National Development Plan 2007 - 2013

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

STRIVE

Report Series No.25

Innovative Data Capture and Presentation Techniques in Support of the EU Environmental Noise Directive

STRIVE

Environmental Protection
Agency Programme

2007-2013

Strategy for Science, Technology and Innovation

Comhshaol, Oidhreacht agus Rialtas Áitiúil
Environment, Heritage and Local Government

Environmental Protection Agency

The Environmental Protection Agency (EPA) is a statutory body responsible for protecting the environment in Ireland. We regulate and police activities that might otherwise cause pollution. We ensure there is solid information on environmental trends so that necessary actions are taken. Our priorities are protecting the Irish environment and ensuring that development is sustainable.

The EPA is an independent public body established in July 1993 under the Environmental Protection Agency Act, 1992. Its sponsor in Government is the Department of the Environment, Heritage and Local Government.

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EPA STRIVE Programme 2007-2013

Innovative Data Capture and Presentation Techniques in Support of the EU Environmental Noise Directive

(2005-UE-MS-44)

STRIVE Report

Prepared for the Environmental Protection Agency

by

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and the
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DISCLAIMER

The EPA STRIVE Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment

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Executive Summary

The Environmental Protection Agency of Ireland (EPA) funded from 2006 to 2007 a research project to develop methodologies to meet data-related challenges arising under the European Union (EU) Environmental Noise Directive (END) (2002/49/EC) for Ireland. The research project sought to assess the role of advanced ground-based spatial video and also aerial digital photography in the creation of data required for suitably accurate noise modelling in road environments..

These imagery sources can be processed and features recorded from the imagery, with these features in turn being used in environmental traffic noise models. The project undertook surveys using these spatial video and airborne imagery technologies to provide a plan and oblique view of the road environment, thereby facilitating a more complete characterisation of elements of the road environment that have an impact on noise propagation and attenuation.

Various features – including natural and artificial embankments and cuttings, buildings, road surfaces, along with vehicle numbers, type and driving speeds – all combine to affect how traffic-related noise is generated and propagated. Two essential pieces of information are needed in order to categorise these noise-related features: (i) the geometry (position, height, length) of these route-corridor features together with (ii) attribution describing the nature of the features (e.g. sound barrier, brick wall, grass embankment). Arising from the research partner's ongoing work in developing these spatial imagery technologies, it became apparent that these technologies had potential application in supporting the collection of the above data to support noise modelling of the road environment.

Custom software allowed a team of processors to view the spatial imagery and extract features describing the road environment (such as embankments, walls and noise barriers, bridges, and buildings); the software was also used to record the objects' plan position and height. The data generated was used as an input to noise-modelling software.

A pilot noise-modelling exercise served to refine the features captured by the project team and led to fine-tuned processes for additional data capture and noise modelling. The data was actively used in the modelling of road noise by the National Roads Authority (NRA) while a separate follow-on project gathered additional data using the project techniques, supporting the NRA across the majority of routes required to be modelled under the Directive. This noise-modelling and mapping exercise conducted by the NRA was part of the first round of strategic noise mapping under the Environmental Noise Directive and required to be completed by 30 June 2007.

The techniques as developed through this project have proven their value in providing selected data requirements for noise modelling. In particular, the role of spatial video has been shown to be of value, supported by aerial imagery where existing mapping is not suitable and where additional plan-view verification of features is required.

Related research by the project partners continues the development of the project technologies and other advanced sensor technologies. The development and fusion of these technologies continues to offer real opportunities in assisting data collection to support the more extensive noise mapping required under further rounds of the Environmental Noise Directive.

1. Introduction

1.1 Overview

The Environmental Protection Agency of Ireland (EPA) funded a research project to develop methodologies to meet data-related challenges arising under the EU Environmental Noise Directive (END) (2002/49/EC) for Ireland. The research project sought to assess the role of advanced ground and air-based spatial video and photography in the creation of data required for suitably accurate noise modelling in road environments. Such data gaps had previously been identified in a study undertaken for the National Roads Authority (NRA), a key organisation in Ireland's fulfilment of it requirements under the Directive. The techniques as developed through this project have proven their value in providing selected data requirements for noise modelling: the data was actively used in the modelling of noise in the road environment by the NRA and a separate follow-on project gathering additional data using the project techniques, supported the NRA across the majority of routes required to be modelled under the Directive. In addition the methods developed are applicable in other environments and other applications – including transportation- and utilities-infrastructure assessment and mapping, and water- and natural-environment monitoring and management.

The project team consisted of an end-user (the National Roads Authority [NRA], liaising with other relevant urban local authorities); a private sector company (Compass Informatics Ltd); and a third-level research body (the National Centre for Geocomputation [NCG], National University of Ireland, Maynooth).

1.2 Background

1.2.1 Environmental Noise Directive

Further to the European Commission's proposal for a Directive relating to the assessment and management of environmental noise (COM(2000)468), the European Parliament and Council adopted Directive 2002/49/EC of 25 June 2002 (the Environmental Noise Directive). The Directive's main aim is to provide a common basis for tackling the noise problem across the European Union (EU). Its underlying principles are similar to those for other overarching environment policy directives (http://ec.europa.eu/environment/noise/directive.htm):

- Monitoring the environmental problem, by requiring competent authorities in Member States to draw up 'strategic noise maps' for major roads, railways, airports and agglomerations, using harmonised noise indicators L^{den} (day-evening-night equivalent level) and L^{night} (night equivalent level). These maps will be used to assess the number of people annoyed and sleep-disturbed respectively throughout Europe.

- Informing and consulting the public about noise exposure, its effects, and the measures considered to address noise, in line with the principles of the Aarhus Convention (United Nations Economic Commission for Europe, 1998).

- Addressing local noise issues by requiring competent authorities to draw up action plans to reduce noise where necessary and maintain environmental noise quality where it is good. The Directive does not set any limit value, nor does it prescribe the measures to be used in the action plans, which remain at the discretion of the competent authorities.

- Developing a long-term EU strategy, which includes objectives to reduce the number of people affected by noise in the longer term, and provides a framework for developing existing Community policy on noise reduction from source.

1.2.2 Scoping Study

In spring 2005, the lead project partners, Compass Informatics Ltd, undertook a scoping study for the NRA to assess possible approaches to noise modelling under the Environmental Noise Directive. The study looked particularly at the data requirements for noise modelling, and possible data sources to meet those required inputs. In undertaking this work, the study viewed recent and ongoing studies being undertaken at European level. It also assessed other requirements, including dissemination and reporting obligations, and outlined selected issues and approaches in this regard.

The scoping study highlighted the noise-modelling requirement for good-quality data on the immediate road environment and also the surrounding corridor. Features noted for accurate mapping and attribution included the road carriageway, medians, side embankments, noise barriers and walls, bridges, overpasses and cuttings, and land surface topography and type. Building heights, aspects, and use were also of great importance in both the noise-modelling exercise and the assessment of population exposure.

Possible data sources identified included Ordnance Survey (OSi) large-scale mapping, road-design drawings, road and traffic surveys, and existing aerial photography. However, all these sources have associated difficulties including cost, difficulty in sourcing and compatibility, problems with resolution, little if any detail on side surfaces, and risk of out-of-date data. It became apparent through the study that there was a significant gap in data and data-capture services that provide current, accurate, and high-value contextual data in a relatively affordable manner. It is this gap that the project's ground-based spatial video sought to fill, complemented by the high-resolution aerial digital imagery.

1.2.3 European Research Projects

A series of inter-related projects and work groups have considered various noise modelling and Environmental Noise Directive related issues at the European level, with a number of these projects running concurrently with this research project. Among these were the Harmonoise (www.harmonoise.org) and Imagine (www.imagine-project.org) projects. These activities considered noise-modelling approaches and data inputs and have led to more consistent approaches to noise modelling. The Working Group Assessment of the Exposure to Noise (WG-AEN) issued various versions of the *Good Practice Guide for Strategic Noise Mapping* (http://ec.europa.eu/environment/noise/mapping.htm). These guides recommend stop-gap methods for data substitutes where accurate data does not exist.

1.2.4 Digital Mapping of Route Corridors for Noise Modelling

Route corridor mapping that uses onboard vehicle acquisition systems is a relatively new technology. These systems are typically used to measure and store information about roadside objects, such as street furniture and building infrastructure. The features generally extracted are those that are within a 50-m range of the vehicle and are less than 5 m in height. It is these features that have a significant impact on traffic noise propagation.

Airborne image mapping systems generally operate at 500 m to 1500 m above ground level (AGL) and collect relatively wide swaths of imagery which are then geo-rectified or ortho-rectified for use within a digital-mapping system.

Varieties of both these systems have been designed by the project partners, Compass Informatics and Dr Tim McCarthy of the National Centre for Geocomputation (NCG), and are used operationally in Ireland and abroad.

