

## MOBILE MAPPING SYSTEMS IN CULTURAL HERITAGES SURVEY

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### ABSTRACT

A Mobile Mapping System (MMS) can take photos with external orientation parameters thanks to GPS and INS. Even if this system was created for road survey it has recently found an application to Geographic Survey for Cultural Itineraries along Europe. With this purpose it has been tested in the area of Verona. The test has been made widening the meaning of “*cultural*”: it includes landscapes, high quality agriculture and food specialities production.

### 1. THE SURVEYING APPROACH

Mobile Mapping System (MMS) is a well known van equipped with high performance surveying system, including GPS/INS positioning and digital cameras.

The camera images provide all the relevant mapping data for the Road Cadastre by photogrammetric processing. Each camera image is therefore georeferenced in the global frame from the positional data got by the GPS/INS system. INS gives also data for the external orientation of the cameras.

This MMS GIGI-ONE of the University of Trieste, Centre of Excellence TELEGEOMATICS, which has been used for the present research, has been already described in Manzoni et al., 2004.

Summarising, the MMS equipped at the University of Trieste is an Applanix POS/LV (Position and Orientation System for Land Vehicles); this is a GPS/INS integrated system, able to supply high accuracy real time navigation data thanks to the aid of DGPS, a second GPS antenna for high precision Azimuth detection and a 1024 pulses per revolution Distance Measuring Indicator (DMI). INS sensor has three Laser Gyros and three accelerometers. The core system is the LITTON LN-200 optic fibre gyro IMU. This is made of three accelerometers and three optic fibre gyros. It can supply 0.01° Pitch and Roll, and 0.04° true Heading accuracy in real time; 0.005° Pitch and Roll, and 0.02° true Heading accuracy after post-processing.



Fig 1. The vehicle equipped at the University of Trieste

Real time navigation data can be improved by post-processing Applanix POS/LV. This works together with two imaging subsystems, each of them composed by a Matrox 4Sight computer and a Basler CCD B/W camera. A transversal Laser Scanner is now on test.

The MMS runs each surveyed road back and forward. The reason for this is:

- Some road axis topology constraints exist such as bifurcation, roundabouts, lane separations and so on. So a one-way survey is not enough;
- The road slope (transversal gradient) may vary for each lane;
- A complete photo coverage is needed;
- In this way, at least for some road segments, it is possible to achieve two independent axis estimates, with enhanced accuracy assessment.
- Therefore at the end of the survey campaign, the obtained data for each surveyed road includes a number of georeferenced and attitude referenced image files.

These images can be used for other purposes such as territorial planning based on buildings identification (for instance to understand if they are industrial or residential), agriculture inventory, cultural heritages positioning.

This can be considered as a new application in a very interesting social field (of growing interest) as junction among ICT, Information Communication Technology and Humanistic, Geography in particular.

### 2. THE GEOGRAPHIC APPLICATION

Especially today the understanding of LOCAL DEVELOPMENT, related to an increasingly global society/economy, is particularly important. The expression "GLOCAL DEVELOPMENT" usually addresses this issue. ICT (Information Communication Technology), increasingly used in all cultural sectors, adds value to actions undertaken, in particular when dealing with territorial sciences, the development of tourism and planning activities. Using these tools, it is now easier to inform all residents of an area (and also visitors or people just passing by) about all aspects characterising it (cultural, economic, infrastructural...) and events to them related. In particular it is important to enlighten every relevant and interesting feature of the territory, including monuments, housing, commercial and industrial estates or harbour structures, which sometimes make the landscape unpleasant.

