

INTEGRATED IMAGING ON COLLECTIONS FROM UCL SPECIAL COLLECTIONS

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OBJECTIVE

Develop comprehensive imaging strategies to optimize digitalisation of artefacts regarding their different sizes, materials, inks, distinctive conservation histories, varying ages, and other necessary conservation-related factors.

INTRODUCTION

- **Imaging** is one of the most commonly applied methods for digitalisation and conservation of artefacts.
- A set of **28 objects**, including medieval manuscripts, rare books and archives, underwent different imaging treatments for literal studies.
- Different **imaging setups, capture sequences and parameters**, and imaging processing methods were applied due to the various properties of the objects
- **Two imaging techniques and four major imaging processing methods** are employed in the study to establish integrated imaging strategies.

METHODOLOGY

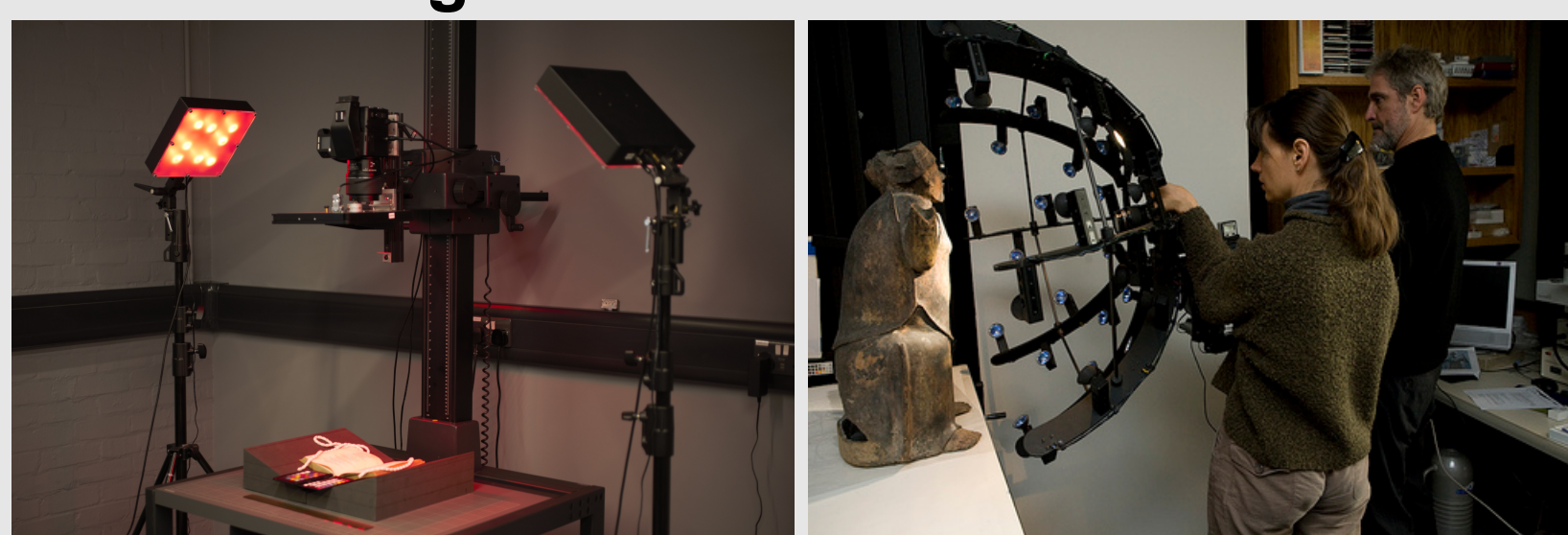
This research used a mixed-methods approaches to explore the possible imaging solutions for various cases of artefacts. The major imaging and processing methods are listed below:

➤ Multispectral imaging (MSI)

- Record both **spatial and spectral information** of the object in one system.
- MSI images were captured as the artefact was illuminated in lights of different wavelengths.
- **16 wavelengths and 5 filters** were shined sequentially in one image set. Each shot has its specific setting of **optical parameters**.

