THE SURVEY OF DECORATIVE ELEMENTS WITH LASER SCANNER

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ABSTRACT

In presence of decorative apparati applied to architecture, traditional survey certainly sets some limits to the representation of the object itself. As regarding elements characterized by plastic forms, reproducing realistic subjects with phitomorphic, zoomorphic and human features or made up of complex geometrical forms, the canonical representative patterns don't allow a true restoration in quality and quantity of data, as they are founded on the traditional of Monge rules, which give back the real object, through the syntetic individuation of its forms.
In support of these "lacks", today new computer methodologies are being discovered; infact, as they are rigorously based on traditional rules and codes of design and survey, they are able to achieve enthusiastic results, succeeding in acquiring complete formal and dimensional data.
A survey, which could be considered "global", defines only the analyzed object, through the laser scanning (scanner 3D), an instrument which revolutionizes the principles of the relief and graphic restoration, as it supplies a digital pattern characterized by a rich code of topographic information (cloud of points), subsequently elaborated to realize a digital (mesh, texture), or mathematical pattern of the object in relief (Nurbs). This is an instrument, which replaces the conventional graphics with a digital model, characterized by a numerous code of topographic individuation, subsequently processed in CAD to realize a numerical or geometrical pattern of the object in relief.
Besied, the possibility of shaping the photograph of the object in form and dimensions.
Some examples of decorative elements belonging to different ages and keeping the memory alive about the ancient architecture of the town of Catania, have been chosen: traces of the Catalan domination, undamaged by the earthquake of 1693, which destroyed almost entirely the town, are represented in the balcony inside the Cortile Platamone, symbol of an architecture with geometrical elements in the traditional black-white chromatism, characterized by a linear plasticity. This plasticity reaches extraordinary examples in the Baroque architecture of Catania, as in the facade of Monastero dei Benedettini, which, with the rich decoration of capitals, frames, corbels and tympani, is a sublime example of mastery in the stone-work.

1. INTRODUCTION

In presence of decorative apparati applied to architecture, the traditional survey surely sets some limits to the representation of plastic forms. As a matter of fact, within the sphere of decorative elements, characterised by plastic forms reproducing realistic subjects with phitomorphic, zoomorphic and human features or made up of complex geometrical forms, the canonical representative models, based on the traditional Monge rules which give back the real object through the synthetic characterisation of its forms, does not allow for realistic restoration in qualitative and quantitative data. Moreover, decorative apparati represent a unicum with the matter to which they belong in a interdependent relation that characterises the individuality of the work, codifying a precise style and a stylistic trend, which is the reason why the reading and representation must be realistic in order to keep the object's natural essence.
These types of architectures are enriched not only by geometric-decorative elements but also by real sculptures that 'emerge' from the massive and complex architectural structure and which, anchored to the latter, make an 'open-air museum' and therefore has to be considered, patrimony to be recovered and preserved with the same care and attention devoted to safeguard sculptural wealth in our museums.
The actual computer methodologies, based on conventional rules and codes in drawing and survey, offer nowadays interesting opportunities in learning about and preservation of cultural heritage both in identification of survey operations and in the representation of the data collected, producing exciting results with

Figure 1.The monastery's court of S.Placido with the loggia of Casa Platamone

the acquisition in their totality of dimensional, formal, chromatic and matter data.
Among those the usage of laser scanning (scanner 3D), a tool that completely changes the principles of the survey method and of graphic restoration supplying a product that we can define "global", which represents univocally the object examined through a digital model characterised by a rich code of topogra-

phic information (cloud of points), subsequently elaborated to realise a numerical (mesh, texture) or mathematical model of the object surveyed (NURBS).
A tool that substitutes the conventional graphics with a digital model characterised by a numerous topographic individuation code (cloud of points), which can be elaborated at a later stage in CAD to realise a numeric or geometric model of the object surveyed. Besides, the possibility to "spread" the surveyed object's photograph on the given geometric surface gives an image which is the restoration itself of the object at hand from its shape to its dimensions, a "digital copy" of great impact in which the three-dimensional image is captured in order to be observed in greater detail.
It is then possible to create a virtual museum generated from digital data, that can be seen by the user from a close up to be able to carry out the necessary analysis.

