OPTO-EMI-SENSE

An Optical Fibre Sensor Based Intelligent System for Monitoring and Control of Exhaust Emissions from Road Vehicles

Funding: European (6th RTD Framework Programme)
Duration: Jan 2004 - Dec 2006
Status: Complete with results
Total project cost: €2,450,783
EU contribution: €1,848,080

Call for proposal: FP6-2002-TRANSPORT-1
CORDIS RCN: 74000

Background & policy context:

The problem of pollution of the environment by road vehicles is well known to vehicle manufacturers and legislative bodies in Europe and the rest of the world. Successive legislations in Europe have required ongoing reductions in the levels of the pollutant gases NO, NO2, SO2, CO as well as hydrocarbons (HCs) and particulates in vehicle exhaust systems. Instrumentation and test procedures have been developed to measure these emissions, but these are currently conducted offline and at irregular intervals, e.g. once every one or two years.

The OPTO-EMI-SENSE project is concerned with monitoring these emissions online and therefore sensors have been developed that can be mounted on the vehicle to continuously monitor the emissions. Sensors for detecting these pollutants have not previously been available and a major part of the novelty of this project has been the development of all optical (optical fibre) sensors for the detection of the above pollutants to Euro IV concentration detection limits and below, as well as monitoring the hot gas temperature (up to 1000ºC) using optical fibre temperature sensors.

The use of novel and state-of-the-art sensing technology provides a promising solution to the problem of onboard monitoring of vehicle pollution, which will ultimately enable this pollution to be minimised and allow European car manufactures to deliver the objective of environmentally clean cars whilst maintaining a commercial advantage in a globally competitive market.

Objectives:

The main objective of OPTO-EMI-SENSE was to develop novel optical fibre-based sensors for monitoring vehicle exhaust emissions on board the vehicle with a view to controlling and reducing them.

The project's specific technical objectives are summarised as follows:

- to isolate and identify the optical signals arising from contaminants present in the complex mixtures of exhaust systems of a wide range of vehicles using advanced and novel optical fibre-based spectroscopic interrogation techniques;
- to measure optically the temperature of the gases in the vehicle's exhaust system;
- to develop novel optical fibre sensors that are miniature and robust in their construction and may be fitted and/or retro-fitted to the exhaust systems of a wide range of vehicles;
- to interface and fully integrate the novel sensor systems into the existing data network of the vehicle, thus providing the driver and/or the engine control system with clear and unambiguous in-car information on contaminant levels of exhaust emissions.

Methodology:

The project investigated novel optical fibre-based sensing techniques for addressing the problem of
environmental pollution in the surface transport area. Optical fibre sensors were used to measure the concentration of pollutant gases to a minimum level of about 10 ppm and temperatures up to 1000ºC in the exhaust of road vehicles. The methodologies employed for the respective measurement techniques are direct optical absorption (with spectral resolution) for the gas sensors and Fibre Bragg Gratings for the temperature sensors.

The use of optical methods for gas sensing means that the response time of the sensor is rapid in comparison to other techniques currently being investigated, which are typically in the order of one second. As the spectroscopic absorption characteristics of the gases in the exhaust system are unique, they are not susceptible to cross interference from each other and other gases when in mixture. The sensors could also be made robust and cheap by using low-cost mass produced components (e.g. LEDs and photodiodes).

Signal analysis of the parameters was performed using standard techniques (e.g. direct calculation of the concentration from the absorption data) and advanced techniques (e.g. pattern recognition of spectra in mixtures). These were mounted on a DSP or microcontroller and interfaced to the CANBUS of the car.

**Parent Programmes:**
- FP6-SUSTDEV-3 - Global Change and Ecosystems

**Institute type:** Public institution  
**Institute name:** European Commission  
**Funding type:** Public (EU)

**Lead Organisation:**

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| **Address:** University of Limerick  
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| **EU Contribution:** €0 |

**Partner Organisations:**

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EU Contribution: €0

Key Results:

Exhaustive research into optical sensors for exhaust gases led to the development of a fully integrated system for numerous pollutants. The system was based on the gas filter correlation (GFC) technique that minimises cross-sensitivity and the resulting interference common for multi-component gases.

The sensor detected nitric oxide and nitrogen dioxide (NO and NO2, respectively), carbon monoxide and dioxide (CO and CO2, respectively) and numerous hydrocarbons as well as exhaust gas temperature.

The OPTO-EMI-SENSE system was installed in the trunk of a test car specifically selected for its technical characteristics including a catalysed diesel particulate filter required for maintaining sensor integrity. The fully operational demonstrator produced results in excellent correspondence with those delivered by commercial instrumentation.

Readiness

The next phase of this work will be to develop commercial prototypes of the optical fibre sensors which are suitable for use by the automotive industry and satisfy the EU directives for On Board Measurement (OBM) and On Board Detection (OBD).

Documents:
- Publishable Technical Summary Report.pdf (Other project deliverable)

STRIA Roadmaps: Cooperative, connected and automated transport
Transport mode: Road transport
Transport sectors: Passenger transport, Freight transport
Transport policies: Environmental/Emissions aspects
Geo-spatial type: Other