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Hypercolorimetric multispectral Imaging and Pulse Compression thermography as innovative combined techniques for painting investigation: the case of a detached wall painting by Pastura

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Introduction

AIM

Application of Hypercolorimetric Multispectral Imaging (HMI) and Pulse Compression Thermography (PuCT) to a detached wall painting, to evaluate the preservation state, the cracking, grouting, etc. in order to support the restoration



THE ARTWORK

The lunette depicts a Madonna and Child enthroned between the angels and the Saints Jerome and Francis. It has been dated back to 1490 and it is attributed to the artist Antonio del Massaro, known as Pastura. Originally it was located in the convent of Santa Maria del Paradiso in Viterbo, a little city in Central Italy.

The methodology

HMI and PuCT were used for inspecting two historical panel paintings from the renaissance period, one from Andrea Mantegna the other from Michelangelo's workshop, demonstrating to be very promising for on-situ painting inspections.

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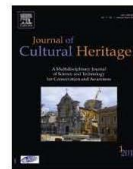


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Original article

Development of integrated innovative techniques for paintings examination: The case studies of *The Resurrection of Christ* attributed to Andrea Mantegna and the *Crucifixion* of Viterbo attributed to Michelangelo's workshop



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HMI technique

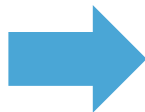
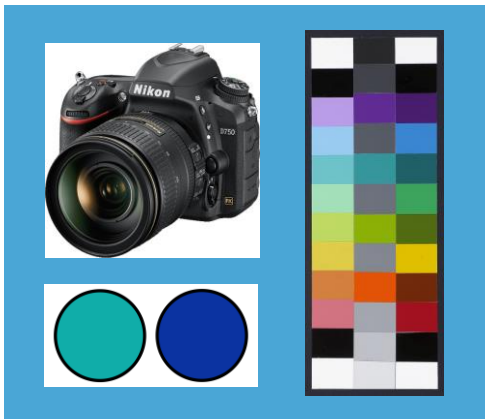
Acquisition of images

- Nikon D810FR 36 Megapixel camera, modified to obtain full-range spectral reflectance measurements
- Nikon SB910 xenon flashes after removing their front plastic lenses, thus allowing also the UV wavelength to be emitted. The UV induced fluorescence (UVF) was then obtained by filtering the flashes light with a UV band pass filter with a cut at 380 nm, and UV-IR cut filter (400-700 nm) in front of the camera
- Various white patches and a sample with 36 patches of colour-checkers built using colour samples from the NCS – Natural Colour System®© catalog were placed next to the object

Calibration was performed through SpectraPick, a software developed by Profilocolore srl.

Image processing was then performed by PickViewer®.

HMI technique



2 shoots and calibration → 7 radiometric bands
+ 1 CIELAB image

Every pixel contains:
L*a*b* colorimetric coordinates
7 radiometric values centered at
350, 450, 550, 650, 750, 850, 950 nm