ICT is, thus, used to point out, in real time too, via Internet routes and places in order to encourage a high quality tourism. ITC methods will be used for data collection, data entry in a Geographical Information System (GIS) and for their diffusion through WEB GIS or similar tools. Mobile Mapping System (MMS) and Satellite Positioning (GPS) [integrated with INS (Inertial Positioning System), EGNOS (the European system) and later on with GALILEO] represent the innovative elements to be used in the collection of such a data. Their use for tourism purposes in general (i.e. not linked to a single case or place) represents something new and innovative, in particular when dealing with Long Distance Trans-European Routes (see fig. 2)

ROUTES FOR TOURISM AND CULTURE

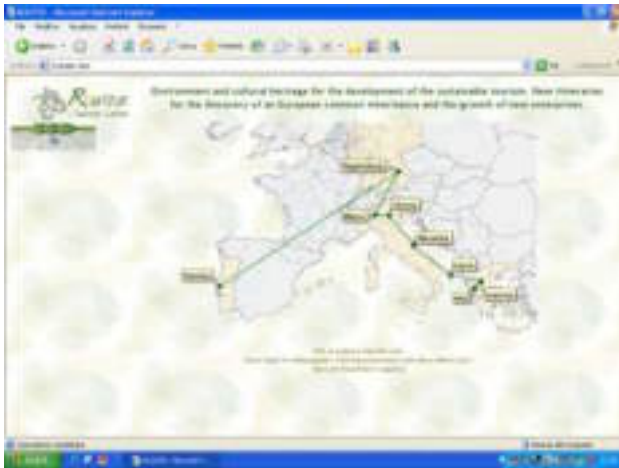


Fig. 2 Wine and oil long itinerary, from C.Robiglio and C.Martinelli,2003

Besides it is very innovative in the field of human settlements planning. Moreover, using landscape images registered by digital cameras (see figure 2) it is possible to draw attention to:

- the presence and typology of buildings at the sides of the road in particular when they destroy an amusing territory (see figure 3,4, 5);

- the state of preservation of road edges;
- the state of deterioration of the environment [as much as the presence of rubbish, people throw along the roads(inappropriately and very often)];
- the existence of fields, pasture lands or woods (see fig.3, 7 , 8);
- the tourist signs and their visibility (pointing at hotels, restaurants, parking places...);
- the degree to which landscapes are (clearly) visible and, thus, the possibility to see the skyline (fig 9, 10);
- the presence of the Cultural and Natural Heritage;
- the presence of (satisfactory) public facilities;
- the presence of adequate parking places.

This information has to be inserted in a Geographical Information System both for tourist purposes and for territorial planning.

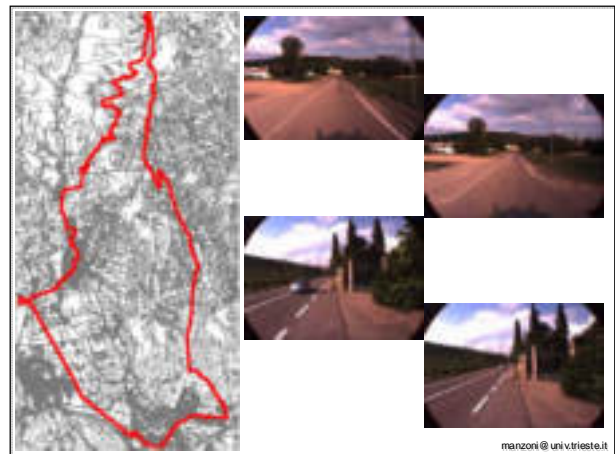


Fig.3.A route of GIGI-ONE on the Verona Hills and an example of its photos; cultivations, villas, hills are visible and their inventory is possible.

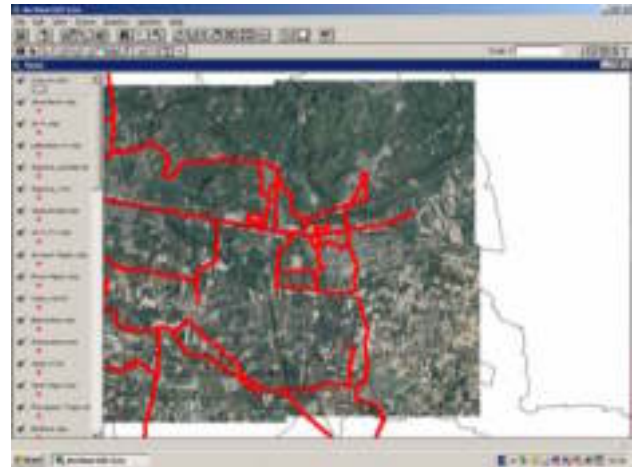


Fig. 4 GIGI-ONE routes across and around the RS-Regional Road ( old SS-State Road) 11 at east of Verona



