THE CYBER SECURITY FRAMEWORK FOR HUMANKIND'S HERITAGE

Humankind's heritage preservation today is crucial since criminal damage and natural threats have increased the likelihood of occurrence and their reach
Global heritage sites monitoring, to be effective, must take place in real time and must be based on geomatic 3D models that allow the gathering of information from the site to identify and mitigate man-made and natural threats.
Security is not only the physical protection related to video surveillance systems, but an advanced model of correlation of measures on the territory, monitoring and operational management based on the risk indicators built.
The model of monitoring proposed, uses optical sensors, laser, thermal, multispectral, photogrammetry by UAV for the modelling of sites to be protected, physical security tools (TVCC, barriers) for the protection, information security methodologies for the classification of the heritage to be protected and key risk indicators (e.g. destruction, unauthorized access) that will then be valued by the various measures collected in the field.
The approach is to use a risk management methods and tools needed in order to have a better handle of vulnerabilities The framework include best practices defining what to protect, how to protect it, and how to monitor deployed controlsand to assess each risk.

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ING. P. ROCCO[1], ING. D. DOMINICI[2], ING. A. TABALLIONE[3], ING. E. ROSCIANO[4]

[1] Engineer, Cyber Security, Ordine degli Ingegneri della Provincia di Roma
[2] Engineer, Prof. of Geomatics,University of L'Aquila
[3] Engineer, Gitais S.R.L, L'Aquila
[4] Enginner, Gitais S.R.L, L'Aquila

rccpla@inwind.it
donatella.dominici@univaq.it
taballione.annalisa@gmail.com
rosciano.elisa@gmail.com

Definitions of the cultural and the natural heritage

The following shall be considered as `cultural heritage':

- **Monument**
- **Groups of buildings**, special value from the point of view of history, art or science;
- **Sites** : topographical areas, are of special value by reason of their beauty or their interest from the archaeological, historical, ethnological or anthropological points of view.

Natural heritage refers to the sum total of the elements of biodiversity, including flora and fauna , ecosystems and geological structures:

- **natural features** consisting of physical and biological formations or groups of such formations, which are of special value from the aesthetic or scientific point of view;
- **geological and physiographical formations, special** value from the point of view of science or conservation;
- **natural sites** or precisely delineated natural areas of special value- from the point of view of science, conservation or natural beauty, or in their relation to the combined works of man and of nature.

RISK MANAGEMENT

R=Risk
P= Hazard (Probability of occurence)
V= Vulnerability
E= Exposure

Risk is one of the most important parameters to be evaluated in order to prevent extensive damages and loss of lives.
Risk management is everything we do to understand and deal with possible negative impacts on our objectives.
It includes the:

- **identification**
- **analysis**
- **prioritization** (we call it evaluation) of risks.

Then we take action to '**treat**' risks, i.e. to *avoid, eliminate or reduce the risks* that we consider unacceptable. We can also transfer those risks to others.

The RISK IS UNDER CONTROL?

Geomatics Science

What does it mean geomatics?

Geomatics is:

the discipline that deals with the acquisition, processing, interpretation, dissemination of geographic data.

Geomatics as discipline for the knowledge and SMART management of the territory…

Geomatics provides the best way to give an efficient response by combining many techniques which are able to observe and measure environment, infrastructures and structures.

All the geomatic techniques may be integrated one with each other. This allows to represent the investigated area «from a lower to an higher» scale .

Geomatics applications from small up to very large scale.

Geomatics

environmental monitoring and management

from small up to medium scale applications (Remote Sensing, GNSS and SAR monitoring of landslide)

cultural heritage monitoring and civil applications

from very large up to large applications (3D modelling using UAV photogrammetry and laser scanner techniques, displacement monitoring)

