Case Report

The “Lost Guardians” of Dante’s Inferno: Medium Wave Infrared Imaging Investigations of a XIV Century Illuminated Manuscript

Noemi Orazi 1, Fulvio Mercuri 1, Cristina Cicero 2,*, Giovanni Caruso 3, Ugo Zammit 1, Sofia Ceccarelli 4 and Stefano Paoloni 1

1 Dipartimento di Ingegneria Industriale, Università degli Studi di Roma Tor Vergata, Via del Politecnico 1, 00133 Rome, Italy; noemi.orazi@uniroma2.it (N.O.); fulvio.mercuri@uniroma2.it (F.M.);
zammit@uniroma2.it (U.Z.); stefano.paoloni@uniroma2.it (S.P.)
2 Dipartimento di Studi Letterari, Filosofici e di Storia dell’arte, Università degli Studi di Roma Tor Vergata, Via Columbia 1, 00133 Rome, Italy
3 Istituto di Scienze del Patrimonio Culturale (ISPC), Italian National Research Council (CNR), Via Salaria Km 29.300, 00010 Rome, Italy; giovanni.caruso@cnr.it
4 Istituto per le Applicazioni del Calcolo “Mauro Picone” (IAC), Italian National Research Council (CNR), Via dei Taurini 19, 00185 Rome, Italy; sofia.ceccarelli@uniroma2.it
* Correspondence: cristina.cicero@uniroma2.it

Abstract: On the occasion of the 700th centenary of the death of Dante Alighieri, medium wave infrared imaging analysis of illuminations of the XIV-century code of the Divina Commedia (MS. 1102), hosted in the Biblioteca Angelica in Rome, was performed and discussed. The investigation was carried out by means of thermographic and reflectographic techniques on illuminations where the iconographic representation appeared severely damaged. In particular, through the combined use of both techniques, it was possible to recover the images of the damaged parts of the pictorial layer of the illuminations and of their underdrawings, displaying details of the “lost guardians”, which was useful to reconstruct the conservative history of the precious manuscript.

Keywords: pulsed infrared thermography; MWIR reflectography; illuminations; imaging investigations; underdrawings; Dante’s Inferno; Divina Commedia

1. Introduction

The 700th anniversary of Dante Alighieri’s death was undoubtedly one of the most important events in 2021. Dante, recognized today as the father of the Italian language, stated without hesitation that the vulgar Italian language had the same value as Latin and that there was no impediment to its use in literary works, as in the case of his famous Divina Commedia, which is considered one of the most famous Italian literature works and it is also one of the most studied poetic-literary texts [1]. In this framework, the code MS. 1102 assumes an exceptional relevance, considering also the originality of the Dante’s Inferno iconography, which is an outstanding example of XIV-century miniatures. Moreover, it contains commentaries by Jacopo Alighieri and Bosone from Gubbio, as well as a fragment written by Gualterus de Castellione [2].

From a conservative point of view, most of the illuminations appear to be in a good preservation state, except for the ones representing the demoniac guardians of the circles, which appear partially or completely erased, perhaps intentionally, by unknown mechanical methods. In this regard, specific non-destructive investigation methods, such as photo-thermal ones, could be well suited to recover some valuable elements, thus enabling a better visualization of damaged and/or buried features. In particular, photo-thermal techniques, which are based on the thermal analysis of samples heated by light absorption,
have been extensively used for the determination of different thermal parameters of several kinds of materials [3,4].

Concerning cultural heritage investigations, these techniques have been employed to analyze different kinds of artefacts [5–8], enabling the study of both optically opaque samples, such as bronzes [9–12], and semi-transparent materials, like paintings [13,14] and manuscripts [15]. Concerning the latter, imaging techniques operating in the medium wave infrared (MWIR) range (3–5 µm), such as pulsed thermography (PT) and MWIR reflectography (MIR), have been found to be very effective for the characterization of different parts of ancient codes, like bookbindings [16,17], texts, and illuminations [18,19]. PT is mainly used for the non-destructive characterization of the main features of illuminations, providing information both on their conservative state and on the modifications that have occurred over time. Moreover, it can reveal structural features, such as the adhesion state of the gildings [19,20] and other subsurface elements, like underdrawings and pentimenti, of the illuminations [18,21]. PT has been proven to constitute a valuable tool for providing a general overview of the various elements composing illuminated manuscripts [18], and is also able to provide information complementary to that obtained by means of traditional techniques like near-infrared reflectography. Moreover, it enables both the detection of underdrawings and monitoring of the conservation state of the parchment support, thus producing a unique reference documentation for directing further investigations, like compositional analysis and elemental mappings. On the other hand, MIR has been recently employed for the detection of possible underdrawings and graphical/pictorial features buried beneath different kinds of paint layers [15,21]. It is worth noting that, while PT enables a more effective detection of subsurface features when these are buried beneath highly MWIR diffusing layers, MIR can give complementary information on elements located beneath transparent layers in the MWIR spectral range. Finally, unlike MIR, PT can provide information about the depth of the detected features.

