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editors

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Drones - Systems of Information on culTural hEritage.
For a spatial and social investigation

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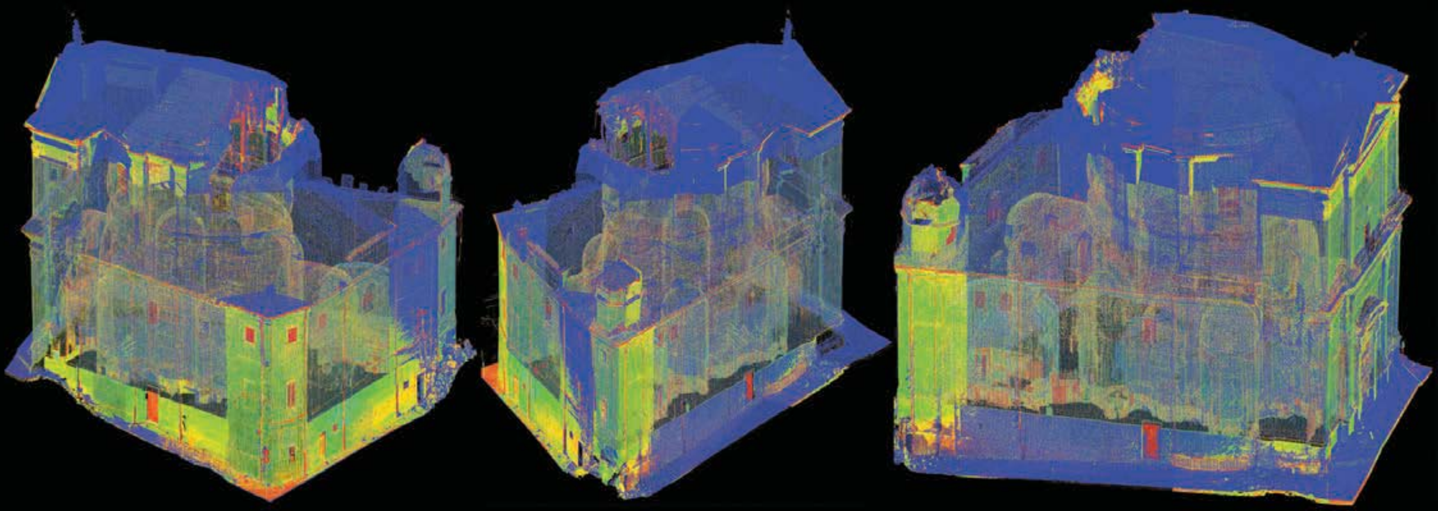

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Keywords:
Integrated surveying, 3D data merging, UAV, point clouds approach, SfM processing.

ABSTRACT

In situations where some portions of a building are inaccessible (particular architectural conformations or earthquake damage) it is necessary to adopt an integrated approach that combines range-based data acquired from terrestrial laser scanning and image-based 3D data acquired using an UAV equipped with a digital camera. This paper presents the results of a point-cloud-based survey made on two different case studies. The goal is to define a workflow for processing dense 3D models that can be used to describe complex buildings for different purposes (high-/low-poly 3D models, specific 2D representations).

The contribution of drone photographic acquisition in risky survey conditions: a comparison of two experiences

1. Framework and Goals of the Studies

In the last decade, the practice of surveying has solidified into a combination of different reality-based methods, that is, the integration of range-based and image-based acquisition technologies (Remondino 2011), enabling a unique dataset of processable information to be obtained more easily. The state of the art includes many cases that document how the use of aerial photogrammetry with digital cameras mounted on unmanned aerial vehicles (UAV) has been combined with surveys based on terrestrial laser scanning (TLS) to acquire 3D data related to the cultural heritage. The result is more detailed and more complete knowledge of architectural buildings characterized by complex geometries (Binda et al. 2011; Colomina 2013; Saleri et al. 2013).

