

LASER SCANNER APPLICATION ON COMPLEX SHAPES OF ARCHITECTURE. PROFILES EXTRACTION PROCESSING AND 3D MODELLING.

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The realization of an exhaustive model of architectural complexities requires sophisticated dedicated instruments and modelling surveying.

Latest 3D modelling tools (Alias WaveFront - Studio Tools) allow to use and to implement of realistic modelling techniques which deeply differ from the traditional approach. These tools generate surfaces from clouds of points surveyed by laser technology and are 'leaders' in completing the reverse engineering modelling process. The main purpose of this work is to decide if these methodologies are able to 'surpass' traditional euclidean solid modelling (applied to finite elements from graphics primitives) in order to build a refined model of the architectural object (complex surface analysis; intelligent filtering; semiautomatic breakline; surface and object based on interpolation and fitting; nurbs; 3D mesh).

Of course also the problem of the metric documentation of Cultural and Environmental Heritage has today a great importance, considering also the development of new national or local normative laws for protection, like risk maps for archaeological and artistic goods. New technologies and new techniques, that offer today high accuracy together with high productivity, can support new quality standards and also drive to set-up further refinements in the methodologies considered by these rules and laws.

Several basic and applied researches have been carried out and terminated at a national and international level that range from the use of traditional surveying techniques (photogrammetry, remote sensing, GPS, laser scanner) to the definition of visual reality techniques and to the formation of relational databases where, apart from the metric and representative information, details from different fields of study are associated (geology, history of architecture, archaeology, etc.).

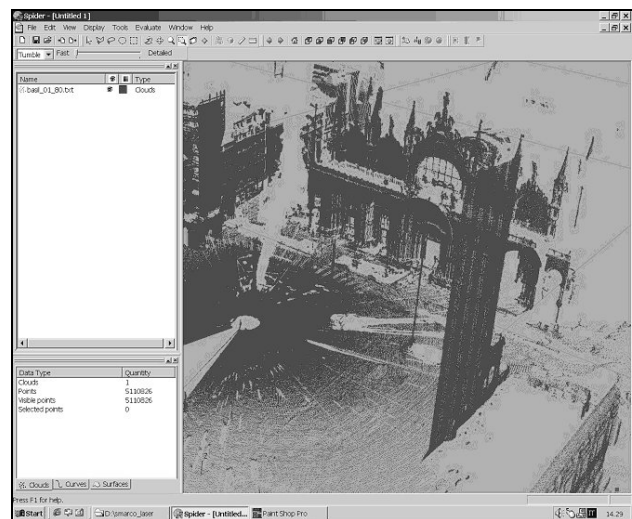


Fig. 1 Laser Scanner Data (5.110.826 points).

The research it is now working on the management of point clouds obtained from L.S.; in particular some main topics are:

- the pre-treatment of data derived from average precision aerial and terrestrial L.S. in order to remove noise from the measurements and to regulate the point clouds so as to create three dimensional models that are useful both as a basis for studies founded on the finite element method and

for the creation of three dimensional orthophotos obtained through the use of geo-referenced digital images;



Fig. 2 Venice Ducal Palace

b) the use of multi-instrumental approach based on the integration of laser measurements with 3D profilometer and roundness data to survey small objects in particular in archaeology and in the study of remodeled samples, with partial reconstructions (surface and 3d) and the presence of different materials (i.e.: archeological artifacts reconstructed in the first of '900);

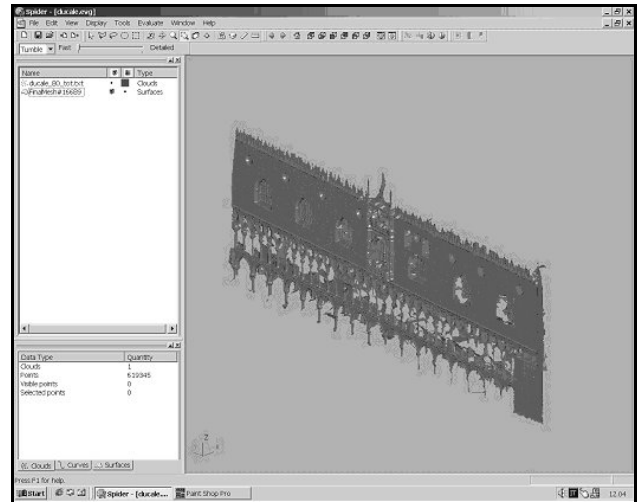


Fig. 3 Pre-treatment of data(619.345 points)

