FIG WORKING WEEK 2012

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SOLDEO: a New Solution for 3D GIS Data Recording

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Summary

1. **Introduction**

2. **The Solid Image (SI)**
   - Definition
   - Structure
   - Generation

3. **The SOLid viDEO (SOLDEO)**
   - Definition and structure
   - Generation

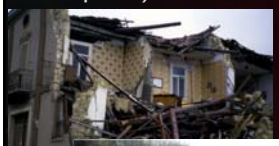
4. **A practical example**
   - The Low Cost LiDAR MMS
   - System Calibration
   - Generation of SOLDEO
   - The SOLDEO viewer

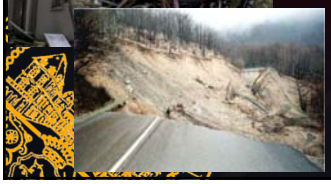
5. **Conclusions**

Introduction

In the market, there are several solutions for high-performance terrestrial survey (Mobile Mapping Systems, MMSs):

- sophisticated and **expensive for high accuracy**;
- Data processing are **complex**, often 'closed' and not fully controllable;
- software for GIS data extraction are only usable by **skilled users** (geomatics experts)





Many applications often require different features:

- **Flexibility** and portability;
- **Quickness** and easy of use;
- **Low Accuracy** and precision (<1m) ;
- **Limited costs** for kick off and management;
- Easy extraction of information from the acquired data in **multidisciplinary groups**

New instruments, methods and products are needed to fill this gap.

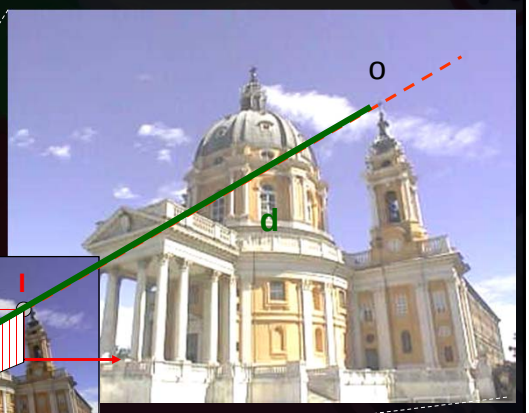
The Solid Image (SI)

Definition (Dequal et al., 2002)

Any image can be considered a **central prospective** of the photographed object.

If the **IO parameters** are known, it is possible to define a direction ***(α, θ)*** in object coordinate system ***(x, y, z)***

The coordinates of an object point O can be calculate if the distance ***d*** between the center of perspective and the object itself is known.



$$\theta = arctan\frac{\xi_I}{c}$$

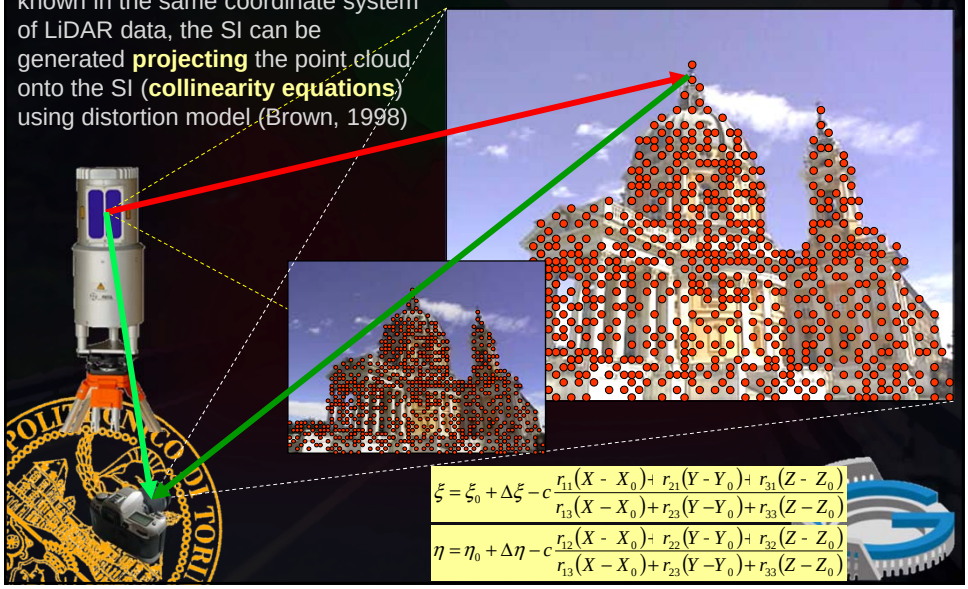
$$\alpha = \frac{\eta_I}{\sqrt{c^2 + {\xi_I}^2}}$$

$$\begin{cases} x_O = d\ cos\alpha\ sin\theta \\ y_O = d\ sin\alpha \\ z_O = -d\ cos\alpha\ cos\theta \end{cases}$$

