing

Transport mode: Road transport

Transport sectors: Passenger transport, Freight transport

Transport policies: Digitalisation, Safety/Security

Geo-spatial type: Other