Comune di Valle Lomellina (PV)

fondazione cariplo

Dipartimento di Scienze ed Innovazione Tecnologica

CONSERVATION OF FRESCOES: A NEW NON-INVASIVE TOOL

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Diagnosis, Conservation and Valorization of Cultural Heritage,
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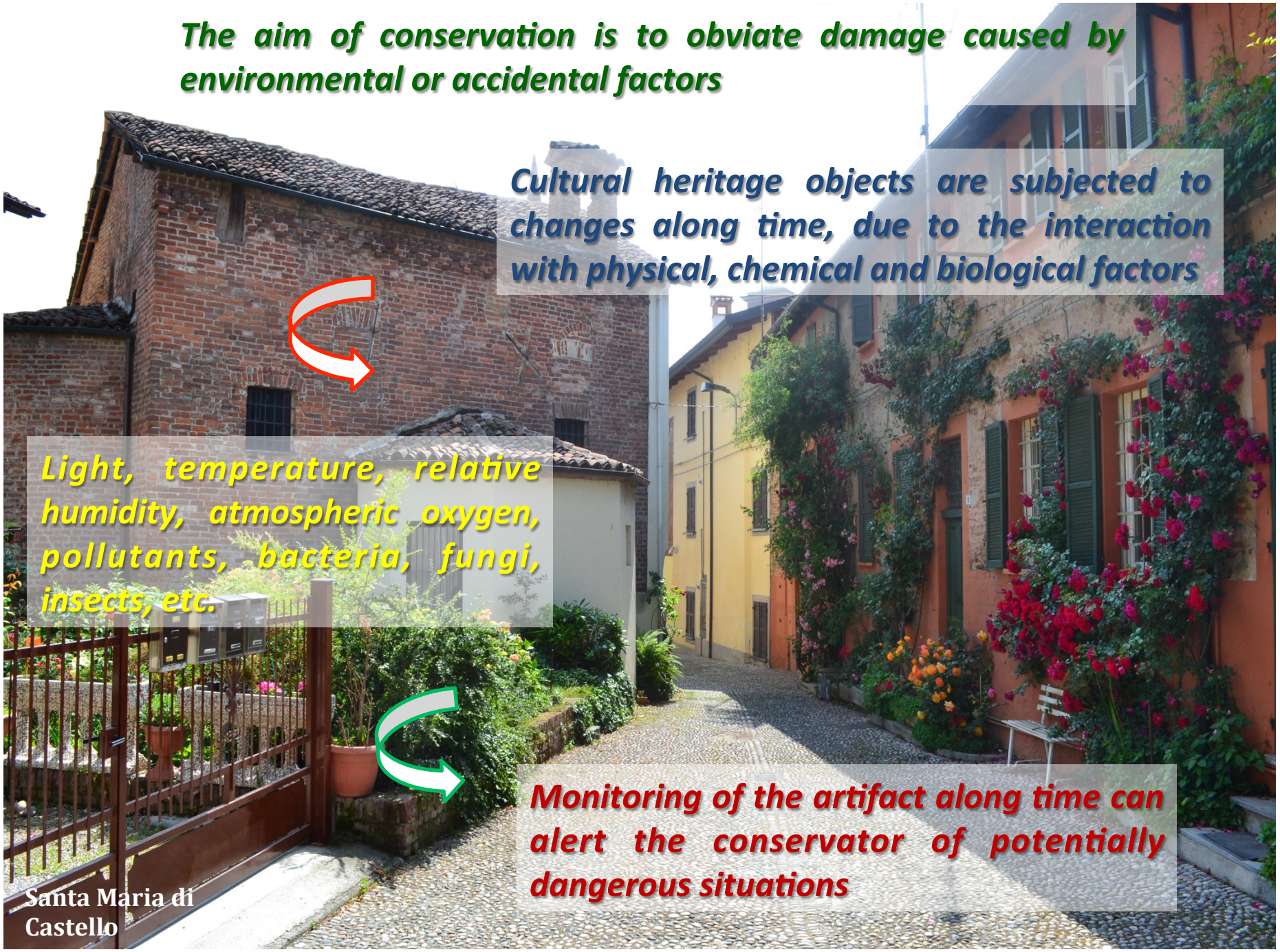
http://affreschivallelomellina.jimdo.com

In the ancient church of Santa Maria di Castello, located in Valle Lomellina (PV), there are five frescoes, now detached and framed, accidentally discovered inside the building under the plaster during the work performed in the seventies.