In this context, the article presents two different integrated survey experiences made on two different buildings in which the use of aerial photogrammetry plays a fundamental role (Remondino et al. 2014). This is an irreplaceable tool without which it would not have been possible to completely acquire the data or therefore provide adequate documentation related to specific planned studies (Kerle et al. 2019).

Given this, the objective of the research was to experiment with and develop a hybrid workflow that combined the advantages and best features of each sensor (Fiorillo et al. 2013) in order to obtain sufficiently accurate three-dimensional data. These 3D data are useful not only for producing various representations aimed at documenting the buildings in question, but also for subsequent analysis, such as the study of seismic risk based on finite element methods (FEM) or to assess damage after an earthquake in order to secure the building.

2. The Church of Santa Maria in Via after the Earthquake of 2016

This religious building is located in the historical centre of Camerino (Province of Macerata). From outside, the church shows a trapezoidal layout resulting from the unification of pre-existing buildings. The more complex structure of the interior is composed of an elliptical hall covered with a dome. The hall is surrounded by four semi-circular chapel niches and two small choirs on the minor axis, while the ends of the major axis host the entrance and a deep chancel apse. The bell tower, likely built at the time of the church, was located at one corner of the rear façade (Mariano 2009).

The original building, consecrated in 1654, was the object of several modifications regarding the roof in particular which, after its collapse in the earthquake of 1799 (Moreschini 1802), was replaced by a gabled roof supported by wooden trusses and, within, by a false dome in camorcanna (reed and plaster). The church unfortunately experienced considerable damage in the earthquake of 2016. The bell tower situated on the rear façade collapsed along with part of the roof, with the consequent collapse of a good part of the camorcanna dome and part of the drum. Damage affecting the body of the façade that is detached from the hall, with a loss of structural consistency of the masonry.

Figure 1. The Church of Santa Maria in Via after the earthquake: collapse of the interior camorcanna dome, roof, and bell tower.

Within, the collapse of the roof and dome littered the entire floor area of the church and parts of the body of the façade were completely inaccessible. Outside, significant piles of rubble blocked access to the side streets and the rear façade while the ruinous collapse of the bell tower on the southern corner blocked access to the adjacent Piazzale della Vittoria (Figure 1). Considering the critical aspects of the site, a point-cloud-based survey campaign was defined. In an integrated reality-based approach, terrestrial range-based data acquired using laser scanners was combined with image-based data taken from a UAV equipped with a remote-oriented camera to produce the most detailed visualization possible of the extent and the locationing of collapses in the roof, trusses, dome, and bell tower. The range-based survey was carried out using the Leica HDS 7000 3D laser scanner. Despite the reduced safety of the site, 15 stations for high-density scans were managed (made) - 10 outside and 5 inside the church along the perimeter of the oval (the only accessible space) - adopting'high' and'superhigh' scans quality and with variable sampling densities in relation to the working distances from the surfaces (6.3 mm and 3.2 mm spacing between the points at a distance of 10 m). This setting of density and quality in data acquisition has aimed to obtain an accuracy (metric precision) such that representations corresponding to a scale of detail of 1:50 can be achieved. The image-based survey made for photogrammetry purposes was carried out with a DJI FC6310 (Phantom 4 Pro Plus) quadcopter with incorporated camera equipped with a 1" sensor and 20 Mp resolution with mechanical shutter to eliminate rolling shutter distortions. The photographic campaign was carried out with different acquisition schemes relating to the different portions of the building: vertical with regard to the'plane' of the roof about 10 m away from the ridge; and pseudo-vertical (axis inclined with panoramic view) along the entire perimeter of the roof at a distance varying from 15 to 20 metres. The snapshots were made with f/5.6 and f/5 apertures, a shutter speed from 1/200s to 1/400s, and ISO 100 to reduce noise. The entire campaign yielded a total of 301 snapshots.