2. SURVEY AND ELABORATION DATA

This study wants to be an application, or more specifically, an applicative tester on the techno-qualitative potentialities of laser scanning 3D used in our lab for the survey of architectures of complex geometry and important decorative apparati.
Few examples have been chosen that represent sculptural elements belonging to different time frames and that have left a testimony of Catania's architecture of that time.
Traces of the Catalan domination can be identified in the balcony of the loggia of Platamone's house, a type of architecture composed of geometric elements characterised by the traditional zig-zag chromatic in black and white white limestone and lava stone, characterised by a linear plasticity. (The balcony that survived the earthquake of 1693 that destroyed almost entirely the city of Catania). This plasticity reaches extraordinary examples in the baroque architecture of Catania: to mention a few the façade of the Benedettini Monastery which, with the rich decoration of the windows with capitals, cornice, corbels, tympanums, in an explosion elements richly decorated (little angels, leaves, flowers..), represents a sublime example of mastery in stone-carving.

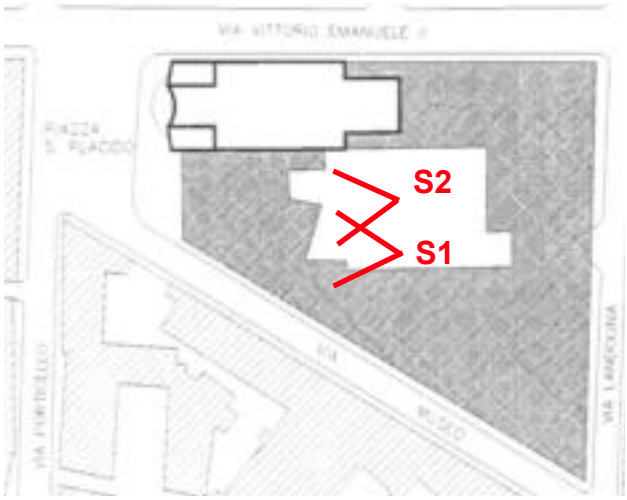

Figure 2. The project of survey

The geometric characteristics and the different plasticity of the elements at hand has obliged us to carry out a different approach in the phase of data collection and on the elaboration of the latter.In both instances the laser scanner 3D Leica Cyrax 2500 of Cyra Technologies has been used.
The laser scanner uses a system based on the measure of the distance (ranging instruments), in correspondence with the electronic metre. The laser ray, through adequate optical/mechanic systems in rotation, is sent towards the object varying slightly the angles azimuthal and zenithal. The distance between the instrumental centre and the first point that the ray intercepts and from which it is reflected is determined by the measure of the "time of flight" that exists between the release and the reception; the distance together with the knowledge of the two emission angles of the ray, enables to determine, through polar co-ordinates, the position of the point examined. These co-ordinates are given to the user in a Cartesian system (x,y,z) originated in the instrumental centre.
In the first experience, the aim of the survey has been the under