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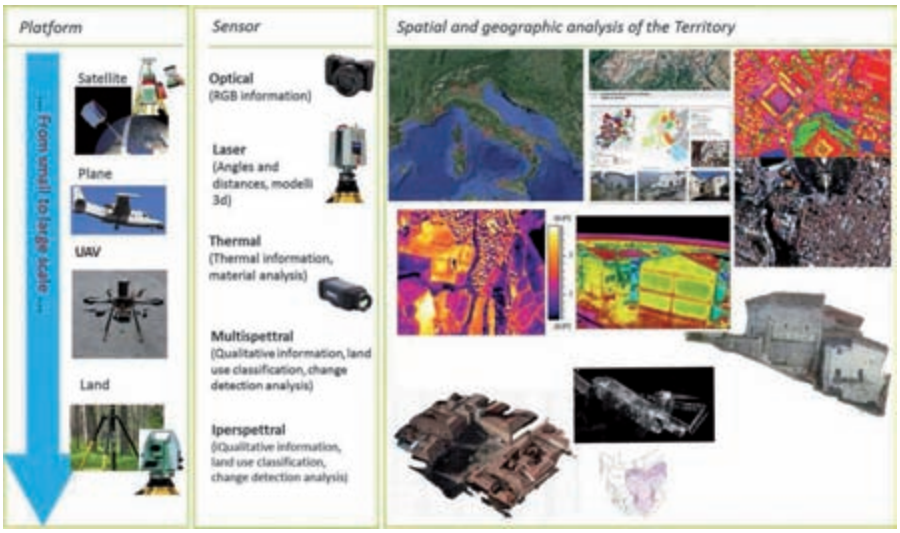
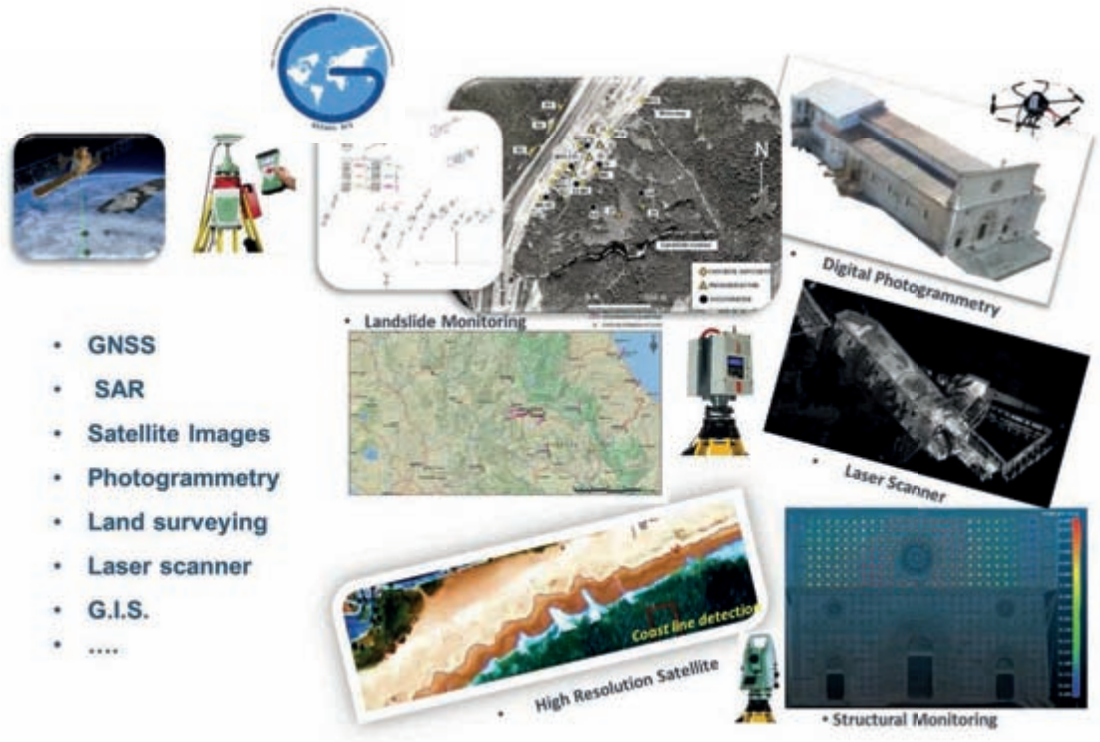
Knowledge Phase – 3d Geo-Spatial modeling

The idea is to develop an OPERATIONAL and COMPLETE METHODOLOGY capable to lead the entire process of the sustainable recovery of the historical centers through the 3 important phases of KNOWLODGE, MULTILAYER ANALYSIS AND DESIGN of the best solution defining a systematic process that can be replicable in any historical centers context.

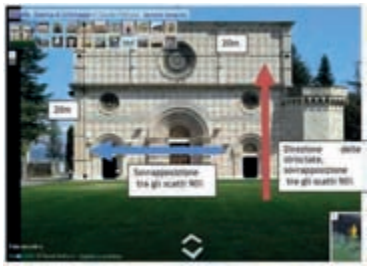


Gitais Model



Case study: 'Collemaggio' Basilica

- Flight planning



The flight planning was generated at the distance of 30 m on the facade.
The overlapping of the photogrammetry was equal to 90%.

