III INTERNATIONAL MEETING ON RETOUCHING OF CULTURAL HERITAGE

POSTPRINTS

2015

RECH 3

INTERNATIONAL MEETING ON RETOUCHING OF CULTURAL HERITAGE, RECH3

POSTPRINTS OF THE 3RD MEETING

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FOREWORD

The retouching is a stage of the restoration intervention. It is a very specific process that is not intended to stabilize the condition of the object in a physical sense but merely to change the way we perceive it. It is also one of last the things to be done during the intervention, and obviously, is one of the most visible parts of conservator-restorers work. Depending from of the geographical location, the retouching process is a called many different names such as inpainting, integration, re-integration, reintegration, image reintegration or loss compensation. If the way of defining the task is so multiple, it is completely understandable that the criteria to follow and the methods and materials to use are numerous and almost infinite per se.

The main focus of RECH is to promote the exchange of ideas, concepts, terminology, methods, techniques and materials applied to the retouching process among professionals, students and investigators of conservation of Portugal and other countries and cultures and in different areas of conservation: mural painting, easel painting, sculpture, graphic documentation, retirar architectural, plasterwork, photography and contemporary art, among others. Also, RECH Meetings provided an excellent opportunity for friendly discussion about all kinds of ideas related to the Retouching process/methods in Cultural Heritage.

This postprints summarized some of the studies from Portugal, Spain, Italy, Slovenia, Lithuania, Netherlands, United Kingdom, Egypt, Croatia, Greece and Brazil. These investigations strengthen the relationship between the retouching process and the conservator.

The first International Meeting on Retouching of Cultural Heritage (RECH), held in 2013, presented the experiences from private and academic conservators about this issue, especially from Portugal and Spain. However, the second and third editions, in 2014 and 2015, has attracted even more international attention. Hopefully this conference will continue to be a platform for improving and sharing our retouching practices between countries and also to increase better understanding about our criteria and our deontological actions.

To finish, on behalf of the organizing committee, I would like to thank all the colleagues, professionals and friends who help in this event.

May 27th, 2016

Ana Bailão

RECH3 conference chair

IV

CROWD FUNDED RESEARCH:
LOW-COST MULTISPECTRAL IMAGING

IV. CROWD FUNDED RESEARCH: LOW-COST MULTISPECTRAL IMAGING

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Abstract

This paper introduces the low-cost multispectral imaging (MSI) system for Art and Archaeology recently developed by Cultural Heritage Science Open Source (CHSOS) thanks to the first crowdfunding campaign in Conservation Science.

CHSOS develops and disseminates affordable methodologies for art examination in order to reach a large audience of cultural institutions and art conservation professionals interested in introducing scientific diagnostics into their workflow. CHSOS disseminates these solutions with its popular blog, open access publications and training programs.

The system is composed of a digital camera with the infrared cut-off filter removed and extended sensitivity to about 360-1100 nm. A set of 18 bandpass filters (representing the spectral features of the most common historical pigments in the 400-925 nm range) provides the spectral images to build up the reflectance imaging cube.

The system was tested successfully on Pigments Checker, a collection of historical pigments, and on a mock-up painting for pigments' preliminary identification and their mapping.

Keywords

Multispectral Imaging; Pigments; Pigments identification; Pigments mapping; Pigments Checker.

1. INTRODUCTION

Cultural heritage scientists use a large number of imaging and spectroscopy techniques to examine works of art and archaeology.

Often, sampling is not permitted and non-invasive and non-destructive spectroscopic methods are preferred, Imaging methods are largely preferred since they do not require any sampling. Technical photography [1], infrared reflectography [2], reflectance transformation imaging (RTI) [3], and Multispectral Imaging (MSI) [4, 5] are among the most used imaging techniques.

MSI is used to map and identify pigments [6], to localize inpaints [7] and to enhance the reading of faded documents. While reflectance spectroscopy [8] provides spectra of pigments for a single point, MSI allows to reconstruct spectra from each image's pixel and consequently to remotely identify and mapping pigments.

An MSI documentation of a painting consists in the acquisition of a series of spectral images, which are necessary to create a reflectance image cube: pixels of each image are represented in the X and Y axes while the wavelength of each spectral image is reported in the Z axis. From this cube is then possible to reconstruct the reflectance spectrum for each image's pixel.

MSI equipment is commonly composed of a monochromatic camera: a CCD camera [9-11] for the UV-VIS-NIR range or a much more expensive InGaAs camera for the SWIR (900–2500 nm) range [12, 13]. Some studies also employed a commercial colour digital camera [14, 15]. In general, the reflectance spectral features in the UV-VIS-NIR range are due to the electronic transitions responsible in part for the colour of the pigments, while those in the SWIR range are linked to the vibrational overtones. A wavelength selection system is added to the camera so that it can capture images of an object in a series of spectral bands.

