CONference  
Monday 18th September 2006  
organized by Giorgio Manzoni and Bernardo Sannino  

THE BALKANS: A LAB OF EXCELLENCE  

SISA Project  
An Informative Adriatic Road Project surveyed driving through the Balkans  
A Project funded by the European Union and implemented by the Friuli Venezia Giulia Region and the Centre of Excellence in TeleGeomatics of the University of Trieste  

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Preface by  
Amb. Harald Kreid, CEI  

PROCEEDINGS  
Giorgio Manzoni and Raffaella G. Rizzo eds.  
Sala Maggiore  
Chamber of Commerce of Trieste
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Sistema Informativo Stradale Adriatico

Survey

Mobile Mapping System GIgI One

Data collection and elaboration

Output formats

Giorgio Bolzon, Rhaula Martinolli, Andrea Mamede
(Universita degli Studi di Trieste)

Survey and Information System of Adriatic roads

Project Partners

Università di Trieste
Centro di Eccellenza per la Ricerca in TeleGeomatica
and
Regione Autonoma Friuli Venezia Giulia
Direzione Centrale pianificazione territoriale, mobilità e infrastrutture di trasporto
Servizio trasporto merci
Surveyed roads: 250km
Photoframes number: 42,000
Database dimension: 8,5Gb

Rijeka - Croatia

Industrial area (1)
Highway's access point (3-5)
Touristic and trading harbour (2)
Rijeka - Croatia

Slide 15

S.I.S.A. - Survey and Information System of Adriatic roads.

Rijeka - Croatia

Slide 16

S.I.S.A. - Survey and Information System of Adriatic roads.
Bosnia and Herzegovina (Bosna i Hercegovina)

Surveyed roads: 30km
Photoframes number: 8,000
Database dimension: 1,5Gb

Sarajevo – Bosnia and Herzegovina
Sarajevo – Bosnia and Herzegovina

Surveyed roads: 100km
Photoframes number: 15,500
Database dimension: 2.0Gb

Serbia (Srbija)
## From Novisad to Beograd - Serbia

![Road Images](image1.png)

## Montenegro (Crna Gora)

<table>
<thead>
<tr>
<th>Surveyed roads:</th>
<th>280km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photoframes number:</td>
<td>43,000</td>
</tr>
<tr>
<td>Database dimension:</td>
<td>7.8 Gb</td>
</tr>
</tbody>
</table>
From Kotor to Bar and Podgorica – Montenegro

Slide 29

Albania (Shqiperia)

Surveyed roads: 310km
Photoframes number: 54,000
Database dimension: 9.0Gb
From Tirana to Shkodra — Albania

From Shkodra to Hoti — Albania
"Project’s numbers”

- Partner countries: 6
- Surveyed roads: 1.280km
- Photoframes number: 182,000
- Database dimension: 45,5Gb

(dimensions of 1,800,000 text pages)

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MMS (Mobile Mapping System)

A MMS is a van mounted high performance surveying system, both made up by positioning and survey sensors, which are synchronised to each other.
APPLANIX POS LV
Position and Orientation System for Land Vehicles

2 GPS RECEIVER
+ IMU
(Inertial Measuring Unit)
+ DMI
(Distance Measuring Indicator)
+ Real Time DGPS systems

REAL TIME 3D POSITION OF VEHICLE IN WGS84 SYSTEM (GPS coordinate system)

MMS (Mobile Mapping System)

PCS
Central processing unit
Integration of position data
Position data storage
2 GPS receiver

The whole system positioning accuracy depends on GPS mode:
- metric level using a good DGPS
- decimetric level using RTK.

The system uses both Primary and Secondary GPS single frequency data for GAMS (GPS Azimuth Measurement Subsystem), which permits to improve IMU heading performances.

IMU

The LITTON LN-200 fiber optic gyro IMU is the core of the system. It is made up by three accelerometers and three fiber optic gyros, and is able to 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.
DMI
1024 pulses per revolution.
DMI aids IMU on GPS outages, making the trajectory a nearly continuous line, as position data can be output at 200 Hz rate.

