

BOOK OF ABSTRACTS

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BRIDGING SCIENCE WITH ART



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HYPERSPECTRAL IMAGING APPLIED TO THE STUDY OF PAINTINGS

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The spread of digital photographic cameras (predominantly of D SLR type) during the last decade has opened new possibilities to the investigators of work of arts, having now a tool not only to document the conservation state of a work of art but also to examine in the invisible spectrum (such as in Infrared or Ultraviolet) or to collect and analyze information in the visible spectrum in new ways [1]. This is the case of the present work, which presents some results obtained on building, calibrating and testing a system using a commercial digital camera (a Nikon D300 D SLR) that showed to be possible, entirely on the visible spectrum, to capture hyperspectral images composed of 28 bands, between 420 nm and 690 nm, in steps of 10 nm (22 bands are directly captured with the system and 6 are interpolated), a number of bands superior to many other multispectral and hyperspectral imaging systems built with more complex and expensive hardware.

Compared to a reference spectroradiometer (Photoresearch PR650) using a standard 24 color chart *ColorChecker X Rite*, the proposed system showed good results, indicating that it presents an accuracy good enough to many of the new and promising uses in hyperspectral imaging.

It showed average values for RMSE (Root Mean Square Error) of 3,4% and 99,3% for GFC (Goodness of Fit Coefficient); the colorimetric precision of the system presented values for color differences equations of 6,0968 units for ΔE^*_{ab} , 3,8228 units for ΔE^*_{94} and 3,6794 units for ΔE^*_{00} ; the tested metameric indices showed values of 1,1457, 1,2410, 0,8078 and 0,7777 for illuminant pairs “D65,A” and “D65,F2”, all quantified in terms of color differences equations ΔE^*_{ab} and ΔE_{00} , respectively.

The possibility of capturing images in more bands than the traditional three channels color models (the RGB model, commonly used on digital camera’s sensors), opens new possibilities, because this type of data contains reflectance values (data independent of the type of illuminant) and in an higher number of wavelength bands. This type of data is more colour accurate than conventional photography and it is not susceptible to colours metamerism, a frequent problem with trichromatic reproduction systems [2].

With the present work we have shown some of the possible applications of hyperspectral imaging. In a practical case using a XVI Century painting (*Triptico de Pentecostes de Miragaia*, Porto) and a XX Century work of Art (*O Cabouqueiro*, by Julio Pomar) observing and analyzing individual isolated bands in certain wavelengths of the visible spectrum, allowed us to detect alterations in paintings, areas with repainting, reintegration, under drawings and other type of information, traditionally only possible to obtain using invisible radiation imagery. Using adequate software programs it was possible to virtually test the appearance of the work of art in different types of illuminants or light sources, preventing more time consuming experiences or, in both situations, avoiding submitting the work of art to unnecessary stress or more destructive radiations.

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[2] Ferreira, F. B. (2010). Digitalização Hiperespectral de Pinturas e Obras de Arte. PhD dissertation, Universidade da Beira Interior, Covilhã.