Rediscovery of the shape of artistic artefacts from moulds of Richard-Ginori collection: tools and methods for 3D archive implementation

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***Abstract*— In this paper we illustrate the possibilities offered by a particular application of three-dimensional laser scanning techniques: recognition of models from plaster moulds belonging to the ancient artistic collection of Richard-Ginori Museum of Manifattura di Doccia (Florence – Italy). The activity arises from the need to categorize and classify moulds according to sculptural structures made from them. In this perspective, the acquisition technique through 3D laser scanning, with reconstruction of the positive internal image of the moulds and subsequent reassembly of complete models, is an optimal solution for the immediate creation of a digital archive, that does not occupy space and can be organized and managed efficiently in a DBMS (Database Management System). Through the database a simple identification of moulds referring to the same model is possible, provided that these moulds, while handled for the scan, are labelled with an automatic readable identification code, such as a QR code (Quick Response), free and easy to read, thus allowing their easy classification.**

Keywords-3D laser scanning; mould; digital cast; 3D archive; artistic heritage database; reverse engineering.

I. INTRODUCTION

The fast evolution of technologies that allow generation of three-dimensional digital models has led their application from original industrial field to the sector of Cultural Heritage. In this field the focus is mainly on three-dimensional laser scanning techniques, which applications are numerous: from the documentation and storage of the actual state of a monument, especially in case there is the need of reconstruction and conservation work, to the ability to detect very complex geometries with remarkable accuracy for the study of construction techniques and analysis of details hardly detectable by traditional technologies.

In this paper we illustrate the possibilities offered by a particular application of these new technologies: recognition of three-dimensional images (models or artistic artefacts) from moulds or hollows, which in our case are “impressions” in plaster and are used to create parts of a three-dimensional subject in different materials, such as porcelain, wax, etc. The considered moulds belong to the collection of the Manifattura Richard-Ginori 1735 S.p.A., located in Sesto Fiorentino (Florence), Italian leading manufacturer of artistic and tableware porcelain, whose tradition dates back more than 270 years. The collection is housed at the Richard-Ginori Museum of Manifattura di Doccia.

The original core of the collection was created by the founder of the Factory, marchese Carlo Ginori, since 1744 approximately [1]. The collection has been enriched since then until today, although the historical moulds are those dating up to about 1930. Although the origin of the various moulds is not always known, some of the oldest were initially designed by sculptors specialized in creating bronzes, like the "Pieta" (1708) by Massimiliano Soldani Benzi, which is a bronze statue currently stored at the Art Museum in Seattle [2]. Others were made to realize copies of statues of particular artistic interest, as those made for reproduction of the “Venus de' Medici”, a Hellenistic marble sculpture housed in the Uffizi Gallery, Florence (I).

The collection consists of groups made up of piece-moulds (see Figure 1.), which number is not exactly known, from each group a three-dimensional model is obtainable, through casting of porcelain or other materials. Obviously the complexity of the obtainable figure is a function of the number of moulds needed for its reconstruction: only two pieces for the simplest artefacts, about 60 for more elaborate, such as sculpture groups like the aforementioned Pietà.

Usually one of the pieces of the group has an inscription, made in fresh plaster, not always significant, because it is an ancient name which meaning is often obscure. A symbol that accompanies the inscription is repeated on the other pieces of the same group. In some cases the same part of a model has been used for different compositions, that is the same figure (eg. a “putto”) could be used in different groups of piece moulds. In this case it is likely that some parts transited from one set to another.

From the foregoing the need to categorize and classify moulds according to sculptural structures made from them, taking into account the following aspects:

- the large number of moulds would require excessive space occupation to accommodate the models obtained by pouring the porcelain;
- obtaining porcelain models implies an effort in terms of time and cost of materials and skilled workforce;

- since the hollows have a life expectancy of 30-40 castings, their deterioration, after pouring operations that would be necessary for obtaining just one model with no imperfections, precludes the proper preservation of the collection.

II. METHOD

A digital moulds archive, produced starting from laser scanner survey, is seemed immediately to the research team a possible solution to the issues listed in the introduction. In order to verify the method a test was leaded on six pieces (like those shown in Figure 1.) of the moulds' group belonging to the figure so called "The Giant".

Figure 1. Example of a group of piece-moulds for obtaining casts, the shown hollows were used for porcelain reproduction of "Venus de' Medici" statue, housed at the Richard-Ginori Museum of Manifattura di Doccia. In the foreground you can see the two semi-moulds of legs.

