PETER BERNINI IN CALABRIA: THE SCULPTURES OF THE "SS. PIETRO E PAOLO CHURCH" IN MORANO CALABRO

G.Artese[a], V.Achilli[b], G.Boatto[b], M.Fabris[b], G.Salemi[b], A.Trecroci[a]

[a] Dept. of Land Planning, University of Calabria, Cosenza - Italy – g.artese@unical.it
[b] Dept. of Architecture, Land Planning and Surveying, University of Padua, Via Marzolo, Padua – vladimiro.achilli@unipd.it

KEY WORDS: Cultural Heritage, Laser Scanning, Classification, Virtual Reality, Digital Photogrammetry

ABSTRACT

In this paper, the surveying of the statues of St. Lucia and St. Caterina d'Alessandria, obtained by laser scanner technique, is presented. To obtain the statue models, several acquisitions have been made, using a high precision triangulation laser scanner. On the digital surface models, the radiometric characteristics acquired by digital camera shots have been applied; in this way, realistic 3D models have been obtained, useful for virtual reality videos, and for the set up a Web site.
The accuracy of the laser scanner acquisitions allows to detect some statue manifacturing characteristics, useful for recognizing the paternity of the works.

1. INTRODUCTION

Among the activities related to the cataloguing of cultural heritage in Calabria, Italy, several surveys have been realized by the Universities of Calabria and Padua, regarding the main monuments of the region. One of the most interesting sites in Calabria is Morano Calabro, a little town in the Pollino National Park. The old town of Morano was built around a hill, in a strategic position near the ancient "Capua – Rhegium" roman road. The town is a real treasure, due to the high number and the quality of its monuments and works of art. Peculiar characteristics are the town planning scheme and the panoramic views of the Pollino massif (Figure 1).
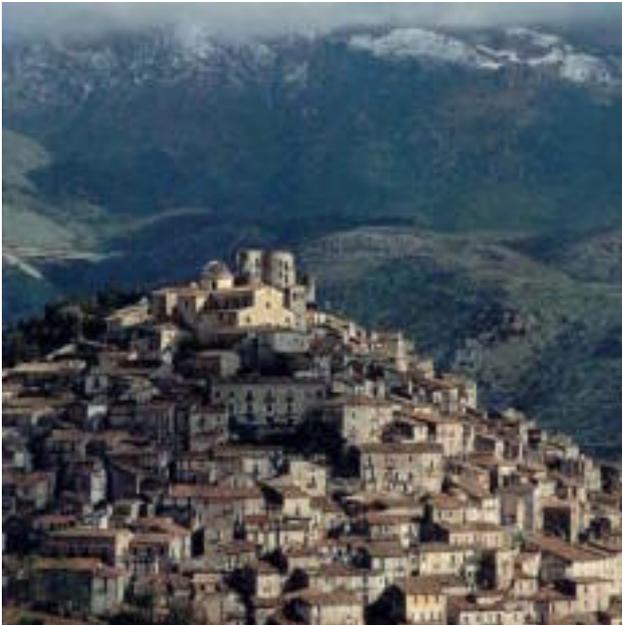

Figure 1 – View of Morano Calabro

Among the main monuments of Morano Calabro, the SS. Peter and Paul Church (*Collegiata dei Santi Pietro e Paolo*) is the most interesting. The church, sited in the upper part of the town, near the castle, was built in 1007. Several changes were realized during 13th and 15th centuries; the last important works were made during 17th century (Tozzi, S., 1996). The church is characterized by a romanic square bell tower, and the internal area is divided in three naves. Several works of art are housed in the church; noticeable are a silver crucifix dated 1445, two ancient organs and the wooden "coro" (1796-1805). The most important works of art are four marple statues (St. Peter, St. Paul, St. Lucia and St. Caterina d'Alessandria). Two statues (St. Lucia and St. Caterina d'Alessandria, dated 1591) are certainly attributed to the tuscan sculptor Peter Bernini (1562 – 1629), the most important italian sculptor of his time and the father of the famous Gian Lorenzo (Figures 2, 3).