Various inputs are required in order to build up a robust and consistent record of noise along a route corridor. Typically, the affected route corridor extends along the length of the road and has a cross sectional footprint of 100 m on either side of the road centre line. Various features – including natural and artificial embankments and cuttings, buildings, road surfaces, along with vehicle numbers, type and driving speeds – all combine to affect how traffic-related noise is generated and propagated. Two essential pieces of information are needed in order to categorise these noise-related features: (i) the geometry (position, height, length) of these route-corridor features together with (ii) attributions describing the nature of the features (e.g. sound barrier, brick wall, grass embankment). Arising from the research partner's ongoing work in developing these technologies, it became apparent that these technologies had potential application in supporting the collection of the above data to support noise modelling of the road environment.

1.2.5 Proposal Inception

Arising from the scoping study and the growing awareness of the requirements for appropriate noise modelling in the road environment, alongside the technical feasibility offered by existing systems, a project proposal was presented to the EPA with the NRA as industry partners. The project was awarded funding in February 2006.

1.3 Objectives

The project had a series of objectives:

1 Ground spatial video: To evaluate and enhance the role of ground-based spatial video for data capture of features critical to accurate noise modelling and mapping. Features would include roadside embankments, barrier walls, bridges, and cuttings, and natural topography, while attributes to record for features would include height and position, and surface type/roughness.

2 Aerial imagery: To evaluate and enhance the role of aerial video and photography for data capture of features critical to accurate noise modelling and mapping. Features would include roadside embankments, barrier walls, bridges, and cuttings, and natural topography, while attributes to capture will include plan position, and surface type/roughness.The combination of both aerial- and ground-based imagery would provide both plan and oblique views of features, thereby allowing the recording of features and attributes otherwise particularly difficult to capture from other data sources but of great importance in noise mapping.

3 Support a noise-mapping exercise to be undertaken by the NRA using the innovative data sources to be provided by the project. The NRA would provide

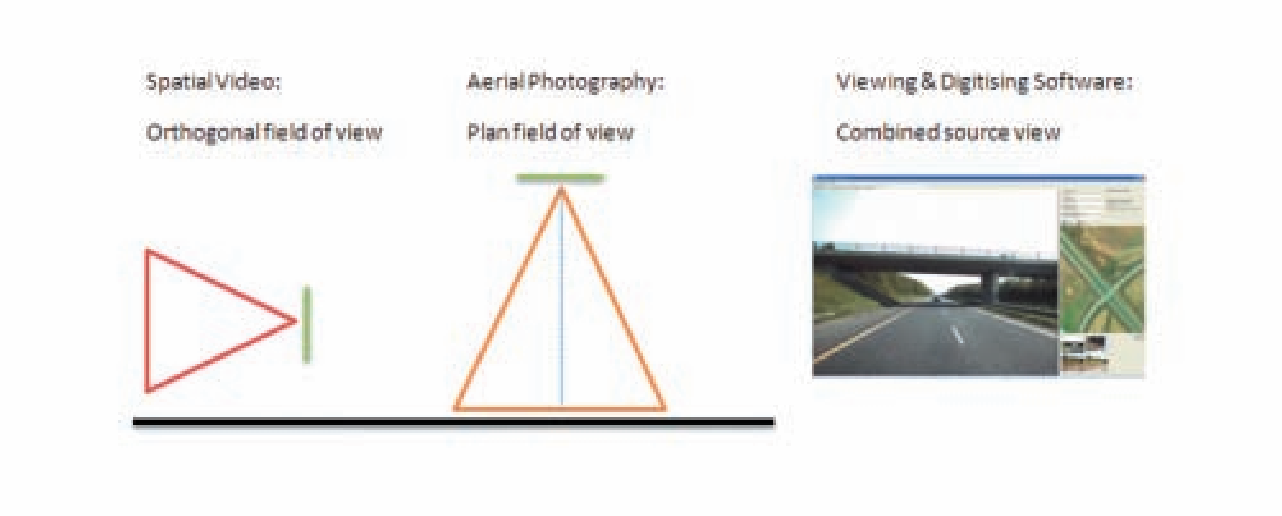

Figure 1: Combined plan and orthogonal view of the road environment from ground-based video and aerial imagery.

support in the form of noise-modelling expertise and effort, noise-modelling software, and other data sources including OSi and NRA traffic data. This noise-modelling and mapping exercise would be part of the first round of strategic noise mapping under the END required to be completed by 30 June 2007.

4 Develop and demonstrate techniques to integrate and present noise mapping and spatial imagery to the public and professionals alike via a Web platform. This task was progressed through technical investigations and prototype systems but ultimately this objective was superseded by the development of the EPA Envision mapping system (http://maps.epa.ie/). In addition, the greater value to the industry partner of focusing on the spatial video element became apparent and this project element was downgraded in consultation with the NRA.

5 Transfer knowledge of the project achievements to other noise-modelling and mapping agencies in Ireland, and inform the key European noise-modelling projects including IMAGINE (www.imagine-project.org) and the WG-AEN group. In this regard, the project attended and presented at a major European conference, Euro-Noise 2006, held in June 2006 in Tampere, Finland, and presented to national noise-mapping working groups (see Appendix 1). Papers on the technologies have also been presented at a range of conferences.

2. Technology Overview

2.1 Introduction

The project sought to utilise two advanced spatial imagery technologies – ground-based spatial video and high-resolution digital aerial photography - in order to facilitate the creation of appropriate data about the road environment. The project team has existing systems operating in this regard – an aerial high-resolution digital imagery system, and a vehicle-based spatial video system. The project investigated both systems and utilised the imagery captured through the project to create the required data for noise modelling. The following sections provide an overview of the technologies employed.

2.2 Aerial Camera System

The aerial camera system jointly developed over recent years by Compass Informatics and the NCG, NUIM, is termed the Compact Airborne Image Mapping System (CAIMS) (McCarthy, 2007a). The system (see Figure 2), comprises a 12.8 megapixel Canon EOS 5D digital camera capable of acquiring images of 4368 x 2912 pixels in size (Canon, 2005) connected to a General Dynamics XR-1 ruggedised laptop. This laptop is ideally suited to a mobile-mapping environment where equipment is subject to vibration and temperature change as well as to continual movement in and out of the aircraft (General Dynamics, 2007). Data-acquisition software was written based on Canon's software development kit to acquire and store images (Canon, 2007). This software is capable of controlling image capture based on current aircraft position along a flight survey line or based on a fixed time interval. A maximum, sustained image capture rate of 1 frame per 2 seconds is possible with the current system, which is a significant improvement on previous systems.

A global positioning system (GPS) is also connected to the laptop. This allows a GPS position to be logged at the time of image capture. These data are logged in a separate file. The GPS is also encoded onto live video

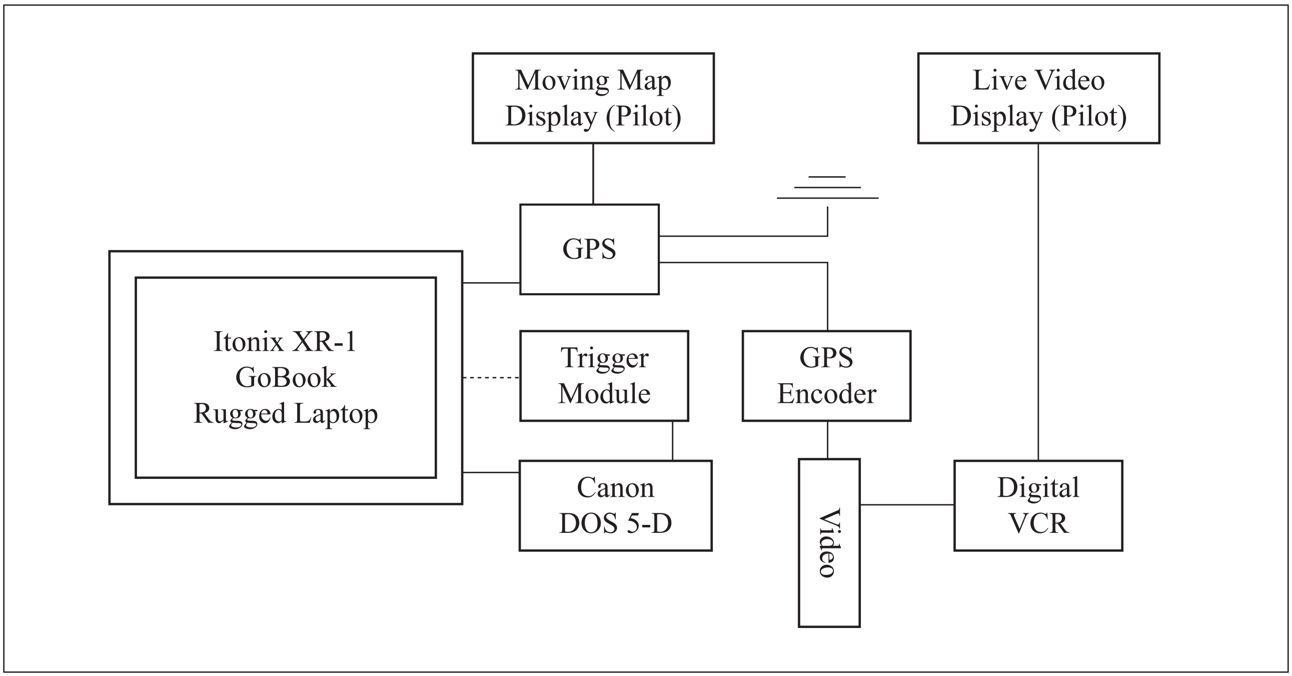

Figure 2: Schematic of CAIMS aerial camera data acquisition system.

stream and logged onto a digital video recorder (VCR). The current GPS position and planned course are available on a yoke-mounted Garmin 96 (Garmin, 2007) display which has basic moving map capability. This is used to fly pre-planned routes as a series of way-points. The live video feed is displayed on a co-mounted monitor display. This enables the pilot to track linear features, such as rivers and roads that may not be depicted in any great detail on conventional maps because of poor map revision.

