Driving Monitoring System implementable in any means of transport

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La empresa AMBIMETRICS, con la colaboración del Instituto de Biomecánica (IBV), ha desarrollado un sistema de monitorización de la conducción adaptable a diferentes medios de transporte. Su objetivo es ampliar las prestaciones de los instrumentos y sistemas de AMBIMETRICS a través de un Equipo Móvil de Adquisición de Datos (EMAD) para monitorizar la conducción de vehículos ferroviarios y de transporte por carretera. Este proyecto supone, además de un avance en las herramientas y conocimientos de la empresa, la obtención de un producto nuevo, basado en tecnología GSM y sensores de movimiento, con múltiples capacidades. El dispositivo tiene la finalidad de ser usado, en primera instancia, con propósitos científicos, y ser el embrión de futuras aplicaciones comerciales que van desde el desarrollo de sistemas de ayuda a la explotación o gestión de flotas hasta servicios personalizados sobre la base del uso del vehículo o el control del tráfico rodado.

Introduction

The AMBIMETRICS, S.L. company, founded in 1993, and located in Castellón, is an expert in the development of computing applications, equipment, instrumentation and electronic cards for the remote measurement and control of processes and installations. Its core sphere of action is process automation in power stations, the remote control of civil work structures and water control.

AMBIMETRICS seeks to expand its sphere of work, leveraging its experience in sensor and communication technologies for their application to new areas. Through this project, the company intends to embark upon an evolution and an extension of its business, catering to a need which is similar to its ongoing projects and is also closer to the end user (drivers and passengers on any means of transport), which will afford its results a broader social dimension.

To this end, it had to create a new measuring, control and communication device, with considerable space and design constraints, subject to a highly variable dynamic and environmental context and capable of measuring driving control parameters. The development process enjoyed the backing of the Instituto de Biomecánica (IBV), experts in human factors and with an extensive track record in Automotion and Transport, which provided AMBIMETRICS with assessment in the research and definition of the prototype and its evaluation.

Hardware development

The project will run for two years, during which the development of two prototypes is envisaged (EMADv2011 and EMADv2012). The IBV was commissioned with defining the potential specifications for the device (functionality and on-board integration), according to the needs detected on the market and the restrictions established by the legislation, considering that the ultimate use of the device should permit a basic

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Ambimetrics, in collaboration with the Instituto de Biomecánica (IBV), has developed a driving monitoring system adaptable to different means of transport. The objective of this project was to expand the instruments and systems capabilities of Ambimetrics through the construction of a mobile data logger (EMAD) to monitor driver behaviour in railway and road vehicles. This project enabled the company to develop a new product, based on GSM technology and motion sensors, with multiple capabilities, while also constituting an advance in the company's tools and core knowledge. The device is intended to be used, in the short term, for scientific purposes, and will be used as the core for possible commercial applications, ranging from fleet management to customized services based on the use of vehicle or traffic, to be developed in a very near future.

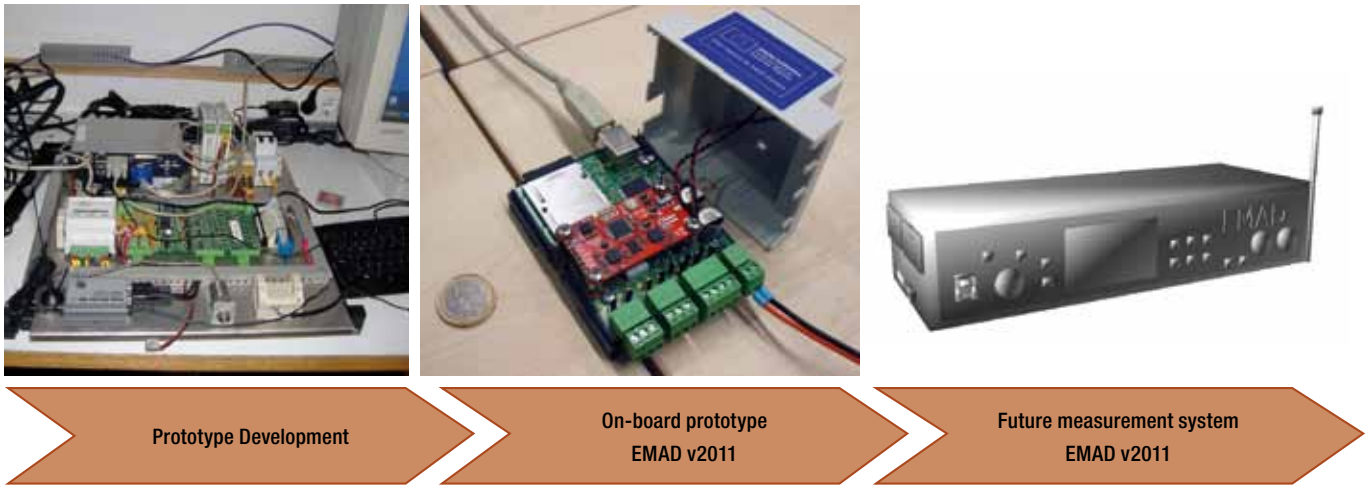

Figure 1. Prototypes developed during the project.

monitoring of driving behaviour, besides the environmental conditions that may affect vehicle conservation and maintenance.