➤ Reflectance Transformation Imaging (RTI)

- Record **surface structure** of the object.
- RTI images was taken by capturing a series of images while having the flashlight shot in a **dorm-shape pattern**.
- RTI images were superimposed in RTI building software, allowing **precise change of lighting positions** while exhibiting the **surface shadowing information**.



System settings of MSI (left) and RTI (right) used in this research. Notice that MSI needs to be captured in completely dark environment. The dorm-shape flashlight holder in RTI allows recording of light information from multiple directions but also constrains size of the object.¹¹

➤ Flat Field Correction

- Correct the **non-uniformities of illumination** due to factors concerning camera and lighting.
- A **flat, white card** were captured in all wavelengths with the **same setting and sequence** as that of capturing the object.

➤ Principal Component Analysis (PCA) & False Colour Alignment

- PCA: multivariate statistical operation used for **dimensionality reduction**.
- A new sequence of images, called **principal components (PCs)**, is created in which the covariances between the original images are minimised.
- **False colour images**: coloured images generated by aligning PCs into red, green, and blue channels randomly.
- **Hidden information** can be shown in false colour image due to the colour contrast.



Fig. 3.1 The exhibition of red and blue ink character under lights of different wavelengths on parchment MS FRAG/LAT/18. The one at top left corner is the character in room ambient light and the wavelength are increasing from 1 to 11. The reverse pattern of the blue and red ink w.r.t. the increase of wavelength can be a clue to the composition of their ink, as only some show such pattern.