Figure 3. The black and white materials that decorate the parapet of the loggia

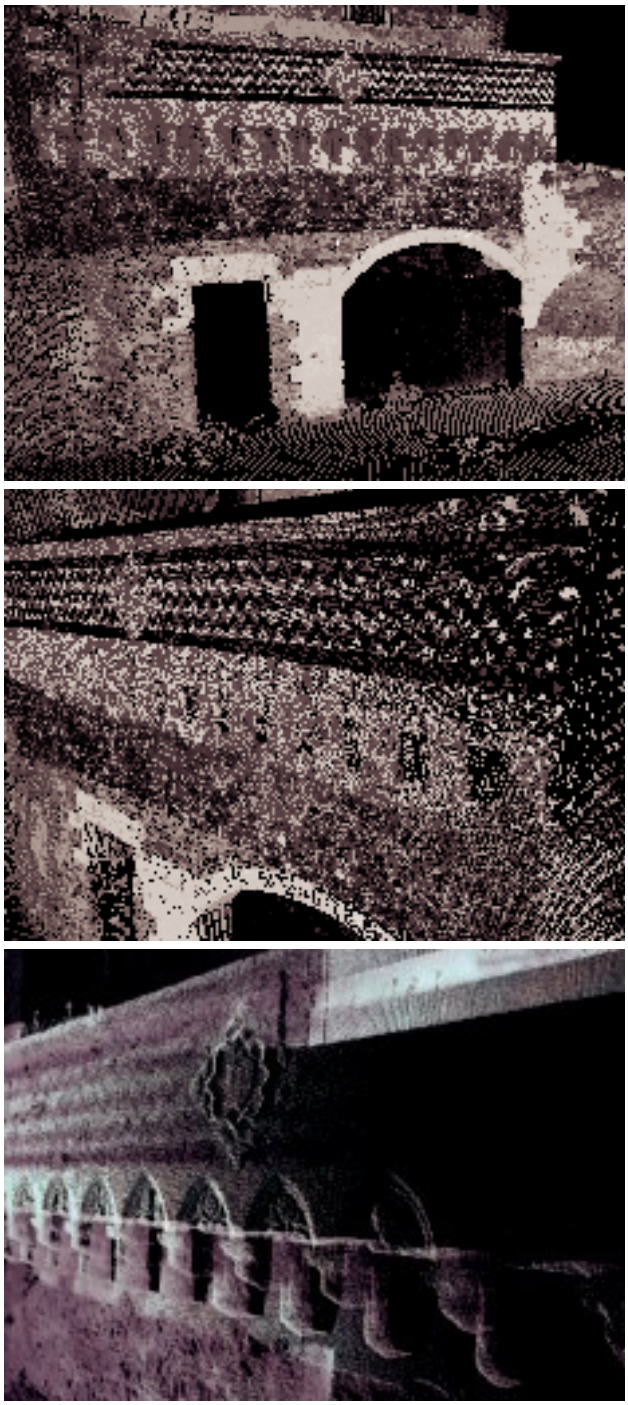

Figure 4. Clouds of points obtained from two scanning

standing of geometric-spatial and chromatic-matter characteristics of the parapet of the balcony of Platamone's house in which the flatter surfaces demanded a less detailed scanning, partly neglecting the corbels' plasticity made of stone to sustain the pointed arches from the nice decorative patterns (human faces, fruit, flowers) for which it was expressly chosen an approximate survey.

We proceeded with a new architectural survey, not sculptural, of all parts, carrying out, as in the project scanning, two scanning from two different locations fixed about 8,00 m from the object, which have restored two clouds of points whose density was respectively 572718 and 399997 points.

In this phase the collected data are the same from a qualitative point of view, and create a product far from the classic graphic representation obtained by traditional or photogrammetic surveys in which the drawing is achieved through an operation of graphic synthesis of the data collected.

For an adequate result it is fundamental to choose the right type of software in relation to the object's features and to the result one wishes to achieve. Thus, it is necessary to decide first if the outcome of the work is to achieve the type of knowledge regarding only the geometric development of the surveyed shape, through the recognition of solide elementary/elementary solids, or to study in greater detail the plastic forms that cannot easily be traced back to well-known geometries, the roughness of the materials, the engraving of the chisel on the stone, etc.

Once the clouds of points have been imported we have united them in one single whole referred to a unique system of reference through the recognition of natural elements belonging to each cloud. As a matter of fact, in the study at hand, it has not been carried out with topographic support because the features of the product allowed an easy recognition during the phase of alignment and recording in the collimation of identical points.

Consequently the data has been elaborated using the JRC Reconstructor software of Inn.tec s.r.l.

Through subsequent stages the initial data have been checked according to the distance and intensity of the points (in RGB) and in respect of clouds of points in which we carried out the cleaning and reduction through filtering erroneous points or points not relevant to the presentation.

The following phase (pre processing), one of the most delicate where the user's sensitivity intervenes critically, consists of mesh creation (triangular surfaces) through the sequence of operations that assign parameters able to define the quality of the mesh obtained which manage the dimensions of the mesh triangles.