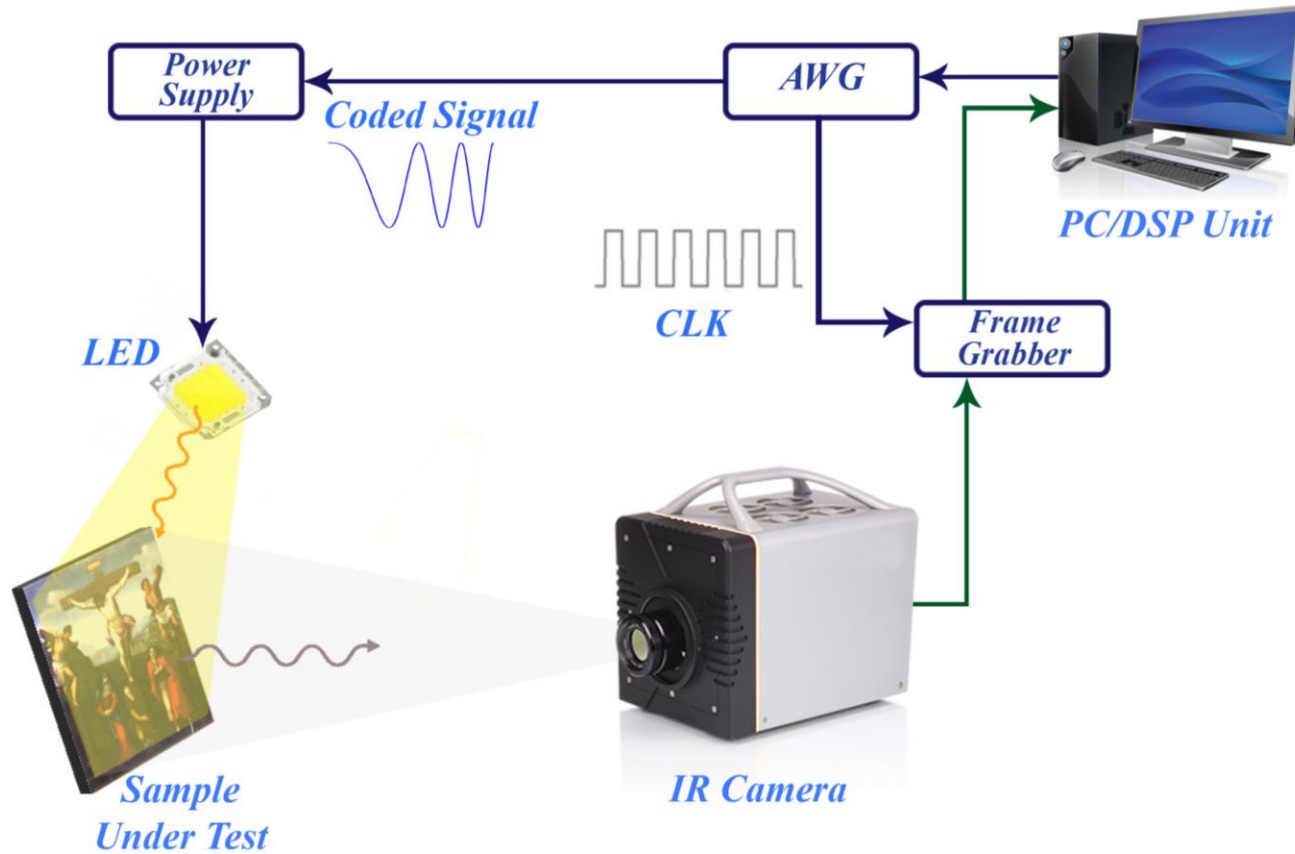
With a third shoot:
RGB colour image of the
UV induced fluorescence

<http://www.profilocolore.com/>

PuCT technique

- Signal generation/acquisition was managed by LabviewTM software
- Thermograms were collected through a Xenics Onca-MWIR (3.6–4.9 μ m)-InSb camera placed in reflection mode, having a resolution of 320×240 pixels, a frame rate of 40Hz, and connected to a NI-1433 Camera Link Frame Grabber
- The lighting systems consisted of eight LED chips, each one with a maximum electrical power of 50W
- The coded excitation voltage signal driving the LEDs was provided by a TDK Lambda GEN 750W power supply. The frame grabber and the power supply were synchronously driven by the signals provided by a National Instrument PCI-6711 Arbitrary Waveform Generation (AWG) board. Both the AWG board and the grabber were connected to a central PC/DSP Unit.

PuCT technique



Results: HMI



The HMI infrared calibrated image at 850 nm (IR2) showing the preparatory drawing used for the construction of the painting

Results: HMI

PickViewer - Multispectral Image Processor

File Settings ROI Reflectance Balanced Channels PCA Clustering Spectral Similarities False Colors NDVI DataBase Target Comparison

