



## Project Gallery

# The Nietulisko Małe Hoard in the light of modern documentation methods

Jarosław Bodzek<sup>1</sup> , Wojciech Ostrowski<sup>2</sup> , Łukasz Wilk<sup>2</sup> , Paulina Zachar<sup>2</sup>   
& Barbara Zajac<sup>3,\*</sup> 

<sup>1</sup> Faculty of History, Jagiellonian University in Krakow, Poland

<sup>2</sup> Faculty of Geodesy and Cartography, Warsaw University of Technology, Poland

<sup>3</sup> National Museum in Krakow, Poland

\* Author for correspondence ✉ [basia.zajac21@gmail.com](mailto:basia.zajac21@gmail.com)

A total of 2848 denarii from the Nietulisko Małe Hoard, one of the largest hoards of Roman coins found in Poland, were digitised and documented using reflectance transformation imaging, highlighting the potential for this technology in numismatic research.

Keywords: Poland, Nietulisko Małe, Roman coins, reflectance transformation imaging, Segment Anything Model, hoard

## Introduction

Discovered in 1939, the Nietulisko Małe I hoard is the largest hoard of Roman denarii known from the Polish territories. In 1942, it was bought by A. Siedlecki and subsequently lost following his death in 1945. In 1948, a tabular list of coins from the hoard was published with a short commentary by Waclaw Makomaski, who had been able to study the coins in 1943. The hoard was said to comprise 3170 denarii from the reigns of Nero (AD 54–68) to Septimius Severus (AD 193–211). In 1995, the remains of a wooden chest containing Roman denarii were discovered buried in the cellar of a tenement house at 20 Szewska Street in Krakow. It was quickly established that these were denarii from the Nietulisko Małe I hoard, although the rediscovered set contained only 2759 coins. In 2000, Jagiellonian University acquired another 89 coins from Mrs H. Makomaski, Waclaw's widow. Makomaski had acquired some of the coins from the hoard, perhaps as payment for their identification, though it remains uncertain how many of the missing 411 coins he originally possessed (Biborski *et al.* 2004).

There are currently 2848 coins from the hoard in the Jagiellonian University collection (Figure 1), and these are the focus of the project 'The Nietulisko Małe Hoard in the light of modern documentation methods' launched in 2021.

## Documentation method and automated workflow

The first part of the project concerned the digitisation of the individual coins using multi-light image collections (Pintus *et al.* 2019) and reflectance transformation imaging (RTI),

---

Received: 22 September 2024; Revised: 18 November 2024; Accepted: 20 December 2024

© The Author(s), 2025. Published by Cambridge University Press on behalf of Antiquity Publications Ltd



Figure 1. The coin hoard from *Nietulisko Male I* (figure by M. Biborski (1999: fig. 2), reproduced with permission).

an established technology in numismatics (Mudge *et al.* 2005) used to create relightable images that enable virtual analysis of the coins. At least 30 photographs of the obverse and another 30 photographs of the reverse of each coin are required for RTI, each staged with light originating from a different direction. Thus, a minimum of 170 000 images were required for the entire hoard. For this reason, it was decided to use a dome with an integrated camera to automatically take the images (Wilk *et al.* 2024); this was further extended by an automated cloud-based system for processing the acquired data based on the CENAGIS (Center for Geospatial

and Satellite Analysis at Warsaw University of Technology) infrastructure (Figure 2). The images were uploaded to a cloud drive, from which they were automatically processed using the Relight library (Ponchio *et al.* 2018) and published online using the M.A.R.L.I.E. viewer (Jaspe-Villanueva *et al.* 2021) tool for RTI data visualisation in web browser; this allowed verification of the results on the next working day.