The goal was to obtain as much data as possible in the form of point clouds in order to accurately and adequately process 2D representations as well as suitable 3D display modes (with orbitable textured views of the point cloud) of the state of the church after the earthquake, i.e. to document types and objects of the damage and therefore compose reliable graphical bases for the subsequent project to secure the building. The data-processing phase primarily regarded the creation of a homogeneous database. The range-based survey campaign resulted in a total set of 522 million points. With regard to the photographic data acquired using the drone, qualitative analysis of the photos resulted in 150 snapshots chosen for processing. Using a structure-from-motion (SfM) tool, all the selected photograms were oriented and the absence of alignment errors was verified, followed by extraction of the dense cloud with a'high' setting, resulting in a cloud consisting of 44 million points. This dense cloud was then converted into a polygonal model (3.8 million faces) using a proprietary algorithm in the software that works via interpolation. Since the drone was georeferenced during shooting (snapshots equipped with geotags in the WGS84 reference system), both the point cloud and resulting mesh model were already scaled appropriately (Figure 2). The two separate point clouds were aligned and merged by identifying two reference lengths (vertical

Figure 2. The image-based survey and processing of the snapshots made with the camera axis tilted with respect to the roof area.

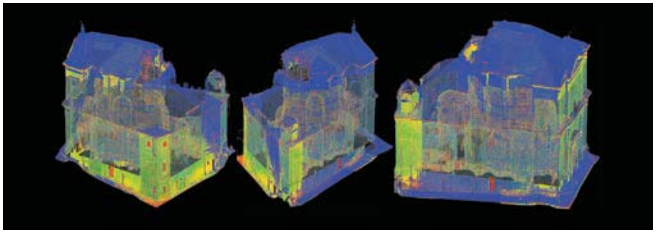

Figure 3. Views of the entire data set obtained after aligning and merging the two point clouds: photogrammetry point cloud (blue), laser scanner cloud (coloured).

and horizontal), that is, a series of points distributed on the different sides of the church that were recognizable in both the laser scanner cloud and the cloud obtained from photogrammetric processing. The coordinates of the points were obtained from the laser scan and then appropriately inserted as markers in the cloud resulting from photogrammetry (Figure 3).

Once a single data set in the form of a point cloud was obtained, the next step concerned the data processing phase. The team of structural engineers in charge of the subsequent safety project has therefore identified and defined types, quantities and scale of detail of the necessary and useful representations. First at all, was indicated as indispensable 2D drawings relating to: all external elevations with the detailed representation of damage, gaps and collapses; four levels of plants; a complete longitudinal external-internal section; two profiles on the macro element of the facade aimed at analyzing the extent and importance of the displacement from the vertical alignment (off-plumb) of some portions of this front (Figg. 4, 5).

From a three-dimensional point of view, it was defined as necessary for the study of process of securing not so much the elaboration of a model (considered in itself not useful given the huge percentage of collapses) but rather a processing that allowed to visually explore the state of the collapses at height. To this end, by re-projecting the shots on the mesh model elaborated with SFM systems, a 3D orbitable and zoomable overview has been produced in order to explore the state of the collapse in elevation (Figure 6).

3. The Complex of San Francesco for Analysing Earthquake Risk

This convent complex is located in the historic centre of Monterubbiano (Province of Fermo). From its foundation (1247) up to the most recent restorations carried out following the earthquake of 1997, the entire complex of San Francesco has changed in use several times (currently a museum) and has undergone substantial formal modifications that have defined its current structure.

Internally the church, choir, and base of the bell-tower form a single body. The church consists of a single nave covered by ogival groin vaults; the choir, covered by a groin vault, is situated at a higher level on the counter-façade and facing the nave of the church. The slender, soaring bell tower is located to the left of the church entrance. Within of the bell-tower a C-shaped staircase, with access on the choir level, is located to reach the higher levels (Figure 7).

