3D scientific visualisation of 19th century glass replicas of invertebrates

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A brief biography of the Blaschka family

- Leopold Blaschka (father) and Rudolf Blaschka were glass artisans from the 19th century, specialised in the creation of plant and marine invertebrate replicas as educational models.

- Overall more than 10,000 replicas were produced.

- Famous collections in the world: Harvard University, Cornell University (US), Wales National Museum and the National Museum of Ireland (Europe)

- The Corning Museum of Glass (NY State) contains a large archive of the artisans’ sketches and drawings.
History of the Florentine collection

- The Fondazione Scienza e Tecnica is an institution established to preserve natural sciences collections.
- Part of this material included 118 invertebrates glass replicas, the largest Blaschka collection in Italy.
- Today they are stored in the Natural Sciences Section of the Fondazione, currently inaccessible to the public.
- Additional items are at the Zoological Section “La Specola” Museum of Natural History of Florence University.
Aims

- Develop a pipeline for the creation of Blaschka glass replicas 3D digital models, to be used for:
  - conservation / restoration,
  - as reference collections,
  - as pedagogic material,
  - Promotion of the inaccessible collections.
- Set-up an initiative to further 3D digitise other Blaschka glass collections and create larger open access repositories for such items.
Most common 3D documentation of objects based either on active or on passive sensors relies on recording the light reflected from their surface (governed by Lambert’s Law).

- Viewed brightness does not depend on viewing direction
- Brightness does not depend on direction of Illumination

3D Documentation of semi opaque or transparent surface objects (Non-Lambertian) is an open problem, due to their transparency, reflectivity and specularity.
Proposed approach

❖ Based on:

- portability restrictions of the objects

the photogrammetric approach has been selected for the pilot study.

❖ The system setup:

- DSLR camera,
- rotating table
- two photographic lamps.
- circular polarised filters
The use of polarised filters results in a surface enhancement effect, increasing image’s saturation and contrast.

To remove reflections, the filters placed over the lamp have to be rotated until perpendicular or crossed planes of polarisation are reached.

A colour checker board was used to normalise RGB values.

A ruler was placed to subsequently scale the 3D model.
Proposed approach

❖ The camera used is a Nikon D3X featuring a 24-megapixel full frame CMOS sensor, 105 mm focal length

❖ The Ground Sampling Distance (GSD) was calculated in 0.4 mm.

❖ Image count (36/72) per item

❖ Data acquisition was performed in a dark room with a controlled light environment.
Description of the sample

- The test sample consists of 17 items from the Fondazione collection, grouped under three categories:
  - coloured semi-transparent glass (ST) colorised during the glass production.
  - coloured glass painted above the surface (PA).
  - coloured glass painted underneath the surface (PU).
Post-Processing

- Photogrammetric pipeline performed in Agisoft Photoscan environment:
  - Image pre-processing
  - External orientation (EO)
  - Dense Image Matching (DIM)
  - Mesh Creation and Editing
  - Image Texturing
Photogrammetric Reconstruction Assessment
Coloured semi-transparent glass (colorised during the glass production)

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Preliminary results

**Coloured glass (painted above the surface)**

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![Image of coloured glass](image.png)
Preliminary results

**Coloured glass** (painted *underneath* the surface)

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3D models: exempla

Polycera lessonii 3D model, Florence, FST Museum, Catalogue I (Zoology), n. 93

Tupibora hemprichi 3D model, Florence, FST Museum, Catalogue I (Zoology), n. 85

Actinoloba dianthus 3D model, Raw (left), Smoothed (center), Textured (right), Florence, FST Museum, Catalogue I (Zoology), n. 33

Cerianthus lloydii 3D model, Florence, FST Museum, Catalogue I (Zoology), n. 81
Conclusions

- The study presents a fast, non-destructive, low cost approach for the documentation of fragile glass replicas.
- Such documentation returned satisfactory results in terms of geometry detail level and colour composition.
- The use of cross polarization showed interesting results in terms of reconstruction improvements.
- We have observed a degrees of success, according to the manufacture processes of these items.
Future work

- Future work includes extension of the 3D documentation on other objects of the three identified manufacture types at FST.
- Improve the proposed methodology for the cases where the applied pipeline failed, or partially failed.
- Metrology tests will be extended in order to quantitatively assess the quality of the obtained 3D models in terms of accuracy.
- Creation of a virtual online museum for the FST collection.
Acknowledgement

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Thank you for your attention

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