

Artificial vision, real results

Spanish research in automatic inspection systems is paving the way for the roads of tomorrow, as **José Papí** and **Marta Esteban** explain

The new European Directive 2008/96/EC on road infrastructure safety management has laid down the guidelines for conducting systematic safety impact assessments, audits and inspections for road planning, design, construction and operation. Advancing towards an effective implementation of this European piece of legislation is a must if we want to secure a substantial reduction in road victims and fatalities in the years to come.

Automatic inspection systems are one of the priorities highlighted in the Spanish Road Research Strategic Agenda 2011-2025, which has defined a detailed 15-year implementation plan for 116 priority R&D actions of relevance to the road infrastructure sector. Three Spanish organisations have developed innovative systems that bring automated road inspection systems into reality and contribute to the enforcement of the aforementioned European Directive. DBI/Cidaut Technologies, LLC have developed AMAC, VISUALISE is the work of Euroconsult while the University of Vigo's Close Range Remote Sensing and Photogrammetry Group are the brains behind SITEGI.

This article examines each system and what they bring the Spanish innovative transport "table".

AMAC (ADVANCED MOBILE ASSET COLLECTION)

AMAC is a mobile system that measures the visibility and legibility of vertical traffic signs. A multidisciplinary team of engineers, physicists, psychologists and statisticians working at the CIDAUT Foundation in Valladolid, one of Spain's leading technology centres, has developed, together with DBI Services (US), a road asset management company, an innovative system able to measure the visibility of traffic signs from the driver perspective, which:

- 1) Secures traffic signs provide the minimum performance levels required,
- 2) Optimises their operation, and
- 3) Decreases their maintenance costs.

Integrating advanced lighting and artificial vision techniques in an instrumented vehicle, AMAC assesses the present performance and usefulness of installed traffic signs and overhead structures – as its

AMAC measures visibility and legibility of vertical traffic signs from the driver's perspective using innovative machine vision techniques

visual system perceives signs in the range as the human eye. The result of this has been a 100 per cent automatic system for the detection, positioning and performance measurement of installed vertical road signs, which at the same time provides an integral inventory of traffic signs.

According to its developers, AMAC provides the following information:



“Three Spanish organisations have developed innovative systems that bring automated road inspection into reality and contribute to the enforcement of the European Directive”

- Retroreflectivity and luminance levels of background and legend of post-mounted and overhead signs, regardless of their colour.
- Sign size, height and distance to carriageway edge.
- Traffic sign inventory with GPS positional data.
- Traffic sign national catalogue code as well as traffic sign colour picture.
- Fully customizable reporting capable of being integrated into existing databases, compatible with all GIS, CAD and online mapping applications.



VISUALISE automatically assesses road signs and panels



The system comprises a mobile system for image and data collection, a software for sign detection and calculation of sign performance, and a data management system.

The lighting control is essential to achieve reliable and solid measurements. The lighting technique used in AMAC allows controlling the light emitted, at any particular time, by isolating external disruptions. Mobile data collection is performed during night time, at highway speed and with no need for lane closing, measuring traffic signs in up to three lanes.

Once measurements have been taken, the operator can input the desired thresholds for classifying the inspected signs according to their adequate visibility and legibility to the young, the adult or the elderly population.

AMAC validation

AMAC was tested in August 2011 by the Texas Transportation Institute in the US. A set of different blind tests was performed and the results showed that AMAC was at least as accurate as a hand-held retroreflectometer and its repeatability was higher – as it takes continuous instead of individual measurements. According to José Miguel Perandones, AMAC Marketing Director at CIDAUT/DBI Technologies, “AMAC is the most cost-effective approach for traffic signs’ maintenance”.

The AMAC technology has been

recently presented both at TRB 91st 2012 Annual Meeting and at the ATSSA 41st Annual Convention & Traffic Expo in the US, and will be demonstrated at Intertraffic 2012 in Amsterdam at the end of March 2012.