## Numismatic description of the individual coins

The project also aimed to create a description for each coin, with the structure of database fields following the Numismatic Description Schema (nomisma.org) and the latest trends, including annotations of individual objects visible on coins (e.g. using deep neural networks; Anwar *et al.* 2021). Machine learning models for image segmentation, such as the SAM (Segment Anything Model, a general-purpose tool that can segment any object from an image; Kirillov *et al.* 2023) can recognise these objects. Due to its versatility and because there is no need to train the model, we implemented the SAM, although it was necessary to create a set of virtual images with various parameters for the position of the light source, as experimentation revealed that segmentation results varied considerably depending on the input illumination parameters (Figure 3).

## Online database with RTI viewer

Publication of the hoard in the form of an online database compliant with nomisma.org ontology (Numishare application <https://github.com/ewg118/numishare>) is planned, with the possibility of an interactive display of RTI data together with SAM-derived image segmentation results. The previously published OpeNumisma portal (Avgousti *et al.* 2017) uses a database with a web interface to visualise RTI data, although the software used for website presentation (WebRTIVIEWER; Palma *et al.* 2014) is now outdated. Newer open-source tools aim to unify the RTI data storage and visualisation system, including Relight (Ponchio *et al.* 2018), which facilitates the construction and visualisation

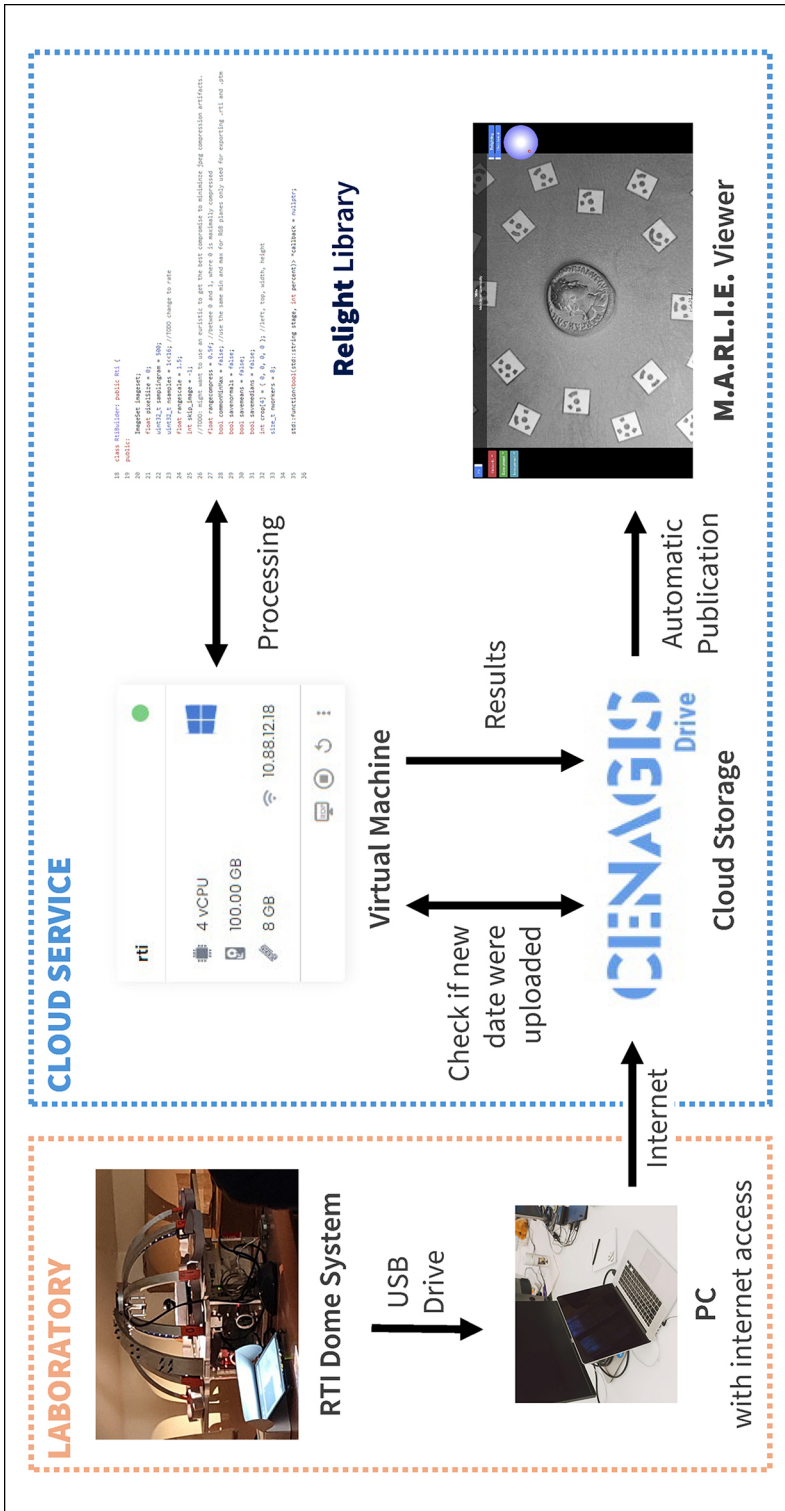


Figure 2. Workflow of automatic data processing within the CENAGIS infrastructure (figure by authors).