Recently, a similar approach combining the use of PT and MIR has been successfully adopted for the study of painting on wood/canvas. Such an approach allowed us to obtain valuable information concerning the multiple-layered structure of the artworks by revealing features buried beneath the visible pictorial layer and by mapping the restorations and stylistic changes [22,23].

In this work, the combined use of PT and MIR was, for the first time, proposed for the investigation of illuminations. The results obtained in the code MS. 1102 allowed for recovering and/or improving the readability of some illuminations, and for gathering relevant information regarding the interpretation of the illumination iconography.

2. Materials and Methods

2.1. Description of MS. 1102

The manuscript MS. 1102 is an illuminated code of Dante Alighieri’s *Divina Commedia* dated to the XIV century and preserved in the Bibliotheca Angelica in Rome. This manuscript became part of the heritage of the Biblioteca Angelica thanks to the Cardinal Domenico Poweroni, whose book collection was purchased by the Augustinians in 1762, after his death. The binding is similar to many other volumes belonging to him: wooden axes; covered in leather; and decorated in gold, nerves and a piece with a gold title [2].

The text, arranged in two columns, was written by a single hand, which uses the Littera Textualis [2]. The manuscript also contains Jacopo Alighieri’s and Bosone da Gubbio’s commentaries, titled “Capitolo sulla Commedia” and, in addition, a fragment of the poem about the history of Alexander the Great written by Gualterus de Castellione [2,24,25].

However, the relevance of the code is mainly as a result of artistic reasons, such as the original iconography of the 34 illuminations, which display only the canticles scenes of Dante’s *Inferno*. In fact, the manuscript was never completed and the empty spaces meant for the insertion of the illustrations concerning the *Paradiso* and the *Purgatorio* canticles are still visible. Unfortunately, it is not possible to identify the name of the client of the work; however, judging by the ambitious illustrative nature of the project, it can be assumed they
were part of a very high social class, which is also seemingly confirmed by the abundant use of gold leaves that characterizes each illumination [2]. The few studies reported in the literature have dated the illuminations from the XIV century to the first quarter of the XV century. According to these studies, the illuminations were ascribed to an illuminator of the Bologna workshop, where famous artists like Oderisi da Gubbio and Franco Bolognese are considered as possible authors [2,26,27].

The manuscript appears in a good state of conservation, with few water stains and some holes due to woodworm attacks, which were restored in part in 2008 (as attested from the manuscript digital catalogue Manus, link https://manus.iccu.sbn.it/cnmd/0000304519, accessed on 12 April 2022).

2.2. Experimental

The characterization of the illuminations contained in MS. 1102 was carried out by means of the following experimental procedures and set-ups.

PT is based on the locally resolved detection of the emitted IR radiation from the sample surface following sample heating induced by the absorption of a short visible (VIS) light pulse [28]. The detection of the emitted IR radiation map is carried out by means of an IR camera, which provides a sequence of images referred to as thermograms. The presence of inhomogeneities in both the thermal and optical properties into the sample volume as a result of, for instance, the presence of voids or buried drawings, can be detected thanks to the corresponding induced modifications in the amount of locally emitted IR radiation, which then appears in the recorded thermograms [29–31]. In the PT technique, the sample heating is induced by means of two 3 kW flash lamps oriented at 45° with respect to the surface of the investigated sample, delivering a few ms-long pulses. The employed pulse power was around 20% of the maximum, thus producing a temperature increase of less than 10 °C, which is considered low enough to not cause irreversible modifications in the investigated artifacts [18]. The emitted light from the lamps was then filtered in order to eliminate the MWIR spectral component, thus allowing for removing spurious contributions to the recorded signal originating from the reflection at the sample surface. In the case of the MIR technique, the sample illumination in the MWIR range was provided by continuous wave (CW) hot carbon filament sources positioned at about 2 m from the manuscript. The reflectographic images were collected right after the start of the sample illumination so as to minimize the MWIR radiation emission by the sample associated with its cumulative heating. In both techniques, the images were recorded using a Cedip JADE MWIR camera (320 × 240 pixel, InSb focal plane array, 30 μm pitch, 3.6–5.1 μm wavelength range) characterized by a noise equivalent temperature difference (NETD) <25 mK at 30 °C. Altair 5.50 software was used to process the images collected in full frame mode with a 150 Hz frame rate. To obtain the time-dependent change in the thermographic signal starting at the zero level in all of the pixels, a pixel-by-pixel subtraction of the frame obtained just before the flash pulse from the sequence of the thermograms was performed.

