VPL geometry processing for open multilevel and multiscalar databases

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Abstract

This study investigates open-source VPL algorithms for storage, geolocalization and comparison of diagnostic multi-sensor data on 3D semi-automatic geometric database extracted from low-cost image-based models and shared on open web-based platform to support information, conservation/restoration and monitoring of multiscalar elements (*e.g.* artworks, architectural or urban objects).
The information system consists of an interoperable parametric box/synoptic mesh/grid for semi-automatic definition and segmentation of 2D and 3D models of artworks, regardless of size, materials and digitalisation technique to validate interoperability between VPL algorithm and different information systems/approaches (*e.g.* BIM/HBIM, EM, multiplatform graphic engines): restorers and diagnosers can geolocate and annotate numerous results, observations, hypotheses or indications in geometric cells to visualize and compare heterogeneous visible and invisible structural and material data at different levels of detail. The database consists of a neutral grid extracted from the 3D reality-based mesh to wrap points cloud, surface or mesh: box or grid cells work as containers for storage of diagnostic information; the texture is however displayed in 3D modeler/viewer as visual reference for data geolocalization. The system allows semi-automatic clustering of areas, cells, colours attribution and labelling of text and image from link data list. The algorithm has been tested on high resolution images and architectural/structural object-oriented elements (VPL-BIM interoperability) and it is in progress on digital photogrammetric models of artworks. Work in progress consists of testing the algorithmic database on the largest number of works and elements, also considering the integration of automatic AI Data annotation/comparison as possible future works.

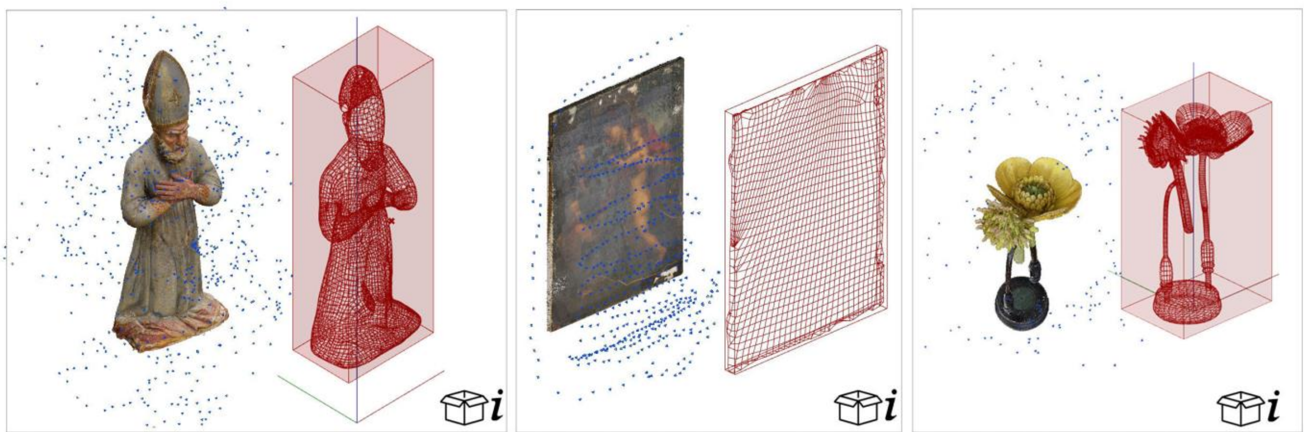

Figure 1. Low-cost digitalisation (Digital Photogrammetry) of multiscale case studies:
from textured Triangular Mesh (High-Poly models) to Quad Mesh (Low-Poly models) and bounding box.

1. Introduction

Documentation of Cultural/Existing Heritage requires acquisition, management, integration and continuous updating of high volumes of multimodal and multidisciplinary data for implementation of multi-scalar digital model, from artwork to architecture and urban environment.
Information systems workflows include multisensor and multispectral data collection (digital photogrammetry, laser scanning, structured light, diagnostic imaging) and historical and technical documents/sources aimed at the development and characterisation of compatible and interoperable models: this activity should be performed periodically and systematically to support monitoring, prevention and prediction for the entire life cycle of a system.
Versatile and interoperable approaches and tools should support optimisation and characterisation of information processes to meet the specific needs of different application fields and scale.
According to a LOIN oriented approach, recent methodologies and tools aimed at systematization, accessibility and sharing of complex data descriptive of cultural heritage (*e.g.* BIM/ HBIM for documentation of conservation status and/or environmental monitoring), aim to structure and integrate information systems regardless of the level of detail of the supporting graphic model.
Adaptability and potential reuse of parametric elements support the process specifying additional descriptors based on the required level of detail: recent approaches use or seek solutions for the construction of dedicated information systems aimed at link graphic model quality and information (Lo Turco et al., 2022).