Figures 2, 3 – St.Lucia (left) and St.Caterina d'Alessandria

Two other statues (St. Peter and St. Paul, which dating is about 1601), have been initially attributed to Berninis disciples. Recent studies, based on the manufacturing characteristics, assign the paternity to the master (Tozzi, S., 1995). In the paper, the surveying of the statues of St. Lucia and St. Caterina d'Alessandria, obtained by laser scanner technique, is presented. Among the several techniques used for surveying solid objects, laser scanner is actually one of the most effective. The increasing of computers performances allows the management of very large point clouds, and discovers interesting perspectives for the utilization in different fields (cultural

heritage, medicine, reverse engineering), where 3D models can be obtained using the high density surveying of real objects. The problems related to the registration of 3D images and to the global alignment, can be solved by following different ways. Some methods use tie points (generally 4 or more) in two 3D images which are to be merged. One of the most popular methods is the Iterative Closest Point (ICP) algorithm developed by Besl and McKay (1992), Chen and Medioni (1992), and Zhang (1994). An automatic method has been proposed by Akca (2003). Other procedures use retro-reflecting or volumetric (conical, cylindrical, spherical) targets. In this case, it is possible to calculate the position and the sensor orientation data during acquisition of the 3D images (Valanis and Tsakiri, 2004; Artese et al., 2004). For the surveying of statues, it is generally difficultous to place volumetric or reflective targets. In this case, the use od the ICP algorithm can be considered the most effective. Some control points (well visible points on the statue) should be used to verify the registration of the 3D images, while external control points can be used to obtain the global alignment.

2. THE SURVEYING

2.1 Methodology

Each statue is placed in a niche. The height is about 155 cm, and the basement height on the ground is 125 cm. For each statue, to obtain the coverage of the visible part of the surface, the acquisitions have been performed from left, front and right side at three heights (150 cm, 220 cm and 300 cm). From each point of view, three acquisition have been performed (Figure 4). Other shots have been executed to obtain details and to acquire hidden surfaces. About 40 laser scanner acquisitions have been performed. For the registration the ICP algorithm has been used. Images have been obtained also by means of a digital camera.

Figure 4 – Laser scanner acquisition

2.2 Instruments

For the 3D surveying, the Laser Scanner Minolta VI 910 has been used in FINE mode. Its main characteristics are:
- Laser scanning method: Hi performance galvanometer-driven mirror
- Ambient light condition: Office Environment, 500 lx or less
- 3 interchangeable lenses (Tele f= 25 mm ; Middle f= 14 mm Wide f= 8 mm)
- **X**-Direction Input Range: 111 to 463mm (TELE), 198 to 823mm (MIDDLE), 359 to 1196mm (WIDE)
- **Y**-Direction Input Range: 83 to 347mm (TELE), 148 to 618mm (MIDDLE), 269 to 897mm (WIDE)
- **Z**-Direction Input Range: 40 to 500mm (TELE), 70 to 800mm (MIDDLE), 110 to 750mm (WIDE)
- Number of Output Pixels: 3D-data: 307.000 (for FINE-mode), 76.800 (for FAST mode)
- Colordata: 640 x 480 x 24 bits colour depth-Precision: +/- 0.008mm (Condition: FINE mode, Minolta's standard)
- Accuracy: X: +/- 0.22mm, Y: +/- 0.16mm, Z:_ +/-0.10mm to the Z reference plane (Conditions: TELE/FINE mode, Minolta's standard)
- Input Time: 0.3 sec (FAST mode), 2.5 sec (FINE mode),0.5 sec (COLOR)-Transfer Time: Approx. 1 sec (FAST mode), 1.5 sec (FINE mode)

For the laser scanner acquisitions, the 8 mm lens has been used; some details have been scanned by using the 25 mm lens.
Images have been also acquired by a digital camera Nikon D1X, with a 35 mm lens; the resolution is about 6 megapixels.

2.3 Data Processing

The data obtained by the acquisitions have been processed both with Polygon Editing Tool[TM] (Minolta software) and Rapidform[TM] software. For every 3D shot, the points close to the borders of the acquired surface have been eliminated, and regular border lines have been obtained; in fact, for the border points, the angle between laser beam and normal of surface is often very high, and the obtained coordinates are less accurate. For every point cloud a triangulation has been executed, then break lines have been individuated and imposed. The obtained DEM has been divided into *regions*; selective decimation and smoothing have been done for every *region*. Adjacent clouds have been registered (coarse and fine) by using ICP method. The border of the shells have been cut in order to reduce the total number of points of the model. In spite of the high number of acquisitions, some holes had to be filled. The laser scanner Minolta VI 910 acquires the radiometric characteristics of the surveyied surface. In some cases (wide angle between normal to the surface and laser beam direction) the results are not satisfactory; for these shots, the images acquired by digital camera have been superimposed to the shells, lighting and contrast have been regulated, and the merging of the shells has been perfomed.