The history of the Church is linked to the Strada family's, already present in Valle in the fifteenth century. The frescoes were painted in the first middle of the '400 and are therefore one of the oldest and most interesting of the Lomellina.

Santa Maria di Castello

The church is not equipped with an adequate air conditioning and lighting and the frescoes are subjected to high thermo hygrometric changes which undermine the conservation. Sometimes the high humidity causes waves on the surface.


The aim of conservation is to obviate damage caused by environmental or accidental factors
Cultural heritage objects are subjected to changes along time, due to the interaction with physical, chemical and biological factors
Light, temperature, relative humidity, atmospheric oxygen, pollutants, bacteria, fungi, insects, etc.
Monitoring of the artifact along time can alert the conservator of potentially dangerous situations
Santa Maria di Castello

S. Maria di Castello, Frescoes of XV sec

↑*Fresco just detached*

↑*Fresco just restored*

Santa Lucia e Sant'Antonio Abate

Fresco today →

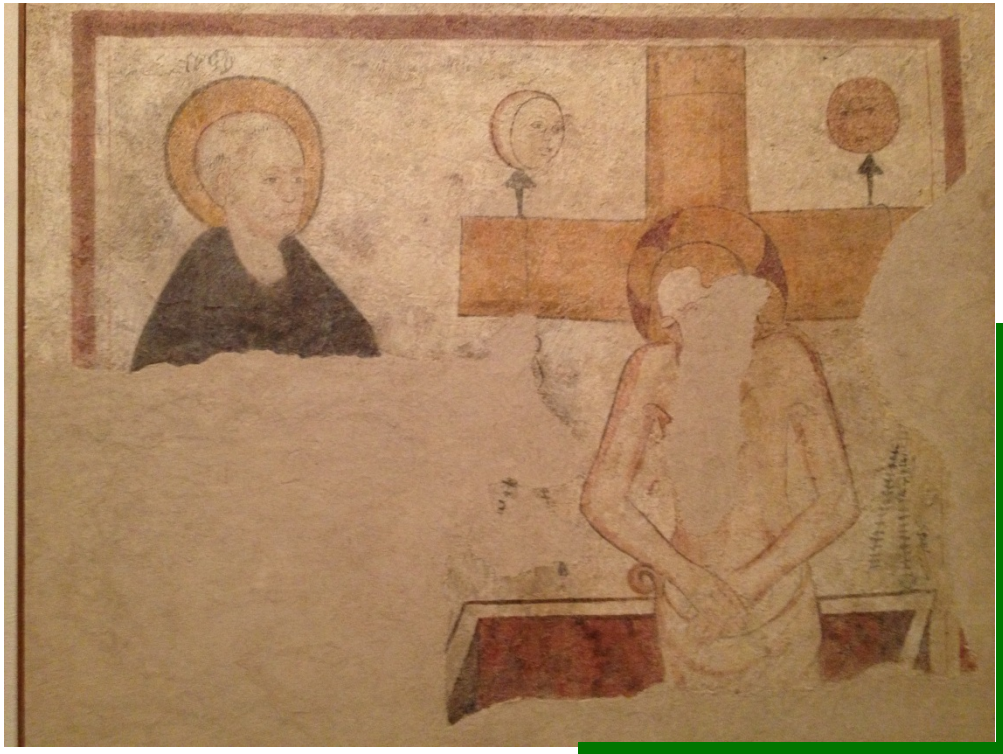
S. Maria di Castello, Frescoes of XV sec.

↑*Fresco just detached*

↑*Fresco just restored*

"Ecce Homo"