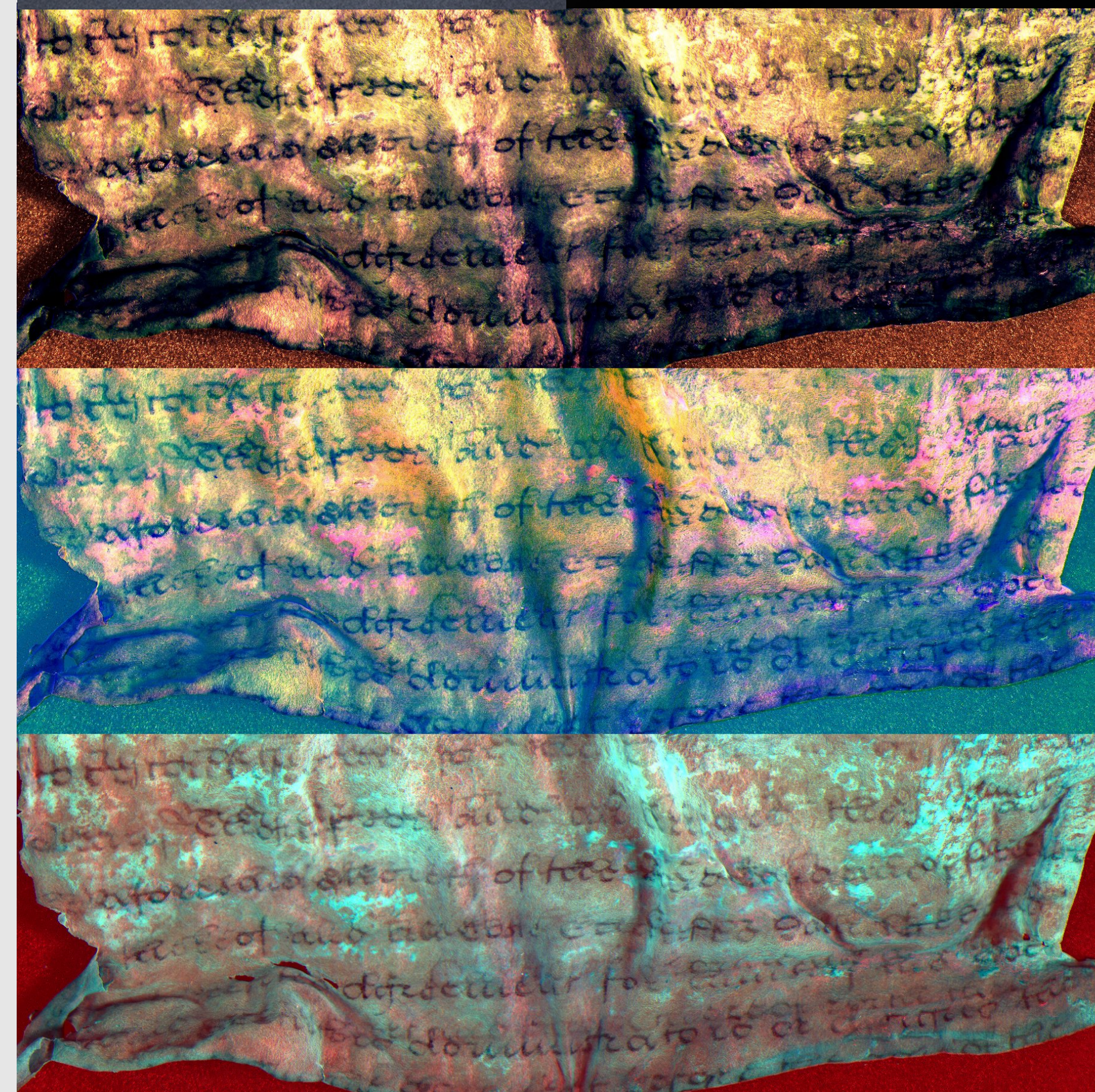
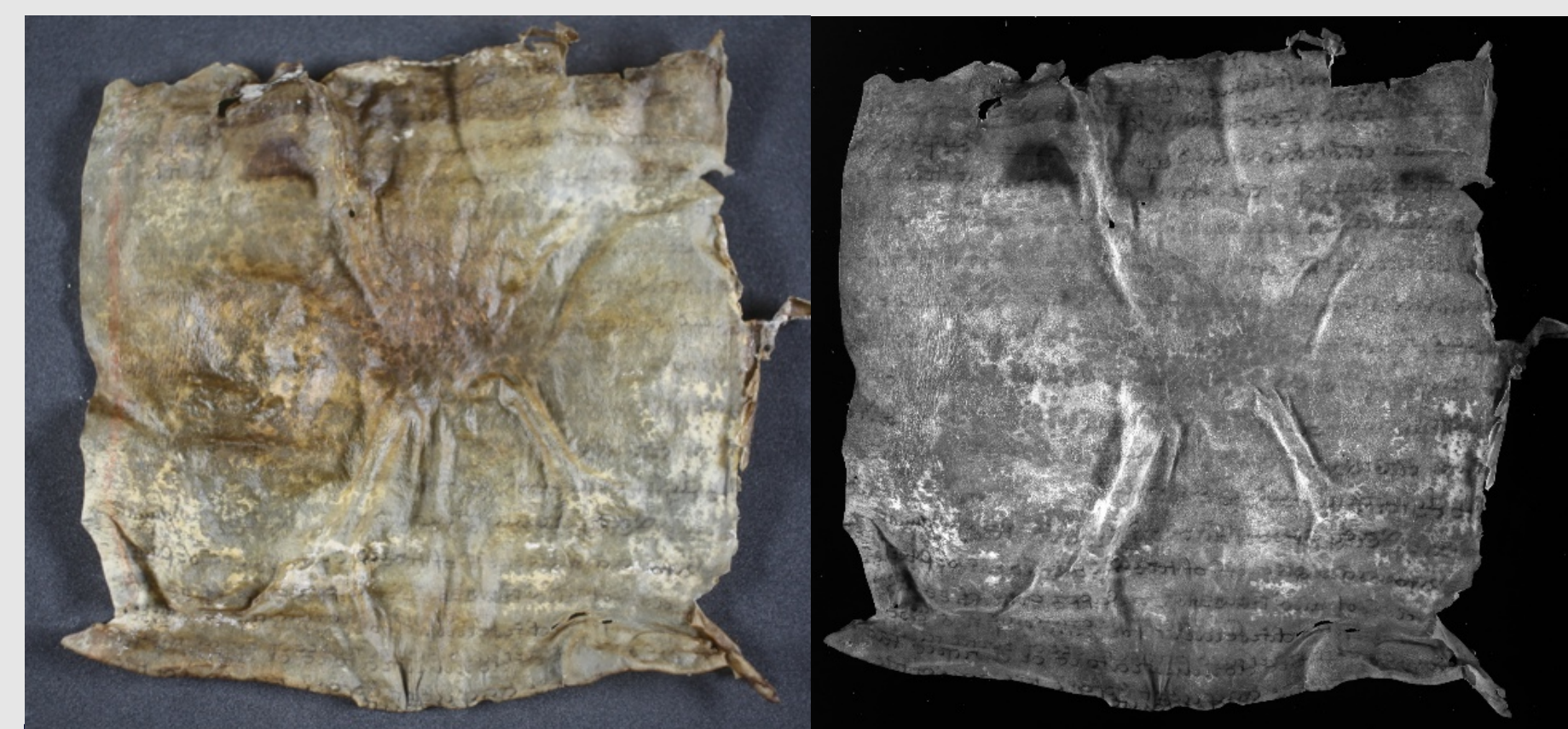