This paper presents a new low-cost system using a digital camera, 18 bandpass filters and in-scene calibration card. The system is designed to have sufficient accuracy to be used in art diagnostic studies, to be affordable (it uses free software) and versatile so that it can be modified or upgraded for MSI documentation of different kind of Art and Archaeology.

This system was recently developed by CHSOS (Cultural Heritage Science Open Source) thanks to the first crowdfunding campaign in Conservation Science: "Multispectral Imaging (MSI) for Art and Archaeology", Figure 1. The project was funded by 43 donors from 16 Countries. Micro funding came directly from professionals in the art conservation sector to develop an affordable MSI system.

Figure 1. Multispectral Imaging for Art and Archaeology was a successful crowdfunding campaign launched on Indiegogo.

CHSOS develops and disseminates each year an affordable version of a scientific tool for art examination and documentation, Figure 2. CHSOS promoted Technical Photography in 2013 [1], an affordable Infrared Reflectography system in 2014 [2] and the low-cost Multispectral Imaging system discussed in this paper in 2015.

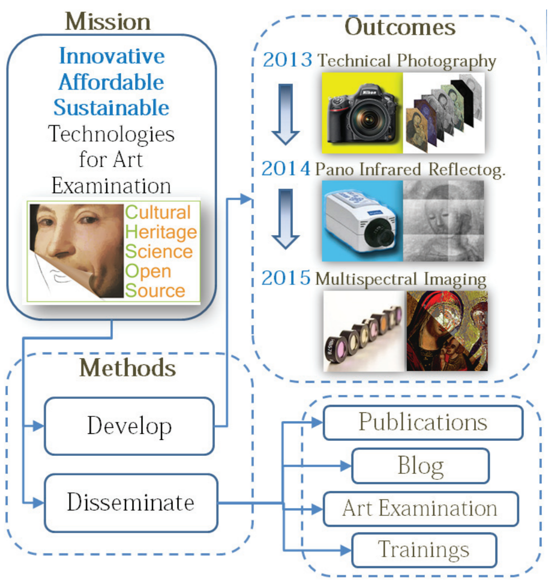

Figure 2. CHSOS Mission. Disseminate innovative, affordable and sustainable Technologies for Art examination.

Scientific examination and documentation of art is notoriously expensive. The most important and recognizable works of art from prestigious museums are often subjected to extensive scientific studies, unfeasible forthe vast majority of cultural heritage objects, existing in local communities simply because they lack comparable financial resources.

Typically larger museums have budgets sufficient for scientific departments equipped with cutting-edge technologies.In contrast, small to medium sized cultural institutions have relatively limited access to the same science and technology.

CHSOS wants to bridge this technological divide, developing and disseminating affordable and sustainable methodologies for art examination.This search for low-cost methods is becoming a rapidly expanding research topic with a growing number of researchers exploring affordable technical solutions for their workflow in art examination.

2. MATERIALS AND METHODS

2.1. MSI system components

The system is composed of a digital camera (Nikon D800) modified to be sensitive to approximately 360-1100 nm range by removing the inside IR-blocking filter, Figure 3. It was chosen to use a digital camera, rather than a monochromatic camera so that the same camera could also be used for other imaging methods, such as technical photography, RTI and photogrammetry, making the overall imaging equipment compact, and versatile.

The system uses a set of (1 inch dimeter) 18 bandpass filters (bandwidth 10 nm) covering the 400-925 nm range, (center wavelength, nm): 405, 430, 450, 467, 480, 500, 532, 560, 580, 610, 640, 671, 700, 730, 760, 840, 860, 920. The filters' center wavelengths represent the spectral features (absorption or inflection points) of the most common historical pigments, table 1. The filters are held on the photographic lens with a 3D printed filters adapter, Figure 3.

Figure 3. MSI system components. A) Full spectrum modified DSLR camera. B) 18 bandpass filters set. C) Filters adapter. D. In-scene calibration card.

Table 1. 18 filters' center wavelengths and corresponding pigments' spectral features.