A laser scanner survey was also combined in this case with photographic survey using a UAV, which allowed for control of shadowed areas from above and photography of high parts that would otherwise be unreachable (roof and bell tower). The range-based survey to acquire 3D geometrical data both inside and outside the complex was designed using multiple resolutions. Eighty-three scanning stations were carried out, of which 26 were outside and 57 were inside. A total of 421 million points were acquired.

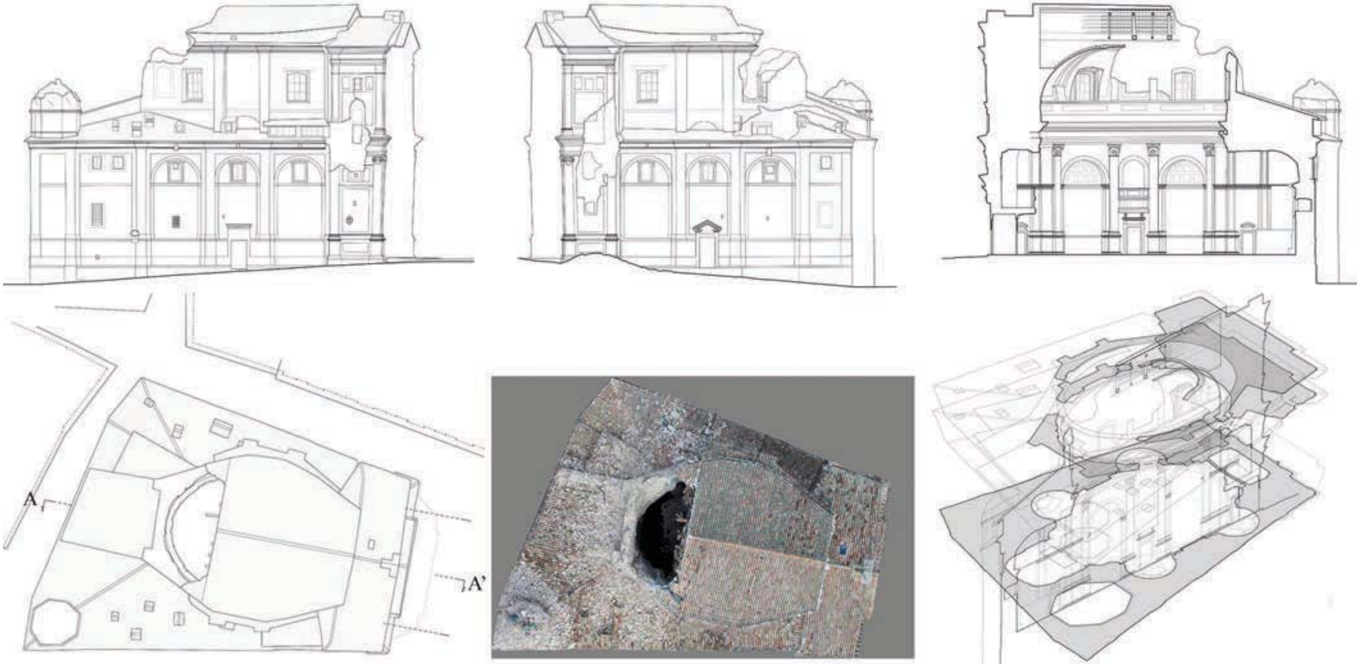

Figure 4. Some 2D representations: elevations of the left and right sides, longitudinal section, to-scale textured orthophoto and related plan of the roof, axonometric view of four plan levels.

The image-based survey — of fundamental importance for acquiring data relating to the horizontal and vertical configuration of the roofs and the structure of the richly moulded bell tower — was made using a UAV powered by six 400 KV brushless electric motors and 15''-diameter rotors.

Figure 5. Some pictures of the operations to secure the church: interior drum and dome, corner and top of the bell tower, left side of the façade.

It was equipped with a Sony NEX-5R camera with a fixed 22-mm focal length and an APS-C sensor (23.4 mm x 15.6 mm) with a maximum resolution of 4912 x 3264 (16,032,768 pixels), yielding a physical pixel dimension of 0.004763 mm (p = 23.4 mm/4912). For the entire photography campaign, the main shooting characteristics required by the software used to process the images (minimum overlay, convergence, etc.) were considered.