Software modules (see Figure 3) are available for planning surveys, controlling acquisition and formatting data for downstream data processing. Canon's software development kit (RC V8.4 SDK) is used to acquire and store images (Canon, 2007) and ESRI MapObjects 2.1 (ESRI, 2007) is used for all spatial data handling.

The flight planning module allows the user to choose to plan either (i) a block or (ii) a linear feature survey. The former applies to features such as forest stands, agricultural fields and municipal buildings (i.e. features with areal extents). The latter applies to roads, rivers, coast-lines – features that are linear in nature.

A polygon tool is available for block-survey planning and a simple line tool for linear survey planning such as the road corridor survey. The user first traces the extent of the feature on the map display, and enters the planned flying height, focal length and amount of along-track and across-track overlap needed. A preferred flight line orientation can be chosen for block flying. A 24-mm lens is typically used giving a survey swath width of roughly 1.4 times the flying height AGL. Flight lines and associated camera trigger points are automatically calculated. These coordinates are then available for uploading into the tracking GPS.

The data-acquisition module allows the position of the aircraft to be plotted on a moving map during survey. Any planned survey can be loaded and the operator can choose whether he or she acquires images based on calculated trigger points from survey planning or from

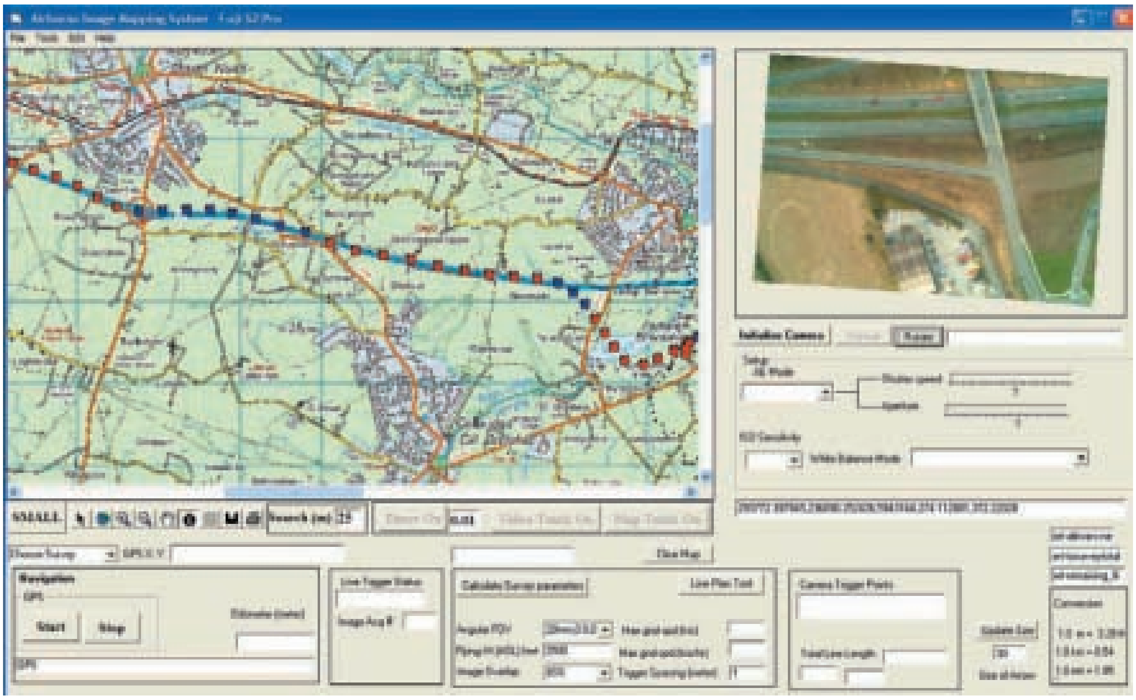

Figure 3: CAIMS software comprising survey planning, data acquisition and pre-processing modules.

a pre-set, fixed time interval. The operator can set, for example, a tolerance of 50 m so that an image is acquired only if the aircraft comes to within 50 m of the intended trigger point. In addition, a fixed time interval can be used if the base map data are unsuitable and the pilot is tracking features using live video display. The GPS position is logged continuously against system time and images are tagged with system time at the moment of capture. The aircraft's track is plotted on the moving map display, which can be cleared at any point to reduce clutter (McCarthy, 2007a).

2.3 Spatial Video System

Project team member, Dr Tim McCarthy (now based at NCG) has been involved in designing spatial video systems for a numbers of years (McCarthy, 2007b) and has designed the RouteMapper UltraX system (RouteMapper, 2007). The underlying objective for RouteMapper UltraX was to design a fit-for-purpose mobile-mapping solution that could be easily replicated and transported for mobile mapping. Installation, calibration, operation and support had also to be relatively straightforward, allowing this to be a one-person operation.

The RouteMapper UltraX stereoscopic mapping system as utilised in the project comprises four progressive scan cameras (1392 x 1024 pixel arrays). These are connected to a dual Xcon 3.6 MHz datalogging computer via CameraLink. Synchronisation and triggering functions are provided using an industry standard module including a high-speed GPS timing unit. Standard real-time, corrected dGPS (differential correction GPS) is used as a primary navigation module while various configurations of sensors can be used for secondary navigation, depending on the operating environment – including optical distance measurement instruments through to full inertial measurement units (see Figure 4).

Camera calibration is carried out each time cameras are moved, with this calibration designed to be carried out in the field. In undertaking camera calibration a number of three-dimensional control points are set out directly in front

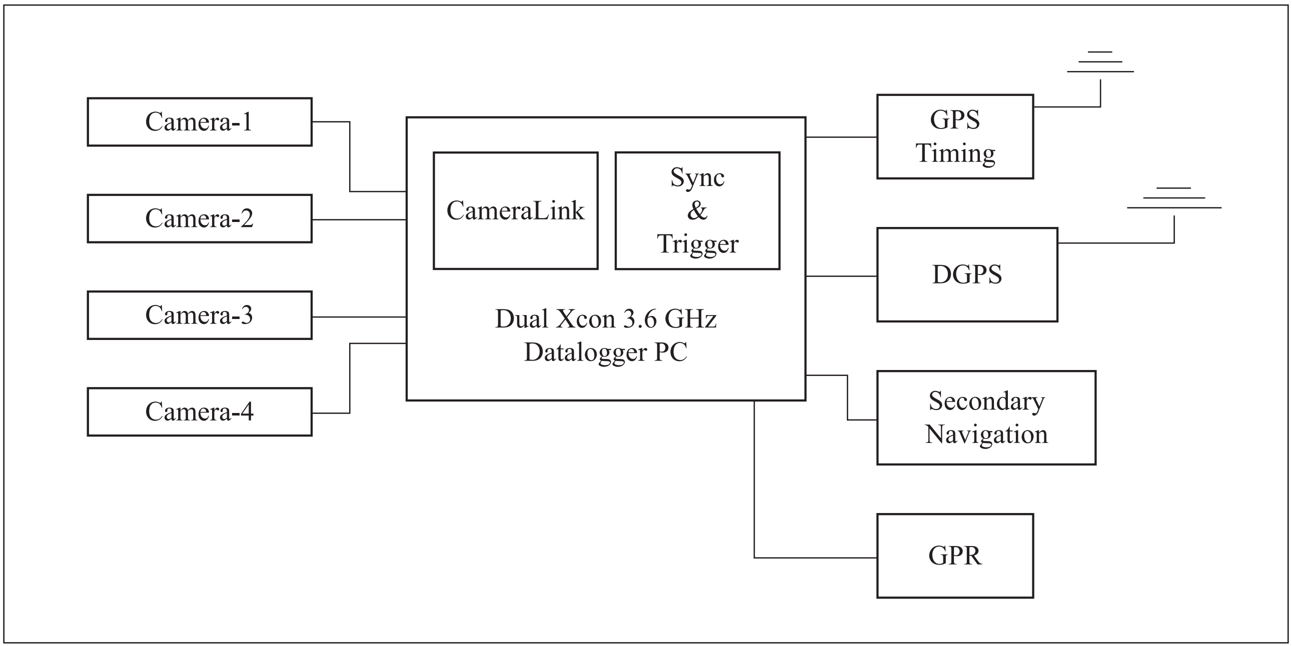

Figure 4: Schematic of spatial video data acquisition system.

of the cameras, usually extending out to about 50 m range and 7 m in height. The resulting transformation handles camera model as well as exterior orientation with respect to a datum point on the survey van. This enables three-dimensional measurement to be carried out, using the dGPS antenna as the local datum point. All stereoscopic three-dimensional measurements are calculated with respect to this datum point. A secondary transformation is carried out to rotate this vector into local map grid coordinates. All measurements are usually carried out in the same plane as the survey van. Platform orientation, using an inertial measurement unit (IMU) is required for out-of-plane measurements. If there are two pairs of stereo, then two sets of calibration are performed.