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Some research approaches aim at the acquisition and recognition/categorization of different types of multiscalar objects to elaborate reality-based models and corresponding digital twins as a dataset for the development of information systems aimed at continuous data recording and monitoring (Bayrak et al. 2024; Croce et al., 2024a; Croce et al., 2024b); at the same time, others confirm reality-based model processing, analysis and editing aimed at topology and texture optimization aimed at the valorisation and communication of Cultural Heritage (*e.g. Mixed Reality* applications, *Real Time Rendering*).

In the multispectral diagnostic field (visible and invisible), storage and querying of extensive collections of heterogeneous digital data requires the use of specialized platforms to display and compare high-resolution multisensor imaging.

However, recent information approaches (IFC Data model) and technical standardization addressed to the field of documentation and conservation of Cultural Heritage (UNI 11897:2023, UNI CEN/TS 17135:2021, UNI EN 15898:2019) aim to standardize and unify data classification and systematization. Despite the logics of organization of standardized information systems and according to actual and specific application in the field conservation and restoration of the Cultural Heritage, real need for integrable and accessible specialist databases to store and compare a large number of heterogeneous and detailed data to concretely plan integrated intervention strategies (*e.g.* restoration activities, conservation and preventive maintenance approaches) emerges in order to support restorers and diagnosticians involved in integrated activities. Therefore, while confirming the usefulness of required standardized systems to simplify data management, there is still a real need for storage, systematization and comparison of many heterogeneous data to support concrete professional activities, such as preventive conservation and monitoring.

2. Main goals

The open-source information system showed in this research work is an open interoperable VPL algorithm independent of specific modelling environment and approach for geolocalization, storage and comparison of diagnostic multi-sensor data on open 3D semi-automatic geometric database extracted from *image-based* models and shared on open web-based platform to support informatization, conservation/restoration and monitoring multiscalar elements (*e.g.* artworks, architectural or urban objects).

The proposed information system consists of an interoperable and adaptable parametric synoptic box/grid for automatic and semi-automatic definition and segmentation of 3D and 2D digital models.

The LOIN (Level of Information Need) approach adopted and applied in this work to unique, original, non-replicable and complex artifacts whose digital copy coincides with particularly detailed reality-based models (*e.g.* artworks), also extendable to other categories of objects, reverses the process of progressive geometric-information model characterization (LOD): the LOG (*Level of Geometry*) of the ideal model (from the reality based model) decreases while the LOI (*Level of Information*) increases. Therefore, the proposed tool aims to manage the LOG_*Level of Geometry* of the digital model by simplifying the containers to reduce computational issues and facilitate data collection, management and accessibility consistent with specific information needs. The container may consist of a single external box independent from the original configuration of the object or a morphologically similar but geometrically simplified geometric copy.

The many heterogeneous data, high-resolution or diagnostic imaging, are attributed and geolocated on a rationalized reality-based model/container, then idealized (from bounding box to detailed cells/patch), based on the type of information and the specific interoperable approach (*e.g.* VPL/BIM-HBIM/GIS).

This approach is aimed to propose a copy of the reality-based model as an ideal/scalable container/database for storage, systematization and expeditive update of complex data regardless of scale, absolute and/or relative, specific object/element/part and reference system or environment.

Then, the simplified ideal model is proposed as a solution for parameterization of a non-parametric reality-based model, also adaptable to parametric objects/models as a single or discrete container to geolocalize multiple visible and invisible information.

The algorithm connects the model/container with a specially structured ACDat on open web-based platform.

The open platform for collecting data in categorized lists and the possibility of open web-based linking to the components of the VPL algorithm, then to the sub-elements of the model, have been tested on case studies which present a wealth of multidisciplinary documentation.

More specifically, the system is tested on 3D models of artworks, highly complex systems due to the large amount of heterogeneous data involved.

This tool support restorers and diagnosers to geolocate and annotate numerous results, observations, hypotheses or indications (*e.g.* multisensor *diagnostic imaging*) in geometric cells to visualize and compare heterogeneous visible and invisible structural and material data, at different levels of detail allowing model exploration to retrieve any information associated with each element.

3. Theoretical background

The scientific literature offers numerous solutions regarding structuring of information systems and interoperable databases (*e.g.* VPL/BIM-HBIM/GIS) aimed at documentation, management and planning of activities related to architectural and urban contexts, also extended to the artistic heritage, especially for the management of museum and archaeological contexts (Lo Turco et al. 2022; Ferretti et al., 2022; Garagnani et al., 2021; Tucci et al., 2019; Manuel et al. 2019).

The proposed VPL approach is derived from previous interoperable algorithmic design activity (*i.e.* VPL-BIM/HBIM) aimed at diagnostic imaging processing and management for conservation and restoration of artworks (Lanzara 2024; Scandurra & Lanzara 2023).