The flight paths were primarily linear except around the bell tower, where the motion was more circular on several different horizontal planes. The views in the snapshots (one every 2 seconds) were tilted with respect to the building's vertical surfaces to control shadowed areas from above. The UAV campaign resulted in 517 photographs in RAW and JPG format. An initial look at the lighting conditions in all the photographs showed

Figure 6. Orbitable 3D model obtained from the processing of aerial photos taken by drone: overall views and detailed views of damage to the roof and façade.

that the JPG images could be used directly without corrections via RAW processing. Therefore, a qualitative analysis of the photos was made; 129 were initially selected in which radial distortions were eliminated. After an initial orientation with SFM tools, additional problematic shots were identified, reducing the overall image count to be processed to 93. Once no alignment errors were found, extraction of the dense point cloud began with the'high' setting. The resulting point cloud cleaned of all outliers and points not pertaining to the building, consisted of around 39 million points (Figure 8). In order to align the point clouds from the two campaigns (TLS and UAV), it was necessary to scale the point cloud produced by processing images taken by the drone. We then proceeded to identify a reference length for both point clouds. The extreme points of the straight line were identified near corners of the building (unaligned, distant enough, and visible to both systems). The clouds from the two campaigns were aligned using the Geomagic software for which a reference length was identified. This program allows for a 'best-fit' alignment only between one mesh and one point cloud.

Figure 7. Orbitable 3D model obtained from the processing of aerial photos taken by drone: overall views and detailed views of damage to the roof and façade.

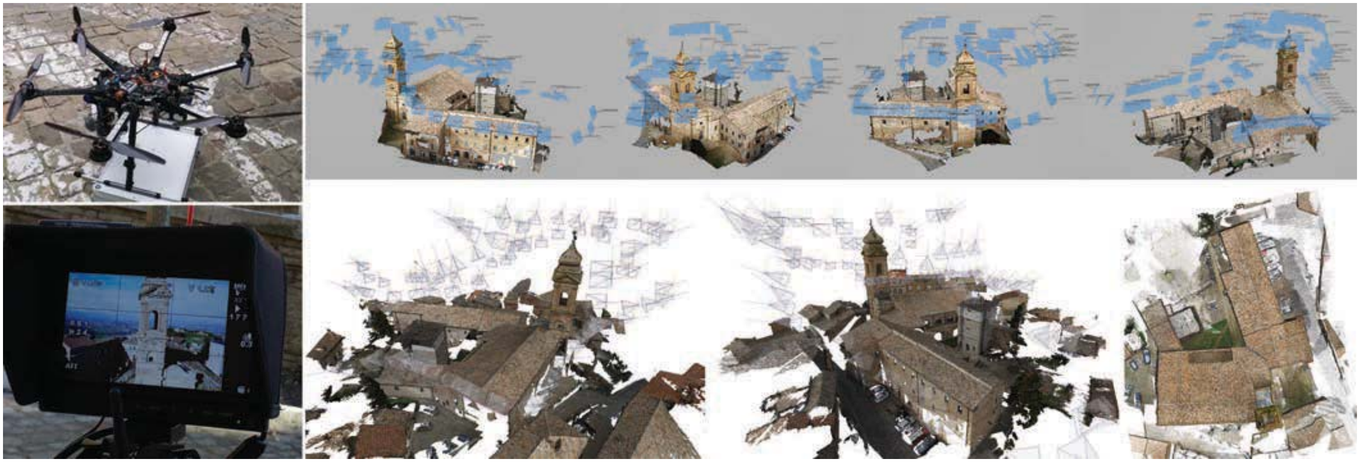

Figure 8. The image-based survey and the photogrammetric processing of the shots: coloured point cloud and position of the pictures taken from the UAV.