The Solid Image (SI)

Generation (Dequal et al., 2002)

If the image EO parameters are known in the same coordinate system of LiDAR data, the SI can be generated **projecting** the point cloud onto the SI (**collinearity equations**) using distortion model (Brown, 1998)

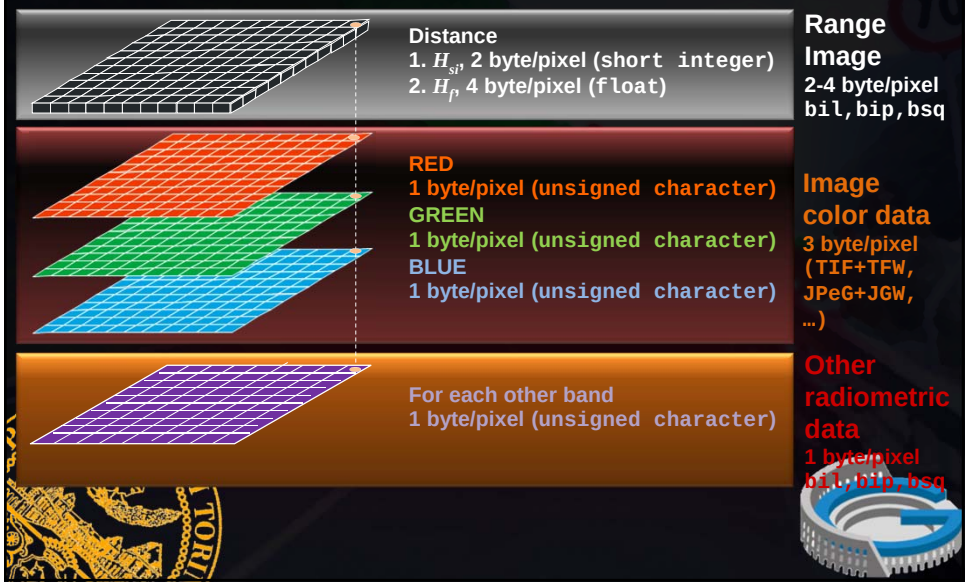


$$\xi = \xi_0 + \Delta\xi - c\frac{r_{11}(X - X_0) + r_{21}(Y - Y_0) + r_{31}(Z - Z_0)}{r_{13}(X - X_0) + r_{23}(Y - Y_0) + r_{33}(Z - Z_0)}$$

$$\eta = \eta_0 + \Delta\eta - c\frac{r_{12}(X - X_0) + r_{22}(Y - Y_0) + r_{32}(Z - Z_0)}{r_{13}(X - X_0) + r_{23}(Y - Y_0) + r_{33}(Z - Z_0)}$$

The Solid Image (SI)

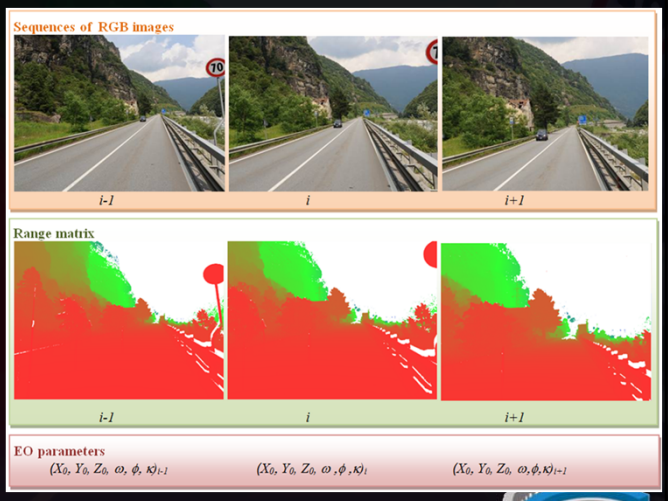
Structure (Dequal et al., 2002)



