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Original article

A study on a set of drawings by Parmigianino: integration of art-historical analysis with imaging spectroscopy

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Abstract

Due to the extreme fragility of paper-based artefacts, few techniques are available for scientific investigation and characterisation of ancient drawings or paper-based artefacts. Image reflectance spectroscopy represents an almost unique tool for scientific analysis on precious drawings, for which even micro-invasive techniques of analysis cannot be used. Indeed, beside the high fragility of the support, drawings and graphical works are typically characterised by a very limited number of artistic materials, which in principle could give information on the work of art. In this paper an interdisciplinary study on a set of drawings by Parmigianino (1503–1540), selected from the collection of the Uffizi Gallery in Florence, is presented. Non-invasive measurements of image spectroscopy (IS) have been employed to support the work of art-historians in the critical re-examination and interpretation of the graphical work of the artist. The multispectral analysis has been carried out over the extended spectral region (400–1700 nm), in order to provide simultaneous indications both on the pictorial materials and on possibly underlying hatches. The data processing has been performed by means of Principal Component Analysis (PCA) and the elaboration of each case has been addressed to specifically respond to questions related to the art-historical problem.

Keywords: Imaging spectroscopy; Principal component analysis; Drawings; Image processing; Parmigianino; Image reflectance spectroscopy

1. Introduction and research aim

Francesco Mazzola (Parma, 1503–Casalmaggiore, 1540), better known as "Parmigianino", was one of the most important painters of the high Italian Renaissance. Some of his paintings are well-known worldwide, such as the *Madonna with Long Neck* (Uffizi Gallery, Florence), the intriguing feminine portrait *The Turkish Slave* (Pinacotheca, Parma), or the frescoes of the Sanvitale fortress (Fontanellato, Parma). Furthermore, it has to be reminded that a very important component of Parmigianino's activity was constituted by drawings, as tested by the numerous examples of graphical artworks (about one thousand) attributed to this artist. The *Gabinetto dei Disegni e delle Stampe* at the Uffizi Gallery in Florence has a remarkable collection of the Parmigianino graphical production, with a number of examples characterised by the use of different techniques.

This paper gives an account of an interdisciplinary study—involving art historians and conservation scientists—on a selection of drawings by Parmigianino. The opportunity for this investigation arose from the fifth Centennial of the artist's birth, which in 2003 was widely celebrated with a number of exhibitions and events that renewed interest in the opus and personality of this famous mannerist painter. For the occasion, the Uffizi Gallery organised the temporary exhibition "*Il Parmigianino e il fascino di Parma*" [1], displaying the entire collection of drawings by Parmigianino (about 70 works), preserved at the *Gabinetto dei Disegni e delle Stampe*, including some important examples of the school of the artist, whose fame was already largely established among his contemporaries.

The design and preparation of the exhibition have constituted the starting point for a new critical re-examination of

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Parmigianino's graphical corpus, that belongs to the Uffizi Gallery. This precious collection has been reconsidered from an updated art-historical point of view with a special focus on the artist's techniques and the related temporal order. Indeed, a careful attempt to establish their correct temporal order is closely related to improvement in the knowledge of the artistic path. Thus, new interpretative questions concerning the attribution of certain drawings have been raised and proposed for deeper investigation.

Within this framework, a program of scientific investigations based on image reflectance spectroscopy has been planned, in a search for additional 'objective' information on selected works.

Image spectroscopy (IS) is a well-established diagnostic tool for investigating drawings and paintings [2–5] since it provides spectral information on each point of the surface, by retaining at the same time the visual aspect of the scene. Nowadays, more and more sophisticated techniques and instrumentation (scanners, cameras, etc.) are available for IS applications on artworks.

In addition to many practical aspects—such as the availability of portable devices, costs, logistical details, etc.—a fundamental factor to be considered in selecting an IS technique for diagnostics on artworks concerns the performances of the detector, and, more precisely, the spectral region which can be covered by the instrument, as well as its spectral resolution. Indeed, the extension of the spectral interval and the precision of the multi-wavelength response determine the informative potential of the measurements. Therefore, the technical specifications required are closely related to the conservation problem to be solved.

In the present work, an extensive and explorative characterisation of a heterogeneous group of drawings, aimed at enriching our knowledge of the different selected drawings, was required. To this purpose, an IS device, based on a readapted multi-wavelength Vidicon camera was adopted. Measurements were performed on the 400–1700 nm range (VIS–NIR), in order to provide simultaneous indications both on the pictorial materials and on possibly underlying hatches.

Each measurement on a drawing provided a *collection* of images, each image being the reflected signal of the sheet at a given wavelength within a narrow spectral band (10 nm) over the entire spectral interval. Based on these imaging spectral data, the reflectance spectrum of any point—whatever on the drawing—can be extracted, as it would have been recorded locally, by means of a spectrophotometer. At the same time, visual correspondence with the original scene is maintained. Moreover, the most attractive advantage of IS is that it provides of applying suitable algorithms for data elaboration, the results of which can be displayed as images or maps that can be superimposed onto conventional images of the object [6].

Specifically, in this paper, a data elaboration based on Principal Component Analysis (PCA) has been adaptively used to answer specific questions related to each case considered.

Here as follows, each drawing is introduced separately, with a brief explanation of its historical and artistic features, and a description of the aspects of interest related to it.

2. Experimental section

2.1. Measurement system

The experimental device is based on a PbO–PbS Vidicon camera (Hamamtsu Model C-2400) that can cover the entire 400–2200 nm band. Wavelength selection is achieved by means of a set of 32 interferential filters, with 10 nm FWHM and 50% transmittance. In the set-up adopted, the selected filters cover the 400–1700 nm range, and this was the spectral interval of analysis. The filters have central wavelengths spaced every 20 nm in the VIS and every 50 nm in the NIR region. Filters are lodged on a PC-driven wheel placed in front of the camera. The automatic rotation of the wheel makes possible a sequential selection of the filters during the acquisition time. Timing and activation of the wheel are controlled via software.

Focusing of the image is PC-driven, and is achieved using a software-controlled dc micromotor which locks the configuration when the maximum image contrast is reached.

Two projectors (150-W quartz tungsten halogen lamps) with a protective UV-cutting glass are used as sources for lighting the target. The projectors are symmetrically positioned with respect to the target, and are oriented at a 45° angle with respect to the normal to the drawing surface. Measurements are performed in diffuse reflectance configuration. Indeed, the reflected signal is collected along the normal direction, so that the specular component is excluded from the reflected signal collected by the camera.

The projectors are equipped with shutters that automatically interrupt the lighting on the surface as the acquisition is concluded. This way, light-exposure of the target is reduced to the minimum time needed for the acquisition.

The calibration of the camera is performed using five diffuse-reflectance Spectralon® standard, certified 99%, 75%, 50%, 10% and 3% reflectance. These standards are placed on the frame of the drawing and imaged simultaneously with the object (Fig. 1).

2.2. Experimental procedure and methodology

Before starting the measurement campaign on the set of Parmigianino drawings, the experimental system and the measurement procedure were tested on a less valuable artwork. For this trial, a drawing by an anonymous author—almost a contemporary of Parmigianino's—was selected. This drawing presented physical/structural features (materials, level of vulnerability, kind of support, etc.) similar to Parmigianino drawings.

This preliminary check was aimed at adjusting the operative measurement parameters (such as light exposures, acquisition times, distances between lamps, camera and drawing, etc.), and at evaluating the possible impact of the measurements on the