The system is powered-up at the start of survey. Self-checks are carried out ensuring correct camera initialisation, adequate navigation operation and sufficient disk space. The progressive scan cameras are fitted with auto iris-lens enabling sections of route corridor to be surveyed under varying illuminations.

The present system handles four cameras but has the ability to handle more using a simple client-server architecture. These cameras are positioned and orientated on top of the survey van depending on mapping requirements. The frame capture rate also depends largely on mapping requirements and associated vehicle speed. Typical capture rates vary between 3 and 8 frames per second. Over 1.2 kW of power is provided using split chargers, deep cycle batteries and sine wave inverters. A stable power supply is one of the key ingredients to successful day-to-day operation of these systems (see Figure 5).

The navigation, timing and image datasets are processed after survey. The prime function is to ensure that the correct navigation record is assigned to the correct image set. Secondary navigation is back interpolated where the primary source has failed. Additional sensor data such as ground probing radar (GPR) can also be integrated – GPR is used for investigating ground conditions. The sampling rate can be set to match any sensor using standard interpolation techniques. The final step of data processing is to produce metadata for all survey datasets. This enables a large number of surveys to be rapidly accessed by the browser in a structured fashion.

The browser software comprises image, map and database displays together with associated toolbars and drop-down menus (see Figure 6). This allows the user to navigate through the recorded data using interactive image controls or via the mapping interface. The user can click *Play* and view all four cameras while position of survey van updates dynamically in a moving map display. Three-dimensional in-frame measurements can be carried out, recording both dimensional as well as positional information. This together with any additional attribute can be stored in the survey database. Standard GIS functionality is available including spatial and aspatial data query. The browser is lightweight and designed so that users can learn basic functions in a very short time. Presently, three-dimensional line measurements require four separate mouse clicks. This is a task that could be more efficient with automated pattern matching.

Additional modules have been developed to enable specialist asset register construction. A wider audience can access this data over a recently developed, easy-to-use Internet browser plug-in. This can be particularly useful if an organisation comprises many departments such as road planning, maintenance and operations. The project assessed this browser and discussed its use with project partner the NRA. However, the desk-based browsing software for imagery viewing, and the EPA’s Envision web mapping system were deemed to suffice.

Figure 5: Roof mounted video camera; Driver guidance system; Operator monitoring system.

Figure 6: Browser depicting imagery and map displays.

3. Methodology

3.1 Survey Routes

In consultation with the NRA, a selection of the primary road network was selected for survey. The route selection formed an approximate triangle travelling from Dublin to Galway along the N/M6, and from Limerick back to Dublin along the N/M7. This route provided a selection of suitable test environments, including a mix of villages, rural towns, major urban environments, combined with efficiency in survey operation. This also included the Limerick area where the NRA was undertaking a pilot noise-modelling exercise. Spatial video imagery was not recorded for all open countryside but rather focused on built-up areas where populations impacted by road noise would occur. Aerial imagery was captured for longer route segments, including open countryside.

3.2 Spatial Video Imagery Capture

The project engaged IBI (www.ibigroup.com) to undertake a spatial video survey on behalf of the project and along the specified survey routes. This survey was undertaken in May 2006 using the specialist video technology and an equipped survey vehicle as detailed above. The spatial video imagery then went through a post process to check the imagery and allow the viewing of imagery pairs within the imagery-viewing and feature-extraction software.

3.3 Feature Extraction

In tandem with the survey, an advanced and customised version of the associated spatial video software – RouteMapper Ultra (www.routemapper.net) – was created in association with the project partners (see Figure 7). This software allows both the viewing of video imagery from the four video cameras (two pairs) and the in-frame digitising of visible features. The digitised features are saved to a geographical information system (GIS) shapefile format with position (x, y) and height recorded for each vertex of each object (see Figure 8).

The following were the categories of features extracted:

- Buildings – classified by number of storeys.
- Embankments; bridges – by material type.
- Walls, barriers and fences – by material type
- Pavement or road edge – by kerb type.

Initial feature-extraction work sought to extract a wider range of features. These included open spaces along roadside (no embankment or other feature); vegetation (hedges, forestry), and road furniture (signs etc.). However, after initial testing and noise-model runs by the NRA, these features were removed, keeping only those features with clear noise-attenuation characteristics (see Figure 9).

Process and geometry optimisation was also undertaken. This included a simplified geometric representation of features being recorded. This simplification of geometry was found to speed up the noise model runs with no impact of note on model output. Along with the features characteristics and position and height, the height and gradient of the road surface were also calculated from the survey vehicle GPS track-log.

Accuracy levels for extracted features vary with distance of the object from the camera and range from 10 cm to 1 m approximately from 10 m to 50 m distance from the cameras.

Figure 7: View of the RouteMapper software in imagery viewing mode and showing typical road environment requiring feature extraction.

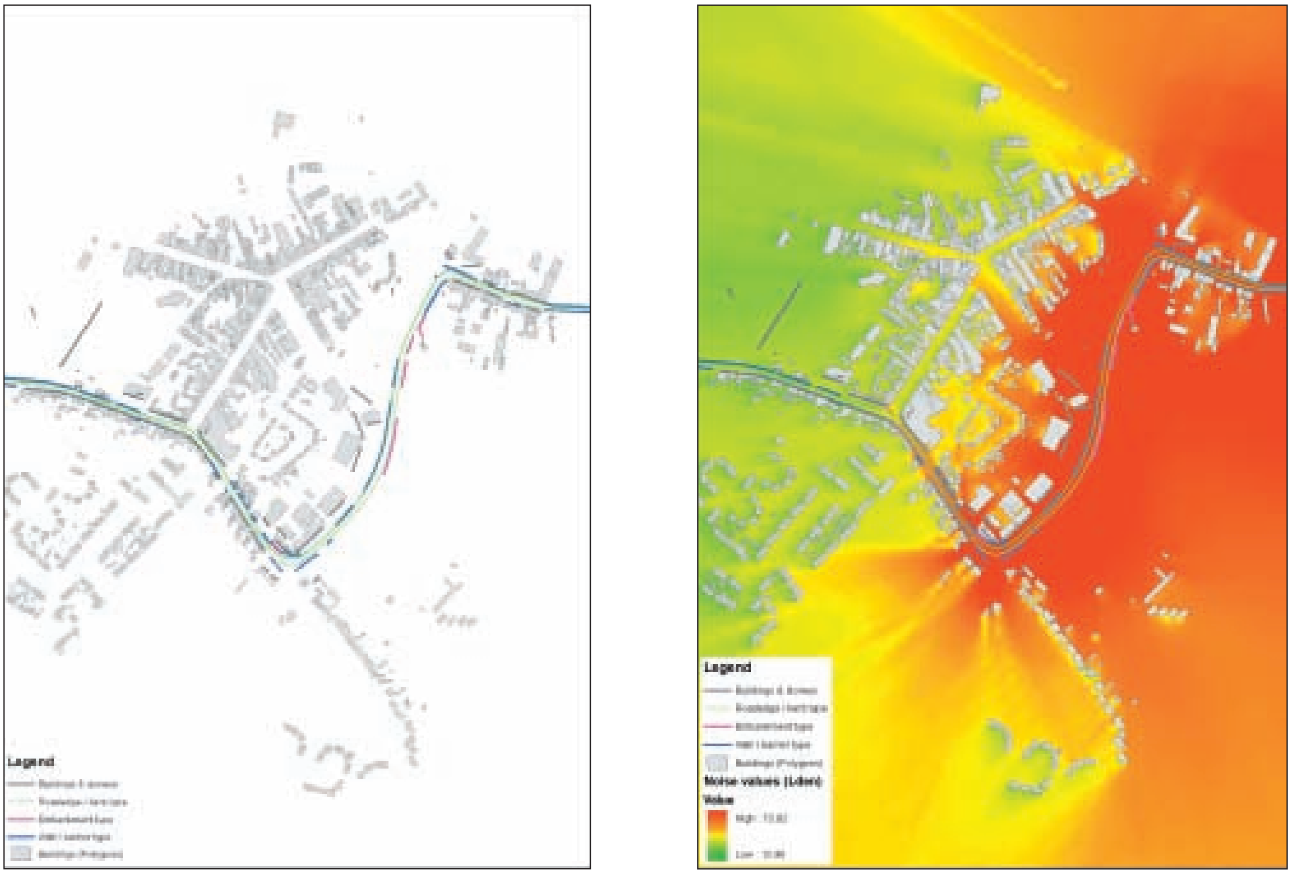

Figure 8: View of features extracted from spatial video for a section of Ballinasloe, County Galway. Left – Features and OSi building polygons; Right – Data viewed on noise map generated by the NRA.