The SOLid viDEO (SOLDEO)

Definition

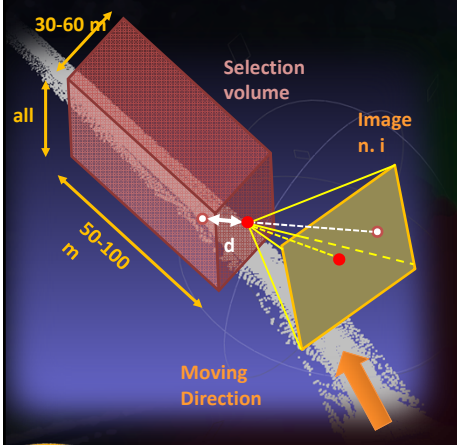
MMSs can acquire sequence of digital images to describe the road and neighbors area. Using LiDAR data, **each digital image** can be transformed in **a solid image** with:
- An **image ID** for identify an image inside the sequence;
- **EO parameters** derived by GNSS/IMU solution of MMS;
- A **range image** generated by LiDAR data.



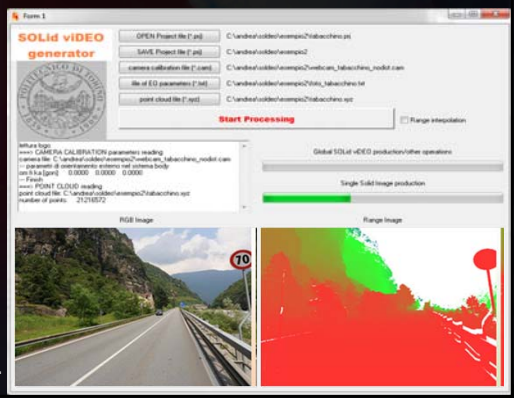
The solid video (SV) is a series of solid images collected like a video.

The SOLid viDEO (SOLDEO)

Generation



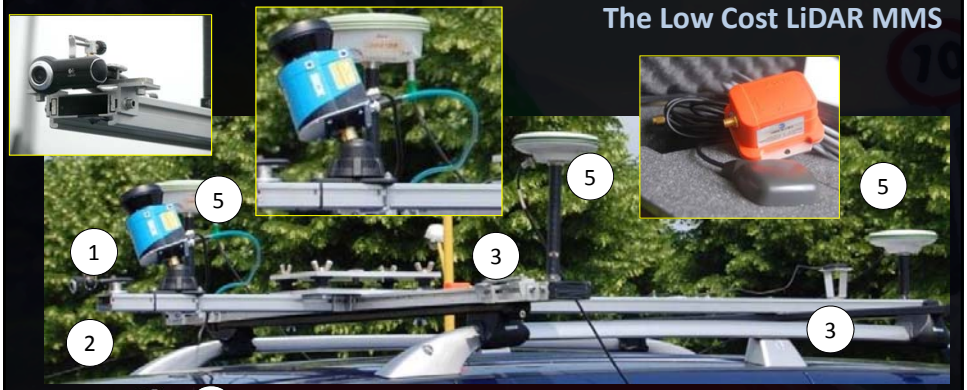
To generate SOLDEO, the large amount of LiDAR data requires an effective optimization: it is possible to select a little set of points from the entire point cloud using a **selection box** along the vehicle direction with correct versus.



A specific software has been developed by the authors using **Intel Visual Fortran** and GINO Graphic Libraries.