Selezione Risultati

C:\Users\User\Desktop\lunetta pastura hmi puct\HMI-LUNETTA_PASTURA

PCA 1

PCA 2

PCA 3

PCA 4

PCA 5

PCA 6

PCA 7

☐ UV

☐ B

☐ G

☐ R

☒ IR1

☒ IR2

☒ IR3

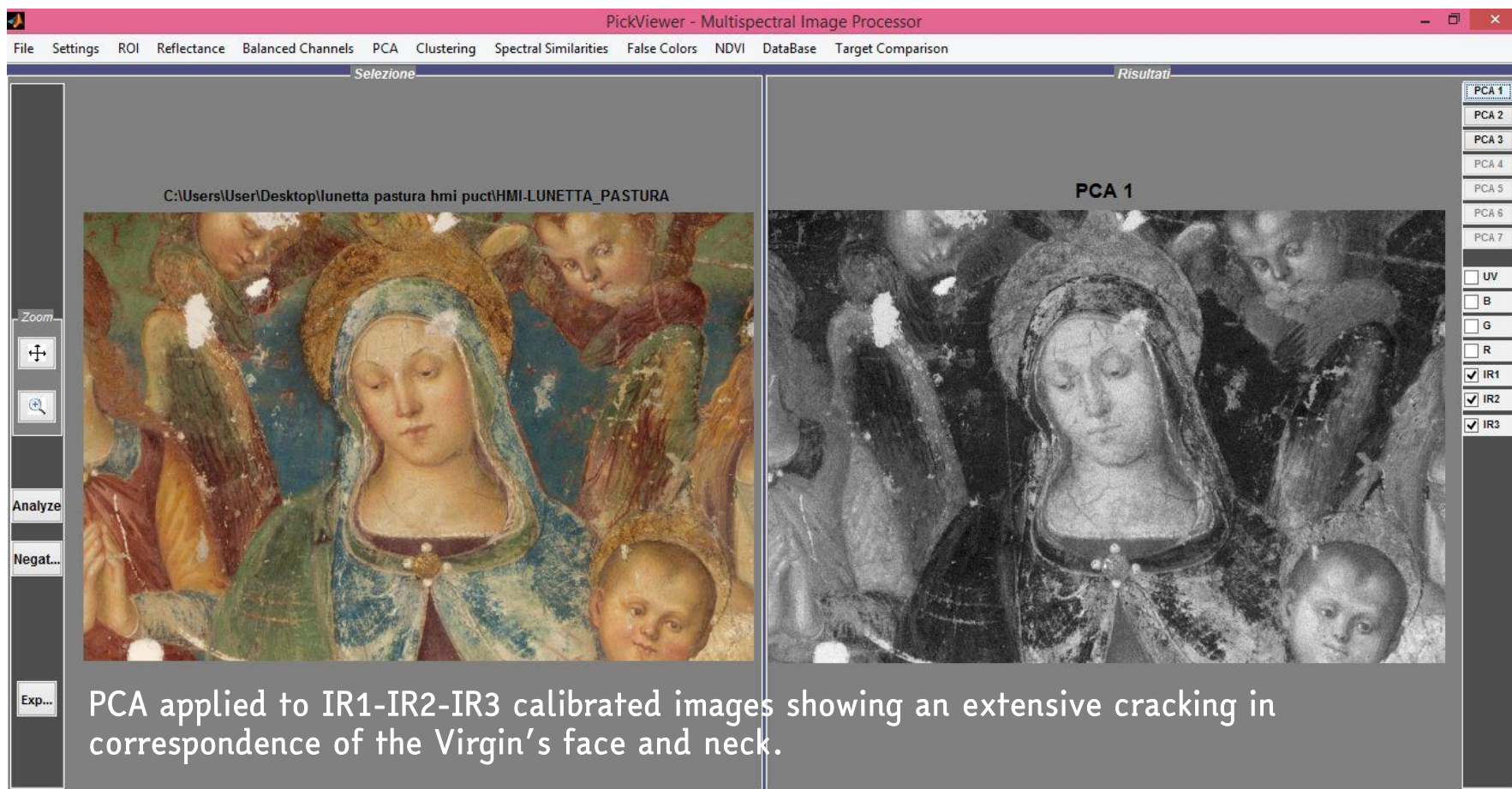