Figure 9: Sample features extracted from imagery – Top: road edge, roadside embankment, barrier wall and bridge; Mid and bottom: Sample noise barriers types.

3.4 Aerial Imagery Processing

Data acquisition with the aerial camera system produces large quantities of data in a relatively short time. For example, 2 hours survey flying can produce over 3,600 image files totalling 21 GB together with associated navigation log files. Some of these data are redundant, however, or are of lesser interest owing to, for example, the features in or out of view. The pre-processing of data enables the separation and the structured storage of useful imagery together with associated navigation details. It also enables the comparison of the track flown with the planned survey flight lines in order to assess the quality and completeness of the survey. Along-track and across-track stereoscopic coverage (imagery with significant overlap with adjoining images) can be set so that only imagery matching the parameters is extracted and saved for further processing. This results in a structured dataset which helps speed up georectification or orthocorrection during the main processing stage (see Figure 10).

A software module is available to enable the operator to perform these steps and output a range of control file formats. These are usually required by georeferencing or orthocorrection applications and comprise essential information on such items as image names, locations, nominal GPS image centre, camera model etc. Planned and flown flight lines, together with thumbnails, enable rapid review by the operator before the main processing.

In relation to georeferencing and orthocorrection, many photo-grammetric software tools are available for processing digital aerial images. These include ER Mapper, ERDAS Imagine and the Leica Photogrammetry Suite (all from ERDAS.com), Geomatica from PCI (PCI.com), Inpho (Inpho 2007) and BAE System's Socket Set (BAE, 2007). Other systems, perhaps less well known, include EnsoMosaic (Enso, 2007) and PhotoMOD (Photomod, 2007).

The project worked extensively with the EnsoMosaic software in particular in order to improve the processing of the imagery. Nonetheless, processing data remains a relatively cumbersome task for small- to medium-digital format cameras. Factors that affect smooth processing include choice of camera and lens, variable terrain availability of quality navigation onboard the aircraft and a lack of quality ground control points, typically taken from existing mapping or photography. Arising from these tests the approach towards capture of data has been altered with parallel lines flown, even along narrow corridors, in order to get side overlap between images – it is this side overlap along with forward overlap that assists with the more efficient semi-automated processing of imagery.

The project captured aerial imagery of the selected road sections and provided these to the NRA for use in their collation and assessment of data for the noise-modelling exercise. Ultimately, this imagery was largely used for verification of features as already mapped in OSi large-scale vector mapping or for visually updating such mapping (e.g. of buildings). This use highlights the most valuable role for the CAIMS aerial imagery – namely, the survey of routes where no digital mapping is available (e.g. newly constructed routes), or where the available data is not of sufficient detail (e.g. 1:50,000 map data) or low-resolution aerial photography.

3.5 Pilot Noise Modelling

The data generated by the project was presented to the NRA noise-modelling team as a series of GIS shapefiles covering each feature type and each route section. The initial first batches of data supported a pilot noise-modelling exercise around the Limerick area. Feedback from this exercise assisted in refining the process of feature extraction from the spatial video in particular.

Once with the NRA, data were loaded to the NoiseMap (www.wsanoise.com) application and, following a change in the software used within the NRA, to the Lima noise model (www.bksv.com). The NRA undertook noise modelling over the course of a number of months with each run of a model taking many hours and sometimes days.

Figure 10: Stages in image processing: Original image (top); Georectified image to align to underlying coordinate system (middle); Mosaic of images (bottom).

3.6 Presentation

The project undertook the development of a prototype web application to present mapping data, including noise mapping results and also survey imagery. This prototype was developed using open source MapServer software, along with evaluations of Google Earth Pro (earth.google.com). In addition, investigations were undertaken into web-based delivery of the spatial video imagery as a streaming data format. This initial research has fed into ongoing research within NCG. This work on presentation of noise maps was however downgraded in importance based on feedback from the project's industry partner, the NRA, whose focus was on delivery of a solution to meet data-generation challenges. In addition, the development of a new map viewer became less important with the separate development of the EPA's own Envision mapping system (www.epa.ie). However, the research and prototyping work undertaken has supported related research and project delivery.

3.7 Summary of Advantages and Disadvantages of the Methods

For the aerial imagery and spatial video approaches, the following is a summary of the key advantages and disadvantages:

3.7.1 Spatial Video

☺ Readily repeatable and largely not weather dependent.

☺ Provides measurements (x, y and z) and attributes for key road environment features, via an oblique view of those features.

☺ Flexible catalogue of features to extract.

☹ Manual extraction of features required with few efficiency gains over large surveys.

3.7.2 CAIMS Aerial Imagery

☺ Readily repeatable and not as weather dependent as standard aerial photography due to flexible flying heights.

☺ Provides positions (x, y) and attributes for key road environment features, via vertical view of those features, complementing the oblique spatial video.

☺ Progress being made in automated feature extraction using object identification methods.

☺ Flexible catalogue of features to extract.

☹ Where manual extraction of features is required, there are few efficiency gains over large surveys.

4. Project Outcomes

4.1 Deliverables

The project delivered the following important deliverables:

- Operation of spatial video survey of 350 km and similar length of aerial imagery of national primary road network.
- Processing of spatial video imagery and feature extraction.
- Processing of aerial imagery and delivering as georeferenced images with selected rectification.
- Delivery of key data to support noise modelling by the NRA.
- Investigation of data-delivery methods and prototype web-system creation.
- Development and application of methodology for survey and data generation of plan and oblique road corridors

4.2 Follow-on Project

Following the valuable deliveries of data from the project to the NRA, the NRA sought to follow the same approach to filling their critical data gaps for other national routes. They therefore as a wholly separate project undertook a spatial video survey of an additional 600 km of road. Feature extraction – following the methods and feature dictionary created by this research project – was undertaken and the data outputs used as a key part of the noise-modelling exercise. Thus, the project through its methodology development, direct creation of valuable data, and support to related projects, played a key role in allowing Ireland to meet its obligations under the EU Environmental Noise Directive (see Figure 11).

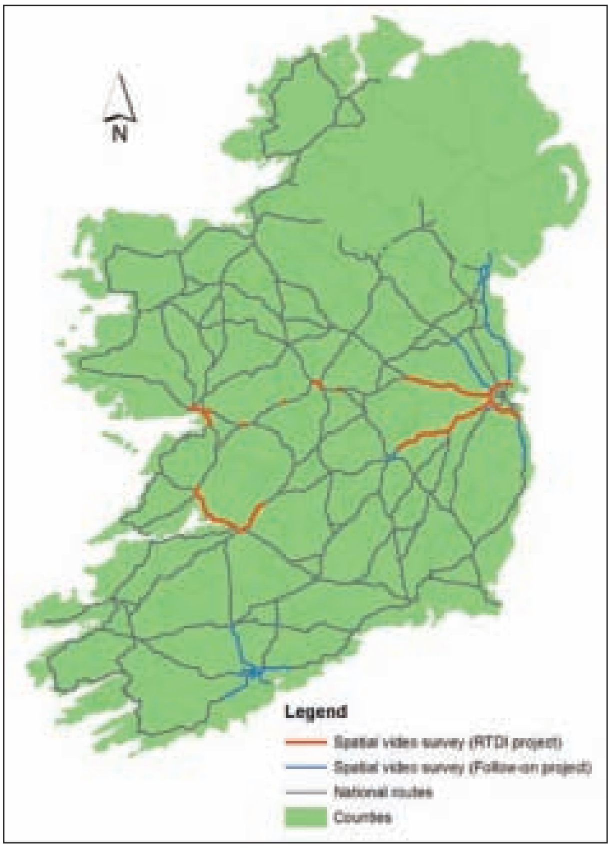

Figure 11: Spatial video survey coverage (this research project in red, follow-on project in blue)

4.3 Research Requirements

Data extraction from spatial video remains a time-consuming task and one that reduces the feasibility of large projects because of the associated resource and timescale requirements. The automated identification and extraction of features in imagery is an area of some interest currently, with software such as ERDAS Objective (www.erdas.com) and the Definiens product suite (www.definiens.com) focusing on context-based classifiers. Nevertheless, the successful application of these tools requires the development of rule sets – and the integration of these approaches with spatial video has not yet been approached to any great extent.

