DIGITAL TECHNIQUES FOR DOCUMENTING AND PRESERVING CULTURAL HERITAGE

Edited by **ANNA BENTKOWSKA-KAFEL** and **LINDSAY MacDONALD**

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DIGITAL TECHNIQUES FOR DOCUMENTING AND PRESERVING CULTURAL HERITAGE

COLLECTION DEVELOPMENT,
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AND DIGITAL HUMANITIES

This exciting series publishes both monographs and edited thematic collections in the broad areas of cultural heritage, digital humanities, collecting and collections, public history and allied areas of applied humanities. In the spirit of our mission to take a stand for the humanities, this series illustrates humanities research keeping pace with technological innovation, globalization, and democratization. We value a variety of established, new, and diverse voices and topics in humanities research and this series provides a platform for publishing the results of cutting-edge projects within these fields.

The aim is to illustrate the impact of humanities research and in particular reflect the exciting new networks developing between researchers and the cultural sector, including archives, libraries and museums, media and the arts, cultural memory and heritage institutions, festivals and tourism, and public history.

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FOCUS STACKING

AURORE MATHYS and JONATHAN BRECKO

The COSCH Case Study that has employed this technology: Roman coins (fig. 15.1)

Definition

Focus stacking is a technique which extends the depth of focus of an image by combining different images with low depth of field. It is mostly used in close-up and macrophotography since in those cases the lens, even at high f-stop, is not able to render everything in focus. This method, although not used often in cultural heritage, is useful to document objects and to illustrate details. It can also be used in combination with Structure from Motion (SfM) in order to create accurate 3D models of small artefacts.

Description

Focus stacking allows the extension of the focus range of a single view, using the lens at its optimal f-number (typically in the range f/8 to f/11). If the lens is stopped down more than its optimal f-number, the depth of field is larger, but the image is softer (less sharp) due to diffraction. The starting point for focus stacking is a series of images, with different regions in focus. Although none of the images has the object of interest entirely in focus, collectively they contain all of the data required to generate an image that has all parts in focus. The in-focus regions of each image may be selected manually or detected automatically, for example, via edge detection or a sharpness metric or Fourier analysis. The in-focus regions are then blended together, pixel by pixel, to generate the final image.

This process is also known as z-stacking or focal plane merging.

Figure 15.1. Focus stacking record of a Roman coin. © Aurore Mathys, 2015.

Significant Applications

Example 1: Rock Art Studies

Plisson and Zotkina (2015) tested the potential of focus stacking for 3D recording of submillimetric details of prehistoric petroglyphs and paintings. They tested their technique at open air sites in France, Portugal, and Russia. The study shows that focus stacking and photogrammetry are complementary.

Plisson, H., Zotkina, L. V. 2015. "From 2D to 3D at Macro-and Microscopic Scale in Rock Art Studies." *Digital Applications in Archaeology and Cultural Heritage* 2.2: 102–19.

Example 2: Venus of Frasassi

The Venus of Frasassi is an 87 mm high Palaeolithic sculpture carved in a stalactite. It was found in a cave in the Frasassi Gorge (hence the name) in Central Italy and is housed in the National Archaeological Museum of the Marche in Ancona. The figurine was recorded using focus stacking pictures combined with photogrammetry to achieve a 3D model. The model was compared to 3D data captured through a state-of-the-art laser scanner, and the results were shown to be similar, at a lower price. Therefore focus stacking combined with photogrammetry has potential for the 3D digitization of small artefacts.

Clini, P., Frapiccini, N., Mengoni, M., Nespeca, R., Ruggeri, L. 2016. "SfM Technique and Focus Stacking for Digital Documentation of Archaeological Artefacts." *Proc. 23rd ISPRS Congress*, Prague*, 229–36.* International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XLI-B5. ISPRS.

Figure 15.2. Edge of an ancient copper nail. The nail was broken and restored, but broke again after some time. The glue used to fix the nail is clearly visible. © Jonathan Brecko, 2015.

Literature

Cremona, J. 2014. *Extreme Close-up Photography and Focus Stacking*. Marlborough: The Crowood Press. www.pixellized.com/assets/extreme_close_up_photography_and_focus_stacking.pdf.

Longson, J., Cooper, G., Gibson, R., Gibson, M., Rawlins, J. 2010. "Adapting Traditional Macro and Micro Photography for Scientific Gigapixel Imaging." *Proc. Fine International Conf. on Gigapixel Imaging for Science*, Pittsburgh, 1–12. Pittsburgh, PA: Carnegie Mellon University. http://repository.cmu.edu/gigapixel/1.

Zhang, C., Bastian, J., Shen, C., van den Hengel, A., Shen, T. 2013. "Extended Depth-of-Field via Focus Stacking and Graph Cuts." *Proc IEEE International Conf. on Image Processing* (ICIP), Melbourne, 1272–76. IEEE.