Specialistic literature proposes similar approaches and information systems based on geolocations heterogeneous data on detailed reality-based models of artefacts (Apollonio et al., 2023; Apollonio et al., 2019); flattening of 3D mesh models in 2D maps for graphic documentation (Barazzetti et al., 2024); GIS-based informative systems of artworks (Bertozzi et al., 2017); VPL informative systems for multiscalar objects (Scandurra & Lanzara, 2023; Lanzara et al., 2021; Spreafico et al., 2020); BIM/HBIM system for artworks conservation and monitoring (Lanzara & Scandurra, 2023); metadata system for documentation of multisensor images (Pamart et al., 2022); open-source multiplatform graphic engines and information system (*e.g. Unity*; *Blender*; UE); deep learning automatic vectorialization of images (Betsas et al., 2024); automatic multi-sensor annotation ad labelling interface (Qazi et al., 2024); Web-based Platform (Angheluță et al., 2023); online open source framework (3dhop.net/; osiris.itabc.cnr.it/aton/).

However, it is not easy to store, systematize, geolocalize and superimpose numerous heterogeneous data referring to numerous categories and located in correspondence with the same point or area. According to these premises and requirements, the proposed parametric database is aimed at storage, geolocation, sharing and comparison of multisensor images to facilitate overlapping of heterogeneous numerous and heavy information on 3D reference models.

4. Methodological Workflow

The characterization of an artefact documents its state of conservation to propose adequate preventive conservation strategies based on a multidisciplinary and multitemporal approach. According to the considered scientific references, this open system works on the interlacing between 3D mesh and heterogeneous data.
The methodological framework, post diagnostic activity, consists of the following steps:
- data storage on open web-based platform (CDE);
- 2D/3D digitalisation of the object;
- filtering/optimization of Triangular Mesh;
- upload of edited textured Triangular Mesh into 3D modeler/viewer (CAD or BIM environment);
- transformation of Triangular Mesh into Quad Mesh or NURBS/SubD (CAD/VPL-BIM interoperability);
- upload of textured Triangular Mesh/surface into VPL modeler;
- upload of data links from CDE (web-based platform) to Data Set VPL algorithmic component (*i.e.* Data List management);
- VPL manipulation of mesh or surface (subdivision or paneling algorithms) for extraction of scalable mesh/grid-containers;
- faces/patches labelling according to correspondence between listed cells/element – listed data/text indices;
- geolocalization of multi-sensor diagnostic data using appropriate labels and markers (according to previous correspondence system).

The overlapping of multiscalar grids allow the comparison of different databases (according to different level of detail) on the same object. Quadrilateral pattern simplifies future mesh/surface texturization and projection of diagnostic imaging data on planar or curved patches/cells, according to the geometric genesis of the shape.

5. Application: case studies

The algorithm has been previously designed and tested on 2D VPL informative system to geolocalize high resolution images (Lanzara et al., 2024) and on a similar version on object-oriented model of architectural and structural elements, thanks to VPL/BIM-HBIM interoperability (Lanzara et al. 2021, p. 381). Its upgrading is now tested on digital photogrammetric models of complex artworks with different shape, size and construction technique (fig, 1): in particular, two polychrome wooden sculptures with plaster inserts (complex shape/free form) and a hybrid system composed of painted canvas on wooden panel (mainly flat system).
The restoration of both artworks is *in progress* and the system allows the geolocation and precise recording of the numerous data collected before, during and after activities, such as stratigraphy, high-resolution detailed images acquired by *low-cost* instrumentation (*e.g.* Dino Lite acquisition, X-Ray, UV analysis and others). Both works are rich in physical, chemical and biological information, then it is possible to test overlapping or geolocation of multiple diagnostic information for the same point/area or very close points/areas.
Restorers require tools that allow quick consultation and comparison between data, especially if related to the not visible.

5.1 Case study 1: wooden panel with painted canvas

Figure 2. Case study 1: painting canvas on wooden panel. Traditional CAD Data Mapping.