Project partners, NCG, are currently building a mobile mapping experimental test-bed including GPS and inertial measurement units (IMU), multispectral cameras and high-speed LiDAR. LiDAR is a prevalent method to determine distance to an object or surface using laser pulses. This test-bed system will be used to capture comprehensive three-dimensional route corridor information for noise modelling in 2009. This same group plans to deploy a first-stage prototype multi-hop wireless sensor network in 2009 to empirically monitor and measure noise along roadways as well as residential, commercial and public spaces. Both initiatives will provide valuable information for tackling new challenges centred around monitoring noise, not only along road networks but also in urban environments.

Other related work includes the ongoing development of airborne camera systems between project partners, Compass Informatics and the NCG, and the NCG's own work on fusion of data from the multiple sensor sources (including aerial imagery). This work promises an even richer suite of data where one sensor compensates for weaknesses in another. Again, a challenging issue is the efficient identification and extraction of features from the individual or combined data sources.

4.4 Recommendations

The project has highlighted the valuable role of spatial video in characterising the road environment and particularly those features not so readily apparent or measurable from a vertical view – namely, noise barriers, walls and bridges – those same features that impact on noise propagation. It is recommended that the use of spatial video be combined with other sensors (to potentially include ground-based LIDAR, aerial LIDAR, aerial photography e.g. from the CAIMS system) to continue to create a data source for the road environment.

Recognising that feature extraction from all imagery sources continues to be a challenge, it is recommended that research work continues on the application of object-based image analysis to road environment image sources. Progress in this area would lessen this disadvantage in relation to spatial imagery and general imagery use.

Given the large increase in road lengths to be reported on in the next environmental noise-mapping phase (see below) it is recommended that an assessment of fit-for-purpose approaches to data creation and noise modelling for these additional routes be conducted. This would seek to optimise the use of existing data sources and identify the survey methods required for these routes.

4.5 Conclusions

The project has been successful in achieving its ultimate aim of supporting the responsible authority in Ireland, the NRA, in undertaken road noise modelling for specified national routes as required under the EU Environmental Noise Directive. In particular, the role of spatial video has been shown to be of value, supported by aerial imagery where existing mapping is not suitable and where additional plan-view verification of features is required.

The reporting requirements of the Environmental Noise Directive grow more onerous with each reporting cycle. While the areas requiring noise modelling and mapping by December 2007 included major roads with over 6 million vehicle passages per annum, this threshold drops to 3 million plus vehicle passages in 2012. As a result, significantly more roads will require noise modelling and mapping for the 2012 reporting phase. A similar lowering of thresholds and extension of relevant areas occurs in the other areas of railways, agglomerations, with airports remaining the same. This underlines the challenges ahead in terms of characterising road environments. Each data source – including OSi large-scale mapping, aerial and ground LIDAR, spatial video and aerial imagery – may have to be combined to meet these data requirements. The challenge ahead will be the optimal use of each source and the fusion of all sources.

References

Applanix (2007) *Digital Sensor system* (see: www.applanix.com).

BAE Systems (2007) *Socket Set photogrammetry software* (see: http://socetset.com/products/socetset_index.htm / www.baesystems.com/).

Canon (2005) *Manual for Canon EOS 5D*. Canon (UK) Ltd, 178 pp.

European Commission (2002) *Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise (the Environmental Noise Directive).*

General Dynamics (2007) XR-1 Rugged Laptop (see http://www.gd-computing.com/).

Inpho (2007) *Inpho photogrammetry software* (see http://www.inpho.de/).

McCarthy T., Zheng, J. and Fotheringham, A.S. (2008) Integration of dynamic LiDAR and image sensor data for route corridor mapping. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Beijing, Vol. XXXVII, Part B5, pp. 1125–30.

McCarthy T., Fotheringham A.S. and O'Riain, G. (2007a) Compact Airborne Image Mapping System (CAIMS). *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Padua, Italy, Vol. XXXVI, Part 5/C55, pp. 198–202.

McCarthy, T., Charlton, M., Fotheringham, A.S. and O'Malley, V. (2007b) Integration of LiDAR and Stereoscopic Imagery for Automated Route Corridor Inventory. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Padua, Italy, Vol. XXXVI, Part 5/C55, pp. 203–9.

PCI (2007). *Geomatica photogrammetry software* (see: http://www.pcigeomatics.com/products/products_overview.html).

Photomod (2007) *Photomod software* (see: http://www.racurs.ru/).

RouteMapper (2008) *Stereoscopic image mapping system* (at: http://www.routemapper.net/).

United Nations Economic Commission for Europe (1998). *UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention).*

Zheng J., McCarthy T. and Fotheringham A.S. (2008) Linear feature extraction of buildings from terrestrial LiDAR data with morphological techniques. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Beijing, Vol. XXXVII, Part B1, pp. 241–4.

Appendix 1 – EuroNoise 2006 Paper

EURONOISE 2006
30 May - 1 June 2006 Tampere, Finland

DATA CAPTURE AND PRESENTATION TECHNIQUES IN SUPPORT OF THE EU ENVIRONMENTAL NOISE DIRECTIVE

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ABSTRACT

Arising from the requirements of the EU Environmental Noise Directive (END) (2002/49/EC), an ongoing project supported by the Environmental Protection Agency, Ireland, is furthering the development of advanced spatial video and photography capture and integration, along with interactive display of noise maps and spatial imagery.

Data gaps have been identified that are to be filled to fully meet the road-related noise modelling and mapping requirements under the Directive. The techniques under development will allow the efficient vehicle- and air-based survey of roadways and the buffer zone, and the extraction of features from the derived ground and aerial imagery.

An additional weakness is the lack of dissemination systems to present noise maps and action plans to the public and professional user alike, and that can also integrate the project's spatial and aerial imagery. A demonstration system and procedures for providing web-based public information systems are being developed. It is expected that the approaches once developed and proven through this project, will be of use in efficiently meeting the Directive requirements, and will indeed be applicable in other environments and other application areas.

Introduction

Arising from the requirements of the EU Environmental Noise Directive (END) (2002/49/EC), an ongoing project supported by the Environmental Protection Agency, Ireland, is furthering the development of advanced spatial video and photography capture and integration, along with interactive presentation of noise maps and spatial imagery. The project commenced in early 2006 and builds on previous work by the project partners in these technologies. The enhanced systems and methodologies will assist in the process of strategic noise mapping required under the Directive by June 2007.

Data gaps have been identified [1] that need to be filled to fully meet the road-related noise modelling and mapping requirements of the Directive. The techniques under development will allow the efficient survey of roadways and the roadway buffer zone, and the extraction of features from the derived oblique ground and vertical aerial imagery. Features to be extracted include position and elevation of barrier walls, buildings, and embankments; façade materials; building footprints and heights; road surface type, width, and slope; among other features and attributes not readily available from existing data sources.

Possible existing data sources include national mapping agency (Ordnance Survey of Ireland) large-scale digital mapping, road-design drawings, road and traffic surveys, and existing aerial photography. However, all these sources have associated difficulties including cost, difficulty in sourcing and compatibility, resolution, little if any detail on feature surfaces, and currency of the data.

An additional existing weakness is the lack of dissemination systems to present noise maps and action plans to the public and professional user alike, which can also integrate spatial and aerial imagery, such as that generated by the project, in an accessible manner. A demonstration system and procedures for providing web-based public information systems are therefore also being developed.

It is expected that the approaches, once developed and proven through this project, will be of use in efficiently meeting the Directive requirements, and will indeed be applicable in other environments and application areas outside of noise modelling.

Imagery and Data Capture Systems Overview

Route corridor mapping using onboard vehicle acquisition systems is a relatively new technology. These systems are typically used to measure and store information about roadside objects such as street furniture and building infrastructure, and utilise sets of calibrated video systems. Within the project team's video systems the stereoscopic view, along with advanced imagery processing techniques, allows features to be digitised from the oblique spatial video and to record the position and height of each feature, along with attributes for each feature. The system typically comprises two or more sets of stereoscopic cameras linked with onboard dGPS and secondary navigation systems.

On the other hand, the airborne image-mapping system generally operates at 1,500 ft to 3,000 ft (450 m to 900 m) above ground level (AGL) and collects relatively wide swaths of imagery which are then orthorectified and then mosaiced, ready for use typically within a geographical information system (GIS). The airborne system is made up of a high-resolution digital single lens reflex (SLR) camera, GPS and data-acquisition system, and uses a light aircraft platform.

Figure 1: Basic spatially encoded video mapping system software views (courtesy of Routemapper).

Figure 2: Airborne image-mapping system operation software showing image preview and image tracking along with various configuration controls.

