ENABLE EVERY ROAD ADMINISTRATION WITH MOBILE MAPPING TECHNOLOGY – KIT MOBILE MAPPING

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ABSTRACT:

This paper describes how AMBISIG Kit Mobile Mapping can be an important tool to ensure efficient traffic flow and safe roads, accessible to all entities that have the duty to manage and maintain road infrastructures.

An efficient road transport system is seen by most countries as an essential pre-condition for general economic development. The resultant road networks usually have an asset that represents a significant proportion of national wealth, and the road sub-sector should make an important contribution to gross national product. Road networks are, by their nature, spread over a wide geographic area, and their condition is changing continuously as a result of traffic effects, climate and environmental conditions. The need to monitor, conserve and rehabilitate the road infrastructure is a consequence of this ongoing transformation suffered over time. Therefore it is extremely important to provide the Road Authority’s instruments that ensure the capability to continuously update and georeference the physical state of various aspects/components contributing to the quality and safety of the Road. Minimize the occurrence of errors, not only by the road users but also by the road traffic system, it’s necessary to suppress the loss of human life.

The Kit Mobile Mapping offers continuous spatial and temporal monitorization and allows the democratization of this technology’s usage. This democratization is possible because it allows it’s usage to any entity regardless of the dimensions or economics relevance.

Given the low cost of this technology and the fact that it’s extremely easy to work with, the Kit Mobile Mapping assures a correct and easy spatial identification. To facilitate this process, this technology integrates with any GIS platform or even with simple map viewers, such as Google Maps or Virtual Earth.

In this way, Kit Mobile Mapping Technology can be an important part of managing a road network, because it allows building and maintaining an inventory of assets such as, signs and line marking, security and drainage equipment, geometry, surface pavement, etc. It can automate these management tasks from road inventory and data collection to data analysis, decision support, budgeting, and reporting. Bringing the information from the infrastructure to manager’s desks them making better decisions.

AMBISIG’s Kit Mobile Mapping, which is used in Road Administration Institutes and Municipalities, is becoming increasingly recognized as an essential for those who want to ensure efficiency and safety.

It will be described a specific implementation of AMBISIG Kit Mobile Mapping, as well as how the derived data can be used to aid decision support.

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1. INTRODUCTION

The mobility of people and goods has grown exponentially in the last decades, especially in urban areas as a result of economic and social development. The urban governments need to be prepared for the challenges that would arise. Monitor and maintain the roads and existing infrastructure in good condition for millions of people who make daily use, is certainly a challenge.

The action of atmospheric agents combined with the impact caused by the traffic of persons and goods, continuously contributes for the transformation of urban infrastructures. Both a network of roads and streets require ongoing maintenance to ensure appropriate security conditions for people and goods. The good state of pavement and signs conservation, signs visibility, the sidewalks regularity and lack of barriers to pedestrian users are examples of aspects that contribute to the quality and safety of a reality as long as it is continuous over time, such as road and pedestrian infrastructures.

This commitment for a safe and comfortable environment requires a georeference “road network”, for engineers and administrators ensure safety standards, quality and economy.

In this context, the Mobile Mapping System (MMS) play an important role in data collection and supply of geographical information systems (GIS) (Li & Murai, 1999), whose the greatest benefit is the ability to take images and data from streets and highways in a database (computer) with all the features visible and referenced in a coordinate system. “Vehicle-based Mobile Mapping System (MMS) proved to be an effective technology for sign inventory and has the potential for many other types of roadway features and characteristics” (Xiong and Floyd, 2004).

Among all entities that may benefit of this kind of instruments, Municipalities can be distinguished for its organizational complexity and role in society, but are not alone. Protection authorities, security and surveillance forces are for obvious reasons, also strong candidates to use these tools.

2. KIT MOBILE MAPPING

AMBISIG Kit Mobile Mapping is the combination of geographic information system (GIS) software, global positioning system (GPS), inertial navigation system (3 axis gyroscope), 3 axis accelerometer, magnetometer, video camera and mobile computing devices that allows visualize information in a digital map, collect information where it is observed. This kind of technology changes the way information is collected, viewed, and shared with the rest of an organization.

2.1 A brief history of KIT MOBILE MAPPING

AMBISIG started to realise the potential of rapid data collection techniques to efficiently collect large volumes of asset data. It was found that this type of data collection was more efficient than manual collection techniques in terms of cost and time required to collect the data.

It was also found that most organizations, whose work depends on a complete georeferenced and updated database, do not have the means to make the data acquisition. Very often this organizations use external services to the job that, in some cases, it is made with years in between, leaving out the database unchanged for a long period.

Therefore, AMBISIG tried to simplify the process for collecting georeferenced information producing an autonomous, user friendly and low cost equipment. So friendly that could be accessible without the need to recruit more technicians to the majority of Portuguese Municipalities and Other Road Administrations.

Because AMBISIG has already experience in Mobile Mapping Systems, decided to adopt the know-how to the new concept Kit Mobile Mapping, a portable system that captures georeferenced videography of all the information visible on road network.

2.2 Overview of KIT MOBILE MAPPING

The first KIT MOBILE MAPPING system became operational in September of 2008. The KMM, composed by a video camera, gyroscopes, accelerometers, magnetometers and a notebook, allowed capture images that could be displayed on digital maps like Google Earth for example. For each image there was information associated such as their coordinated, date and time of survey, longitudinal and transverse inclination of the pavement. See Figure 1.

![Figure 1.](image)

The latest generation of Kit Mobile Mapping comes with a more complete backoffice software that, not only allows linking information in the image displayed, as allows access to a library of anomalies and reports to assist management maintain a more integrated and preventive approach.