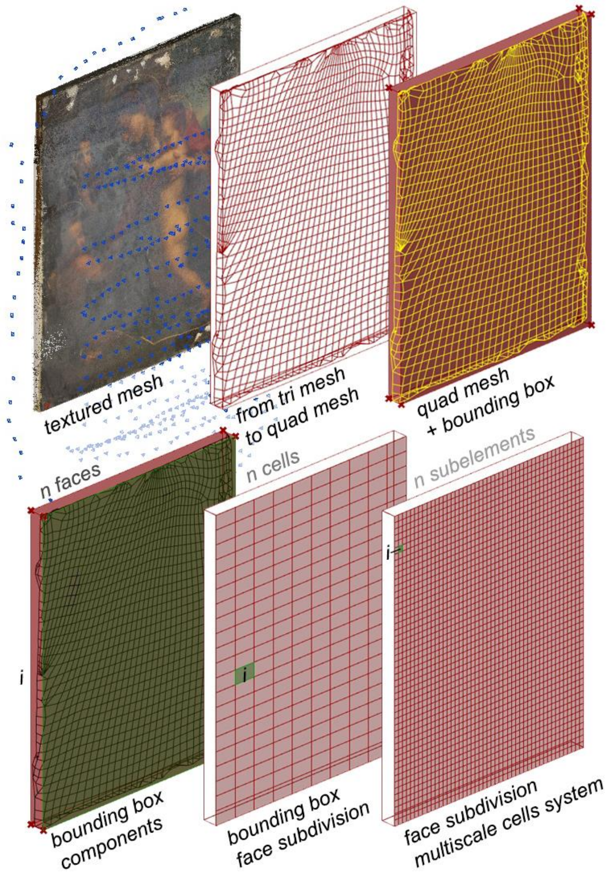

Figure 3. Quad Mesh cells and bounding box faces as geometric data container: list/selection of cells/faces indices.

The painted canvas on wooden panel belongs to the Church of San Giacomo degli Spagnoli, located in the historic center of the city of Naples. The artwork is an ancient copy, probably seventeenth century, of a famous composition by Andrea del Sarto, Madonna with Child, San Giovannino and angels.
The pictorial layers of the wooden margins have an accentuated mechanical cracking, which over time has evolved into widespread dislocations and color lifts, cracks in the central area of the painting, although it is diffuse but much less pronounced and more superficial, consistent surface deposits and a thick film layer that alters the readability of the work.
The preliminary diagnostic activity has provided a vast campaign of investigations for the acquisition of not visible data as support to visual analysis of the painting.
Examination of the problems affecting the work, applied by areas, was then combined with data from point analyses (both chemical and stratigraphic).
The diagnostic analyses included micro and macrophotographic documentation in diffuse and grazing light, Dino-Lite acquisitions for the study of stratigraphies, UVF_UV Fluorescence and X-Ray_Radiography.
3D digitization of the painting allowed an easy remote analysis of the work, which were better diagnosed macro and micro-deformations of the surface, identified mechanical stresses induced by the thermal hygrometric variations of the environment of placement and analyzed the real extent of gaps in the pictorial layer.
The non-invasiveness and high resolution that this tool offers proved to be particularly useful for the restoration planning as the work is positioned horizontally due to the numerous fragments of color not attached to their original location and at risk of falling. This artefact was chosen because flat and characterized by a complex stratigraphy (Figg. 2, 3).

5.2 Case study 2: St. Catello polychrome wooden sculpture

Compared to the wooden table described above, characterized by a predominantly flat configuration, this work is characterized by a more complex geometric configuration.
The artwork is a polychrome sculpture of San Catello, carved by anonymous author belonging to Neapolitan school and dated XVIII century, measuring approximately 107,5 x 39 x 25.5 cm, composed by a wooden support and a preparation based on plaster and glue and a polychrome layer.
The artwork comes from the deposits of the Cathedral of Maria Santissima Assunta and San Catello, in Castellammare di Stabia, near Naples.
The wooden support is assembled from 19 pieces (deduced from a cross-comparison between X-Rays and a careful visual analysis of the work). Diagnostic investigations carried out are taxonomic analysis, microbiological, environmental parameters, gas-chromatography, FT-IR, UV Fluorescence, X-Ray_Radiography. The sculpture shows the lack of bastions and pastoral sticks, as suggested by the iconography and the material traces found on the works. As for biological degradation, the statue of San Catello shows pronounced signs of attack by xylophagous insects. In addition, some burns are visible on the wooden surface.

6. Digitalisation: photogrammetric acquisition & editing

Both works have been acquired with digital photogrammetry. The wooden panel with painted canvas was acquired with mirrorless camera Canon EOS R with FF (1.0x) sensor and 30.3 megapixels (456 photos), lamps and polarizing filters for reflections of the pictorial film, especially in correspondence of the edges and darker areas.
The polychrome wood sculpture was captured with a Canon EOS 250 D reflex camera, 24.1 MP APS-C sensor. For both works a colour checker was used to compare the colour variations of the pieces pre and post restoration.
Both models have been optimized (*Laplacian* filter) and decimated in a digital photogrammetric environment to export lighter and smoother mesh.
After texturing, the edited models were exported in .obj format with unique texture and transformed from Triangular Mesh into Quad Mesh, then imported as input in the VPL algorithm/database to proceed with subdivision, extraction of the container grid and labelling of boxes and faces/patches. Exported mesh have been imported and edited using CAD/VPL transformation (from Triangular Mesh to Quad Mesh/NURBS/SubD) and VPL subdivision algorithms.
The original textured Triangular Mesh of wooden panel with painted canvas consists of 2.768.058 faces (High-Poly model) and has been decimated to get a final Quad Mesh composed of 1596 vertices and 1513 faces (Low-Poly model).
The original textured Triangular Mesh of wooden polychrome sculpture consists of 1.558.938 faces and has been decimated to get a Quad Mesh composed of 7053 vertices and 7180 faces (Low-Poly model), (Fig. 4).