Fresco today →

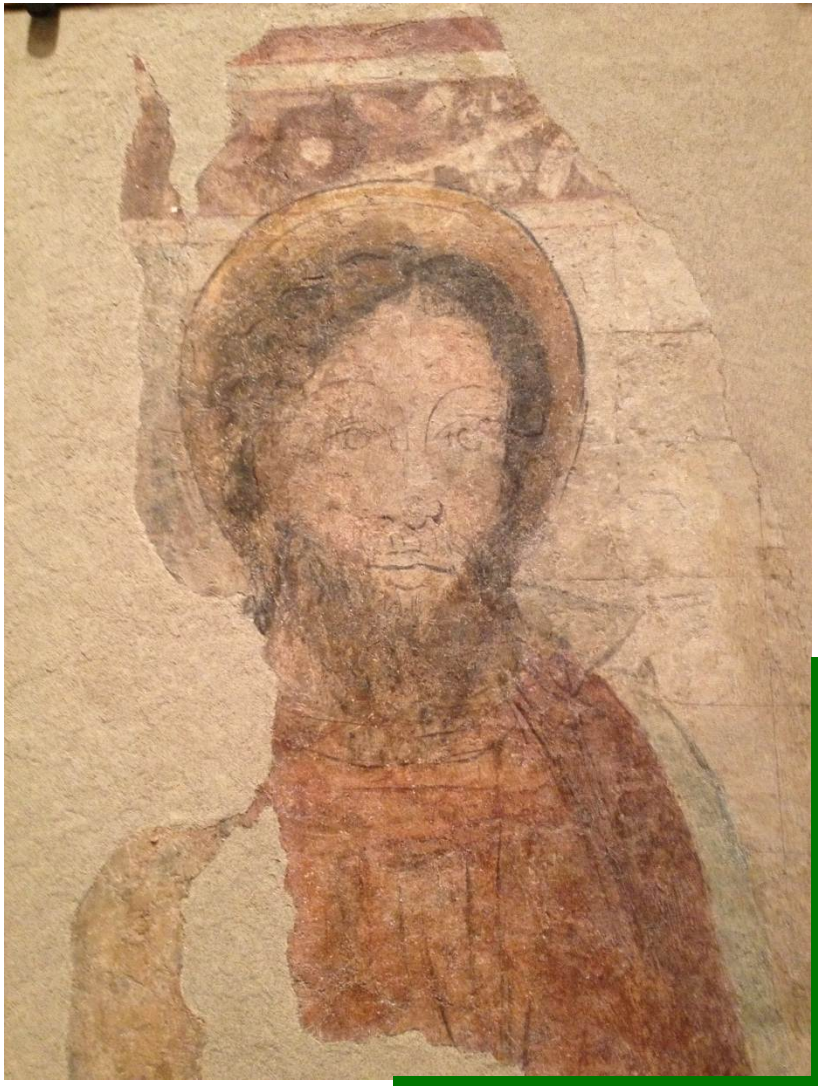


S. Maria di Castello, Frescoes of XV sec.

↑*Fresco just detached*

Testa di Santo

Fresco today →



S. Maria di Castello, Frescoes of XV sec.

↑*Fresco just detached*

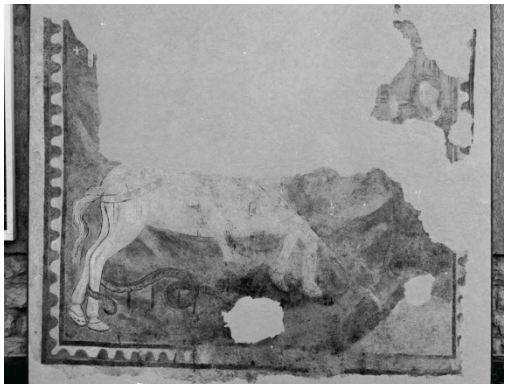
↑*Fresco just restored*

La "Crocefissione"