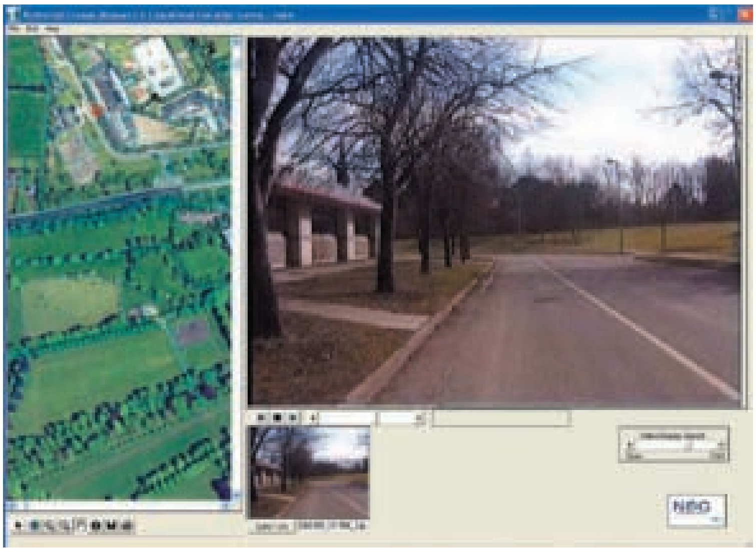

Figure 3: An example of a prototype co-located airborne and ground based imagery viewing system.

Versions of both these systems have been designed previously by lead members of the project team and are used operationally in Ireland and abroad. The systems are currently being redesigned to operate in a more robust fashion, to work with improved cameras and image-processing technologies, and to be focused on data capture suited to road noise modelling.

The team is developing an integrated system whereby the combination of low-altitude vertical image mapping together with spatially encoded ground stereoscopic imagery will provide both the overview and detailed data necessary to measure and classify route corridor features. The advantage of this approach is that both spatially encoded image streams can be synchronised so that every feature from road surface, to embankments, to buildings within a specified range of the road centre line can be measured and classified.

Feature Extraction

The project's imagery systems are designed to capture imagery for the immediate road environment and the buffer zone to a distance of approximately 200 m on each side:

- The ground based video system is capable of measuring features such as buildings and walls out to 50-m range, 10 m in height at sub-meter accuracy and features such as large embankments and tree canopy out to middle ranges of 100 m to 150 m to approximately 2 m accuracy.

- The airborne imagery will cover a wider swath and allow data such as digital terrain models and derived contour lines, buildings, and road-related features to be captured. With an image resolution of 10 centimetres or less possible, the level of detail visible in the airborne imagery is high.

Both systems therefore allow the position of a feature to be captured along with attributes of that feature, including attributes such as wall surface type which is only visible from an oblique view.

Feature extraction is undertaken within a custom imagery browser for both aerial and ground imagery. Pre-processing of the video imagery is also done through custom software, while for the aerial imagery use is typically made of the EnsoMOSAIC [2] software for image ortho-rectification, digital terrain model generation, and mosaicing in a semi-automated fashion. Output imagery is typically saved to an ECW format [3] for use within the image browser and project GIS.

A data schema has been designed that guides the capture of features and the attributes required, and serves to store that data in a structured and integrated fashion. This data specification is based on the requirements of various road noise-modelling software and can be extended as further guidance is provided by the various Environmental Noise Directive guidance bodies and organisations. The schema is also designed to allow integration of Environmental Noise Directive-related data with the existing data holdings of the reporting authority for Ireland, the Environmental Protection Agency.

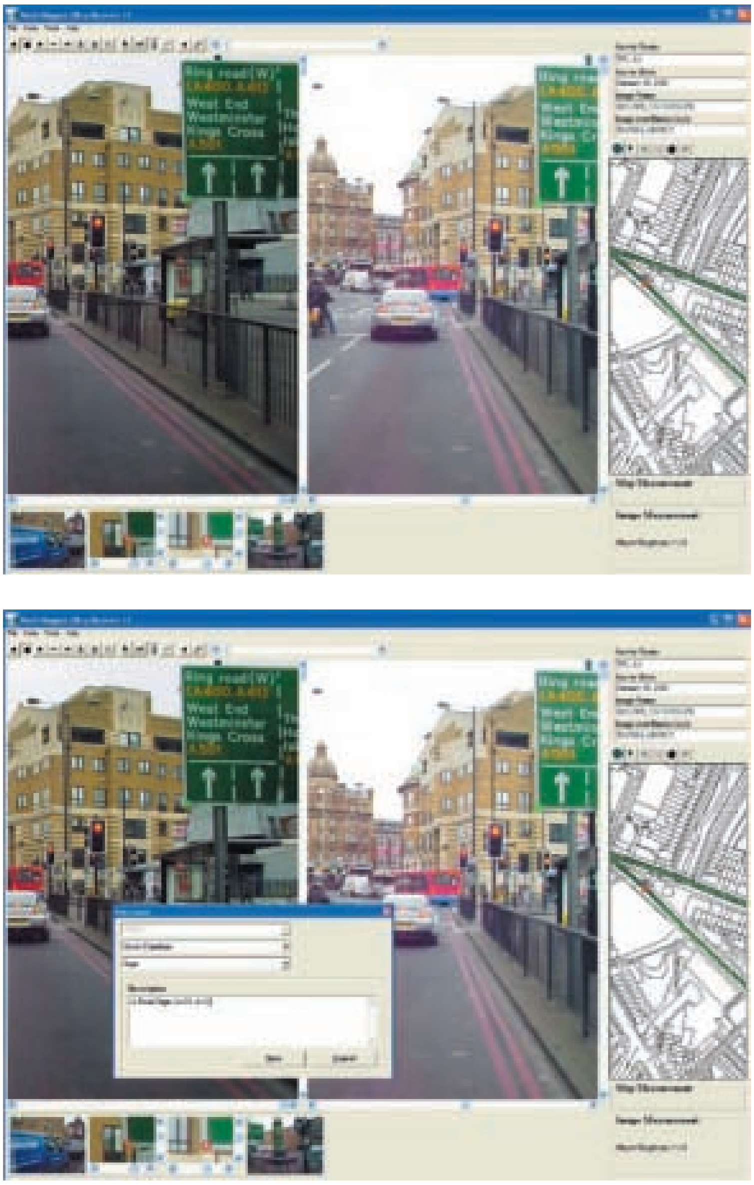

Figure 4: Sample feature extraction and attribution software interface for the ground spatial video imagery.

Project Surveys

An imagery capture exercise is being undertaken on up to 350 km of roadway – on routes for which strategic noise mapping will be required by June 2007. Route segments have been chosen that represent a range of road environments, from modern motorways, to dual carriageways, to main streets of villages and towns.

Features will be extracted for these routes, to provide a dataset in GIS and noise model-compatible formats.

Road Noise Model Impacts

A sensitivity assessment of noise model results to the quality of the data used in the model will be undertaken with the objective of designing an optimised and fit-for-purpose approach to imagery capture and data extraction. The trade-off between effort and associated cost, and model accuracy will be assessed through a type of cost–benefit analysis.

Presentation Systems

Along with the attempt to fill data gaps, the dissemination of this data integrated with noise maps is another requirement identified by stakeholders in the noise mapping and management process. A readily accessible (web-based) system is required that will integrate the display of strategic noise maps and the ground and aerial imagery in a meaningful and interactive fashion for users. The system will also seek to present action maps, as the format for these plans becomes more apparent. It will also seek to assist in organisation and national reporting of END requirements.

The project team is thus developing techniques to integrate and display data to the public and specialist users alike via a web browser and to establish a demonstration system. The system will use WebGIS software to display maps and action plan elements using interactive mapping and multimedia, while also allowing tours of road corridors using the aerial and ground based imagery.

Concluding Comments

While the project under discussion is still ongoing, its outputs are timed so that they can be used in the strategic-mapping exercises required under the Environmental Noise Directive. The Euronoise 2006 conference presentation will discuss the latest system developments; data derived from the project surveys; results of the road noise modelling using that data; and the web-based presentation systems. Project progress can be followed by contacting the authors or monitoring the project partner's website, [4] and will be presented at further END-related workshops through 2006.

References

[1] G. Ó Riain, *Scoping Study on Implementation of Directive 2002/49/EC and the (draft) Environmental Noise Regulations 2004*, Unpublished report to the National Roads Authority, Ireland. 2005. Compass Informatics Limited (www.compass.ie).

[2] www.storaenso.com/ensomosaic or www.ensomosaic.com

[3] www.ermapper.com

[4] www.compass.ie

Acronyms and Abbreviations

GPR ground probing radar

Ground-penetrating radar / Ground-probing radar (GPR) is a geophysical method that uses radar pulses to image the subsurface. This non-destructive method uses electromagnetic radiation in the microwave band (UHF/VHF frequencies) of the radio spectrum, and detects the reflected signals from subsurface structures. GPR can be used in a variety of media, including rock, soil, ice, fresh water, pavements and structures. It can detect objects, changes in material, and voids and cracks (see http://en.wikipedia.org/wiki/Ground-penetrating_radar).