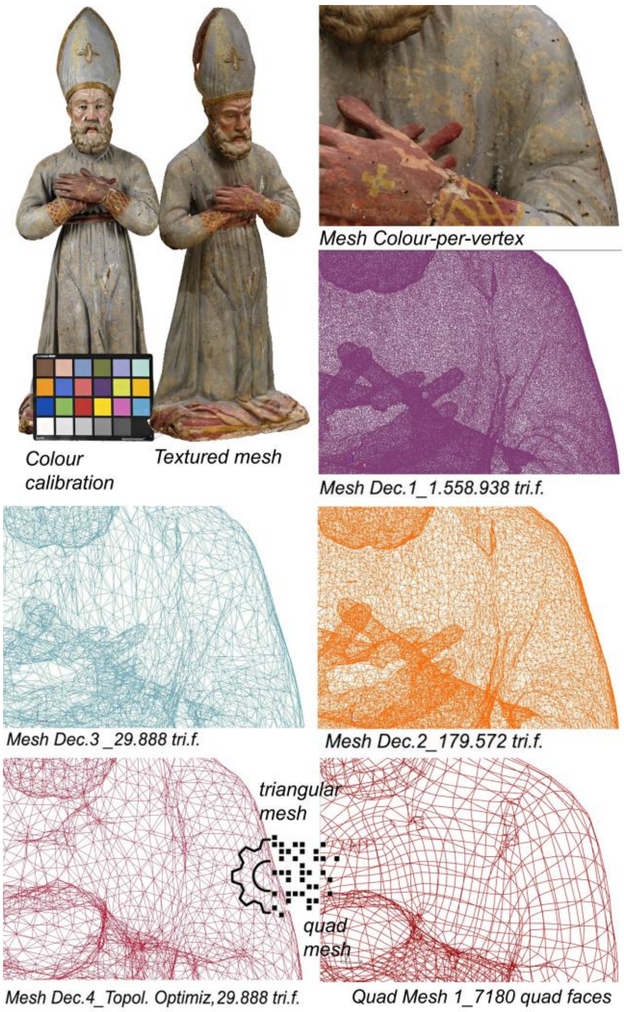

Figure 4. *Reality-based* mesh editing: filtering and manipulation from High-Poly Triangular Mesh to Low-Poly Quad Mesh.

7. Information system: open VPL algorithm & open Web-based Platform

The proposed approach provides interoperability between open-source VPL algorithm (*Grasshopper*, *Rhinoceros* plug-in) and open web-based platform. It is structured in four main phases linked by interoperability between the different open-digital environment involved in the process:
- Mesh subdivision/Surface paneling (input: open VPL environment);
- Data storage (input: open web-based platform);
- Data management (operation: open VPL environment/Data List management);
- Data Sharing (output: open web-based platform and open VPL environment).

The proposed geometrical VPL database consists of an ideal mesh/neutral grid extracted from the 3D reality-based mesh (from Triangular to Quadrilateral Mesh or SubD) to wrap points cloud, mesh or surfaces of the object (CAD/VPL NURBS/mesh/SubD, BIM object oriented models/mesh): the box or grid of cells/patches extracted from reality-based models or superimposed on the ideal model (overlapping but non-coinciding edges and cells), work as a light containers for storage of diagnostic information (images, numerical and textual data).
The original texture of the model is however displayed in the 3D modeler/viewer (CAD/BIM) and in web-based open platform as visual reference for data geolocalization, regardless of the quality of the model. Thanks to subdivision algorithms, the edited mesh can be divided into cells/patches of different length to document areas of different sizes and at different levels of detail.
The system allows semi-automatic clustering of cells, colours attribution and labelling of text and image from link data list.
The quadrilateral pattern is considered more suitable for potential diagnostic imaging mapping on the quad cells/patches. Anyway, data can also be geolocated in correspondence of points distributed on the mesh/surface, therefore not necessarily referring to the cells of the mesh. According to previous existent reference (Angheluță et al., 2023), the innovative aspect of this approach lies in the use of digitised 3D cultural heritage assets as key elements for the dissemination of multi-layer imaging data in an interactive informative online environment.
For data storage the approach uses an open web-based platform (usBIMplatform, ACCA software) to meet the following requirements:
- Data accessibility via web browser;
- adaptability of the algorithmic system in BIM environment and data loading for any type of cultural heritage property, from urban objects, architectural buildings to works of art;
- interactive interface;
- local 3D data storage and management;
- integration of multimodal imaging data into specific parts of the digitised 3D models.

The system requires intermediate 3D optimization and editing skills for the preparation of 3D data. The system is designed to act as an online platform for multiple 3D models comprising different types of imaging data sets.