Zoom

Analyze

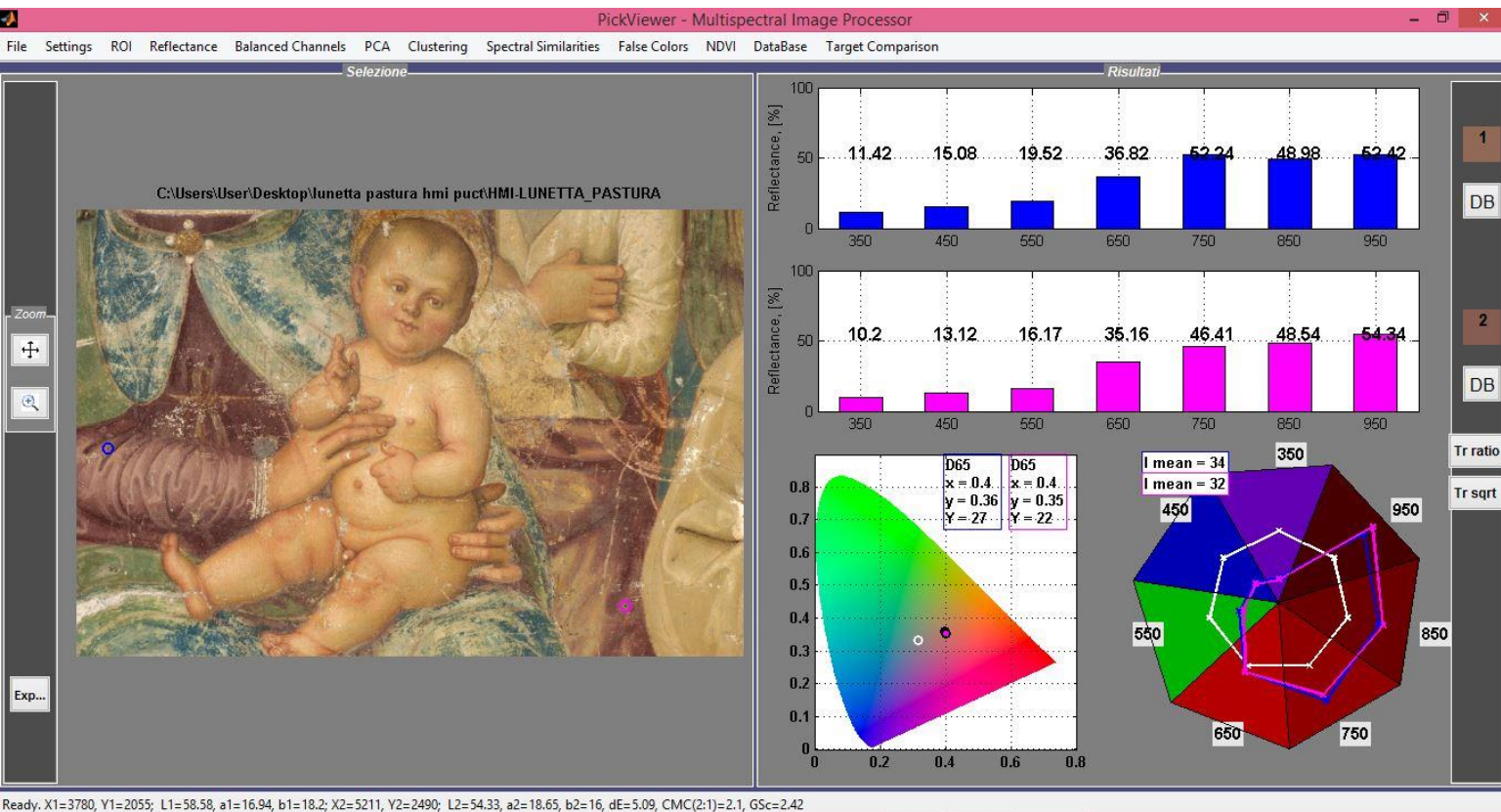
Negat...

Exp...

PCA applied to IR1-IR2-IR3 calibrated images showing an extensive cracking in correspondence of the Virgin's face and neck.