A. *Acquisition*

Scan operations, leaded by means laser stripe technology (useful for the survey of small objects characterized by an high level of detail, as artistic artefacts)[5][6][7], have produced four different range map's sets (one for each piece-mould). Each range map is represented by triangulate surface (boundary representation)[6][7]; for each triangle was detected the RGB value related to diffuse colour level. The main shape features and details of each piece-mould were documented using a grid of sample never less than 0.25 mm. For each set we took the range map registration in order to obtain a complete 3D digital model of each piece-mould. The registration were made using an initial alignment based on homologous points directly identified on surface (shape features). Then it was followed by a fine registration based on I.C.P. (interactive closet point) algorithm in order to reduce the average distance between the range maps and keep the model into the tolerances allowed range (Figure 2.).

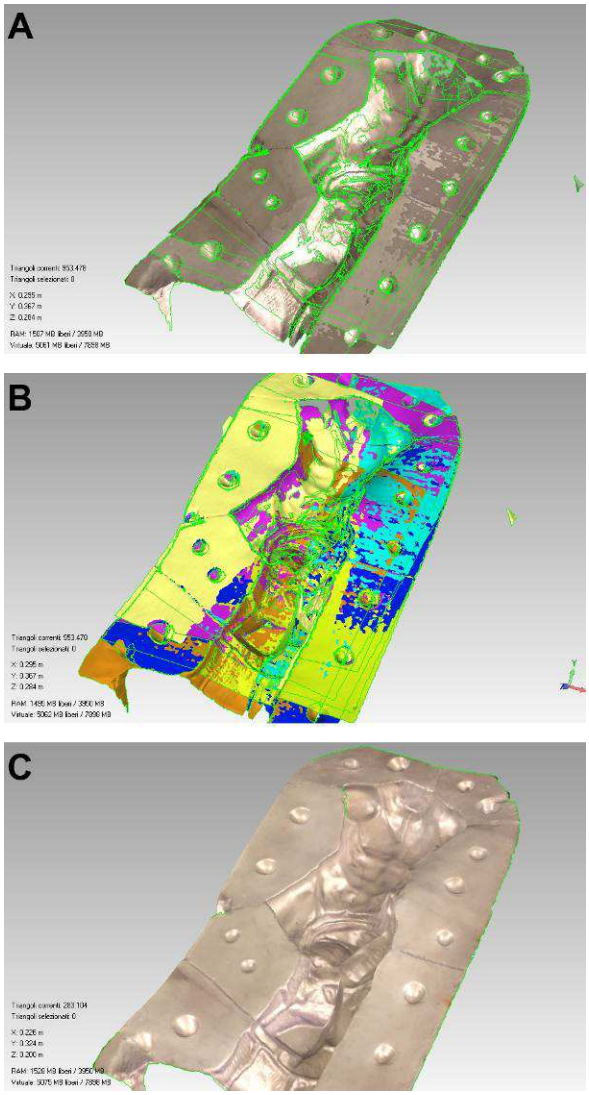

Figure 2. A: initial alignment based on homologous points directly identified on surface. B: ine registration based on I.C.P. (interactive closet point) algorithm. C: Complete 3D digital model of one piece-mold.

B. *Reconstruction*

The polygonal surface of each piece-mould describes, in its convex side, the shape of the artefact; in this way it is possible to recognize immediately the artefact starting from its piece-mould survey. The piece-mould's contact surfaces are characterized by the presence of joints which are useful to identify the right correspondence between the different part of the mould. The accurate survey of these contact surfaces has allowed to detect joints and, once placed some tie points into each one, they were used to constrain the alignment between semi-moulds (Figure 3. and Figure 4.). In the case of "Giant" these operations have resulted in the complete model of the bust and the arms.

According to the contact surfaces and the shape features of the pieces some solutions have been formulated about the right position of the arms in the bust. Moreover, especially in absence of references,

the scholars have the possibility to verify immediately their reconstruction hypothesis (Figure 5.) just handling these three digital models, which could be used to visualize solutions in order to share the knowledge with other scholars.