8. Multiscale parametric database: geometry processing

The VPL algorithm is structured in two main parts, Mesh/Geometry subdivision and Data List management, and it consists of the following steps:
- conversion/transformation of the input *reality-based* Triangular Mesh into Quad Mesh/SubD for neutral grid construction;
- manages/manipulates Quad Mesh using subdivision algorithms (*e.g.* Catmull-Clark subdivision algorithm according to *Weaverbird* Gh add-on), (Kuth et al., 2023, Catmull and Clark, 1978) to establish number and size of cells based on type of acquired data/acquisition area;
- extrapolates edges and vertices for grid construction or transforms Quad Mesh into SubD or BRep for extrapolation and scalable grid management (*e.g.* Quadrilateral pattern according to *LunchBox* Gh add-on) and its UV domain (nmber of curves and cells);
- cells clustering;
- geolocalization of links corresponding to stored data (web-based platform) and collected in data list (link index = cell index) through specific algorithmic input/output tools (Panel, File path, Text Tag; Smart Bitmap_Gh components);
- semi-automatic loading of data collected in web-based platform (data list of links) for data geolocation and comparison between *reality-based* and ideal models (CAD/VPL modelling, BIM/*object-oriented* modelling);
- uploading VPL algorithm through interoperability between CAD /BIM software and connection with open web-based platform;
- data analysis and comparison pre, during, post-restoration and future monitoring.

The unique output bounding box and/or the neutral mesh are superimposed on the detailed textured model.
The scalable cell/container patch prototype allows to work on any geometry, whether mesh or NURBS, also point cloud, making the system versatile, independent, interoperable and applicable to any type of digital object (Fig. 5).

8.1 Mesh Subdivision: multiscalar containers

Starting from the management of the mesh/container, according to a correct algorithmic approach, the input geometry is the original quad mesh, the operation consists in mesh transformation and subdivision, the output is the edited/subdivided Quad Mesh/Database aimed at data attribution/geolocation in cells.
A 3D mesh refers to a geometric-spatial structure composed of vertices, edges (segments connecting the vertices) and polygons (or faces bounded by the edges).
The different regular pattern need special subdivision algorithms (*e.g. Loop* Algorithm for Triangular Mesh subdivision; *Catmull-Clarck* algorithm for Quad Mesh subdivision).
The Catmull–Clark algorithm is a technique used in 3D computer graphics to create curved surfaces by using subdivision surface modeling. It was devised a generalization of bi-cubic uniform B-spline surfaces to arbitrary topology (Catmull & Clark, 1978): given a surface described as a set of points and a set of polygons with vertices at those points, the algorithm transforms a starting Quad Mesh into a more refined Quad Mesh. The process for computing the new locations of the points in refined Quad Mesh works as follows:
- starting cubic mesh as geometry input;
- application of different rounds of the Catmull-Clark algorithm (original quad mesh converging to a quad mesh that looks more smoothed); for each face, a point as average of all the points of the face is created; for each edge, an edge point is created which is the average between the center of the edge and the center of the segment made with the face points of the two adjacent faces;
- for each vertex point, its coordinates are updated as geometry output.

The subdivision of the Quad Mesh (*Weaverbird*'s Catmull-Clark Subdivision_*Weaverbird* Gh add-on component) obtained because of the CAD transformation of the Triangular Mesh

from digital photogrammetric processing allows to refine the input Mesh to manage the number of square faces in relation to the level of detail and the point location of the data.
The new smoothed mesh will be composed of generally non-planar quadrilaterals, according to the geometrical genesis and identity of the shape (only revolution and translational surface can be subdivided in planar quadrilateral faces).
Repeated subdivision produces more smoothed meshes after a series of iterations, the number of extraordinary points on the surface remains constant.
The approach disregards the formal alterations of the object, then it is aimed only at data geolocation with reference to the correspondent original or edited textured mesh.
Therefore, models can be used as an informative system and cannot be used to record or compare any morphological or volumetric transformations over time or post restoration (Fig, 6).

8.2 NURBS/BRep subdivision

The alternative geometric database is structured as a system of quadrilateral patches from paneling (*Quad Panels*, *LunchBox* add-on) of BRep or SubD from Quad Mesh transformation.
Similarly to the mesh database, the algorithm allows the selection (*List Item*_Gh component) of the patch/cell to associate the corresponding data: for both Mesh and BRep/SubD systems, it is possible to divide the total geometry or each patch/cell and generate a grid of UV points or a system of mesh components, such as faces and vertices (*Divide Surface* or *Deconstruct Mesh*_Gh components) to associate data, generating a series of subsystems.

