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CER TELEGEOMATICS APPLICATIONS AND PROJECTS IN CENTRAL EUROPE

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ABSTRACT

Applications and Projects of the Centre of Excellence in TeleGeomatics, University of Trieste, are herein reported, in particular as far as regards the Interreg SISA (Survey and Information System of Adriatic Roads) Project.
The new instruments and devices of MMS used for the surveys are described together with the obtained results and accuracies.
Moreover the results of laser scanner surveys from the Mobile Mapping Systems are presented and compared to another more accurate system.
Future developments and application are presented linking together different techniques and methodologies for real time surveys, in particular with the use of WADGPS techniques also through InterNet (SISNeT ESA Project), with a software developed at the Laboratory of Topography and GIS, Department of Civil and Environmental Engineering.

1. INTRODUCTION

The Interreg SISA (Survey and Information System of Adriatic Roads) Project links together the Universities of Trieste, Italy, Rijeka, Civil Engineering Faculty, Novi Sad, Faculty of Technical Sciences, Sarajevo, Civil Engineering Faculty, Geodesy Department, Polytechnic of Tirana, Civil Engineering Faculty, Tirana, Institute of Transport Studies, Autonomous Region Friuli Venezia Giulia, Central Direction for Territorial Planning, Mobility and Transport Infrastructures, Transport Services, Goods Transport, Trieste, Italy.
In the Framework of the SISA Project more than 1000 thousands km have been surveyed using the MMS (Mobile Mapping System) of the Centre of Excellence in TeleGeomatics, University of Trieste, Italy.
The instruments installed on the vehicle and the implemented software permit to obtain with high accuracy the parameters relative to the roads surveyed and to extract the geometry and the features relative to particular elements in the surrounding of the surveyed roads. Moreover a laser scanner installed on the vehicle permits to have more distance informations, also in dynamic mode.
2. THE MOBILE MAPPING SYSTEM (MMS) OF THE CER

The MMS G.I.G.I. (GPS Integrated with Glonass and Inertial Navigation system) was born in the framework of the COFIN 1999 and COFIN 2000 Projects, co-ordinated by Professor Giorgio Manzoni, University of Trieste, Italy. The Universities of Parma, Bologna, Ancona, Pisa, Roma la Sapienza, Cagliari, Napoli Istituto Universitario Navale and Catania participated to the Projects.

G.I.G.I one was born in 2003 like an evolution of G.I.G.I (Fig. 1). In the new MMS a digital camera has been substituted by the equivalent colour model (Basler A101fc), a digital Hitachi DZ-MV200E camera with direct storing on DVD has been added, moreover a monoaxial laser scanner IBEO has been installed on the back of the vehicle.

The GPS/INS integrated system computes the vehicle position with high accuracy; it is composed of the PCS (POS Computer System), a computer containing also two GPS cards and getting the data of four external sensors: the IMU, Inertial Measurement Unit, the DMI (Distance Measuring Indicator) and two GPS Trimble cards (Fig. 2).

The sensor errors are estimated on continuous basis using Kalman filters.

The heart of the System is the PCS that receives all the data coming from the different sensors of the POS/LV for real-time processing of the vehicle position. The real time navigation data can be stored inside the PCS and get available for post-processing, using a specific software.

The Inertial System mounted on board the vehicle is a LN-200 fiber optic gyro I.M.U Litton, composed by three accelerometers and threeer optic gyroscopes, giving in real-time the asset of the vehicle. The I.M.U is linked to P.C.S by a data transmission cave. The odometer (D.M.I) is mounted on the left back wheel of the vehicle; it generates 1024 impulses per second. The principal GPS receiver is a L1/L2 one, the secondary is a L1 receiver. They can receive and process the RTCM and RTK differential corrections. A DGPS Max receiver, able to receive and process the differential correction data
transmitted from the Omnistar Geostationary Satellites, is also used. The corrections can be used as input for the System mounted on the vehicle.