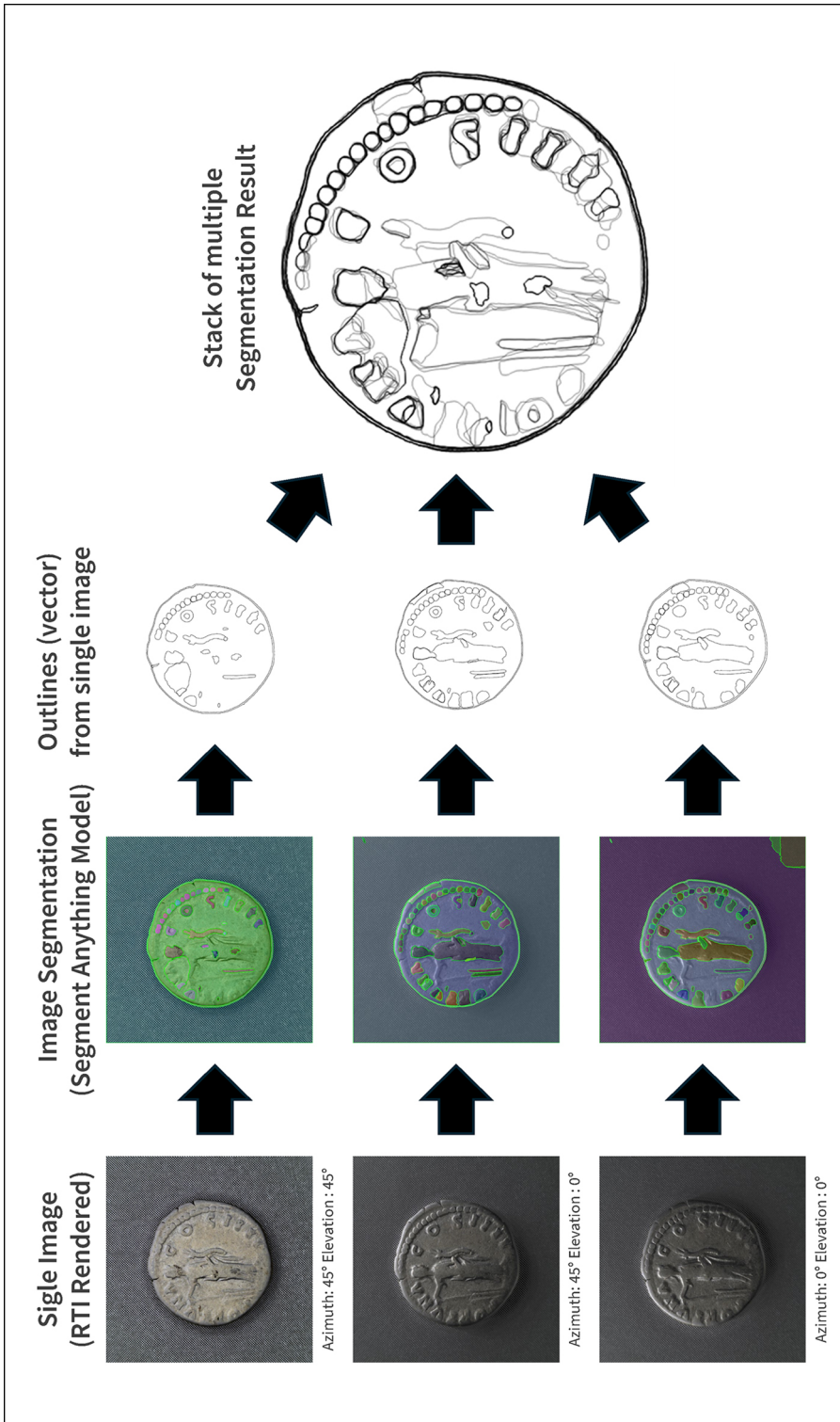


Figure 3. Segment Anything Model on the RTI documentation (figure by authors).



of RTI data. The M.A.R.L.I.E. viewer (Jaspe-Villanueva *et al.* 2019) is another development that allows the addition of rasterised annotations. Our solution (Figure 4) relies on the open Leaflet library, natively used in Numishare, to display high-resolution coin images from the IIF (International Image Interoperability Framework) server. We implemented a Relight-inspired WebGL plugin for Leaflet, allowing rendering and interactively displaying the relighted image in the web browser. The proposed solution not only provides a real-time image of each coin with a given illumination direction based on RTI data from the IIF service inside the existing Numishare web interface but also allows vector annotations to be added in the future as a regular Leaflet vector layer to be easily presented (without additional implementation) against a relighted image visualisation.

**Denarius (0281)**  
Canonical URI: <https://numishare.congms.edu.pl/nietulisko/0281>

**A**

Obverse: SABINA AVGVSTA - Draped bust of Sabina right, hair in plait behind

Reverse: VENERI GENTRICI - Venus standing right holding an apple

**B**

**Physical Description**

Axis: 6

Measurements

Weight (in g): 3.24  
Diameter (in mm): 19.1

**Typological Description**

Object Type: Coin  
Manufacture: Struck  
Material: Silver  
Date Range: 128 AD - 136 AD  
Denomination: Denarius  
Geographic

Mint: Rome  
Authority

Authority: Hadrian  
Dynasty: Nerva-Antoine Dynasty  
State: Roman Empire

**Findspot Description**

Findspot

Description: Nietulisko Mate

Location

Latitude: 50.96946090619845  
Longitude: 21.259601314889635

**C**

Map

Legend: Mint (blue), Findspot (orange)

Figure 4. Our modification of the Numishare application—the image viewer is replaced with the RTI viewer based on the IIF service (box A) and accompanied with attributes describing a specific coin (box B) and map (box C) with indication of the findspot (figure by authors).

## Conclusion and future work

Use of RTI to document the largest surviving hoard of Roman denarii discovered in Poland demonstrates the utility of this technology for large-scale coin documentation and digital image processing in numismatic research. Application to the Nietulisko Małe Hoard allowed the development of a documentation standard for similar coin deposits. The last stage of the project will focus on making the coin database publicly available and properly integrated in the Nomisma network in Linked-Open-Data manner.

Future research plans include the development of a method for automatic assignment of description parts with specific elements visible on coins. The developed SAM detections can be subjected to a clustering process, by which semantic classes of identified objects will be created. After clustering, the classes can be described using natural language processing techniques in order to create connection between images and the legend and descriptive information contained in the database.