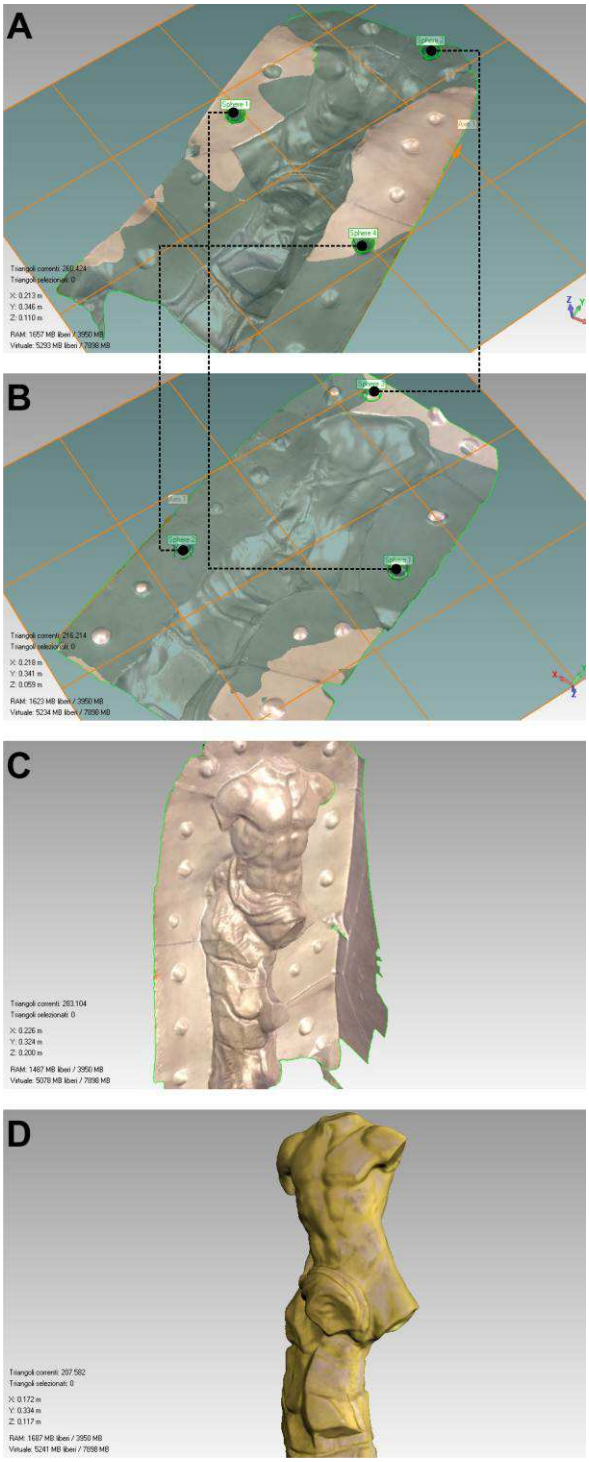

Figure 3. A-B: tie points used to align the two piece-mold related to Giant's bust. C: concave side of the piece-mold. D: Complete 3D digital model of the Giant's bust.

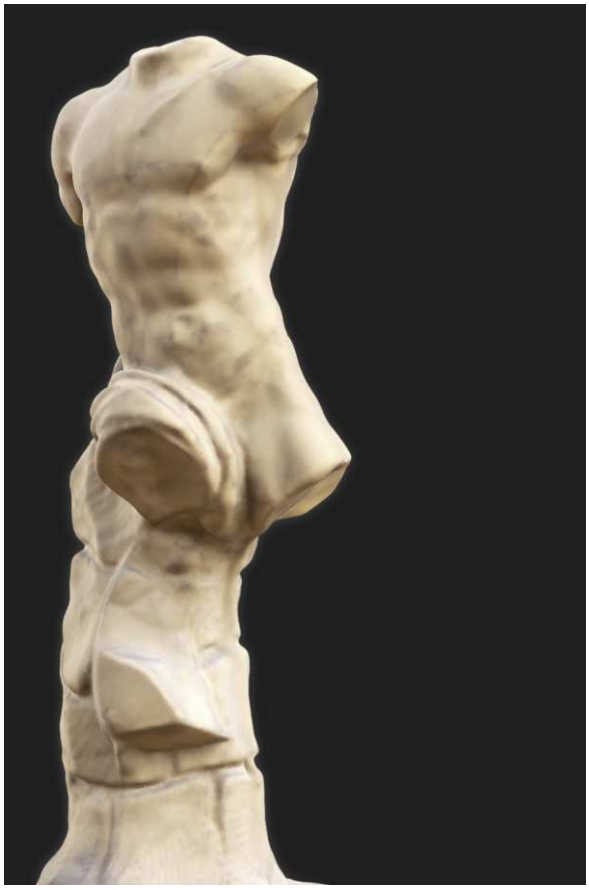

Figure 4. Rendering of the Giant's bust. The image show the level of detail acquired during the survey.