Fresco today →

S. Maria di Castello, Frescoes of XV sec.

↑*Fresco just detached*

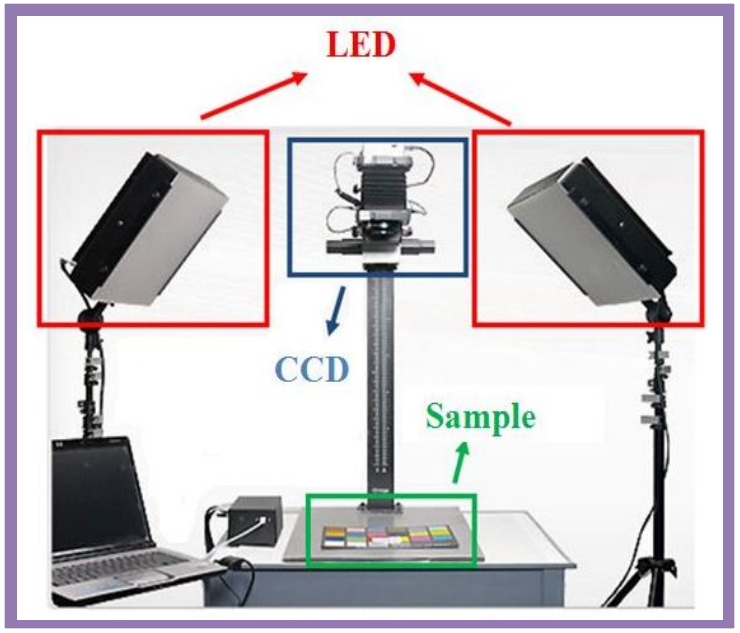


↑*Fresco just restored*

San Giorgio e la Principessa

Fresco today →

Preservation and conservation of cultural heritage needs:
an automatic and fast recognition of damaged area in order to alert conservator.



↑ **LED Imaging system.**

We developed, in collaboration with the Israel Antiquities Authority and the Library of Congress of United States of America, a new technique for monitoring the conservation state of surfaces: the algorithm uses imaging spectroscopy and PCA coupled to multivariate control charts.

The technique is actually in use for monitoring the conservation state of the Dead Sea Scrolls collection in Israel and for S. Maria di Castello frescoes in Valle Lomellina.

Monitored process → *Conservation state of the surface of objects*

Aim →
- *Detection of a possible ageing process*
- *Localization of the ageing process*
- *Its identification (which wavelengths)*

Recognize the presence of degradation/ageing processes at their initiation, (prior to being visually detected), and before significant damage has occurred

Frammenti dei Manoscritti del Mar Morto

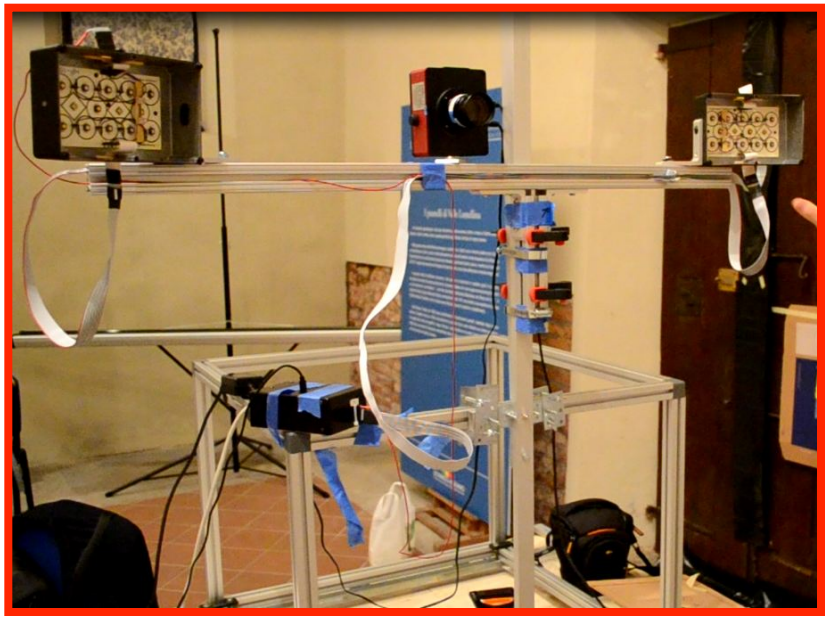
Multispectral Imaging

Acquires images of the same scene simultaneously in many contiguous spectral bands over a given spectral range.

The spectrum of any pixel in the scene can be calculated by adding wavelength to the image as a third dimension.

The technique is well accepted in biology, medicine, atmospheric studies, marine ecology and pollution control.