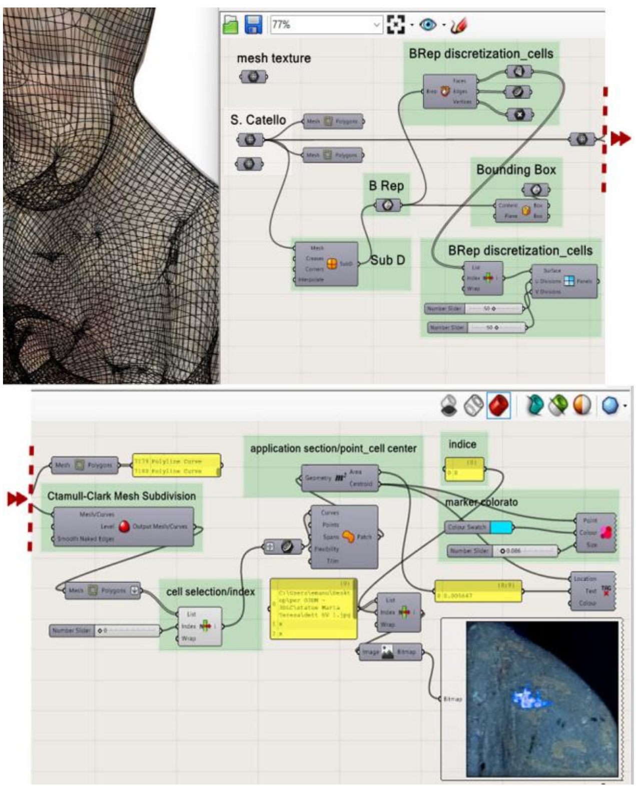

Figure 4. Open VPL algorithm: from Mesh subdivision and BRep Paneling to Data List management and geolocalization.

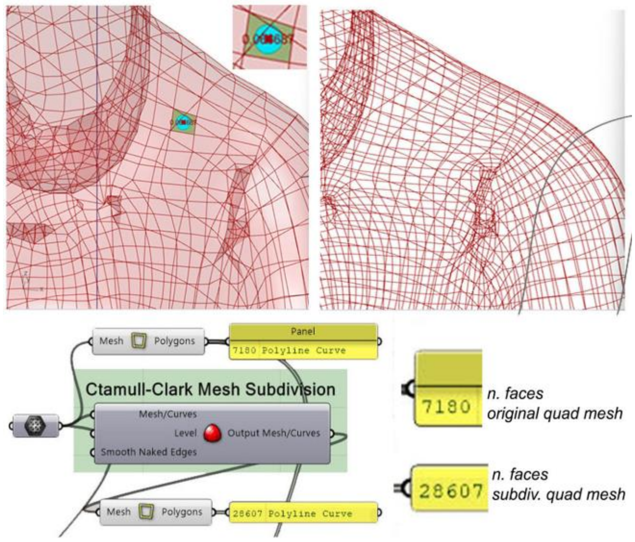

Figure 6. Quad Mesh subdivision (Catmull-Clark algorithm): multiscale and customized marker/labelling informative system.

9. *Web-based* Data storage & VPL Data management

The database should store different categories of available data (different Link-Data List) for each of the element's 3D cells/patches (different Cells/patches-Data List), according to one-to-many relationships logic (Angheluță et al., 2023).
Specific algorithmic components allow the creation and management in input and output of lists of numerical data, text, links for uploading images (Panel, Area, File path, Text Tag, Smart Bitmap, Preview Image, preview Bitmap).
For each list (cells and data) an index corresponds to each element: the index correspondence between data list and patch/cell List ensures the correct geolocalization of information.
Thus, different markers and colours have been designed to label each cell according to its specific contents.
The open web-based platform used for data storage is usBIM Platform (ACCA software), but the algorithm can integrate any list of links.
For data collection and systematization of each work a special ACDat for categorization of numerous heterogeneous diagnostic data has been built for Data storage, sharing and updating.
Geolocation of the data (File-path) collected in the different folders/categories on the geometrical database according to the correspondence between List of Data (link in platform) and List of cells (indexes cells) is manual: a specific area/cell or point on the model and its index of the corresponding Data/Cells List can be used to record from the Data/Link List the file-paths corresponding to the information identified for that point/area, stored in different categories/Data Lists (the same categories stored on platform), in correspondence of the same index as the cell identified.
By repeating the operation for each folder/category of data and using more than one Smart Bitmap or Preview Bitmap Component (Bitmap from File path) for a same cell/index it is possible to simultaneously display and compare different information (Figg. 7, 8 9).