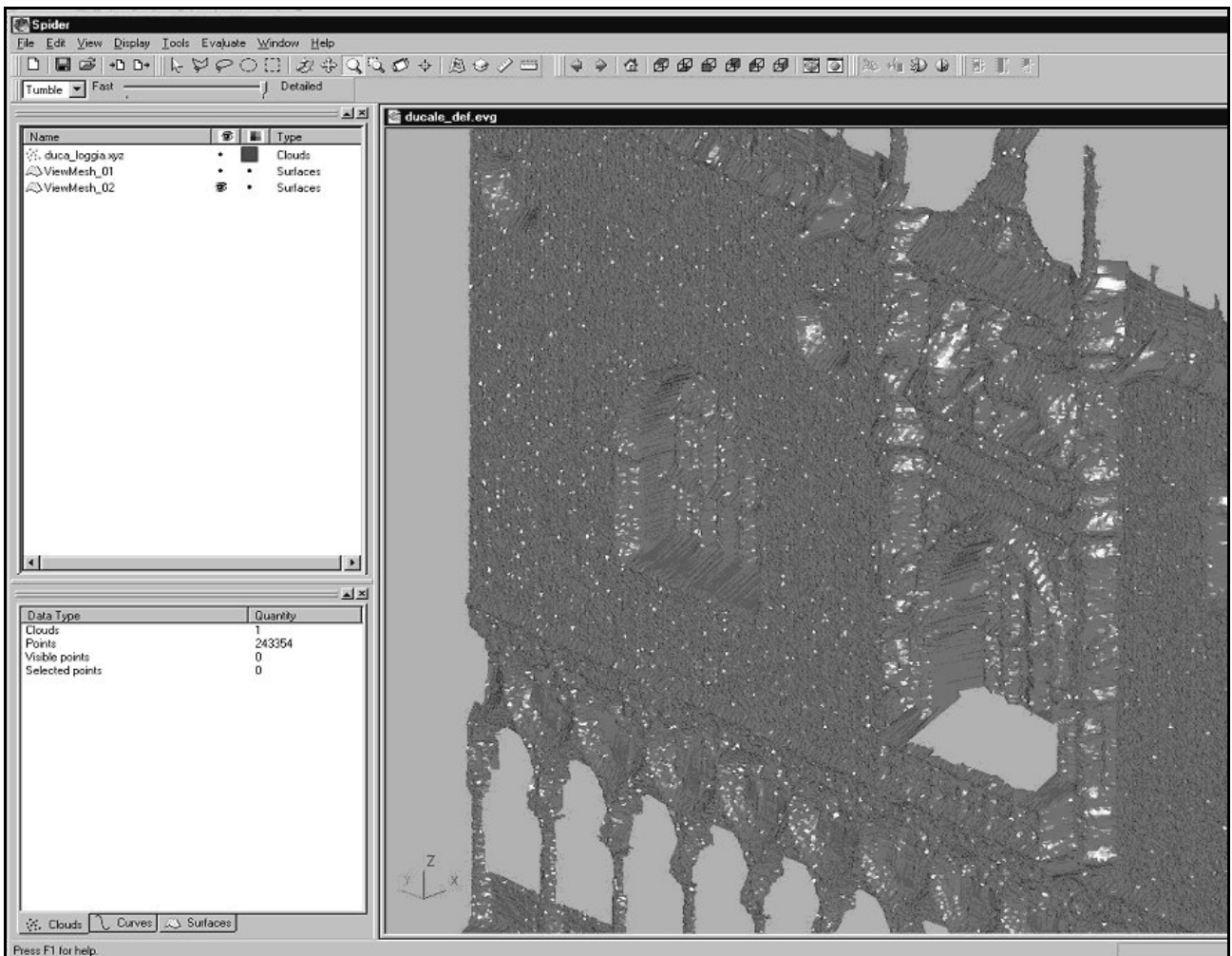


Fig. 4The first level of elaboration: Mesh

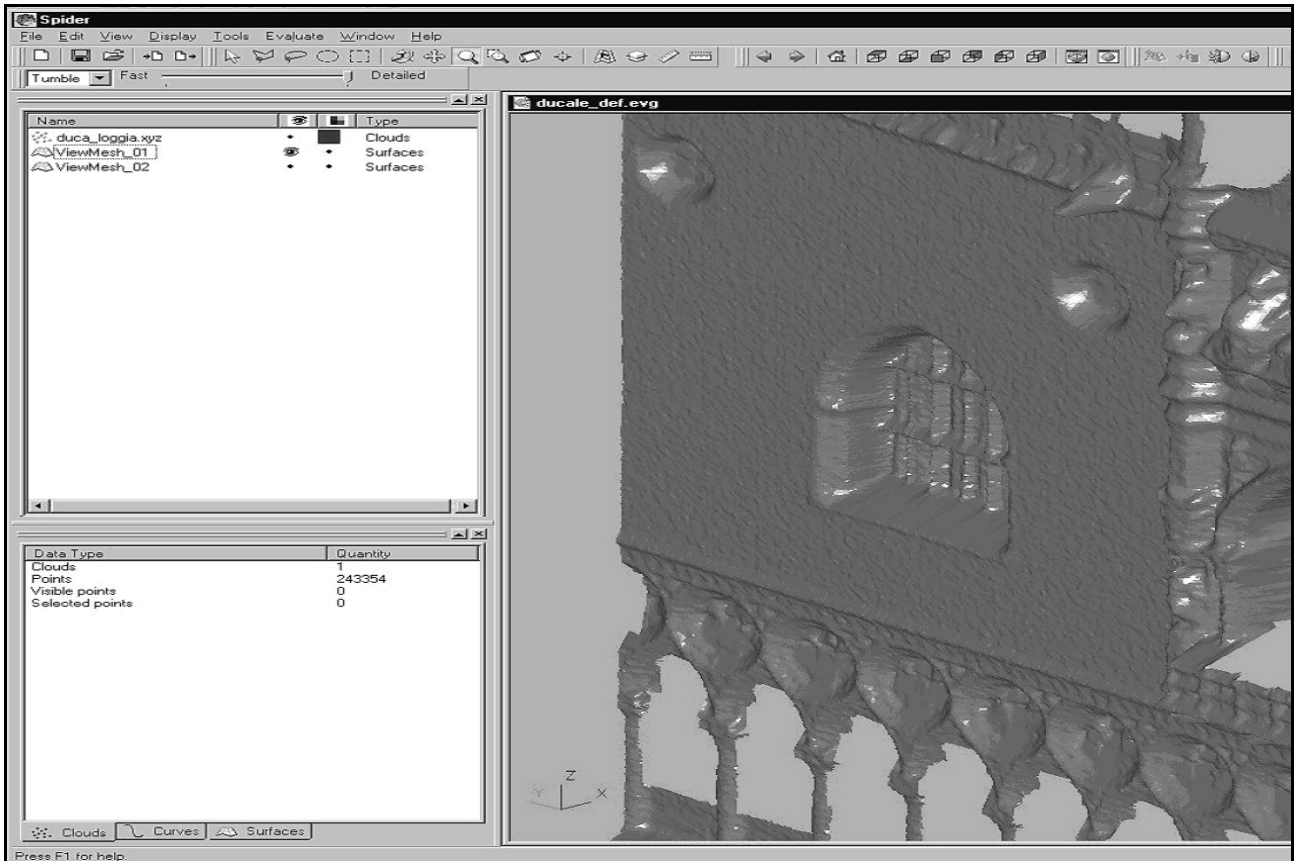


Fig. 5 The first level of smoothing product by Spider- Alias WaveFront software

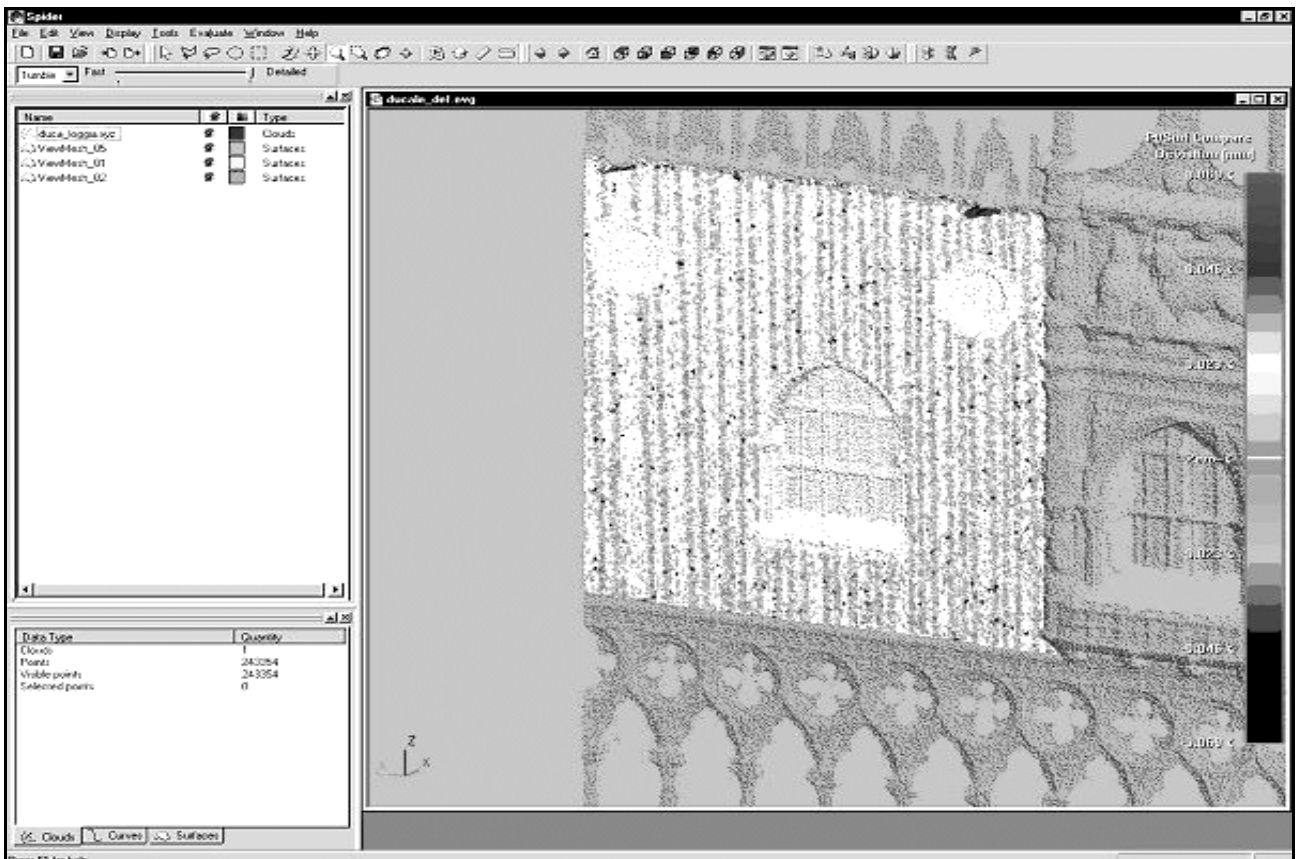


Fig. 6 The complex surface (Spider software) and legend error with mesh

- c) the handling and intelligent filters for rough models;
- d) construction of complex surfaces beginning with simple, complex, and isoparametric curves (NURBS);
- e) the study in mathematical surfaces constructed on edge curves (of various types and degrees) and cloud points; extraction of "on surface" curves;
- f) the integration between different surveying techniques as L.S., digital photogrammetry, direct surveying, topography;
- g) the automatic extraction of edges from the laser scanned object;
- h) the integration between points clouds and images of the object.