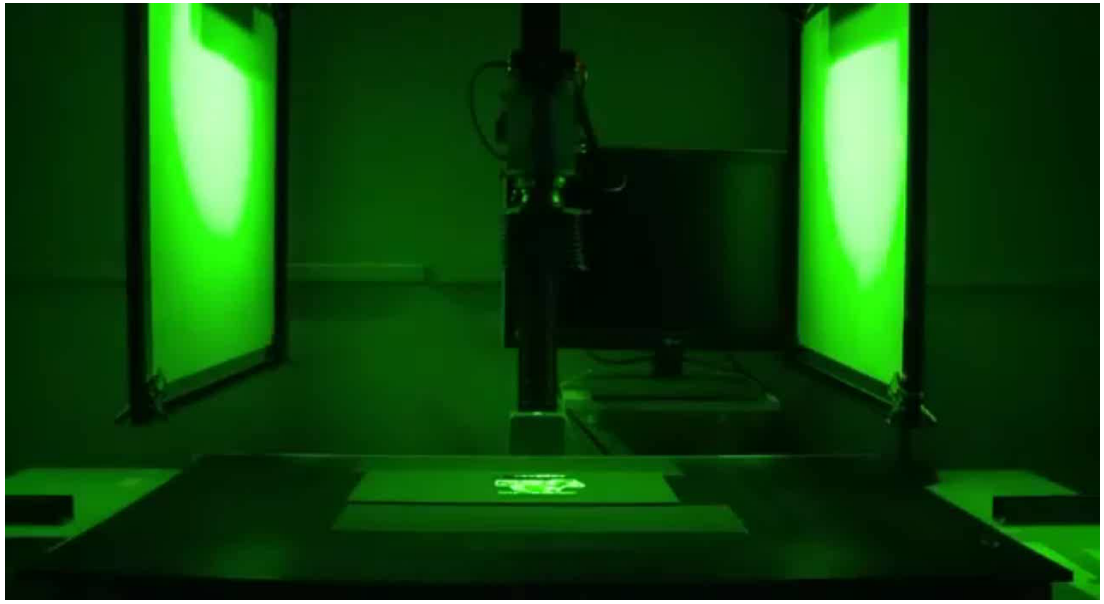
LED Multispectral Imaging



Advantages of LED illumination:

- *High **monochromatic** source*
- *High efficiency **reduces heat** and **stress** on the objects*
- *Higher spectral quality (**no filtration** is required)*
- ***Only enough light** to properly **expose** the objects is generated*
- ***Elimination** of unwanted **wavelengths***

wavelengths (nm)
370
446
466
498
521
600
640
940



PRINCIPAL COMPONENT ANALYSIS AND CONTROL CHART

We perform PCA, which is a variable reduction procedure, to multispectral images.

Process

"Natural" variability: a characteristic of the process investigated. It is constant along time.

Process under statistical control

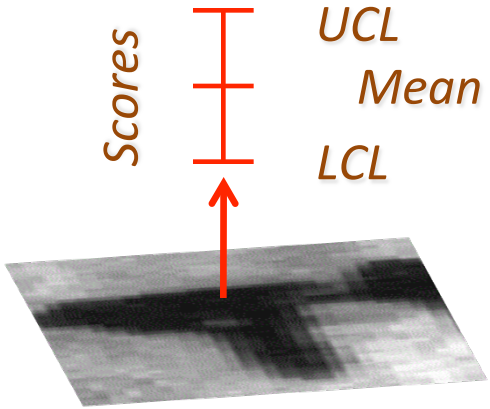
characterized only by its natural variability

Good preservation of the cultural heritage.

Process out-of-control

An 'assignable' or 'special' cause of variation is present.

***Change detected**: raises an alarm that a change or **deterioration** of the cultural heritage may possibly be occurring*



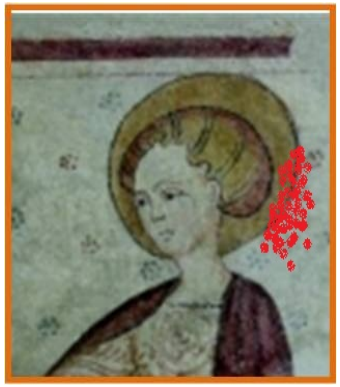
Characterization

t_0

Monitoring over time

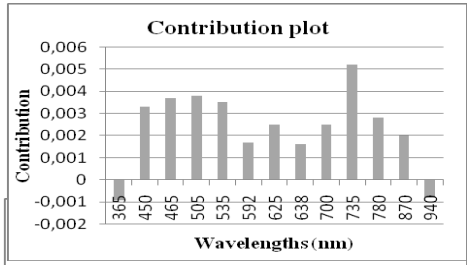
…after 3 months **…after 6 months**

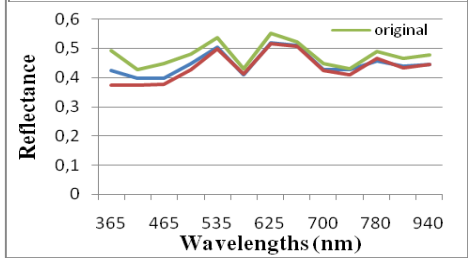
Simulation:



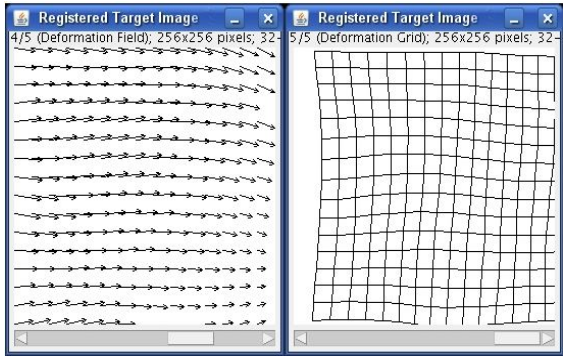
Control chart:
out of control situation

Contribution plot





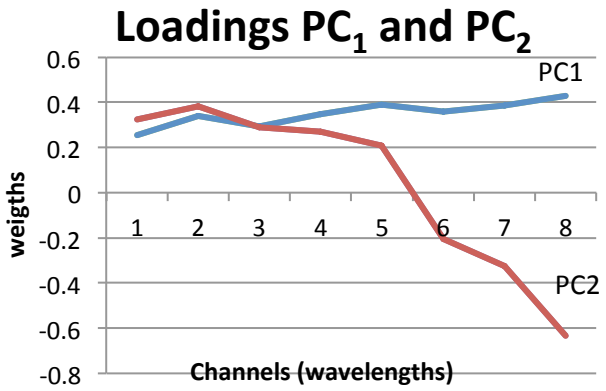
Reflectance spectra

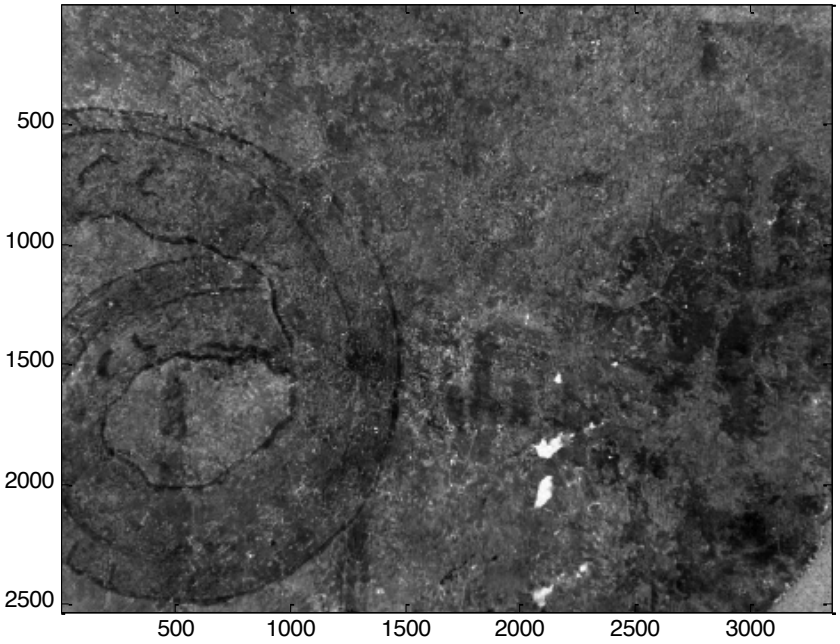


Deformation maps

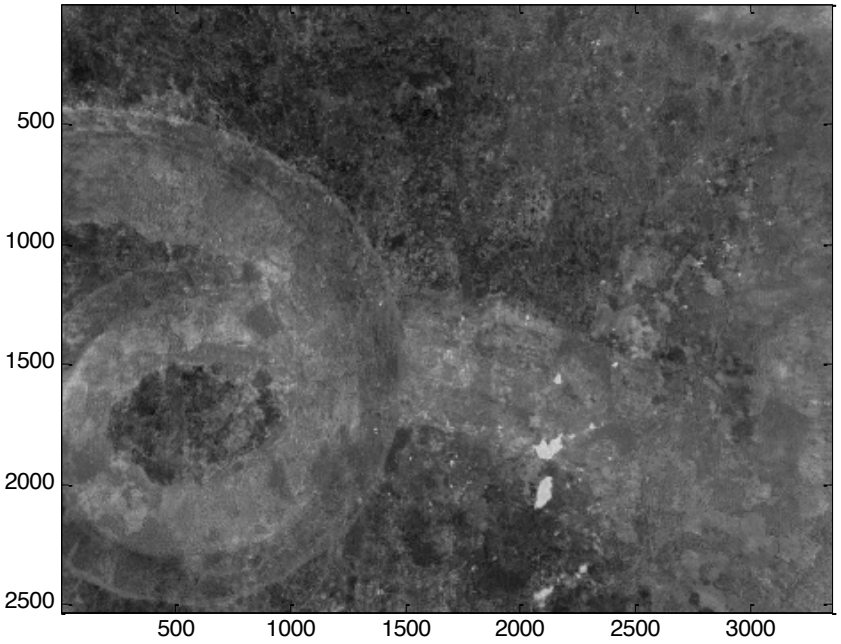
Principal component analysis

var. exp. %
74,14
16,28
5,18
3,18
0,81
0,18
0,11
0,08





Score of PC1

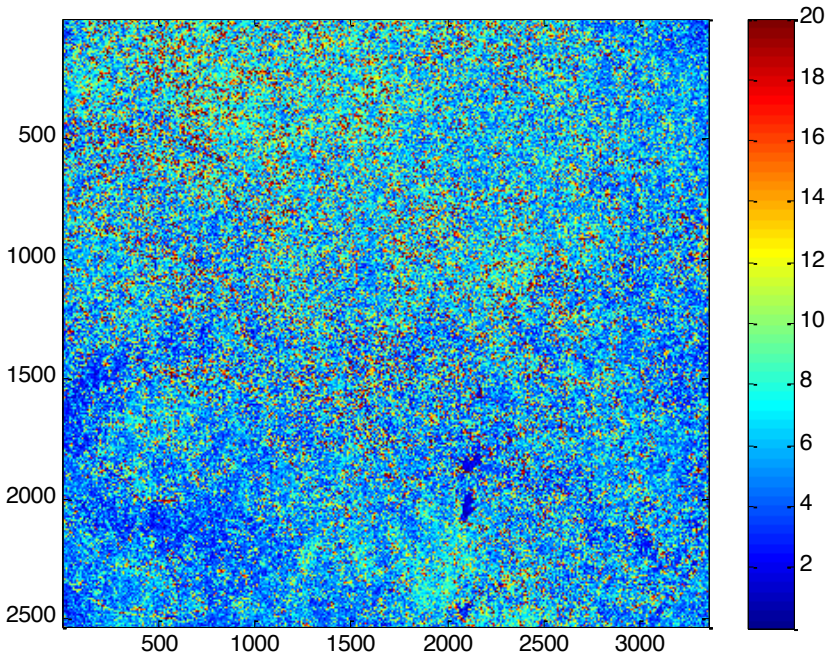


Score of PC2

The monitoring technique identifies the presence of reflectance variation of the surface of the object: the sensitivity of the method, which is the minimum spectral variation that could be detected, is strongly correlated to the quality of multispectral images.

Monitoring → September-December 2012 → in control

	Mean sensitivity %
wavelengths (nm)	PC1
370	7,97
446	9,98
466	10,66
498	11,07
521	11,26
600	11,48
640	11,79
940	9,23



Sensitivity map of the method for reflectance variation of the UV wavelength

CONCLUSIONS

The application of this new monitoring technique to a real case (Dead Sea Scrolls) has shown that this method is able to:

✓***Detect a degradation before it is visible*** *and* ***before*** *there is a* ***significant damage***

✓***Localize*** *the degradation process (****control charts, deformation maps****)*

✓***Identify*** *the causes, from the affected* ***λ*** *(****contribution plot, reflectance****)*

The monitoring technique is completely ***non-invasive****: the monitoring of S. Maria di Castello frescoes is ongoing with a portable multispectral imaging.*

The first results showed that the frescoes are in good conservation state.

The proposed approach is a good strategy for a fast and accurate measurement of cultural heritage goods' preservation state

THANK YOU FOR YOUR PATIENCE
…
AND YOUR ATTENTION