Center Wavelength (nm)	Spectral features
405	Titanium white absorption; chrome green maximum
430	Smalt, malachite maxima
450	Prussian blue maximum, massicot inflection
467	Phthalo blue maximum (465), lead tin yellow I (465) inflection
480	Cadmium yellow inflection
500	Verdigris, phthalo green maxima; yellow lake R. (490) inflection
532	Cobalt blue inflection; cobalt green maximum; orpiment, lead tin yellow II (525), naples yellow (515), gamboge (535) and saffron inflections
560	Realgar inflection
580	Red lead (575) inflection
610	Cobalt yellow absorption (615); ochre (600) maxima, vermilion, cadmium red, alizarin, madder lake inflection
640	Ochre (645) minimum; carmine lake (630) inflection
671	Lithopone absorption (670)
700	Cobalt violet maximum
730	Lithopone absorption (725)
760	Maya blue, viridian (770) inflections; ochre (770) maximum
840	Indigo inflection (830)
860	Ochre minimum
920	Phthalo blue, ochre (915) minima

The system works with a an in-scene calibration card to cover the 400-925 nm spectral range with 6 swatches, pure white, 4 grays and pure black (reflectance values (%): 100, 80, 60, 40, 20, 0,5).

The system is designed to work with any visible and infrared illumination source, such as halogen lamps. (the examples shown in this paper were produced using halogen lamps (2 x 400 W).

2.2. Software editing

The Nikon D800 features a Full Frame FX format CMOS sensor whose photosensors are covered with color filters to select only red (R) green (G) or blue (B) light. Photos are shot in raw format and are then split into their 4 color (BGRG) components using ImageJ. 18 images are selected among the split RGB images in order to build up the reflectance cube with HyperCube (US Army Geospatial Center) imaging spectroscopy software. They are selected among the B channel in the range 400-480, G for 500-560 and R for 580-920. Registration and flat field correction are both performed within ImageJ.

The reflectance calibration of the spectral images is performed using the in-scene calibration card and applying a multi-point 3rd degree polynomial calibration curve with ImageJ.

3. RESULTS AND DISCUSSION

3.1. Reflectance spectra reconstruction

Pigments Checker is a collection of 54 swatches of historical pigments applied using gum arabic as a binder on cellulose and cotton watercolor paper, acids and lignin free, Figure 4.

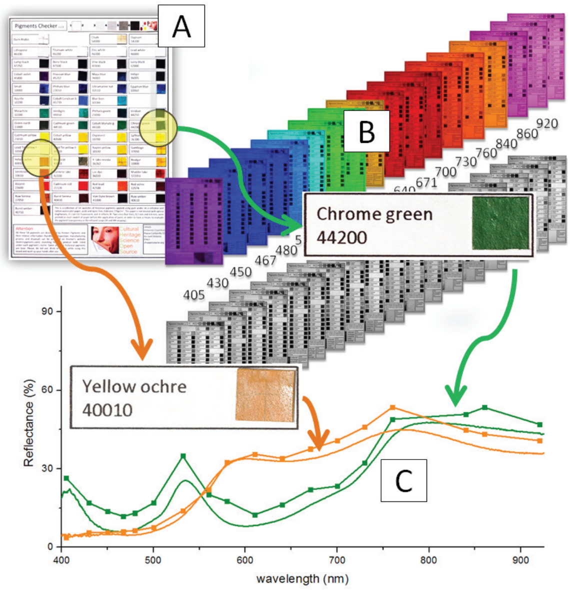

Figure 4. Reflectance spectra reconstruction on Pigments Checker.

The system has been tested on Pigments checker to evaluate its accuracy in reconstructing reflectance spectra. 18 spectral images have been acquired and edited to build the reflectance spectral cube. Figure 4 shows the reconstructed spectra of yellow ochre and chrome green and compares them with reference reflectance spectra of the two pigments also acquired on the same Pigments Checker [8]. The main features of the pigments are represented. Yellow ochre has two absorption bands at about 645 nm and 860 nm while chrome green has absorption bands at 460 nm and 600 nm.

3.2. Mapping pigments

The system was also tested on a mock-up oil painting on canvas “Madonna and Child”, representing a subject in the renaissance style. The painting was created using renaissance age pigments (mineral ultramarine, azurite, yellow ochre, red ochre, lead white, verdigris, vine black and malachite) as well as modern pigments (viridian, titanium white and cadmium red), Figure 5. The system was tested successfully on this painting to evaluate its capacity to map pigments (segmentation).

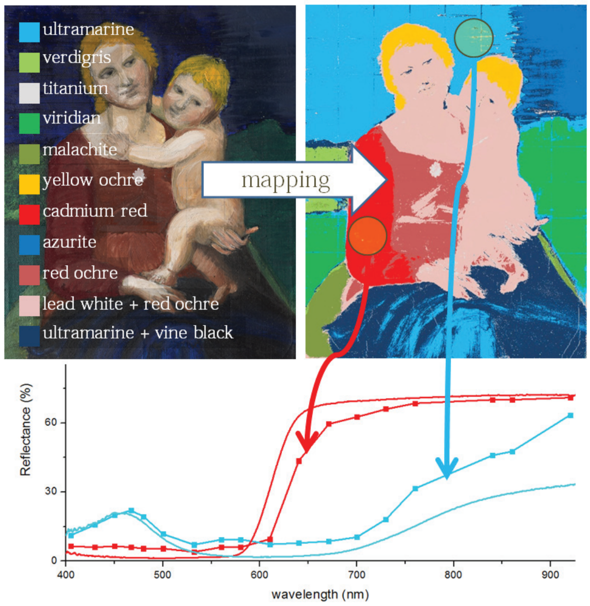

Figure 5. Mapping pigments.