Once the model's mesh has been generated, adding on points to

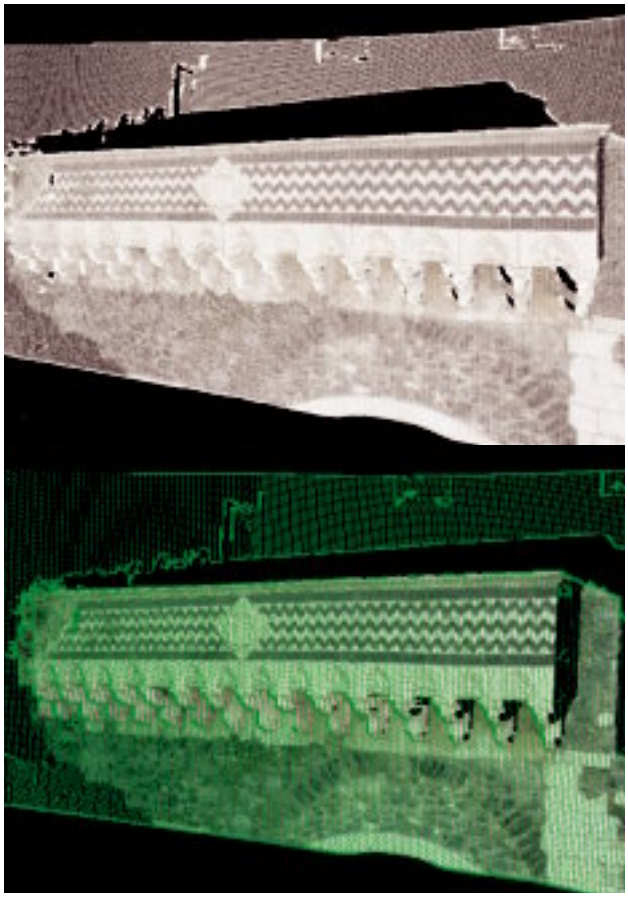

Figure 5. View of the mesh triangled

Figure 6. Projection of the photographic image on the mesh

Figure 7. Calculation of the surface

increase precision, we proceeded exploring the model using the type of visualisation more adequate with artificial textures (flat, wireframe, textured) in relation to the analysis to be carried out. We have also re-projected some photographic images (texture mapping) on the cloud, collimating an adequate number of identical points well distributed and easy to be identified, obtaining a notable informative contribution on the state of preservation of the product, on the pre existence of humidity traces, incrustations and of small lesions of the wall.

In the model produced, a "digital clone" of reality, distances and surfaces can be measured and it has been possible to extract different profiles with vertical, horizontal and inclined levels, that can be exported in CAD.

The quality of the result obtained is strictly linked to the goal of the project previously set, and more specifically devoted to the