Fig. 1.1 digitalisation of a folio of flooded deed in UCL Special Collection. The deed is mostly illegible in room ambient light (top, left), but after MSI some of the inscriptions on its edge are showing more clearly (top, right). And with the help of PCA and false colour alignment, some of the inscriptions can be read by combining three false colour together.



Fig. 1.2 One folio of the parchment MS FRAG/HEB/1 are shown in room Ambient light (left), under UV light (middle), and after contrast enhancement and reverse colour (right). The inscriptions on the parchment are getting more and more Readable with more processing on the images are taken. This case shows the possibility of applying other image processing techniques for the same results to make the content more distinguishable. Part of the inscriptions are further enhanced to see its contour (right).

RESULTS AND DISCUSSIONS

In this research, many of the medieval manuscripts and rare books have serious damages due to poor conservation conditions, natural disasters and human activities. Among the 28 objects, some common cases are presented among which imaging has proved to be effective.

- **Faded inscriptions**: shown by false coloured images and multispectral images under ultraviolet(UV) light. Fig. 1.1-1.3
- **Overlapping signatures**: shown by image calculation and false coloured images generated by principal components. Fig. 2.1-2.2.
- **Coloured patterns**: fading and showing inscriptions due to wavelength change. Fig. 3.1
- **Decorative layers on manuscripts**: RTI imaging with specular enhancement to show its surface corrosion. Fig. 4.1