## Funding statement

This research was funded by the Priority Research Area Heritage under the programme Excellence Initiative – Research University at Jagiellonian University in Krakow.

## Acknowledgements

We would like to thank Jakub Modrzewski and Grzegorz Sochacki for their help with the realisation this project.

## References

- ANWAR, H., S. ANWAR, S. ZAMBANINI & F. PORIKLI. 2021. Deep ancient Roman Republican coin classification via feature fusion and attention. *Pattern Recognition* 114. <https://doi.org/10.1016/j.patcog.2021.107871>
- AVGOUSTI, A., A. NIKOLAIDOU & R. GEORGIU. 2017. OpeNumisma: a software platform managing numismatic collections with a particular focus on reflectance transformation imaging. *Code4Lib Journal* 37. Available at: <https://journal.code4lib.org/articles/12627> (accessed 26 August 2024).
- BIBORSKI, M. 1999. Konserwacja skarbu monet rzymskich z Nietuliska Małego, gm. Kunów, woj. kieleckie. *Notae Numismaticae-Zapiski Numizmatyczne* 3/4: 201–11. <https://doi.org/10.11588/digit.21230.18>
- BIBORSKI, M., J. BODZEK & P. KACZANOWSKI. 2004. Nietulisko Małe Hoard I rediscovered – preliminary information. *Notae Numismaticae-Zapiski Numizmatyczne* 5: 49–59. <https://doi.org/10.11588/digit.22228.10>
- JASPE-VILLANUEVA, A., M. AHSAN, R. PINTUS, A. GIACHETTI, F. MARTON & E. GOBBETTI. 2021. Web-based exploration of annotated multi-layered relightable image models. *Journal on Computing and Cultural Heritage* 14(2): 1–29. <https://doi.org/10.1145/3430846>
- KIRILLOV, A. et al. 2023. Segment anything, in *2023 IEEE/CVF International Conference on Computer Vision (ICCV)*: 4015–26. New York: Institute for Electrical and Electronics Engineers. <https://doi.org/10.1109/ICCV51070.2023.00371>
- MUDGE, M., J.-P. VOUTAZ, C. SCHROER & M. LUM. 2005. Reflection transformation imaging and virtual representations of coins from the Hospice of the Grand St. Bernard, in M. Mudge, N. Ryan & R. Scopigno (ed.) *VAST05: the 6th International Symposium on Virtual Reality, Archaeology and Intelligent Cultural Heritage*: 29–39. Graz: Eurographics Association. <https://doi.org/10.2312/VAST/VAST05/029-039>

- PALMA, G., E. SIOTTO, M. PROESMANS, M. BALDASSARI, C. BARACCHINI, S. BATINO & R. SCOPIGNO. 2014. Telling the story of ancient coins by means of interactive RTI images visualization, in G. Earl *et al.* (ed.) *Archaeology in the digital era*: 177–85. Amsterdam: Amsterdam University Press.  
<https://doi.org/10.1515/9789048519590-019>
- PINTUS, R., T.G. DULECHA, I. CIORTAN, E. GOBBETTI & A. GIACHETTI. 2019. State-of-the-art in multi-light image collections for surface visualization and analysis. *Computer Graphics Forum* 38(3): 909–34.  
<https://doi.org/10.1111/cgf.13732>
- PONCHIO, F., M. CORSINI & R. SCOPIGNO. 2018. A compact representation of relightable images for the web, in *Proceedings of the 23rd International ACM Conference on 3D Web Technology*: 1–10. New York: Association for Computing Machinery.  
<https://doi.org/10.1145/3208806.3208820>
- WILK, Ł., P. LECH, M. KLEBOWSKI, M. BELDYGA & W. OSTROWSKI. 2024. Application of a stand-alone RTI measuring system with an integrated camera in cultural heritage digitisation. *Journal of Archaeological Science: Reports* 53.  
<https://doi.org/10.1016/j.jasrep.2023.104318>