3. Results

The PT analysis was performed on all the 34 illuminations of the code MS. 1102 in order to evaluate the conservation state of the manuscript and to try to obtain IR images of the lost parts of the decorative apparatus. In the case of the gildings, for instance, the obtained results revealed that most of the illuminations appeared in a good state of preservation, with no detachments beneath the gildings that could be detected by thermographic imaging [19,20], as shown in the example reported in Figure 1.
Hereafter, only the results obtained in the four damaged illuminations containing the representations of the demoniac guardians, which are barely detectable in the ordinary pictures, will be shown.

To try and recover their representation, PT and MIR images were captured so as to display the features of the decorative apparatus barely or no longer visible to the naked eye.

3.1. Folio 2 Verso

The illumination of folio 2 verso decorates Canto III and appears to be one of the most damaged parts of the manuscript. As evidenced in Figure 2a, the illumination shows that the colour at the demoniac figure (dashed rectangle in Figure 2a) is very different from that of the other characters in the illustration, and the characters appear hardly visible. This may even be associated with the loss of the corresponding pigment layer. The corresponding area in the thermogram of Figure 2b shows, with greater contrast than in the picture, the details of the waves around the immersed section of the ferry, which, in the thermogram, appear to be clearly distinguishable from the emerged part (yellow arrow). This indicates the high level of the finishing of the original illumination, unfortunately barely detectable in the actual deteriorated state of the illumination. The enlargement of the demoniac character area (Figure 2c) allows for a more effective visualization in the thermogram of some features, such as the hooked nose and the long beard (indicated by the arrows in Figure 2c), typical of Charon’s representation. The presence of Charon, together with the description in the text of the manuscript, helps in identifying the entire scene as representing Dante and Virgil crossing the River Acheron [2].

Figure 1. Illumination of folio 2 recto: (a) picture and (b) thermogram where the gilding appears to be in a good preservation state.
Figure 2. Illumination of folio 2 verso: (a) picture and (b) thermogram where the dashed rectangles mark Charon. The yellow arrow in (b) indicates the waves of the River Acheron; (c) enlarged thermogram of the area dashed in (a,b), where the red arrows indicate the hooked nose and the beard of Charon.

The MWIR reflectogram (Figure 3) displays some further details of interest complementary to the information displayed in Figure 2a,b. Because of the greater depth probed by reflectography, Figure 3 reveals features situated even below the pictorial layers, such as possible underdrawings of tree branches (indicated by the red arrows), which do not appear in either Figure 2a or Figure 2b. Moreover, the profile of the oar (yellow arrow in Figure 3) seems very different from those in Figure 2a,b.
3.2. Folio 4 Verso

The demoniac figure represented in the top left corner of the illumination of folio 4 verso appears to be severely damaged (dashed rectangle in Figure 4a), so it is almost impossible to identify through simple visual inspection. In this case, the thermogram (Figure 4b) enabled us to obtain images where, in combination with the dashed profiles, the improved contrast led to the identification of some relevant details useful for the interpretation of the damaged figure iconography. In particular, in the enlarged thermogram (Figure 4c), corresponding to the dashed area in Figure 4a,b, the arrows indicate some features, such as large claws and the profile of the back end of a beast, which recall the features of the guardian Minos. This information led to the identification of the scene as the descent of Dante and Virgil into the Second Circle of the Inferno [2], where they see the monster Minos standing in front of the endless line of sinners, ready to assign them their torments. According to the text, the sinners confess their sins to Minos, who then wraps his great tail around himself a certain number of times, thus indicating to them the number of paths the soul must cover [32,33].
Figure 4. Illumination of folio 4 verso: (a) picture and (b) thermogram where the dashed rectangles mark Minos; (c) enlarged thermogram of the area dashed in (a,b), where the red arrows indicate the large claws and the profile of the back end of a standing creature.