For third world applications it is necessary to develop "ad hoc" approaches that could permit to acquire the data for the Cultural Heritage sites surveying and risk estimation.

Latest 3D modelling tools allow to use and to implement of realistic modelling techniques with high accuracy.

In phase of editing some options are possible:

- *filtering* of the mesh in function of dimension;
- *interpolation* for the zones not covered from points;
- *smoothing* of the surface;
- production of *profiles* and automatic extraction

Of the *sections* on preestablished directions or according to constant steps along the three cartesian directions.

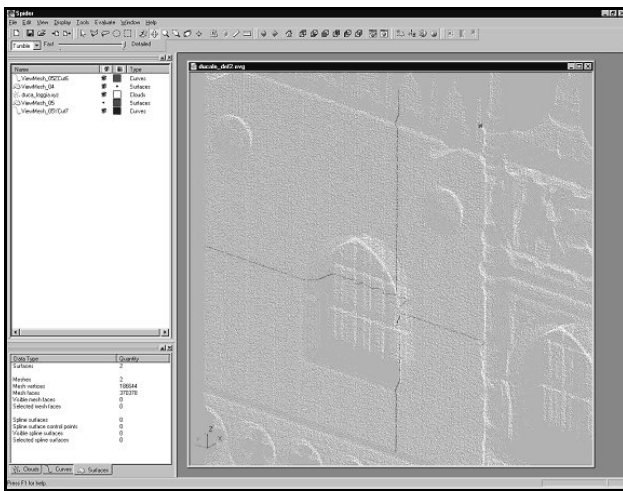


Fig. 7 The profile extraction from point data

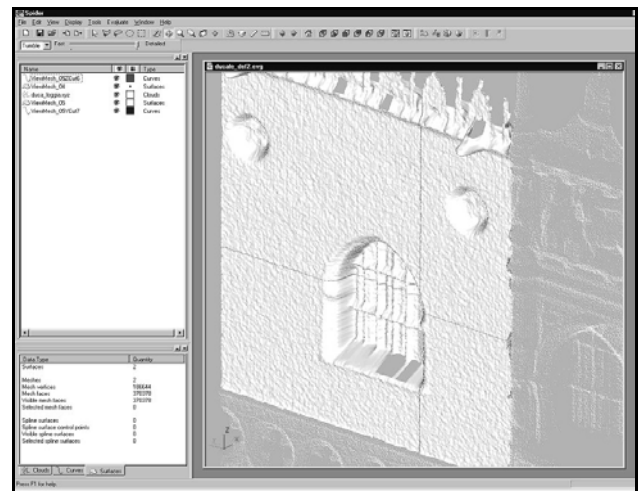


Fig. 8 The profile extraction from complex surface

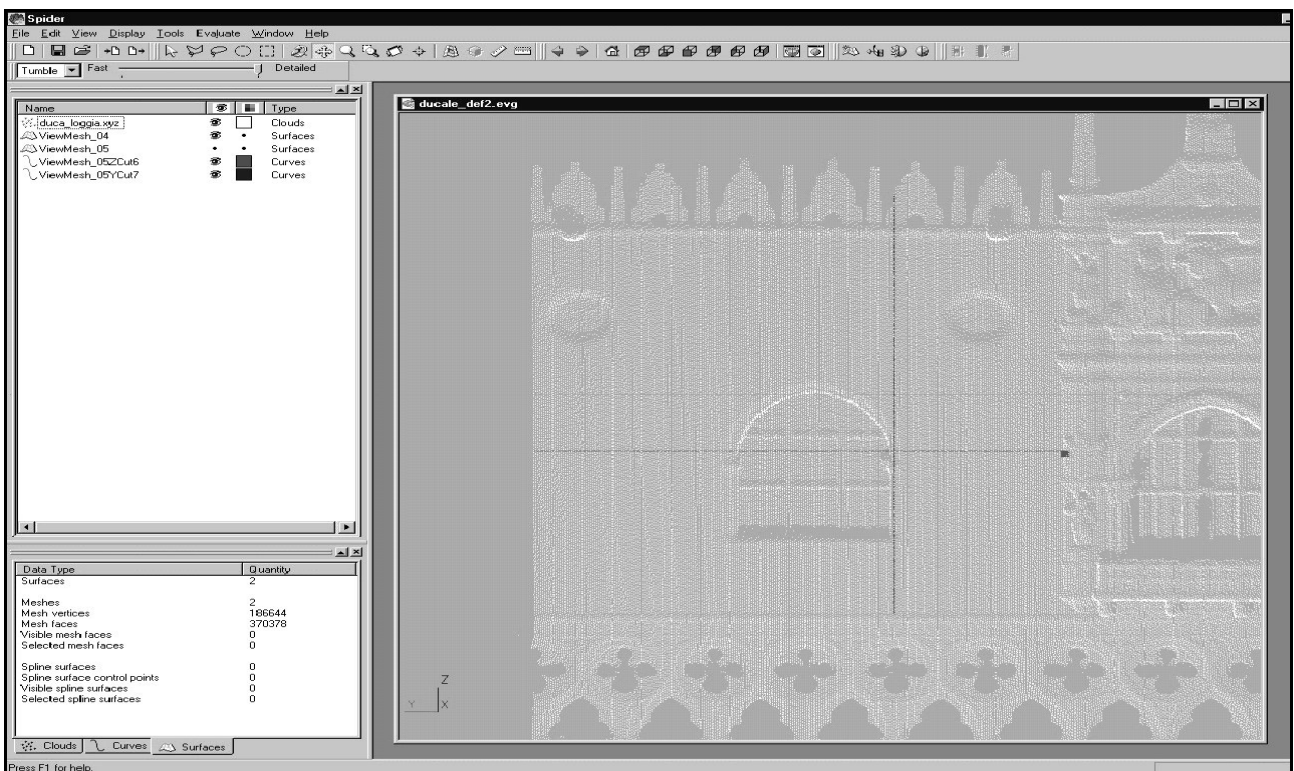


Fig. 9 The profile extraction

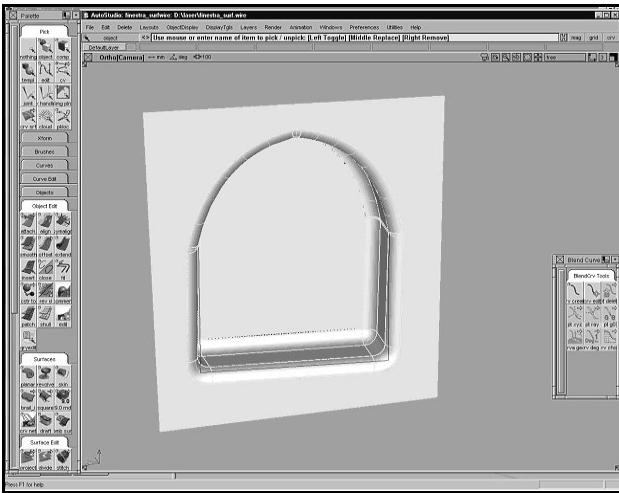


Fig. 10 the surface constructed on edge curves

The research will be continue to:

- modelling laser scanner clouds on complex surfaces and 3D orthophotos;
- implementation and use algorithms for treatment of laser scanning data and processing of different surfaces developed in different environments (Studio Tool, Menci, Spider,...) on two levels: for finished elements (vectorial mesh exportable in DXF standard format) and for analysis of more evolved surfaces (developed in advanced modellation environments, generated by families of curves);
- realization of a series of software able to automatically extract early geometries intended to simplify the final three-dimensional model;
- emphasis through suitable operators (Laplaciano della Gaussiana, Foerstner filter, etc.) automatically the radiometric edges which correspond to geometric borders on the point cloud for definition of DSM (Digital Surface Model) in order to describe the correct morphology of the object with limited memory;

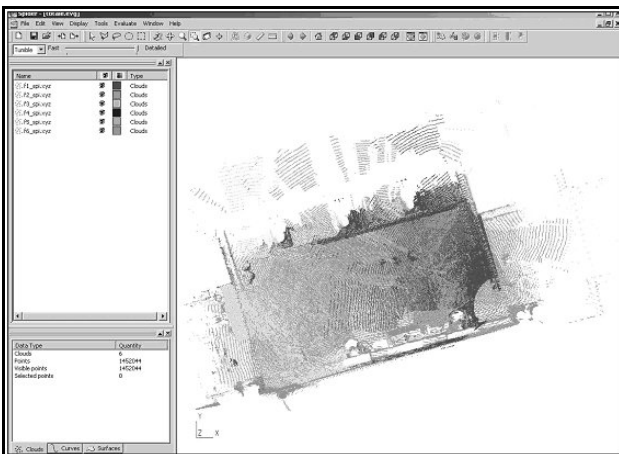


Fig. 13 The clouds of points: S. Marco Basilica - Venice

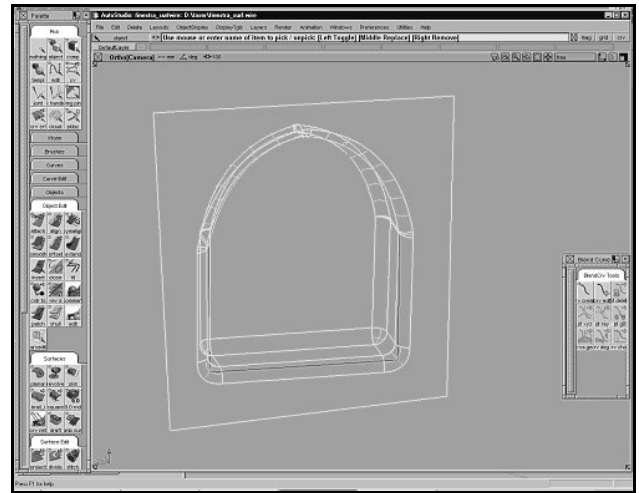


Fig. 11 the wireframe windows: geometric border

- research into geometric borders directly on the point clouds starting from filtering digital images or starting from "geometric reasoning" (along with computing techniques able to show individual points and fundamental discontinuous lines inside a group of points known in a 3D system);
- construction of complex surfaces starting with early 3D, breaklines, simple, composed and isoparametric curves (NURBS), edge curves (of different types and degrees) integrated by internal point clouds using interpolation techniques (fitting,...);
- implementation and use in photogrammetric SW of processed models.



Fig. 12 Callidus terrestrial L.S.