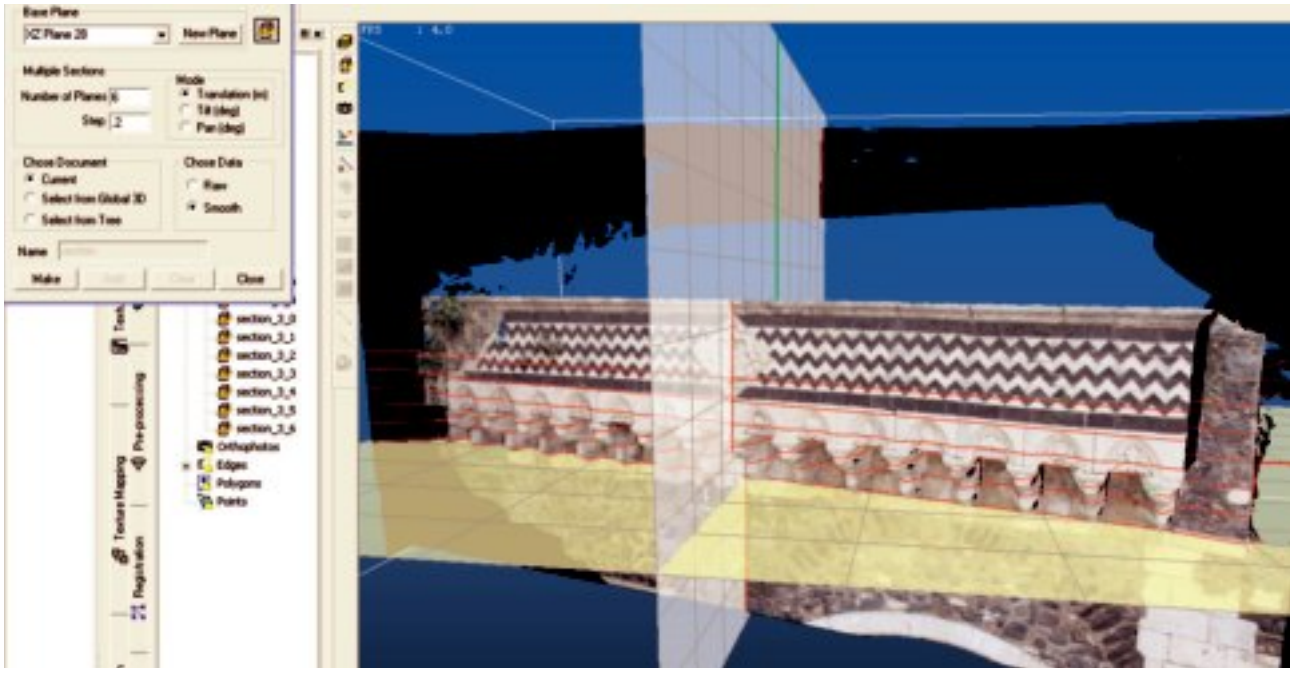

Figure 8. Horizontal and vertical sections

knowledge of the flat surface of the balcony more than the deepening of the plastic elements of the corbels and the pointed arches that for this reason appear with gaps that will be filled by more attentive scanning on the parts in successive studies.
The second experience, the main façade of the Benedettini Monastery, has been carried out in greater precision, where attention to sculptural details applied to the wall requested various scanning with more attention to details.
The same tool has been used to understand the potentialities extended to elements of various nature and shape.
Four scanning have been carried out from a single location about 20 m distant from the object, of which a general one with large-range that places the central balcony and the windows placed to its left on which we have carried out the following three scanning arranging at a closer range in order to document in a more attentive manner the plasticity of the sculptures of the two balco

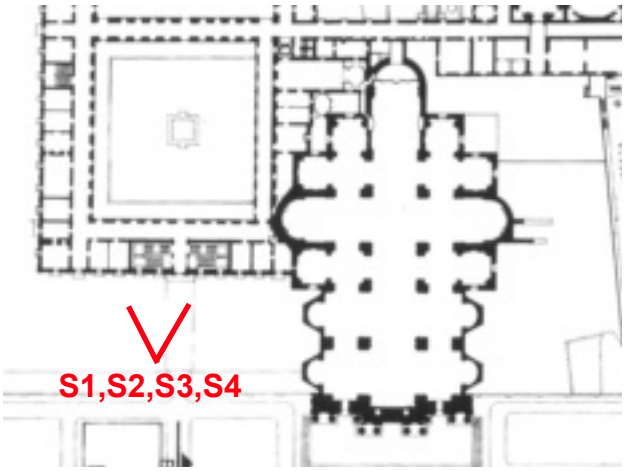

Figure 9. Monastero dei Benedettini - The project of survey

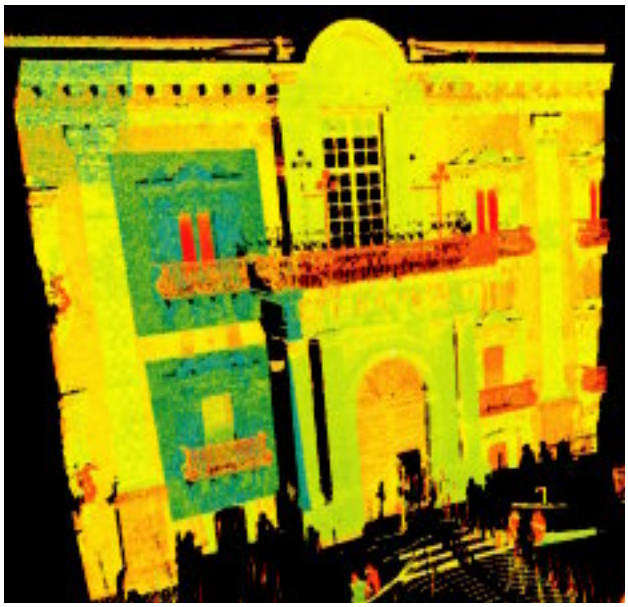

Figure 10. Cloud of points in RGB

nies and the pilaster's leafy capital. The following results have been obtained: in the first general scanning 930101 points, whe reas in the subsequent steps of the second and third scanning, referred to the two windows, respectively 743246 and 656673 points and in the fourth scanning of just the capital 493078. Therefore, we obtain a greater quantity of points on smaller surfaces and a greater precision in the description of the plastic forms.

Figure11. Clouds of points in B/N

The same software has been used for the elaboration of data, so that using the same procedure of the previous experience, without the joining of the clouds, because the location is one, and of the parameters to set for the elaboration of mesh. In this way various attempts have been performed using different values to understand which could be the optimal combination for the representation of the plastic elements, succeeding to obtain good results to be maximised with additional elaborations.
The shade areas created in the model produced, due to elements of disturbance and also by the pronounced overhung of the sculptures, that hide the visibility of some of the object's portions, is a sensitive problem of the exercise. These "holes" can be filled

with additional scanning (from a different location) to complete the surveyed elements.
Moreover, the possibility to project the photographic image on the mesh collimating identical points in the photograph and on the respective cloud, well-distributed and visible, allowed us to obtain a complete representation of the model with information of matter, chromatic and decaying nature.