3. RESULTS

The models of the statues have been obtained. Some details show the typical characteristics of Bernini's works. In figure 5 it is possible to observe the shape of the right hand of St. Lucia, used in many statues of the tuscan Meister.

Figure 5 – The right hand and the eyes of St. Lucia

Figure 6 – Upper view of St.Lucia's statue

Figure 7 –St.Lucia's statue draped cloths

Figure 8 –St. Caterina's left hand

Figure 9 –St. Caterina's head

Figures 6 and 7 show the noticeable draped cloths and the surface finishing which will be found in the works of Peter Bernini's son, Gian Lorenzo. The same characteristics can be found in the details of the statue of St. Caterina d'Alessandria (Figures 8, 9).

The typical problems of laser scanner acquisitions, due to highly reflecting surfaces, had to be solved. The main hypothesis of active optical geometric measurements is that the imaged surface is opaque and diffusely reflecting (Beraldin J.A., 2004). As reported in literature (Godin et al., 2001), marble departs from this hypothesis, and exhibits two important optical properties in this context: translucency, and nonhomogeneity at the scale of the measurement process. This structure generates two key effects on the geometric measurement: a bias in the distance measurement, as well as an increase in noise level,

when compared to measuring a reference opaque surface like vapour-blasted aluminium. Figures 10 and 11 show a detail of the model of St. Lucia's statue with speckle noises, and the model obtained after the smoothing procedure.

Figure 10 –St. Lucia's model with speckle noises

Figure 11 –St. Lucia's model after smoothing

4. CONCLUSIONS AND FUTURE WORKS

The surveying of the statues of the sculptor Peter Bernini, "St. Lucia" and "St. Caterina d'Alessandria", obtained by means oflaser scanner technique, has been performed. Realistic 3Dmodels have been obatined, useful for virtual reality videos, and for the set up of a Web site. In the future, the surveying of the statues of St. Peter and St. Paul is planned, to detect their manufacturing characteristics,useful for assigning the paternity of the works.

REFERENCES

Akca D., 2003. Full automatic registration of laser scanner point clouds

http://www.photogrammetry.ethz.ch/general/persons/devrim/TS 9_5_Akca_neu.pdf. (accessed 5 Apr. 2004)

Artese G., Achilli V., Salemi G., Trecroci A. (2004), "Automatic Orientation and merging of laser scanner acquisitions through volumetric targets: procedure description and test results", International Archives of Photogrammetry and Remote Sensing. XXXV, PART B5, Commission V, pp. 210–215

Beraldin J.A., 2004. Integration of Laser Scanning and Close-range Photogrammetry – the last Decade and Beyond, International Archives of Photogrammetry and Remote Sensing. XXXV, PART B5, Commission V, pp. 210–215

Besl P.J., McKay N.D., 1992. A Method for Registration of 3-D Shapes. IEEE Transactions on Pattern Analysis and Machine Intelligence, 14(2), pp. 239-256

Chen Y., Medioni G., 1992. Object Modeling by Registration of Multiple Range Images. Image and Vision Computing, 10(3), pp. 145-155

Godin, G., Rioux, M., Beraldin, J.-A., Levoy, M., Cournoyer, L., Blais, F., 2001. An assessment of laser range measurement on marble surfaces. In: *5th Conference on Optical 3D Measurement Technique*s, Wien, Austria, Oct. 1-4, pp. 49-56

Tozzi, S., 1995. Due Santi per Pietro Bernini. In: Prospettiva, 79, Firenze, pp. 54-61

Tozzi, S., 1996. La Collegiata dei Santi Pietro e Paolo a Morano Calabro. Florence Art Edizioni, Firenze, pp. 18-42

Valanis Á., Tsakiri Ì. (2004), "Automatic target identification for laser scanners", International Archives of Photogrammetry and Remote Sensing. XXXV, PART B5, Commission V, pp. 1–6

Zhang Z., 1994. Iterative Point Matching for Registration of Freeform Curves and Surfaces.
International Journal of Computer Vision, 13(2), pp. 119-152.