The digital cameras are mounted on the front of the vehicle. The right camera is a black/white one, the left is a color digital one. The photogrammetric data are processed using monoscopic techniques and most of the informations are derived from the photograms stored by the color digital camera. The black/white photograms are used to accurate define the road geometries. The maximum resolution is 1280 x 960. The exposition time is regulated by software. The acquired images are compressed in jpeg format before saving. At the end of the survey all the images are transferred to a local network resident on a personal computer. A trigger signal generator linked to the P.C.S. syncronize the photograms to GPS time.

![Diagram](image)

Fig. 2. The PCS, IMU, DMI and GPS antennas

More then 1000 thousands km have been surveyed in the framework of the S.I.S.A project. Positioning and geographic data are stored by the MMS. The positioning data permit to reconstruct the trajectory through the GPS/INS integration. The geographic data are reconstructed from the digital camera photograms and from the laser scanner and other sensors data. The advantages of the M.M.S are: an high effiency, the absence of ground control points, the integration between different sensors and the automatic
digital data archiving. Moreover the MMS can operate even during traffic conditions. The high System efficiency allows to keep updated the road databases. The implemented software simplify the acquisition and storing of the data.

*Fig. 3. The implemented software for the digital photograms acquisition and storing*

### 3. LASER SCANNER SURVEYS AND COMPARISONS

An IBEO LD Automotive monoaxial laser scanner has been installed on the back of the vehicle. Its accuracy is 5 cm, with a scan time of 50ms. The laser scanner operates during the survey, thus the obtained sections envelope along an elicoidal trajectory. Knowing the continuous vehicle position it is possible to determine the position relative to the various scans. Using also the vehicle asset, the scans can be corrected considering the spatial laser sensor position during each scanning. In Fig. 4 an example of the laser scanner survey of a gallery and sections with the pavement are shown.
Fig. 4. Laser scanner survey of a gallery and sections with the pavement

Thanks to the co-operation between the STT Trieste, and the Center of Excellence for the Research in TeleGeomatics, the laser scanner data have been compared with the data obtained by M.M.S., thus verifying the efficiency and accuracy of the results obtained from the vehicle to respect to the Numerical Technical Cartography and the affidability of this and the ortho images given by Friuli Venezia Giulia Autonomous Region.

A road intersection has been analysed on a provincial road, the SP1, near Prosecco, Trieste – Italy.
Fig. 5. The high accuracy laser scanner survey of a road intersection on SPI, Prosecco

8 scans have been obtained in total from 5 different points, with a very dense grid (2.5cm at 50m) in order to obtain an high detail for the comparison between the horizontal signs surveyed by LS and that surveyed by the photograms obtained from M.M.S (Fig. 5). Contemporaneously the road tract has been georeferenced using a GPS topographic survey. Linking together the scans with Poliworks dedicated software, very good results have been obtained, thus confirming the efficiency of the used technology (MMS GIGlone) for road cadaster purposes.

From the cloud of surveyed points the triangulated model has been created on the basis of the processing of the road sections and of the level curves.
The comparison between the measurements put into evidence the quality of the measurements done by the vehicle, also putting into evidence the limit of the integration between the two systems, using the laser scanner in static mode.

4. IMPLEMENT OF A LOCAL DATA SERVER AND FUTURE DEVELOPMENTS

In order to generate differential corrections to be transmitted through InterNet for real time applications, a local Data Server is under implementation. The Local Data Server will extract the RTCM and RTK corrections from a geodetic L1/L2 GPS receiver and will retransmit them through InterNet in order to make them available for the MMS and other vehicles for real time positioning at different accuracy levels.

The project includes moreover the extraction of the EGNOS SIS from a Novatel geodetic L1/L2 receiver and the retransmission to authorized users for kinematic applications. The local Server will apply the principles of SISNet project (Fig. 6), architected by ESA, in order to make the SIS available also when the Geostationary Satellites are not visible during the survey. Dedicated software will be used for the managing of the SIS messages (Fig. 7).

![Diagram of the SISNet architecture](image)

*Fig. 6. The SISNet architecture*
Fig. 7 Dedicated software built for the managing of the SIS messages