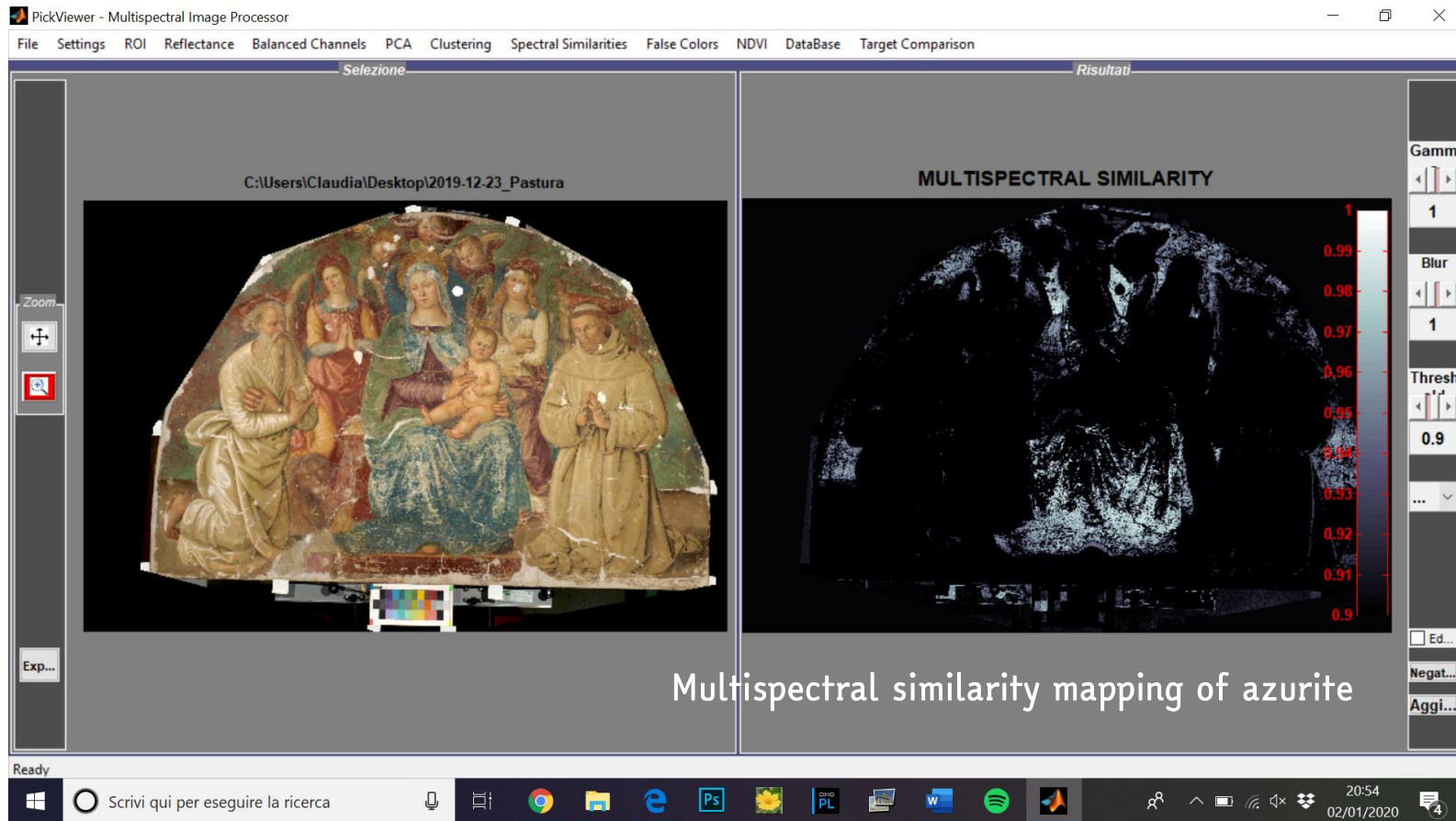


Results: HMI



The Reflectance tool applied to a point on the arm of the Virgin garment and on the Angel's dress. High similarity is found both in terms of reflectance values and of colour coordinates

Results: HMI



Multispectral similarity mapping of azurite

Results PuCT

Emissivity $t = 1$ [s]