Basler CAMERA
The van-mounted Applanix POS/LV is coupled with two imaging subsystems, each composed by a Matrox 4Sight computer and a Basler CCD camera, one B/W and one color.
SISA DATABASE

AUTOMATIC
1. Photoframes
2. Position Data
3. Data for Road Safety

MANUAL
4. Data from Visual Analysis
5. RoadView

Graphical
Numerical
Numerical
Numerical
Graphical

1. PHOTOFRAMES

FRONTAL
LATERAL

Each camera provides 1 photoframe/s, that is 1 photoframe/15m (60-80 photos/km)

Photoframes have a good definition, 1280 x 960 pixels

Automatic color balancing, in order to fix image contrast
2. POSITION DATA

### Coordinate System

Cartographical Local datum, parameters provided by SISA partners

<table>
<thead>
<tr>
<th>PROGR (m)</th>
<th>EASTING  (m)</th>
<th>NORTING  (m)</th>
<th>ELLIPSOID (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5713765.648</td>
<td>4756974.800</td>
<td>114.529</td>
</tr>
<tr>
<td>1 m</td>
<td>5713764.810</td>
<td>4756975.345</td>
<td>114.503</td>
</tr>
<tr>
<td>2 m</td>
<td>5713763.978</td>
<td>4756975.901</td>
<td>114.474</td>
</tr>
</tbody>
</table>

1. Coordinates of MMS tracking wheel
2. Points from a GIGI survey, regardless of jurisdictional ownership of a road

3. DATA FOR ROAD SAFETY

**Our choice:**

<table>
<thead>
<tr>
<th>PROGR</th>
<th>EASTING</th>
<th>NORTING</th>
<th>ELLIPSOID</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Long Slope
- Transv Slope
- Curvature

**STANDARD METHOD**

- Calculation
- Output data format

**Law ?**

**OPEN PROBLEM**

**LONGITUDINAL SLOPE**

**CURVATURE DATA**

**TRANSVERSAL SLOPE**

Special equipment: IMU
3. DATA FOR ROAD SAFETY

Longitudinal Slope

slope = \frac{\Delta Z}{\Delta X}

1. Smoothing elevation data
   - degrees?
2. Setting offset = 10 m
   - percentage?
   - which approximation?

Output format:

Our data type
2.1 %

3. DATA FOR ROAD SAFETY

Curvature data

Progressive (m) | X (m) | Y (m)

1. In straight lines the driver can steer lightly
2. In a curve, driver can cover short straight segments
3. Even when the curve has $R = \text{cost}$, the vehicle trajectory has variable $R$

$K = \frac{1}{R}$
3. DATA FOR ROAD SAFETY

Curvature data

<table>
<thead>
<tr>
<th>Progressive (m)</th>
<th>X (m)</th>
<th>Y (m)</th>
</tr>
</thead>
</table>

1. In straight lines the driver can steer lightly
2. In a curve, driver can cover short straight segments
3. Even when the curve has \( R = \) cost, the vehicle trajectory has variable \( R \)

\[ K = \frac{1}{R} \]

- **K=0.001** Threshold value
- **70 m** Minimal length for straight line

**CODIFICATION**

- **K=0** Straight line
- **K=0.0005** Too short straight line (danger)
- **K=0.xxx** Curves

---

3. DATA FOR ROAD SAFETY

Transversal Slope

It is a feature of a single lane

**RANGE:** 2.5% \( \rightarrow \) 7.0%

**THE MOST DIFFICULT!!**

EXISTING HIGHLY PRODUCTIVE SYSTEMS USE INTEGRATED DATA WITH

- Inertial unit \( \rightarrow \) roll angle
- **Laser Scanner** \( \rightarrow \) roadway section

WE PROPOSE AN INNOVATIVE METHOD:

Transversal acceleration

3. **DATA FOR ROAD SAFETY**

**Transversal Slope**

**UNKNOWN**

**TRANSVERSAL SLOPE**
Of the roadway

**MODELIZED**

**DYNAMICS**
Of the wheels-suspensions springs system

**ROLL**
MEASURED by inertial unit

**YAW ANGLE**

**Our data type**
-2.1 deg

---

4. **DATA FROM VISUAL ANALYSIS**

**Getting measurements**

**Pixel coordinates**

**PHOTOGRAFMETRY**

- Monoscopic approach
- Vanishing point method

**True coordinates**
(True distances)
4. DATA FROM VISUAL ANALYSIS

Segmented attributes

Measured

Output

SEGMENTATION ALGORITHM

For every survey:
- Road width
- Pavements width
- Traffic dividers
- Number of lanes

For demonstrative cases:
- Road margins
- Road works
- Private accesses
- Traffic signals
- Services
- Lights
- ... according with the Italian Law D.M. 01/06/2001

DATA TYPE

5. ROADVIEW

Virtual Tour

Università degli Studi di Trieste
Survey and Information System of Adriatic roads
Serbia - Novisad
Collected data are in right format to build a GIS database.

A Geographic Information System is a tool to support decisions, policy making and Governance.

The construction of Geographic Information System is based on prompt high density and high accuracy data.

The application of a MMS matches these requirements.
Conclusions

Collected data are so useful to
- Real time road status analysis
- Road safety control
- Tourist applications
- Works planning
- Adriatic countries database harmonization

Thanks to all partners for cooperation