- UAV Equipment

UAV

- Ground Control Point (Total Station)

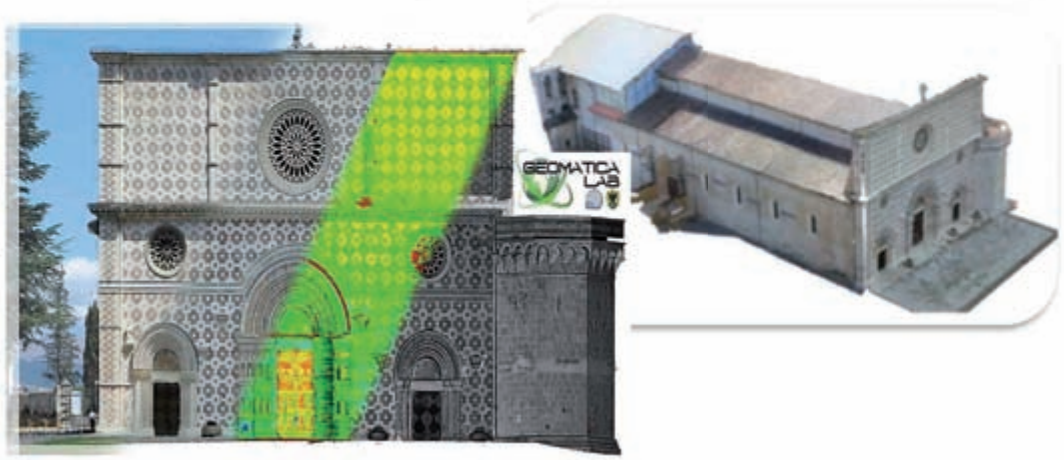
Network of Ground Control Point (GCP)

A network of GCP was measured on the facade using the Total Station TS30.

Camera specifications

Basilica Santa Maria Di Collemaggio, L'Aquila

Acquisition mode/image number	*UAV*	*291*
	Terrestre	*0*
GSD (Ground Resolution distance)		
Geometry acquisition		*Oblique*
Flight height/distance		*30 -15 m*
Photograms overlap		*90%*
		90%



papers

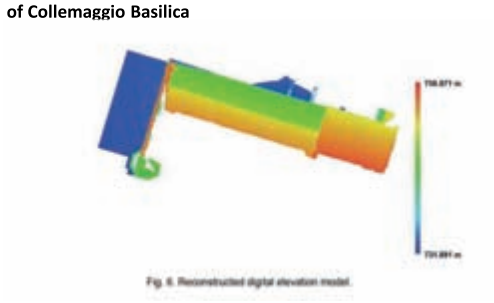
- Results



Results of Bundle Adjustment

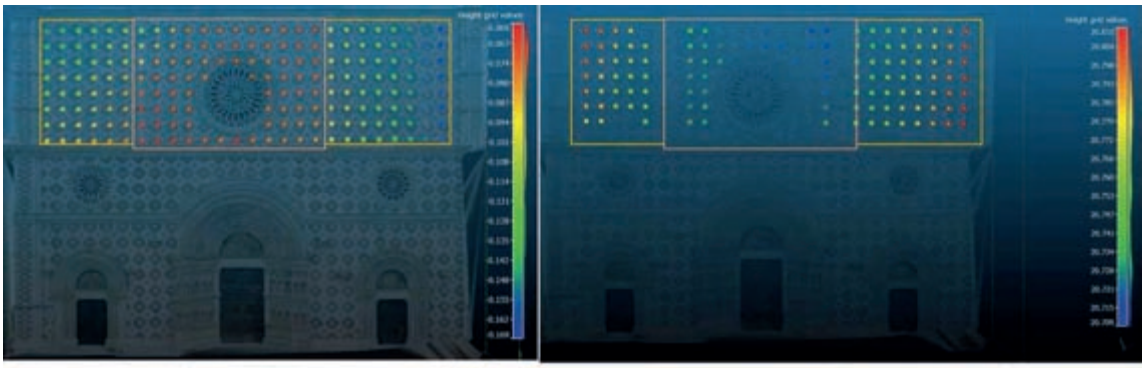
Case 1	Number	Error (m)	Error (pix)
GCP	7	0.035584	1.364605
Check point	45	0.061569	1.397261
Case 2	**Number**	**Error (m)**	**Error (pix)**
GCP	11	0.031943	1.322391
Check point	41	0.038778	1.409865
Case 3	Number	Error (m)	Error (pix)
GCP	20	0.027105	1.364835
Check point	32	0.046871	1.408498