Therefore, the point cloud from the laser scan was tessellated using the proprietary meshing 'Wrap' algorithm in Geomagic.
This algorithm is better adapted to reconstructing architectural shapes than other meshing algorithms ('Poisson', for example), which would have generated a model with corners that would be too soft and smoothed.
Once alignment using the best fit was completed, an additional adjustment was made to decrease the deviation between the two point clouds. The resulting average deviation was 5.5 cm.
To better establish and verify the accuracy of the alignment, different parts of the model were analysed using complete data from the two point clouds without applying any decimation (Figure 9).To merge the two clouds, the laser scanner data were left unchanged while all superimposed parts in the drone point cloud were eliminated, leaving only the parts necessary to fill in the scanner point cloud gaps. The portions of the drone point cloud to be merged with the scanner cloud were determined by identifying the gap edges on the mesh derived from the laser scanner.
These contours were converted into curves, which were then transferred to the mesh derived from the drone data. These curves were then used as a boundary to identify the parts useful for filling in gaps in the scanner data. This procedure yielded a complete model of the roof that was almost entirely absent from the laser scanner data (Figure 10).
The textureless 3D model thus obtained was used to assess the seismic risk of specific large elements (Meschini et al. 2015), including the bell tower (Figure 11).
Furthermore, a textured 3D model was developed by using a mesh with a low number of polygons onto which the aerial photos were reprojected and merged. This model is useful for making more realistic and overall representative views (pdf 3D, 3D player on-line) (Figure 12).
Finally, with respect to the 2D representations and the generation of orthographic images (Ippoliti et al. 2015) useful for analysing wall materials or crack patterns, both aerial and other additional ground-based photographs were reprojected onto portions of a non-decimated 3D model (Figure 13).

Figure 9. Best-fit alignment (reference length in red) of point clouds captured using UAV and TLS (tessellated using the'Wrap' meshing algorithm).

4. Conclusion

The applications described in this paper aimed to identify an operational framework (phases, survey tools, and tools to produce the most suitable representations) that may potentially also be adopted for other objects of historical/architectural value, that is, for contexts with similar characteristics. In both cases, contribution of photographic acquisition from a drone was fundamental in capturing portions of the buildings that could not be accessed using other tools, thereby reducing risk exposure for on-site surveyors and allowing satisfactory data to be obtained.

The cloud-to-cloud procedure to process the data enabled dense 3D models to be constructed.

These models yielded both 2D representations (geometric/metric renderings, scaled orthographic images) and 3D views (models textured with aerial images from the drone) that document a complex architectural object with different levels of visualization and detail; they are also useful for various analytical processes.

It is clear that only with additional applications may fundamental feedback be provided to verify the validity of the methodological approach in its different phases in relation to the quality of the results.

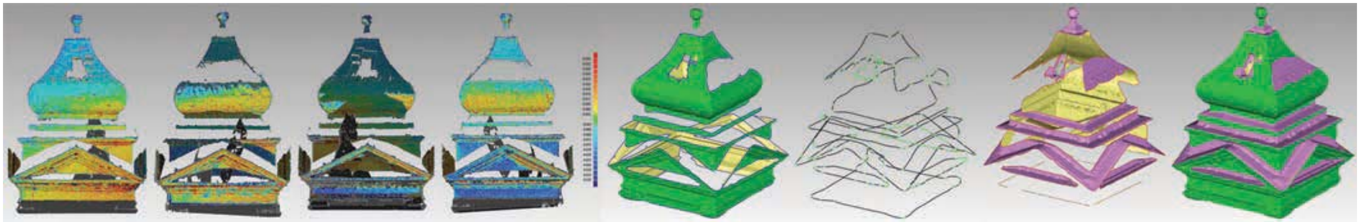

Figure 10. Merging phase (example): hole edges highlighted in LS data; hole edges extracted; UAV data to fill in holes in LS data (extraction after projecting the edges); merged LS and UAV data.