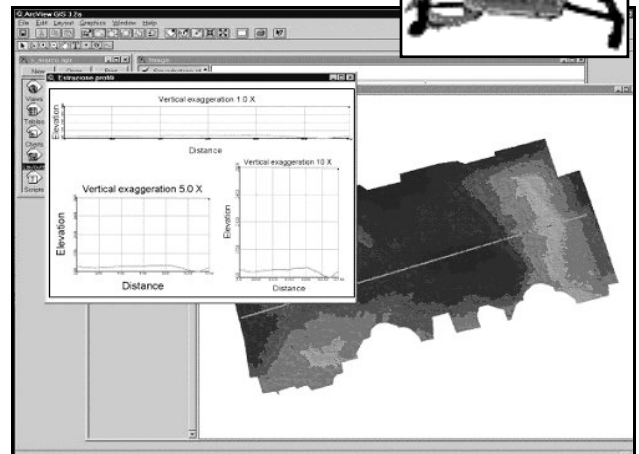


Fig. 14 The surface generate from points surveyed by laser

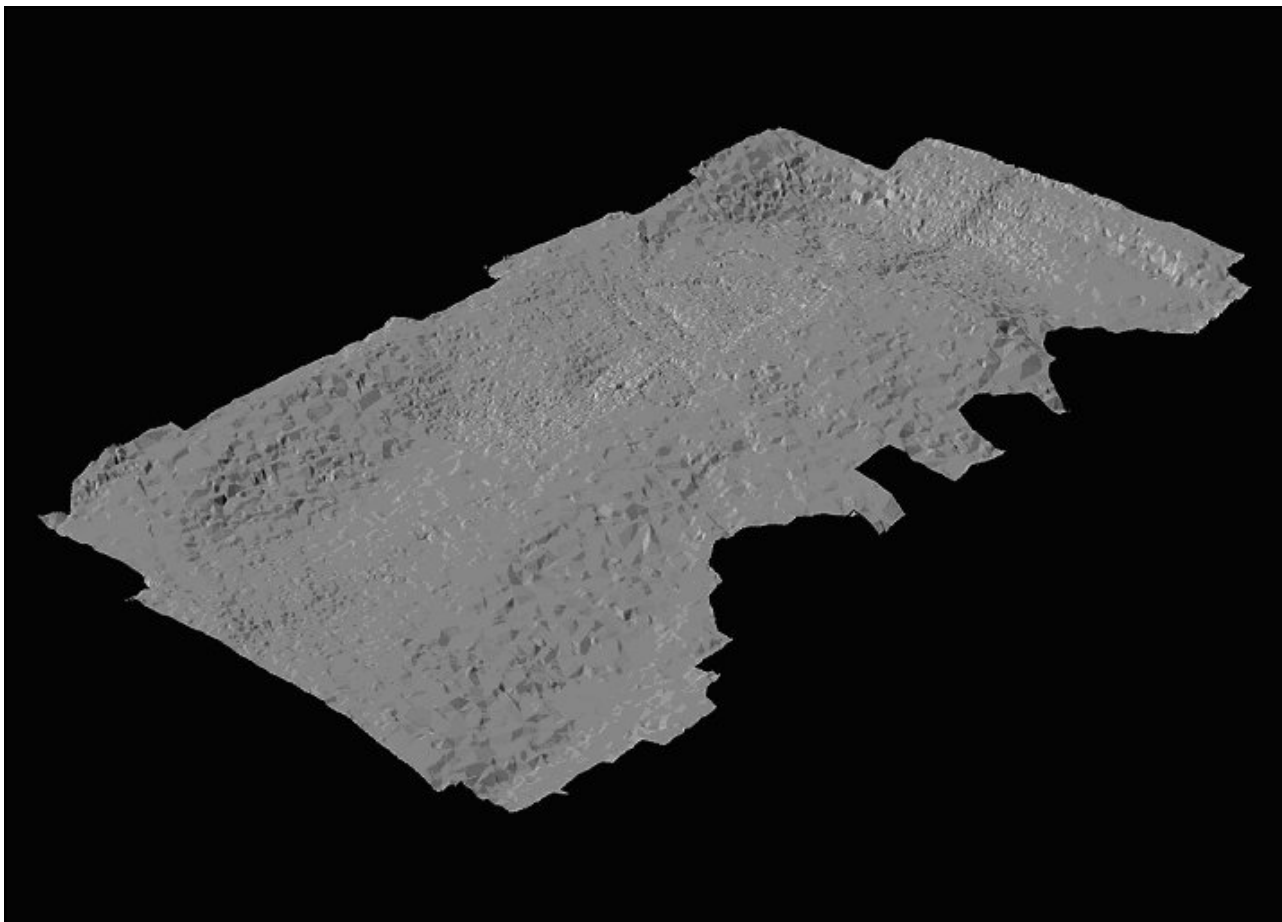


Fig. 14 DTM: 3D representation

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