Development began with a prototype that featured non-integrated modules to perform the operating tests and validate measurement (**Figure 1**). This prototype was used to define a more compact design to be installed on board vehicles for different tests (EMAD v2011).

Table 1. Characteristics of the EMAD v2011.

MEASURING CHARACTERISTICS:
Three-axis accelerometer (±2 g) for measuring movement. Three-axis accelerometer (±2 g) for measuring vibrations. 3-axis magnetometer for measuring the magnetic field. Calculation of pitch, yaw and roll compensated in inclination (0 ÷·360º). Broad range digital temperature sensor (-40 ÷ 123 ºC). Comprehensive range digital humidity sensor (0 ÷ 100 %RH). Five 10-bit analogue inputs for external sensors.
RECORDING CHARACTERISTICS:
SD/SDHC memory card slot. Data are recorded in independent daily files. Record based on changes in (configurable) sensor values. Real-time clock with a duration of up to 5 years.
CONNECTION CHARACTERISTICS:
USB 2.0 connection port. MSD/HID connection interface.
CONFIGURATION CHARACTERISTICS:
Configuration values are saved if there is no power. Configuration values of the measuring range in each one of the sensors. Constant of the variation percentage for recording by each sensor. Constant for noise filtering for recording by each sensor. Adjustable reading time for each sensor.
DIMENSIONS AND POWER SUPPLY:
Power supply: 12 Vdc, 150 mA (battery or external power). Dimensions: 7 x 9 x 6 cm.

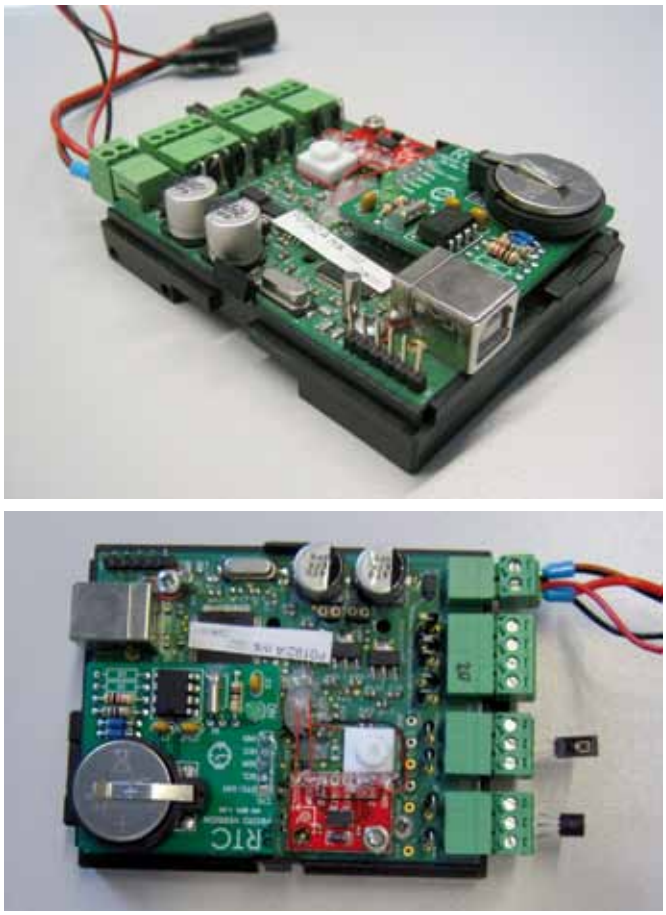

Figure 2. Views of the inside of the EMAD v2011.

The EMAD v2011 can measure accelerations, vibrations, temperature and humidity, as well as the signal issued by any analogue sensor that is connected to its external inputs once they have been prepared. It is comprised of a 32-bit microcontroller, an SD card socket, a USB connector, a real-time

clock/calendar, 5 external analogue inputs and the internal sensors: 2 sensors for measuring accelerations in 3 axes, a magnetic field sensor (magnetometer) and a temperature and humidity sensor.

Moreover, the device's database can be downloaded to an external storage device by USB or be transmitted it by GSM, and it also features software for configuration and monitoring.