GPS global positioning system

GPS is a global navigation satellite system (GNSS) developed by the United States Department of Defense. It uses a constellation of between 24 and 32 Medium Earth Orbit satellites that transmit precise radiowave signals, which allow GPS receivers to determine their current location, the time, and their velocity (see http://en.wikipedia.org/wiki/Global_Positioning_System).

dGPS differential global positioning system

dGPS is an enhancement to GPS that uses a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by the satellite systems and the known fixed positions. These stations broadcast the difference between the measured satellite pseudoranges and actual (internally computed) pseudoranges, and receiver stations may correct their pseudoranges by the same amount. (see http://en.wikipedia.org/wiki/Differential_GPS).

IMU inertial measurement unit

An IMU is the main component of inertial guidance systems used in air-, space-, and other craft or vehicles. IMU works by sensing motion — including the type, rate, and direction of that motion — using a combination of accelerometers and gyroscopes. The data collected from these sensors allow a computer to track a craft or vehicle's position (see http://en.wikipedia.org/wiki/Inertial_Measurement_Unit).

L^{den} day-evening-night equivalent level

An indicator of noise impact and typically seen as a good indicator of noise that continues over a long period of time or on a more or less continuous basis.

Lden is the 24-hr Leq* calculated for an annual period, but with a 5 dB weighting for evening and a 10 dB weighting for night. Directive 2002/49/EC requires EU Member States to produce noise maps in 2007 using the Lden noise metric.

* The term Leq is shorthand for 'equivalent continuous noise level', which is a parameter that calculates a constant level of noise with the same energy content as the varying acoustic noise signal being measured. The Leq is an energy mean of the noise level averaged over the measurement period and often regarded as an average level.

L^{night} night equivalent level

An indicator of noise impact and typically seen as a good indicator of noise that occurs during evening and night-time.

An Ghníomhaireacht um Chaomhnú Comhshaoil

Is í an Gníomhaireacht um Chaomhnú Comhshaoil (EPA) comhlachta reachtúil a chosnaíonn an comhshaol do mhuintir na tíre go léir. Rialaímid agus déanaimid maoirsiú ar ghníomhaíochtaí a d'fhéadfadh truailliú a chruthú murach sin. Cinntímid go bhfuil eolas cruinn ann ar threochtaí comhshaoil ionas go nglactar aon chéim is gá. Is iad na príomh-nithe a bhfuilimid gníomhach leo ná comhshaol na hÉireann a chosaint agus cinntiú go bhfuil forbairt inbhuanaithe.

Is comhlacht poiblí neamhspleách í an Ghníomhaireacht um Chaomhnú Comhshaoil (EPA) a bunaíodh i mí Iúil 1993 faoin Acht fán nGníomhaireacht um Chaomhnú Comhshaoil 1992. Ó thaobh an Rialtais, is í an Roinn Comhshaoil agus Rialtais Áitiúil a dhéanann urraíocht uirthi.

ÁR bhFREAGRACHTAÍ

CEADÚNÚ

Bíonn ceadúnais á n-eisiúint againn i gcomhair na nithe seo a leanas chun a chinntiú nach mbíonn astuithe uathu ag cur sláinte an phobail ná an comhshaol i mbaol:

- áiseanna dramhaíola (m.sh., líonadh talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh., déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- diantalmhaíocht;
- úsáid faoi shrian agus scaoileadh smachtaithe Orgánach Géinathraithe (GMO);
- mór-áiseanna stórais peitreail.
- Scardadh dramhuisce

FEIDHMIÚ COMHSHAOIL NÁISIÚNTA

- Stiúradh os cionn 2,000 iniúchadh agus cigireacht de áiseanna a fuair ceadúnas ón nGníomhaireacht gach bliain.
- Maoirsiú freagrachtaí cosanta comhshaoil údarás áitiúla thar sé earnáil - aer, fuaim, dramhaíl, dramhuisce agus caighdeán uisce.
- Obair le húdaráis áitiúla agus leis na Gardaí chun stop a chur le gníomhaíocht mhídhleathach dramhaíola trí comhordú a dhéanamh ar líonra forfheidhmithe náisiúnta, díriú isteach ar chiontóirí, stiúradh fiosrúcháin agus maoirsiú leigheas na bhfadhbanna.
- An dlí a chur orthu siúd a bhriseann dlí comhshaoil agus a dhéanann dochar don chomhshaol mar thoradh ar a ngníomhaíochtaí.

MONATÓIREACHT, ANAILÍS AGUS TUAIRISCIÚ AR AN GCOMHSHAOL

- Monatóireacht ar chaighdeán aeir agus caighdeáin aibhneacha, locha, uiscí taoide agus uiscí talaimh; leibhéil agus sruth aibhneacha a thomhas.
- Tuairisciú neamhspleách chun cabhrú le rialtais náisiúnta agus áitiúla cinntí a dhéanamh.

RIALÚ ASTUITHE GÁIS CEAPTHA TEASA NA HÉIREANN

- Cainníochtú astuithe gáis ceaptha teasa na hÉireann i gcomhthéacs ár dtiomantas Kyoto.
- Cur i bhfeidhm na Treorach um Thrádáil Astuithe, a bhfuil baint aige le hos cionn 100 cuideachta atá ina mór-ghineadóirí dé-ocsaíd charbóin in Éirinn.

TAIGHDE AGUS FORBAIRT COMHSHAOIL

- Taighde ar shaincheisteanna comhshaoil a chomhordú (cosúil le caighdéan aeir agus uisce, athrú aeráide, bithéagsúlacht, teicneolaíochtaí comhshaoil).

MEASÚNÚ STRAITÉISEACH COMHSHAOIL

- Ag déanamh measúnú ar thionchar phleananna agus chláracha ar chomhshaol na hÉireann (cosúil le pleananna bainistíochta dramhaíola agus forbartha).

PLEANÁIL, OIDEACHAS AGUS TREOIR CHOMHSHAOIL

- Treoir a thabhairt don phobal agus do thionscal ar cheisteanna comhshaoil éagsúla (m.sh., iarratais ar cheadúnais, seachaint dramhaíola agus rialacháin chomhshaoil).
- Eolas níos fearr ar an gcomhshaol a scaipeadh (trí cláracha teilifíse comhshaoil agus pacáistí acmhainne do bhunscoileanna agus do mheánscoileanna).

BAINISTÍOCHT DRAMHAÍOLA FHORGHNÍOMHACH

- Cur chun cinn seachaint agus laghdú dramhaíola trí chomhordú An Chláir Náisiúnta um Chosc Dramhaíola, lena n-áirítear cur i bhfeidhm na dTionscnamh Freagrachta Táirgeoirí.
- Cur i bhfeidhm Rialachán ar nós na treoracha maidir le Trealamh Leictreach agus Leictreonach Caite agus le Srianadh Substaintí Guaiseacha agus substaintí a dhéanann ídiú ar an gcrios ózóin.
- Plean Náisiúnta Bainistíochta um Dramhaíl Ghuaiseach a fhorbairt chun dramhaíl ghuaiseach a sheachaint agus a bhainistiú.

STRUCHTÚR NA GNÍOMHAIREACHTA

Bunaíodh an Ghníomhaireacht i 1993 chun comhshaol na hÉireann a chosaint. Tá an eagraíocht á bhainistiú ag Bord lánaimseartha, ar a bhfuil Príomhstiúrthóir agus ceithre Stiúrthóir.

Tá obair na Gníomhaireachta ar siúl trí ceithre Oifig:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig um Fhorfheidhmiúchán Comhshaoil
- An Oifig um Measúnacht Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáide

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag ball air agus tagann siad le chéile cúpla uair in aghaidh na bliana le plé a dhéanamh ar cheisteanna ar ábhar imní iad agus le comhairle a thabhairt don Bhord.

Science, Technology, Research and Innovation for the Environment (STRIVE) 2007-2013

The Science, Technology, Research and Innovation for the Environment (STRIVE) programme covers the period 2007 to 2013.

The programme comprises three key measures: Sustainable Development, Cleaner Production and Environmental Technologies, and A Healthy Environment; together with two supporting measures: EPA Environmental Research Centre (ERC) and Capacity & Capability Building. The seven principal thematic areas for the programme are Climate Change; Waste, Resource Management and Chemicals; Water Quality and the Aquatic Environment; Air Quality, Atmospheric Deposition and Noise; Impacts on Biodiversity; Soils and Land-use; and Socio-economic Considerations. In addition, other emerging issues will be addressed as the need arises.

The funding for the programme (approximately €100 million) comes from the Environmental Research Sub-Programme of the National Development Plan (NDP), the Inter-Departmental Committee for the Strategy for Science, Technology and Innovation (IDC-SSTI); and EPA core funding and co-funding by economic sectors.

The EPA has a statutory role to co-ordinate environmental research in Ireland and is organising and administering the STRIVE programme on behalf of the Department of the Environment, Heritage and Local Government.

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