The MWIR reflectogram (Figure 5b) corresponding to the enlarged picture in Figure 5a shows some additional elements of the decorative apparatus. In particular, some somatic traits of the demoniac figure in the centre of the illumination can be better distinguished, as in the case of the nose and the open mouth, indicated by the arrows in Figure 5b.
Figure 4. Illumination of folio 4 verso: (a) picture and (b) thermogram where the dashed rectangles mark Minos; (c) enlarged thermogram of the area dashed in (a, b), where the red arrows indicate the large claws and the profile of the back end of a standing creature.

The MWIR reflectogram (Figure 5b) corresponding to the enlarged picture in Figure 5a shows some additional elements of the decorative apparatus. In particular, some somatic traits of the demoniac figure in the centre of the illumination can be better distinguished, as in the case of the nose and the open mouth, indicated by the arrows in Figure 5b.

3.3. Folio 5 Verso

The illumination of folio 5 verso shows an extended damage area on the pictorial layer, in this case also making the representation of the demon iconography (Figure 6) unclear.

Figure 6. Illumination of folio 5 verso.
Even in this illumination, both the thermogram (Figure 7a) and the MWIR reflectogram (Figure 7b) allow for the identification of some characters represented in the figure. The improved contrast displayed in the thermogram reveals some important details, such as the legs of a devoured person that stick out from the demon's belly (red arrow in Figure 7a), as well as the three animals (yellow arrows in Figure 7a,b) that are typical of the representation of Cerberus, the fourth guardian, who Dante met in the Inferno [2]. In particular, the third heat facing the right in the figure can be distinguished in the thermogram, from where human legs emerge belonging to a human figure that is being swallowed (see also Figures 6 and 7b).

![Figure 5. Illumination of folio 4 verso: (a) enlarged picture and corresponding (b) MWIR reflectogram](image1)

![Figure 6. Illumination of folio 5 verso.](image2)

**Figure 7.** Illumination of folio 5 verso: (a) thermogram and (b) MWIR reflectogram where the yellow arrows indicate the three animal heads of Cerberus. The red arrow indicates the legs of a devoured person that stick out from Cerberus's belly.

### 3.4. Folio 6 Recto

The illumination of *folio 6 recto* decorates Canto VII and probably represents the entrance of Virgil and Dante in the Fourth Circle of the Inferno where they meet the demonic guardian Plutus [2]. In this case, the figure appears completely erased (Figure 8), thus its interpretation is difficult, even in the corresponding MWIR images. However, the thermograms of the areas marked by the dashed rectangles in Figure 8 enable enhancing the contrast of some features, such as the part of the wings indicated by the arrows and the legs of the human feature in the lower part of the damaged area. On the contrary, the MWIR reflectogram does not reveal any additional useful information. This is probably because of the in-depth extended damage that caused the complete lack of a pictorial layer.

In conclusion, the thermographic and reflectographic analysis of Dante’s *Commedia* enabled the identification of some important features in all four investigated illuminations. Such details have been proven to be helpful in establishing that all the damaged demonic characters are both personifications of mythological figures and guardians of the Inferno Circles. Moreover, the presence of extended damage only in the areas where such characters are represented may possibly suggest that the damage could have been intentionally applied, perhaps for censoring purposes or by the hand of a believer [2], considering that Dante was already cited in the first *Index Librorum Prohibitorum* of 1559 as an author not to be read because of his treatise *De Monarchia* [33–35].
In this paper, a new approach consisting of the combined use of PT and MIR was proposed for the analysis of the illuminations that decorate the XIV-century manuscript of Dante’s *Commedia* (MS. 1102), preserved at the *Biblioteca Angelica* in Rome. Initially, all 34 illuminations were investigated using PT in order to determine the preservation state of the gilding and of the pictorial layer, and to direct the further MWIR reflectographic analysis on the illuminations, which resulted in a poor conservation state. In particular, the thermographic results allowed for selecting four illuminations characterized by a partial or complete loss of the pictorial layer, which make some demon representations no longer visible. In all four illuminations, both the thermograms and the MWIR reflectograms have enabled the recovery of images of lost details that have been demonstrated to be useful for the identification of Charon, Minos, Cerberus, and Plutus, all of which are demoniac personifications coming from the mythological tradition and playing the role of guardians of the circles of the *Inferno*. This kind of information may possibly suggest that the damage could have been intentionally applied, perhaps for censoring purposes, also considering that Dante was already cited in the first *Index Librorum Prohibitorum* of 1559.

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