The core components of KIT MOBILE MAPPING

- **Video camera** - equipment that captures digital snapshots.
- **Inertial Unit** – is a miniature size and low weight 6DOF Attitude and Heading Reference System (AHRS). Contains accelerometers, gyroscopes, magnetometers in 3D, an integrated GPS receiver, a static pressure sensor and temperature sensor. Its internal low-power signal processor provides real time and drift-free 3D orientation as well as calibrated 3D acceleration, 3D rate of turn, 3D earth-magnetic field, 3D position and 3D velocity data.
- **Notebook** – stores the information. The user can browse images collected through the video survey on digital maps.
- Digital instructions – contains useful information about the system and its mode of operation.
- Transportation suitcase – accommodate KMM equipment allowing a safely transportation.

The Kit can be installed outside any vehicle through a magnetic or fixed support. Once connected to the notebook is ready to operate. With the end of video campaign, all data and images are stored and available for display.

The system has approximately 250 hours of autonomy and the surveys can be done with any vehicle.

3. APPLICATIONS OF KIT MOBILE MAPPING

3.1 Georeferenced road images

A picture is worth a thousand words and it’s certainly true when it comes to terrestrial road images, as an image can reveal so much information. To be able to look at an image and instantly see what asset items are present and what their condition was at the time the image was captured, has proved very useful within the Road Administration Institutes and Municipalities. Adding to this the capability to extract asset position, condition and attribute information and one starts to realise the potential of an MMS.

By far, the most common application of MMS road images is, as mentioned, visual inspection of the road condition/characteristics. Meers (2007) confirmed that “the images are most commonly used for simply ‘visualising’ a section of road - whether it is to confirmed one’s mental image to the section, or create a new understanding of the road and it’s environment for those that are not familiar with it, or to pick exact locations of features in relation to others”.

The advantage of using the road images as a visual data source is that in most cases Road Administration Institutes and Municipalities staff members do not need to travel to a specific location or worksite to undertake their work.

“In terms of occupational health and safety (OH&S), one of the major benefits of utilising the road images is the level of protection given to staff by allowing them to perform their duties in a safe environment rather than having to actually walk out onto the road” stated Dunlop (2007). Alternatively, the road image data could be used to prepare for an actual roadside inspection. This saves time and money in unnecessary travel. Avoiding unnecessary travel to a roadside location is particularly important in remote areas. In case of historical data there is no substitute for an image record. For last, the ability to capture an asset inventory quickly, easily and accurately without the need to travel is an inexpensive and easily repeatable data collection process.

Examples of road image use include:
- Asset inventory data collection for import into the AMBISIG Geoportal System or other GIS.
- Asset quantification (position, width, height, length, area).
- Asset inspection, identification, validation and remaining life determination by asset managers, maintenance planners, designers and engineers.
- Road safety audit and analysis of safety related assets.
- Surveillance of maintenance and construction works by surveillance officers.
- Sharing a common frame-of-reference, as in looking at the same road image.
- Scoping of works with stakeholders such as local government and contractors.
- Inspection of current and historical image data show the presence/absence or condition of assets and roadside environment.
- Visualisation of road geometry and road condition data.
- Verification and geo-specialization of car crashes.

3.2 Georeferenced road geometry data

Kit Mobile Mapping uses a miniature AHRS (Attitude and Heading Reference System) with integrated GPS and Inertial Unit. The Inertial Unit is a combination of different equipments such as gyroscope, accelerometers, magnetometer, GPS and others. This system can calculate some road geometry information, longitudinal/transverse inclination, coordinates, etc.

The advantage of collecting road geometry data via a Mobile Mapping System rather than traditional surveying methods is once more a matter of time and cost. An MMS as KIT MOBILE MAPPING can survey 80 km of road per hour. While the accuracy of the data collected by traditional surveying is more accurate, the rate at which traditional survey methods collect data cannot compete with a MMS in terms of throughput. Once road geometry data is georeferenced, it can be displayed and analysed in a GIS. This information is also linked to the road images.

Examples of road geometry data use include:
- Analysis of accident data by correlating accident sites against road geometry.
- Pavement rehabilitation projects.
- Road-water runoff determination.

4. SPECIFIC APPLICATIONS OF KIT MOBILE MAPPING WITHIN MUNICIPALITIES AND ROAD ADMINISTRATIONS

Kit Mobile Mapping was developed in view of its usefulness to Municipalities and Road administrations. In that way, KMM was designed to be very simple and easy to use. In 3 steps it’s ready to inventory road network:
Through the notebook there is the possibility of defining hours of data collection and direction of survey relative to the time and day and the month of the year.

With this information road administrations do inventories of road features related to security, inspection and maintenance reports or illegal situations (publicity and parking).

The detection of pavement cracks can be done by images observation and anomalies library consultation, available in AMBISIG Geoportal software.

To determine past road conditions or to verify the presence or absence of roadside assets is possible to source historical data. A common search provides all road images between point A and point B on road X, between two dates. But other searches can be done, as verify the existence of sign type at a specific location or verify the speed limit at a specific location.

5. CONCLUSIONS

Kit Mobile Mapping can be routinely used by all Road Administration Institutes and Municipalities that have the responsibility of maintain and inspect roads and road assets. This portable system is very useful for those who want to ensure efficiency and safety road administration.

Given the low cost of this technology and the fact that it’s extremely easy to work with, the Kit Mobile Mapping democratize spatial and temporal monitorization, automating these management tasks from road inventory and data collection to data analysis, decision support, budgeting, and reporting.

6. REFERENCES


Figure 2. Camera image from KIT notebook

Once the data are collected is possible visualize information over map viewers, such as Google Maps or Virtual Earth.

Figures 3, 4, 5, 6. Google Map viewer

Assets collected included signs and line marking, security and drainage equipment, geometry, pavement surface, urban furniture, etc.