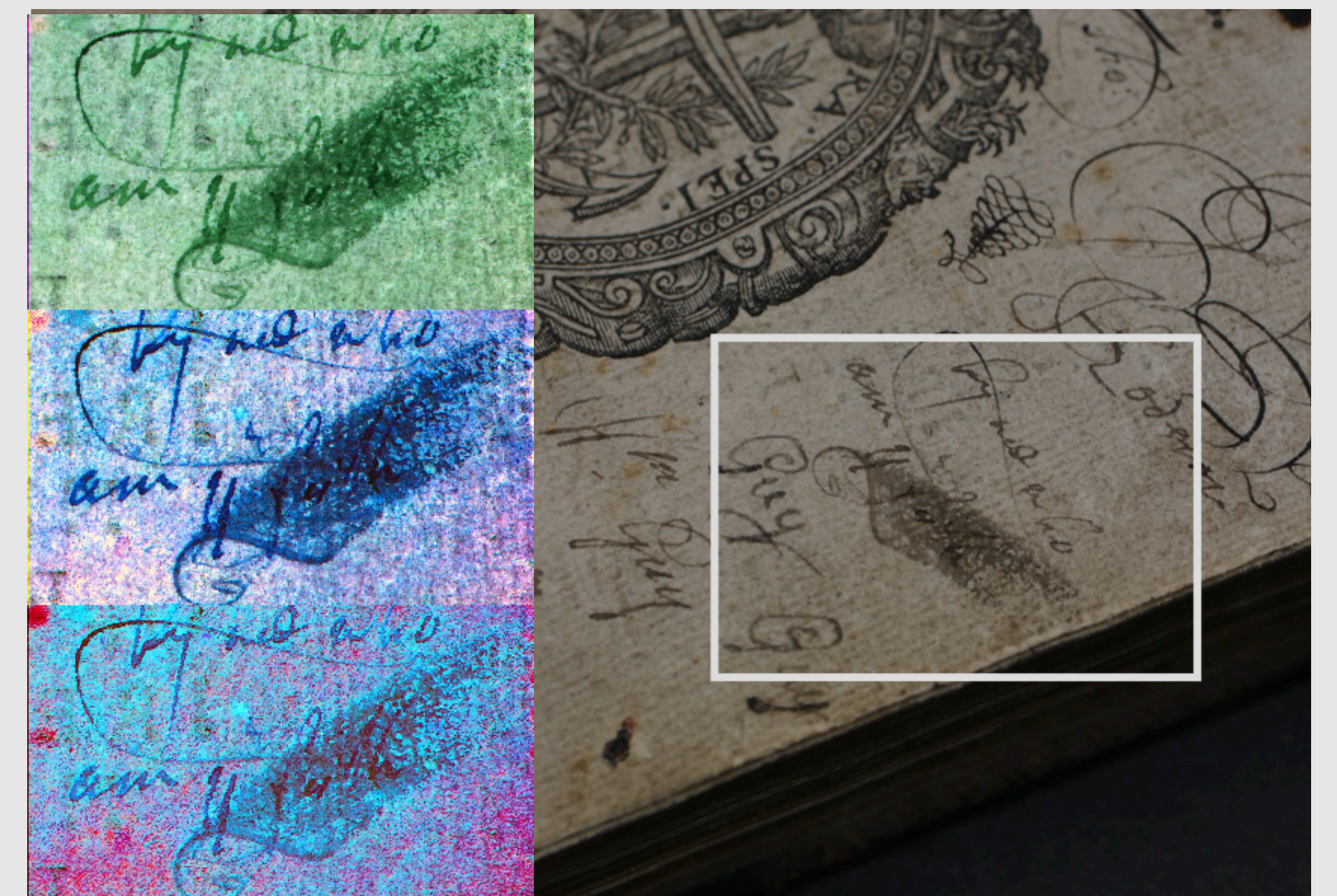


Fig. 2.1 the covered inscription at the cover page of Strong Room Ogden A 264. As shown on the right, the signature of a previous owner has been deliberately covered. And by conducting MSI and PCA, while attaching the signature with darker colour while the cover layer with a brighter one, some of the false colour images are created to show us a readable result of the signature.