Development of the software

The EMAD configuration application is an auxiliary tool that is used to configure and interact with the device through the USB 2.0 connection. This application makes it possible to modify the EMAD's configuration, as well as to create, save and transfer other configurations to it. Besides configuring the EMAD devices, the application is used to configure the internal clock and view channel values numerically or graphically.

The main screen (**Figure 3**) is used to access "Channel configuration", the "Configuration manager" and "Dynamic graphics", where a new screen is opened and can generate real-time graphics of the data received, displaying or concealing the required channels.

The measuring values are distributed by means of channels, permitting the independent configuration of its settings. The user can modify both channel and overall settings (**Figure 4**).

Summarising, the EMAD can be configured in different modes for recording data:

- Recording by change: the channels are recorded if there has been a change in their reading, according to the change constant and noise constant parameter configuration.
- Recording by reading: the channels are recorded whenever a reading is taken; the reading period is configurable.
- Recording by channels: in this recording mode every line recorded will contain the channels recorded separately.
- Constant recording: All the channels will be recorded at a constant reading time.

Figure 5 shows the potential display of the EMADv2011 application where the data of the additional GPS module and the

Figure 3. Picture of the main screen.

Figure 4. Channel configuration screen.

parameters recorded during driving are integrated. This application allows the user to select two display formats: view in Google Maps® of the route travelled, and the graphic view, which permits interaction with the data recorded (both positioning and acceleration and vibrations), selecting the

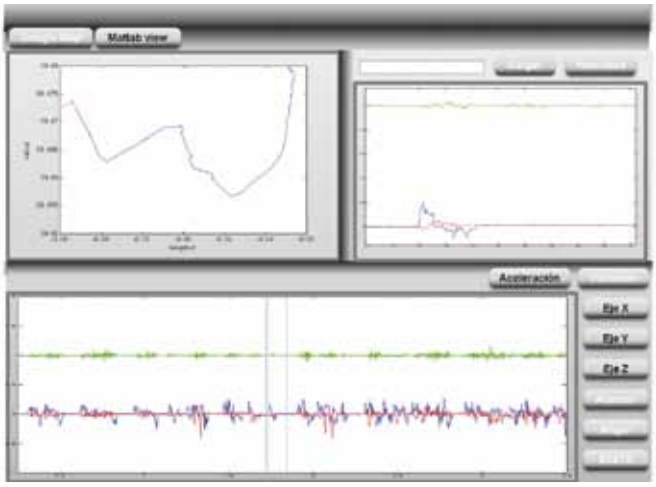

Figure 5. EMAD results exploitation screen.

> parameters to be viewed and doing zooms in the areas of interest. The main screen is divided into 4 zones:

- Main menu, which makes it possible to select view, import data, select the parameters to be viewed and obtain statistics.
- Graphic of the route: Located top left, it displays the route taken during data capture.
- Parameter graphic: Located at the bottom, it displays the parameters recorded by the EMAD during the route (accelerations and vibrations in the 3 axes). This graphic is interactive and zooms can be made for better display.
- Speed or detail graphic. Located top right, it displays, depending on the button selected, speeds during the route or a zoom of the area selected by the cursor in the parameter graphic.

This viewing format makes it possible to quickly identify and analyse areas where events such as abrupt manoeuvres have taken place, and characterise the type of driving.

Future development (EMAD v2012)

The new version of the device (EMADv2012) will extend its functionalities and facilities, incorporating GPRS/GSM communication, the GPS chip, data encryption, increase in sampling speed and storage capacity. This zoom will increase versatility and will allow it to operate autonomously for longer and also monitor device incidents in real time.

Applications

EMAD has been designed for scientific purposes, and at the same time acts as a point of departure for possible commercial applications to be developed in the short term (operation support systems, fleet management) and in the medium-term (personalised services based on the use of the vehicle, traffic control, etc.).

The EMAD is currently being used by the IBV in studies to evaluate driver response in real vehicles; for example, observing how the design of the controls or the information systems affects drivers while handling the vehicle.

The monitoring of driving quality is an application with great interest for R&D in the transport industry. In that sense, the EMAD makes it possible to monitor, with a high level of detail, vehicle driving, providing information that can help to improve new services emerging, such as "Pay as you drive", where the vehicle or insured driver is credited or charged depending on distances travelled, consumption, intensity of use, driving style, as well as to keep the vehicle in good condition and improve its maintenance.

The flexibility and customised configuration of the EMAD and the way it uses the results will permit a broad range of possibilities ranging from its use in measuring driving quality in public passenger transport (on-board driving assistant) or as a complement in burgeoning services such as car sharing. ●

Acknowledgements

Project funded by the IMPIVA through the Technological Research and Development Program 2010-2011. Co-funded by the ERDF Funds, within the ERDF operating programme of the Autonomous Community of Valencia 2007-2013.