Emissivity $t = 7$ [s]

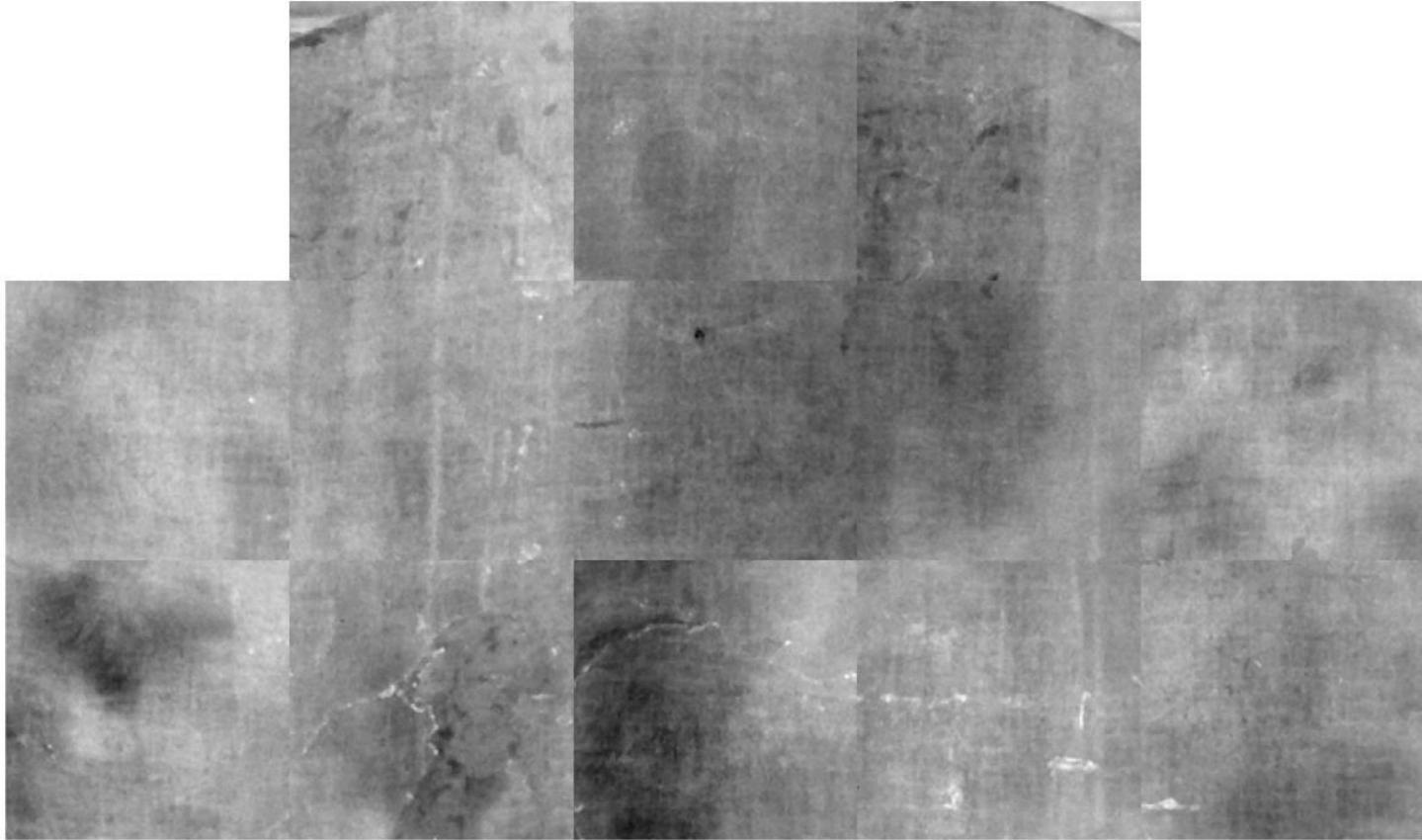


$t = 1$ [s] $t = 2.5$ [s] $t = 4$ [s] $t = 5.5$ [s] $t = 7$ [s]