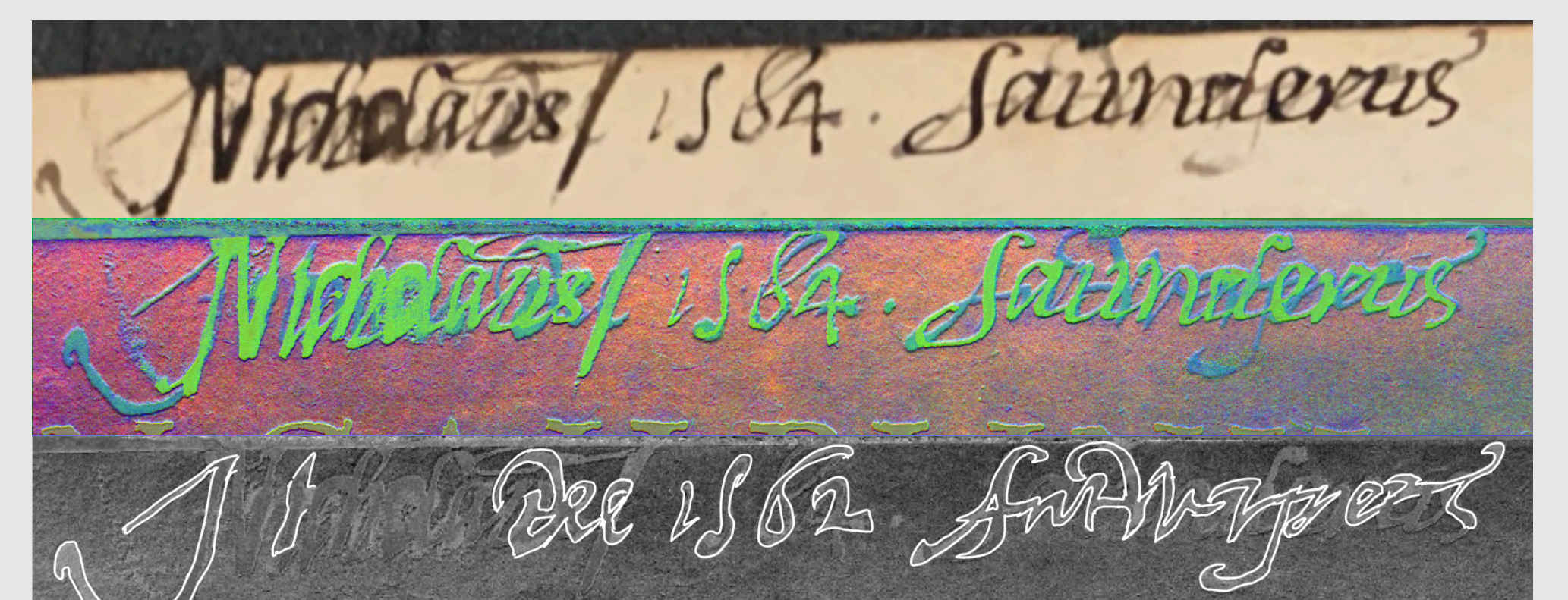


Fig. 2.2 On the cover page of RCP7798 from The Royal College of Physicians, the signature of the previous owner has been covered by the signature of the latter owner of the book, who is believed to steal the book from the previous owner. In this case, the same routine has been taken as described in Fig. 2.1. However, image calculation has also been carried out and the image at the bottom are the result after image subtraction. Some of the readable figure are drawn out on this image.