4. CONCLUSIONS

CHSOS assembled a low-cost, simple and versatile Multispectral Imaging system composed only of standard “off-the-shelf” commercially available components: bandpass filters and a digital camera. It can be used to perform MSI documentation for works of art and archaeology for preliminary pigments identification and their mapping.

REFERENCES

[1] COSENTINO, Antonino – Identification of pigments by multispectral imaging a flowchart method. *Heritage Science*, 2:8, (2014).

[2] COSENTINO, Antonino –Panoramic infrared Reflectography. Technical Recommendations. *Intl Journal of Conservation Science,* 5(1), (2014), pp. 51–60.

[3 COSENTINO, Antonino – Macro Photography for Reflectance Transformation Imaging: A Practical Guide to the Highlights Method. *e-conservation Journal,* 1, (2013), pp. 70-85.

[4] COSENTINO, Antonino – Multispectral imaging system using 12 interference filters for mapping pigments. *Conservar Património* 21, (2015), pp. 25-38.

[5] COSENTINO, Antonino – Multispectral Imaging of Pigments with a digital camera and 12 interferential filters. *e-Preservation Science,* 12, (2015), 1-7.

[6] KUBIK, Maria – Hyperspectral imaging: a new technique for the non-invasive study of artworks. In Creagh, D C and Bradley, D, eds – *Physical Techniques in the Study of Art, Archaeology and Cultural Heritage, Vol. 2.* Elsevier, 2007, pp. 199–259.

[7] COSENTINO, Antonino – Panoramic, Macro and Micro Multispectral Imaging: An Affordable System for Mapping Pigments on Artworks. *Journal of Conservation and Museum Studies,* 13(1): 6, (2015), pp. 1–17.

[8] COSENTINO, Antonino – FORS spectral database of historical pigments in different binders. *e-conservationJournal 2,* (2014), pp. 57–68.

[9] LIANG, Haida – Advances in multispectral and hyperspectral imaging for archaeology and art conservation. *Appl Phys A,* 106, (2012), pp. 309–323.

[10] PELAGOTTI, Anna; DEL MASTIO, Andrea; DE ROSA, Alessia; PIVA, Alessandro – Multispectral Imaging of Paintings.A way to material identification. *IEEE Signal Processing Magazine 27,* (2008), pp 27-36.

[11] TOQUE, Jay Arre; SAKATOKU, Yuji; IDE-EKTESSABI, Ari – Pigment identification by analytical imaging using multispectral imaging. *16th IEEE International Conference on Image Processing (ICIP),* (2009), pp. 2861–2864.

[12] RICCIARDI, Paola; DELANEY, John; GLINSMAN, Lisha; THOURY, Mathieu; FACINI, Michelle; RENE DE LA RIE, E – Use of visible and infrared reflectance and luminescence imaging spectroscopy to study illuminated manuscripts: pigment identification and visualization of underdrawings. O3A: Optics for Arts, Architecture, and Archaeology II, Proc. of SPIE Pezzati, L and Salimbeni, R eds. (2009), 7391.

[13] DOOLEY, Kathryn;LOMAX, Suzanne; ZEIBEL, Jason; MILIANI, Costanza; RICCIARDI, Paola; HOENIGSWALD, Ann; LOEW, Loew, Murray; DELANEY, John – Mapping of egg yolk and animal skin glue paint binders in Early Renaissance paintings using near infrared reflectance imaging spectroscopy. Analyst, 138: (2013), pp. 4838–4848.

[14] BLAZEK, Jan; SOUKUP, Jindrich; ZITOVA, Barbara;

FLUSSER, Jan; TICHY, Thomas; HRADILOVA, Janka –Low-cost mobile system for multispectral cultural heritage data acquisition. *Digital Heritage International Congress, IEEE,* (2013), pp 73-79.

[15] ZHAO, Yonghui; BERNS, Roy; TAPLIN, Lawrence; CODDINGTON, James – An Investigation of Multispectral Imaging for the Mapping of Pigments in Paintings. *Proc. SPIE 6810, Computer Image Analysis in the Study of Art,* (2008).


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