Results: PuCT

Hilbert $t = 2.5$ [s]

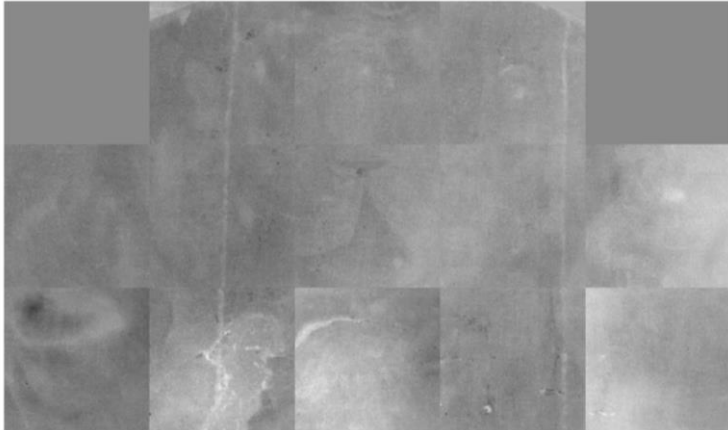


Results: PuCT

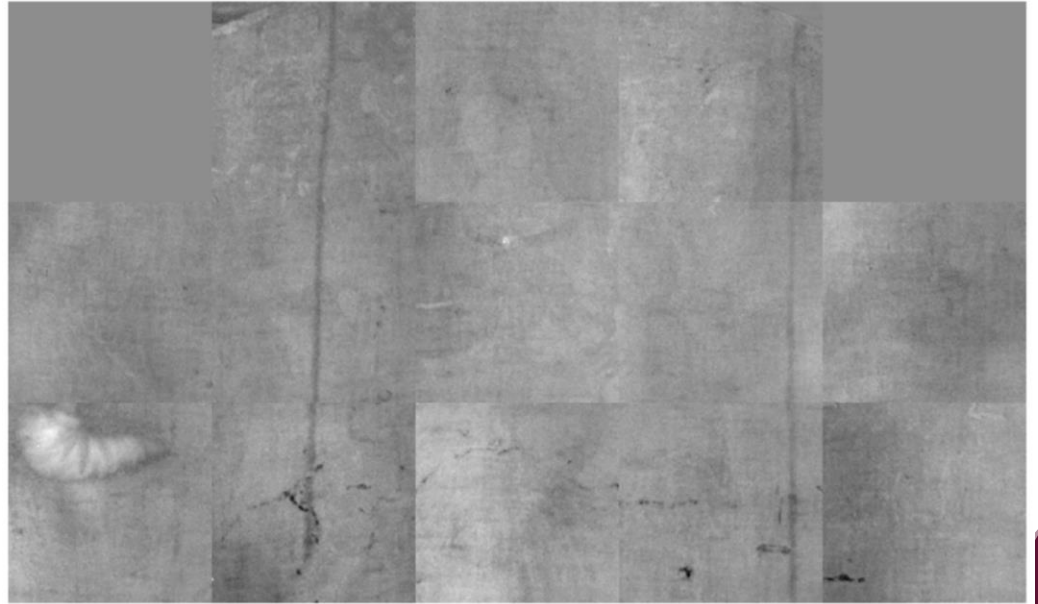
Emissivity PCA1



Emissivity PCA2



Emissivity PCA3



Conclusions

- HMI and PuCT have been used in combination on a detached wall painting attributed to the painter Antonio del Massaro known as Pastura (1450-1519).
- The combined use of the two techniques, for the first time on a wall painting, was possible thanks to the restoration work that offered the occasion for investigating the artwork in detail
- HMI supplied relevant information about surface and immediately sub-surface layers in terms of possible pigment composition and distribution, and preparatory drawing/pentimenti, respectively.
- PuCT was able to study the detachments, grouting, gilding from the surface to the deep layers giving relevant information about the possible presence of discontinuity or deep grouts.
- Further processing of the acquired images will be possible also with the support of conservators that could address the choice of the most useful deepening to supply a valid aid to the intervention.



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Thank you for your kind attention



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