VISUALISE (AUTOMATIC ASSESSMENT OF ROAD SIGNS AND PANELS)

EUROCONSULT, an engineering consulting firm located in Madrid, and the University of Alcalá de Henares (Madrid), are behind the development of VISUALISE, an intelligent system for the automatic assessment of the night-time visibility of road signs and panels.

The system can measure retroreflection from signs at normal vehicle speeds, and at the same time can take inventories of signs with X, Y and Z co-ordinates.

The difference with the system

described previously is that VISUALISE uses infrared light to obtain the retro-reflection of a given sign through radiance measurements. The transformation of radiance into retro-reflection is based on the best approach to a pattern of retro-reflecting material of a sheet 3M® according to the distance and with independence of the irradiance on the sign. This system supposes that, at a 100 meters distance from the sign, the scene is exactly equal to the geometry of laboratory test norm described, being the road configuration irrelevant.

A device for automatic data acquisition from traffic signs and panels, VISUALISE equips a vehicle with a pulsed infrared illumination system, a system of stereoscopic cameras, a GPS, an odometer, a computer mounted on an industrial rack, a data storage system, an event keyboard, and a TFT monitor for viewing results. The infrared illumination system is synchronised with the cameras. This way the infrared illuminator illuminates the road area in alternate images, thereby providing illuminated and non-illuminated pictures.

The key technological innovation of this equipment is that data is acquired dynamically. The system is mounted on a vehicle that travels on roads at normal speed. Valid data can be obtained by vehicles travelling at up to 120 km/h. >>>

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The measuring system used by VISUALISE is based on image analysis: as the vehicle travels along the road it takes wide-screen pictures with a system of high-resolution stereoscopic digital cameras. As pictures are taken, an infrared lighting system cuts in to improve results. Leonardo Benatov, CEO at EUROCONSULT, highlights that “the processing software of the system analyses the images, and the results can be brought up on a display unit so that the information obtained can be immediately put to use”.

The system’s developers state that the system gathers the following information on vertical signs:

- Retroreflection curve according to distance.
- Wide-screen images showing the position of road signs.
- Precise distance between signs.
- GPS co-ordinates of sign positions.
- Sign geometries (rectangular, circular or triangular).
- Detailed images of the sign being checked.

Main advantages

- Faster measurement, enabling checks to be run more frequently and longer stretches of road to be checked.
- Data organised into a database for an easier distribution and analysis.
- Improvements to road safety management: having information on the whole road network enables overall network-wide safety strategies to be drawn up.
- Availability of processed information as soon as the analysis is completed: this shortens time between the detection and the correction of the anomalies identified.

SITEGI (MOBILE SURVEYING OF ROAD INFRASTRUCTURES)

The Close Range Remote Sensing and Photogrammetry Group of the University of Vigo have been developing SITEGI since 2010, a project related to the application of mobile surveying



SITEGI is a mobile road infrastructure surveying system developed by the University of Vigo

- Scan productivity: 200 km/day
- Results compatible with AutoCAD, Microstation, ArcGIS, gvSIG, Quantum GIS,...

The next steps planned by SITEGI’s research team include the application of image and point cloud processing methodologies for the automation of the inspection process.

In fact, Pedro Arias, Director of the Close Range Remote Sensing and Photogrammetry Group of the University of Vigo, is of the opinion that “the application of this technology is a suitable option to improve road inspection works and make them more reliable, accurate and productive”. 📍

technologies for the operation and inspection of linear and road infrastructures.

The University collaborates on this project with companies from the Spanish Galician region such as Insitu Ingeniería, Extraco, Misturas, Enmacosa and Lógica Equipamientos Integrales.

The mobile inspection unit integrates navigation technologies (GNSS, INS and DMI), two LiDAR, four RGB cameras, one thermal camera and two optical profilers for the evaluation of IRI (International Roughness Index) and MPD (Mobile Profile Depth). All the sensing units are installed in the vehicle. The system provides geo-referenced images and point clouds which are extremely useful in road inventories and inspections.

Main advantages

- Repeatability: 7 mm
- Accuracy: 2 cm
- Scanning range: 200 m
- Scan frequency: 1 MHz

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