A practical example

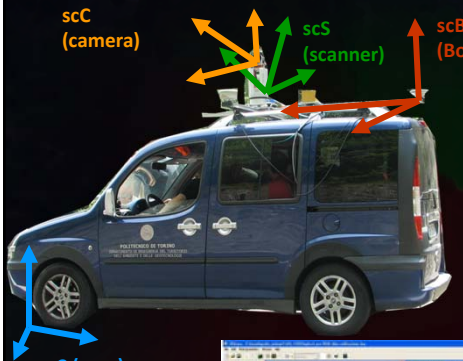
The Low Cost LiDAR MMS



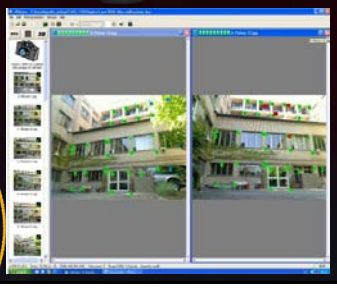
1) LiDAR – Sick LMS 100 (<4000€)
2) Logitech QuickCam Pro (100 €)
3) GPS/INS - X-sens Mti-G (<5000€)
4) Navigational GPS/GNSS receiver (SiRF3, bluetooth, 100 €)
5) Geodetic GNSS receivers (only for testing) **Total < 10000 €**

A practical example

Calibration



Using a specific network, **the EO parameters** of various sensors have been defined to permit the roto-translation of data in BODY coordinate system (El-Sheimy, 2004).



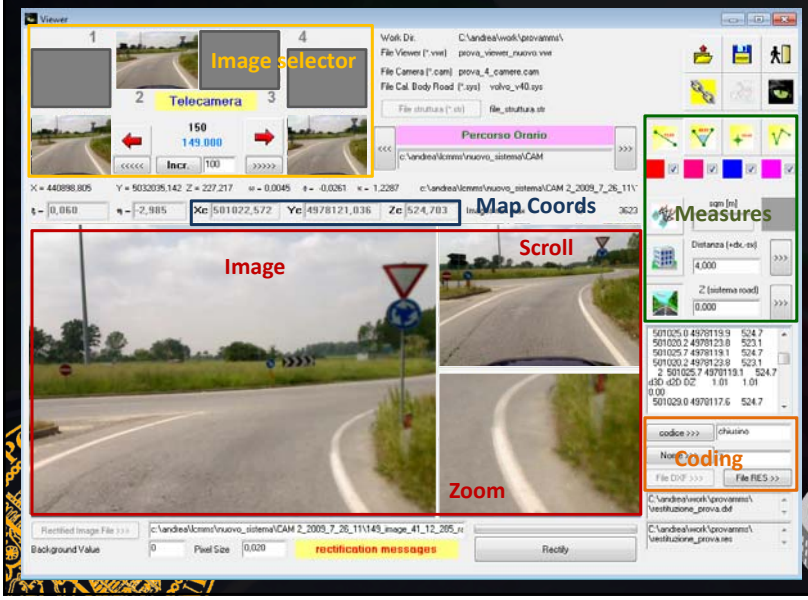
The **photogrammetric calibration** of webcam has been calculated using I-Witness

A practical example

Acquisition

A practical example

The SOLDEO viewer



A simple application (1.2 Mb) has been developed by the authors using **Intel Visual Fortran** and GINO Graphic Libraries to capture 3D GIS data.

A practical example

First results

The extracted points (about 1000) have been **compared with the correct location** defined using kinematic solutions of Geodetic GNNS receivers (table yellow).
In table cyan, only some classes of points relative to the road have been considered.

Coordinates	Mean [m]	Dev.St. [m]
E,N	1.10	0.42
Q	1.18	0.45

Details	Mean [m]	Dev.St. [m]
center line	1.05	0.34
lateral line	1.10	0.45
road border	1.52	0.76
Street number	1.02	0.41
support for traffic signals	0.99	0.31

Relative detail	Mean [m]	Dev. St. [m]
Lane width	0.05	0.10
Carriageway width	-0.04	0.12
Roadway width	0.12	0.25

Table green describe the comparison between relative measures (distances)

The precision is **always sub-metrical** (40-50 cm) but there are **some systematic effects** (the accuracy is about 1.1 m).
Relative measures have **a precision of about 1 dm** without visible systematic effect.

Conclusions

The SOLid viDEO is a new product which permits:

- a **correct** (with controlled accuracy),
- **complete** (3D),
- and **structured** (Coding)

representation of land and environment which is **quickly** applicable in **extensive fields** and wide areas.

The developed **viewer** allows to use the SOLDEO:

- in an **easy way**;
- even for **unskilled** user
- and **without high performance** PCs.

THANK YOU FOR YOUR ATTENTION

A new low cost MMS with LiDAR instrument has been used to acquire **geospatial data** in an road survey and large scale mapping application, demonstrating the effectiveness of SOLDEO in **3D GIS data collection.**