Fig.5 Magnification of fig.3 in correspondence of the San Bonifacio Industrial Area



Fig.6: A GIGI-ONE photo taken inside one of the industrial areas along the SR 11

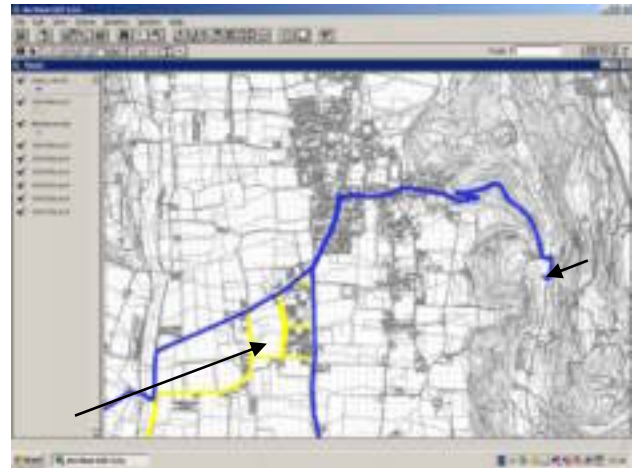


Fig. 9 Routes surveyed by GPS in the Illasi Valley at East of Verona. The trajectory ends at the Illasi Castle. In the small already cultivated field shown by the arrow, an industrial plant now hides the Castle to old houses ( see figure 9)

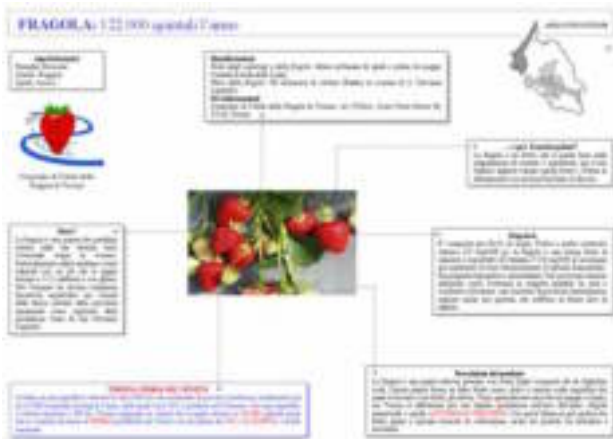


Fig.7 : A description of agriculture products which has been linked to the GIS in fig.7,from R.G.Rizzo, 2004

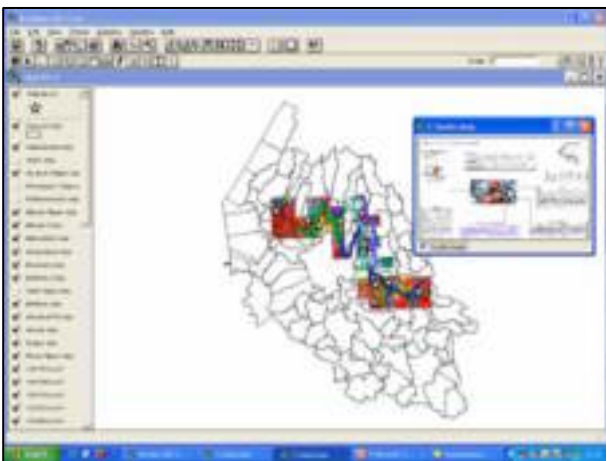


Fig.8 A GIS with GIGI-ONE trajectories in the Province of Verona linked to the agriculture products descriptions, corresponding to the product specialized areas.







Fig. 10 The sequence of photos shows how a new industrial building can destroy a secular panorama. A 10 meter height building has to be built 100 meters apart, to allow the visibility of the Castle

### 3. CONCLUSIONS

A surveying van is available at the University of Trieste for Road Information System (RIS) and data acquisition. Its complementary use in tourism and territorial planning applications is demonstrated through some examples carried on in the province of Verona. Since many thousand of kilometers of roads are already surveyed or to be surveyed in Italy, then a lot of data are available for these applications. In some cases the metric use will be performed as in R.Reulke, A.Wehr,2004

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