3D Model of Collemaggio Basilica



- Results

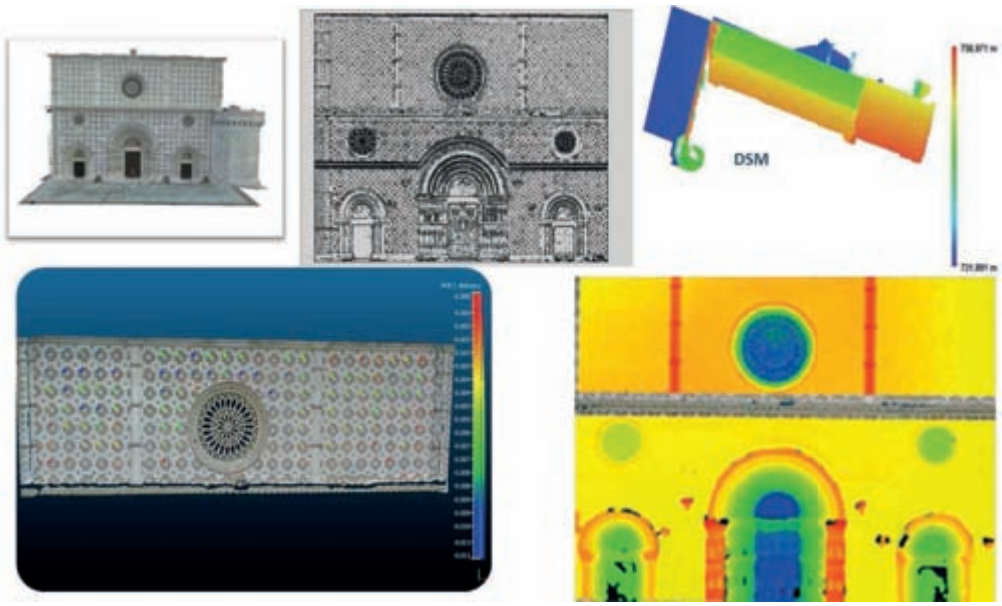
VERTICAL ANALYSIS ON THE FACADE



Photogrammetric point cloud — **Total Station point cloud (σ = 2-3 mm)**

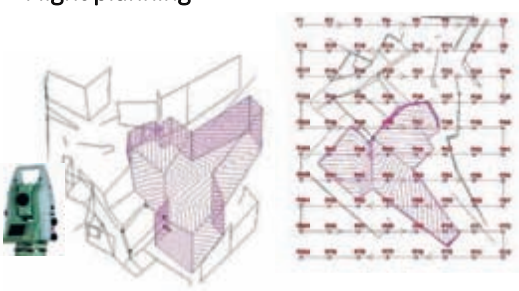
Good agreement

- Results



Case study: 'Fontecchio' build-up area

- Flight planning



For the flight planning has been used the volume of the build-up area previously measured with a total station.
The waypoint computation was performed considering an overlapping value of about 80% between the various photograms.
The obtained flight altitude was equal to 30 m.

UAV

GoPro hero3+

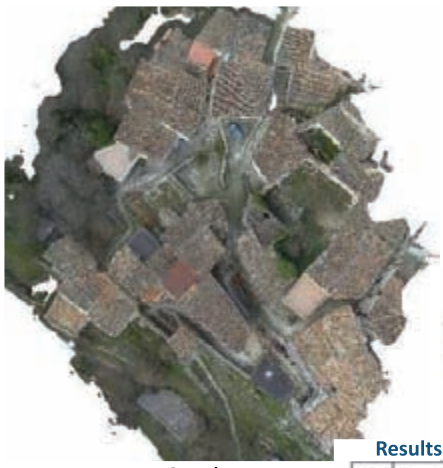
Weight: 74g
Resolution: 12 MP (4000x3000)
Wide field of view
Focal lenght: 3mm

- Ground Control Point (NRTK)

Only 4 GCPs were measured due to the low satellite visibility .

papers

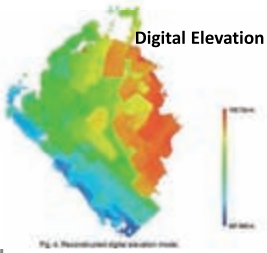
- Results



Ortophoto

3D Model

Lateral view



Digital Elevation Model

Results of Bundle Adjustment

Label	X error (m)	Y error (m)	Z error (m)	Error (m)	Projections	Er
gps1	-0.023200	-0.002612	-0.013203	0.026821	16	1.
gps5	0.016597	0.053314	-0.014569	0.057707	36	1.
gps6	-0.032304	0.042269	0.053469	0.075426	33	1.651860
gps2	0.038617	-0.093032	-0.025533	0.103914	38	2.480539
Total	**0.028933**	**0.057643**	**0.031215**	**0.071653**	**123**	**1.995353**

Table. 2. Control points.

Conclusions

Security is not only the physical protection related to video surveillance systems, but an advanced **model of correlation of measures** on the territory, monitoring and operational management based on the risk indicators built.

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