3. CONCLUSION

The results obtained with the usage of these innovative instruments, "sensitive" to the principles that correct the knowledge in the field of cultural heritage, allow for the creation of digital models clones of reality, with an increased precision of the product with optimal working time. The three-dimensional digital model produced can be examined in its morphologic-dimensional, chromatic, of matter and decaying characteristics and it is inserted into an archive, a data-base, that can monitor the cultural patrimony and preserve it from time passing and from human careless activities.
Moreover, it is possible to obtain a model that with specific tools can be the calque for a authentic reproduction of the object detected and can then be exposed and examined in all its geometric-spatial elements, finding the geometric matrices that lie at the origin of the genesis of the form.

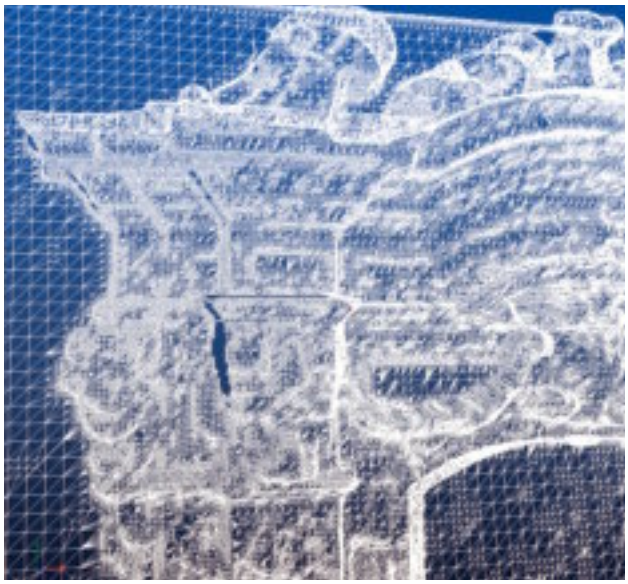

Figure 12. View of the mesh triangled

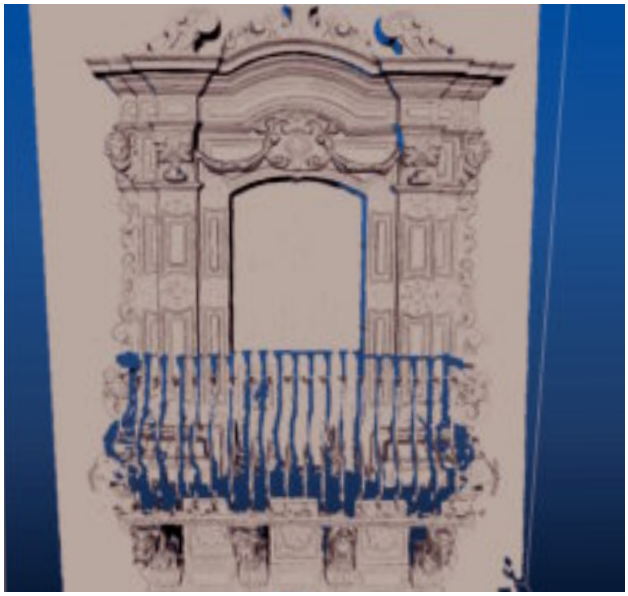

Figure 13. View of the mesh in visualitation flat

Figure 14. Projection of the photographic image on the mesh

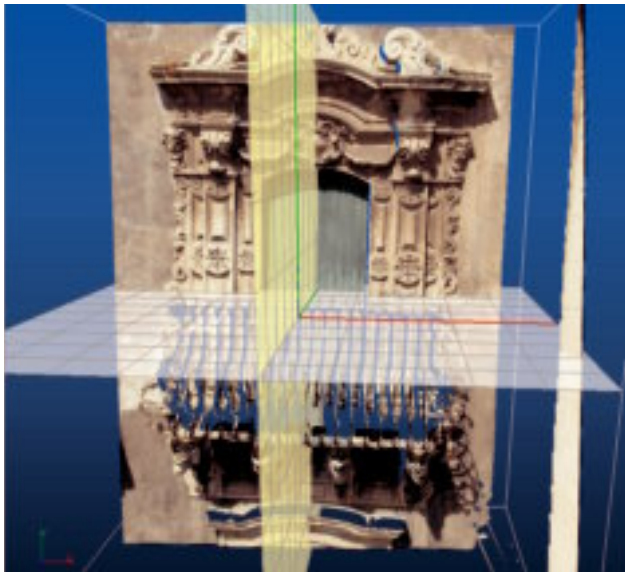

Figure 15. Extrapolation vertical and horizontal sections