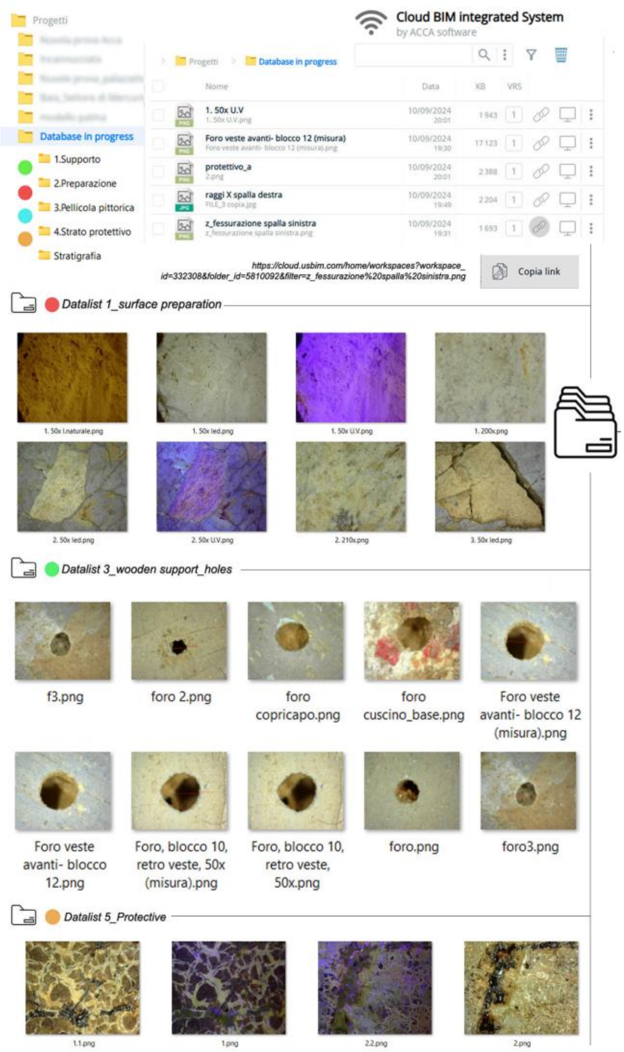

Figure 7. Web-based Data collection: each image is imported as Link in VPL List with the same index of the cell corresponding to the acquisition point/area on 3D model.

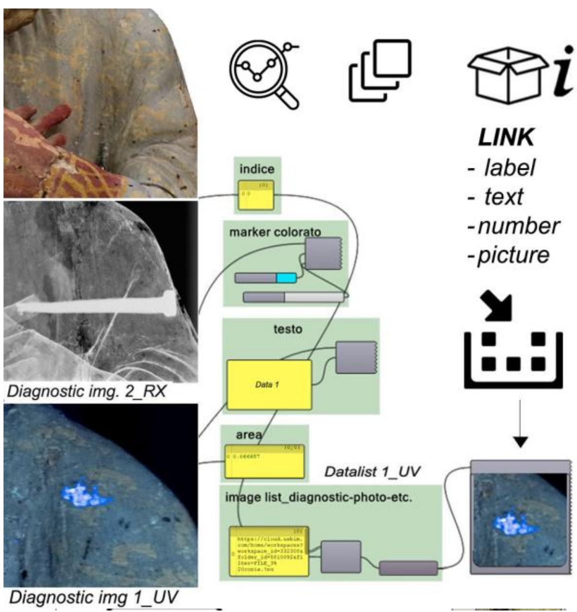

Figure 8. Data geolocalization and overlapping according to the correspondence between Link List and Cells List indices.

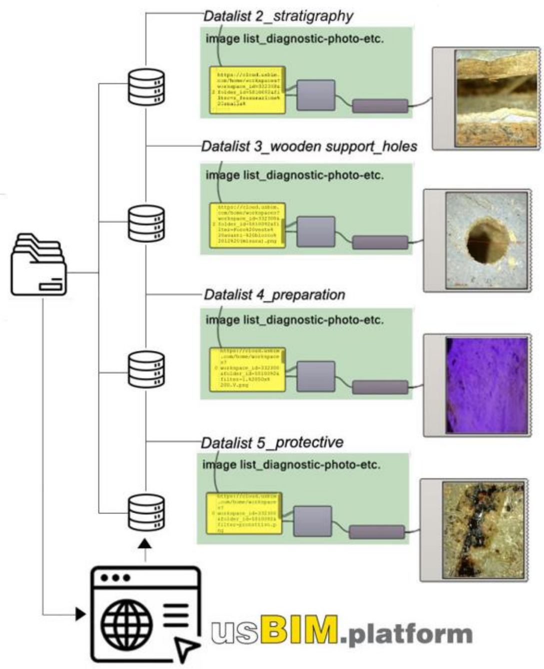

Figura 9. VPL visualizer: from Link List to Data Visualization.

10. Conclusion and future works

In conclusion, this system is testing on any type of 3D/2D model regardless of category, dimension, material, digitalisation technique and geometrical identity, to validate interoperability between VPL algorithm, different information systems/approaches (*e.g.* BIM/HBIM, EM, multiplatform graphic engines) and open web-based platform.

Geolocation and storage of numerous heterogeneous visible and invisible data could allow future comparison and automatic graphic mapping of imaging data, regardless of type of object and diagnostic/survey technique.

Work in progress consist of testing the algorithmic database on the largest number of works and elements, also considering the integration of automatic AI Data comparison as possible future works.

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