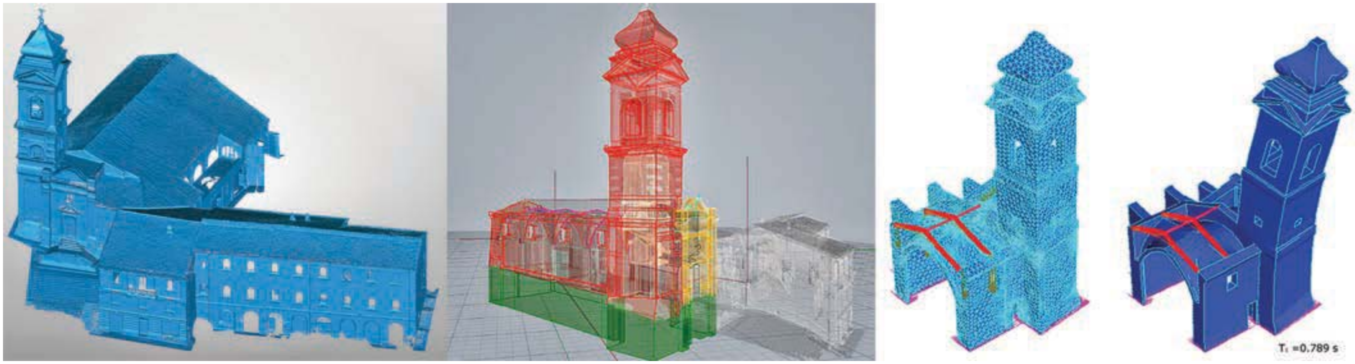

Figure 11. 3D mesh model obtained by merging LS and UAV data. Modelling: union of 865 surfaces into a single closed polysurface. Solid mesh and geometry (low number of polygons) for structural analysis.

Figure 12. Textured 3D model (explorable pdf 3D) for realistic representations: overall views and detailed views of the bell tower and facade.

Figure 13. Scaled orthographic rendering and related elevations of the east and south sides.

Bibliography

Binda L., Modena C., Casarin F., Lorenzoni F., Cantini L., Munda S. (2011). E*mergency actions and investigations on cultural heritage after the L'Aquila earthquake: the case of the Spanish Fortress. Bulletin of Earthquake Engineering*, 9, 1, 2011, pp. 105-138.

Colomina I., Molina P. (2013). *Unmanned aerial systems for photogrammetry and remote sensing: a review. ISPRS Journal of Photogrammetry and Remote Sensing*, 92, 2013, pp. 79-97.

Fiorillo F., Jiménez B., Remondino F., Barba S. (2012). *3D surveying and modeling of the archaeological area of Paestum, Italy. Virtual Archaeology Review*, 4, 8, 2013, pp. 55–60.

Ippoliti E., Meschini A., Sicuranza F. (2015). *Digital Photogrammetry and Structure from Motion for Architectural Heritage: Comparison and Integration between Procedures.* Brusaporci S. (edited by). *Handbook of Research on Emerging Digital Tools for Architectural Surveying, Modeling, and Representation.* Hershey PA, USA: IGI Global, 2015, pp. 124-181.

Kerle N., Nex F., Gerke M., Duarte D., Vetrivel A. (2019). *UAV-Based Structural Damage Mapping: A Review. ISPRS International Journal of Geo-Information*, 9, 1, 14, 2020, pp. 1-21.

Mariano F. (edited by) (2009). *Lo spazio del sacro. Chiese barocche tra'600 e'700 nella provincia di Macerata.* Macerata: Carima Arte, Fondazione Cassa di Risparmio della Provincia di Macerata, 2009.

Meschini A., Leoni G., Petrucci E., Sicuranza F., Zona A., Piattoni Q. Dezi, L. Dall'Asta A. (2015). *An integrated survey experience for assessing the seismic vulnerability of Senigallia's Fortress (Italy): documentation for conservation and FEM modeling, In Proceedings of the 2015 Digital Heritage International Congress.* New York: IEEE, 2015, vol. 2, pp. 21-28.