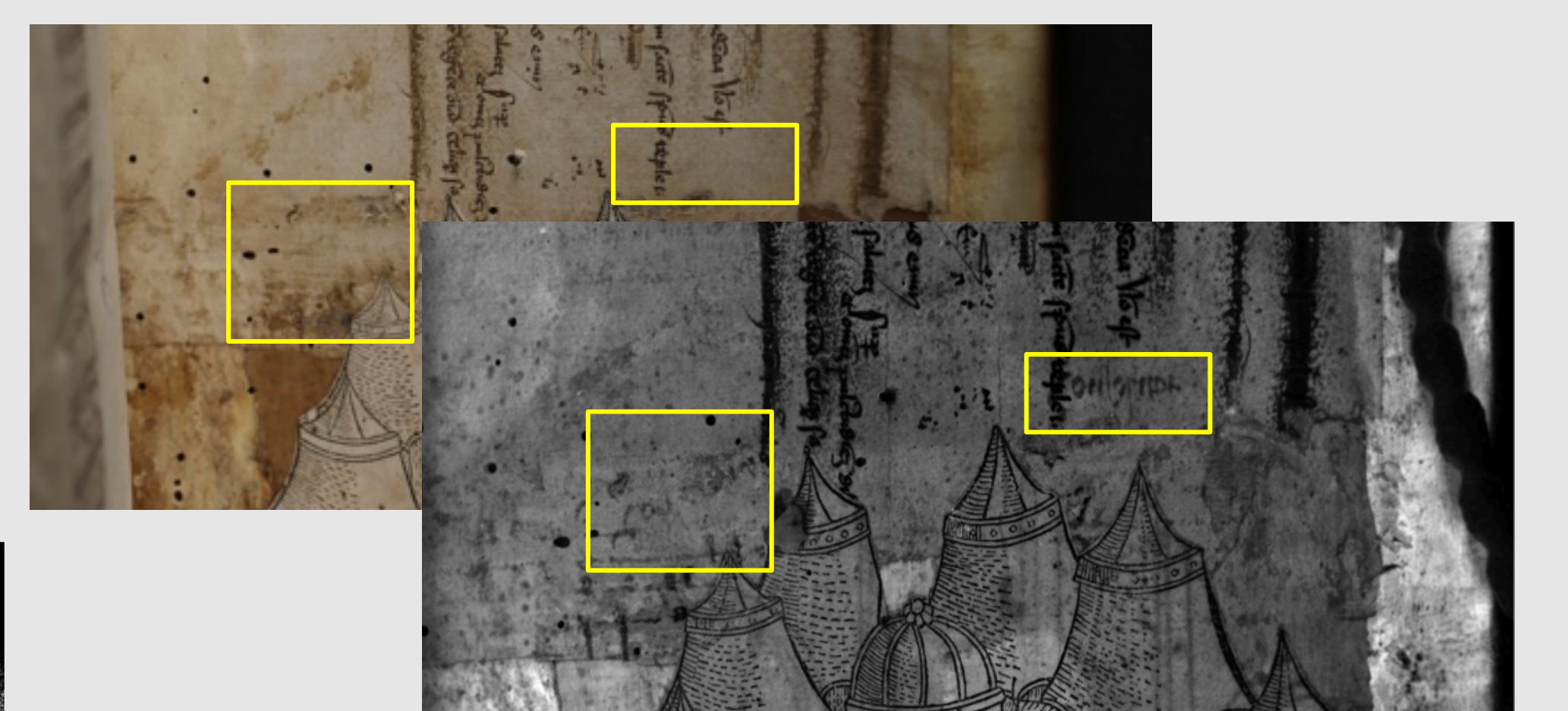


Fig. 1.3 On the last page of INCUNABULA QUARTO 1_e, there are some faded inscriptions that cannot be noticed or seen under ambient room light while only emerges under UV lights and other similar short wavelength illumination. This is an example of how MSI can be implied in showing some of the invisible inscriptions.



Fig. 4.1 For Fragment MS FRAG/LAT/28, the parchment is partially covered with a gold pattern as shown in the graph above, to determine the details of its corrosion for conservational purpose, RTI is carried out (middle) and specular enhancement is also processed for a more precise look of the surface structure (right).

CONCLUSION

- Imaging results and illumination of inscription depends on multiple factors, including **composition of ink and manuscript materials**.
- Generally speaking, lights with shorter wavelength has better **illumination of ink** while lights with higher wavelength perform better in **manuscript penetration**.
- Processing routine: **MSI→Flat Field Correction→PCA→False Colour Alignment**; while other editing techniques can also be employed such as **reverse colour, image calculation** and so on.

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References:

1. "Reflectance Transformation Imaging." Cultural Heritage Imaging. [Online]. Available: <http://culturalheritageimaging.org/Technologies/RTI>. [Accessed: 06-Sep-2019]
2. D. Mattes, D. R. Haynor, H. Vesselle, T. K. Lewellen, and W. Eubank, "PET-CT Image Registration in the Chest Using Free-form Deformations," IEEE Trans. Med. Imaging, vol. 22, no. 1, pp. 120–128, 2003.
3. UCL Archives Catalogue. [Online]. Available: <http://archives.ucl.ac.uk/DServe/dserve.exe?dsqServer=localhost&dsqIn=Dserve.ini&dsqApp=Archive&dsqCmd=Show.tcl&dsqDb=Catalog&dsqPos>