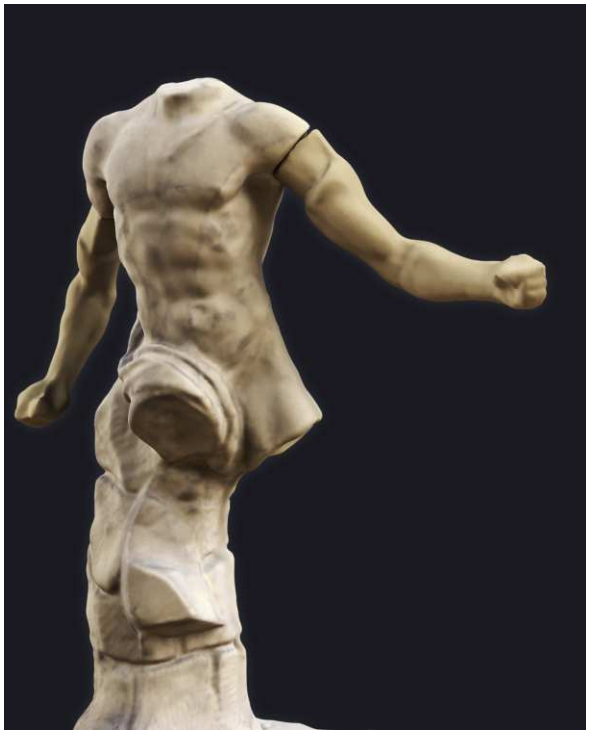

Figure 5. Rendering of the Giant's bust. One of the reconstruction hypothesis.

C. Storage

With regard to the data storage a dedicated server is needed for archiving different types of 3D images: those obtained by scanning of moulds and others by reconstruction of casts and comprehensive models.

Moulds, while handled for the scan, are labelled with an automatic readable identification code, such as a QR code (Quick Response), free and easy to read, so that it is possible to identify piece-moulds of the same model. The QR classification data thus obtained must be entered into a server database.

At least the basic information, listed in TABLE I. , for each piece-mould and for each model will be stored in the database.

TABLE I. DATABASE INFORMATION CONCERNING SEMI-MOULD AND MODEL

Semi-mould	Model
Matching piece-mould ID	Comprehensive model ID
Comprehensive model ID	IDs of different piece-moulds that make up the model
Author	Author
Year	Year
Sizes	Sizes
Shape type	Shape type
Path and filename of original 3D scan	Path and filename of 3D image of the model
Path and filename of 3D image of digital cast	Descriptive sheet

The number of IDs of different piece-moulds varies from a minimum of 2x1 = 2 to a maximum of about 2x60 = 120, but on average it is 2x6 = 12 or 2x7 = 14. The information about the model can then be extended with XML classification files recording specific features or with other fields deemed useful for the research and consultation in the database.

In order to carry out the consultation of the pieces we have to design an ad hoc application that allows to perform specific research query in the database, that presents the resulting information and invokes a program for viewing and navigation of 3D images, according to their storage format.

III. CONCLUSIONS

The presented system, allows to solve all the problems related to the recovery of historical and artistic heritage represented by the Richard-Ginori collection:

- shape recovery from moulds and reconstruction of the artistic artefact in less time than that required by pouring technique;
- implementation of a digital archive which solves space problems;
- capacity of getting actual mould copies through the use of 3D printers.

Moreover this system allows to reach additional benefits, such as:

- realization of new moulds from 3D digital models;
- conservation of the artistic heritage of plaster moulds;
- reconstructions of the same model in different poses;
- association of descriptive digital cards.

As a consequence the digital database implementation opens the field to the usability of the models on a global level, both for scientific purposes and for commercial developments.

Interesting developments for database extension are also possible, in addition to basic information determining the mould's identity card, many special features, which allow a more sophisticated typological classification, can be associated to individual moulds and especially to models in their entirety. For example in the case of a human or mythological form, we can refer to the pose, the represented objects, clothes or more abstract characteristics such as attitude or expression.

This information can be structured in specific XML files, which are suitable for searches based on ontological features, thus opening the door to modern and powerful scientific support tools.

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