Moreschini M. (1802). *Ragionamento storico-filosofico sul tremuoto accaduto in Camerino il dì 28 luglio 1799.* Presso Vincenzo Gori, 1802. - 98,[2].

Remondino, F. (2011). *Heritage recording and 3D modeling with photogrammetry and 3D scanning. Remote Sensing*, 3, 2011, pp. 1104–1138.

Remondino F., Spera M. G., Nocerino E., Menna F., Nex F. (2014). *State of the art in high density image matching, The Photogrammetric Record*, 29, 146, 2014, pp. 144-166.

Saleri R., Cappellini V., Nony N. De Luca, Pierrot- Deseillingy M., Bardiere E., Campi M. (2013). *UAV Photogrammetry for archaeological survey: The Theaters area of Pompei. Proceedings of the 2013 Digital Heritage* International Congress. New York: IEEE, 2013, vol. 2, pp. 497-502.

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Dichiarazione ai sensi del DPR n. 445/2000

La sottoscritta ALESSANDRA MESCHINI, nata a Roma (RM), il 02/09/1966, residente in Roma, via Luca Signorelli 5, 00196, consapevole delle sanzioni penali nel caso di dichiarazioni non veritiere e falsità degli atti, richiamate dall'art. 76 del D.P.R. 28 dicembre 2000, n. 445, relativamente alla pubblicazione:

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DICHIARA SOTTO LA PROPRIA RESPONSABILITÀ CHE

Il saggio, in inglese, è stato accettato per la pubblicazione nel volume dei Proceeeding del Convegno *D-SITE, Drones - Systems of Information on culTural hEritage. For a spatial and social investigation*, dopo aver superato il processo di double blind peer reviewed sia dell'abstract e sia del paper.

Il saggio è stato poi selezionato, ad invito, per la presentazione orale in occasione dell'evento "Waiting for D-SITE 2022".

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Il saggio, riferibile all'ambito del rilevamento fotogrammetrico (in particolare con acquisizione da UAV - Unmanned aerial vehicle), si pone come un confronto/riflessione tra due casi studio trattati nell'ambito di due più ampie ricerche cui la scrivente ha partecipato (ricerca di Ateneo "PROCULT - PRObabilistic performance-based methodology for seismic risk assessment of CULTural heritage" e ricerca in convenzione con il Segretariato Regionale del MiC per le Marche- Unità di crisi Sisma 2016 "Progettazione esecutiva e direzione lavori dell'intervento di messa in sicurezza della chiesa di S. Maria in Via di Camerino") relazionate al tema del rapporto tra eventi sismici e patrimonio culturale.

Rispetto a tale contesto l'articolo presenta due diverse esperienze di rilievo integrato condotte su due differenti manufatti di valore storico-architettonico nelle quali l'apporto della fotogrammetria aerea ha assunto un ruolo fondamentale di insostituibile strumento senza il quale non si sarebbero potute "catturare" importanti porzioni dei manufatti oggetto degli studi, ovvero ottenere una acquisizione completa e quindi fornire una documentazione grafica (esaustive rappresentazioni 2D geometrico-metriche, viste 3D in modelli texturizzati) adeguata agli studi specifici da condurre.

L'obiettivo è stato definire un flusso di lavoro adatto ad ottenere un denso data-set 3D da cui poter poter estrarre diversi livelli di visualizzazione e dettaglio (modelli high/low poly) utili per descrivere architetture complesse per scopi diversi, ovvero individuare un quadro operativo (strumenti di indagine, fasi, procedure di rilievo ed elaborazione dati) potenzialmente adottabile anche per altri edifici di pregio storico/architettonico o per contesti con condizioni simili di rischio.

La presente dichiarazione è resa ai sensi del DPR n. 445/2000

Roma, 16 luglio 2021

In fede

Alessandra Meschini

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