3D Modeling of a Gravestone Exploiting Low Cost Range and Image Based Techniques

Dante Abate

ENEA Research Centre, Via Martiri di Montesole 4, 40129, Bologna, Italy

Technical Unit on Informatics Systems Development and ICT

(UTICT)

dante.abate@enea.it

Bio:

Dante Abate is a research fellow at the ENEA research centre of Bologna (Italy). He has a degree with honour in Humanities and a specialization in Protection and Valorisation of Historical Artistic Heritage. His main research interests are related to 3D surveying and modeling, virtual reality and visualization in the field of Cultural Heritage. He has a good familiarity and preparation with laser scanning instruments and software as well as with all the image-based modeling methodology. Indeed during his studies and research activities he attended different national and international courses and conferences in order to strength his knowledge and capabilities.
Dante Abate has thus an outstanding record of education and training activities as well as a salient number of publications.

Inside the Medieval Museum of the city of Bologna are housed a series of gravestones which originally adorned the tombs of the Doctors belonging to the ancient city *studium*.
One of the most significant in importance and finesse of *ductus*, which refers to the contemporary genre painting, is definitely the one realized in Istria stone by stonemason Bettino da Bologna for to the tomb of Bonifacio Galluzzi during the first half of the fourteenth century.
The iconography shows on either side of the master, pictured in the center of the scene behind the desk, three students per side, sitting on benches, intent and focused on daily *lectio*.
This artifact, among all those preserved in the museum, is the only one that has clear traces of color, thus leaving to assume that originally was completely depicted.
The 3D model of the gravestone was made using the low cost triangulation laser scanner NextEngine Desktop 3D Scanner.
For the digitization of the entire artifact have been acquired around 100 range maps following a boustrophedon path from left to right, from bottom to top. The survey lasted for one and half day.
Each range map took 5 to 7 minutes with an average of 10 scans per hour.
The high number of range maps acquired is justified by the facts that:

- the Nextengine Desktop 3D Scanner, with the sensor in wide mode, has a field of view of 13.5 x 10.1 inches;
- for an optimal registration two contiguous range maps need a considerable part of overlapping region.

The same object was subsequently reconstructed with image-based techniques and software (computer vision).
For this study all software were installed on a quad core 24 GB RAM workstation.
The 3D models obtained with Agisoft Photoscan and 123DCatch were mesh models. The final outputs of Visual SFM and Apero were point clouds instead, which need to be post post processed and triangulated at a later stage.
Besides 123dCatch, which is a web service by Autodesk, all other software run on local machines.
It was intended to test also another web service (Arc3D) but the models reconstructed by the remote server were sometime incomplete in large amount of the surface, sometime completely wrong in the main shape and then unusable.
As well-known Computer Vision techniques are not geometrically accurate. During the post processing step all 3D objects were scaled according to a known distance calculated on the laser model, used as reference model, and subsequently aligned to it in order to estimate the average deviation.
This parameter was calculated among portions of the meshes, and associated section profiles, along X and Y axis.
The results obtained through different methods were analyzed and compared in order to evaluate some parameters such as:

- models accuracy,
- processing time,
- ease of use of hardware and software.

This study aims to present the results achieved, the operating methodologies applied, and the problems encountered during the different phases of the research.

Equipment:
Nextengine 3D Desktop Scanner;
Canon EOS550D Digital Camera.
Software:
Meshlab (laser scanner data post processing);
Rapidform XOV (deviation analysis);
Autodesk123DCatch (open-source software until December 2012);
Visual SFM (open-source software);
Apero (open-source software);
Agisoft Photoscan (commercial software).

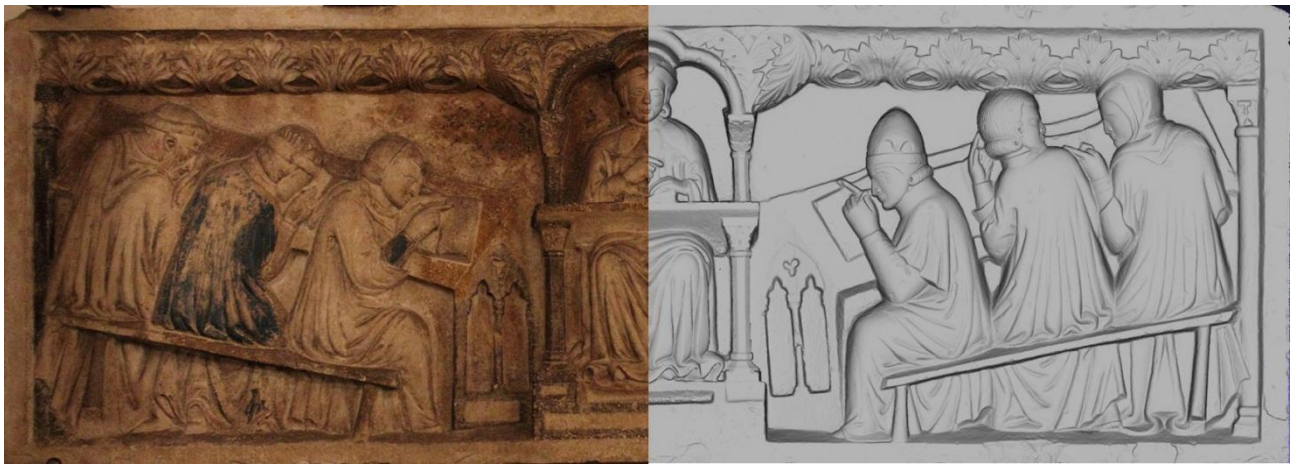
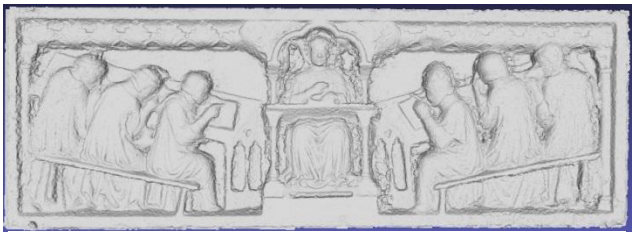
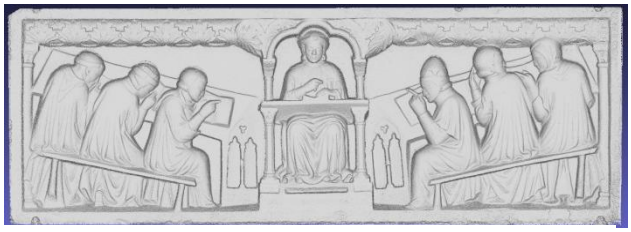


Image which shows the transition between the real object and the 3D model acquired with the laser scanner



Apero 3D Model



Photoscan 3D Model

123DCatch 3D Model

Visual SFM 3D Model