UAV-BASED SURVEY: THE CASE OF COLONIA VARESE IN MILANO MARITTIMA

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ABSTRACT:

The Maritime Colonies are an important part of Italy's cultural heritage buildings. The research focuses attention on a survey with an Unmanned Aerial Vehicles (UAV), using photogrammetry to determine features such as dimensions, object shape, volumes, areas, distances, elevations, and set up the reconstruction of a digital model of the Varese Colony, located in Milano Marittima, in the province of Ravenna. To digitize this structure, it was necessary to use a camera network capable of creating nadir and oblique images with different baselines. The proposed method has proven convincing in real-world application because of its workability, easy implementation, area coverage, and can be used in a wide range of applications on artifacts of many different morphologies.

1. INTRODUCTION

Along the Romagna coast it is possible to highlight the strong presence of colonies.

The phenomenon of marine colonies dates back to the early 1800s but it was in the Fascist era, around 1930, that these structures, in addition to becoming symbols of avant-garde architecture, lived their moment of greatest prosperity with mass tourism dedicated to children and young people who were welcomed from all over Italy during the summer.

The life of these structures remained active until the 1970s, when, due to the continuous demographic decline of the Italian population, the presence of children in the colonies decreased drastically, so much so that it led to their progressive and inexorable abandonment.

The colonies of the Riviera Romagnola represent the cornerstone of the tourism development of the localities of Romagna because they allowed the "discovery of the sea" to generations of Italians. Along the 70 km of the Adriatic coast there are about 246 colonies, of which almost all today is in a state of decay and abandonment. Starting from the north of the coast, the first colonies are encountered in Milano Marittima, a seaside village in the municipality of Cervia, known for its tourist vocation.

In this area the number of colonies is 66 (figure 2): Colonia Ex Patronato Scolastico di Cesena, Colonia Stella Maris, Colonia Sant'Antonio, Colonia Intercomunale Bresciana, Colonia Simon Bolivar, Colonia Cristina, Colonia Paradies, Colonia Primavera, Colonia Mater Gratiae, Colonia Fiordalisio, Colonia Medusa, Colonia Aurora, Colonia Gioiosa, Colonia Giovanni XXIII, Colonia Auxiulium S. Giuseppe, Colonia Serenella, Colonia Comune di Parma, Colonia Infanzia Serena, Colonia La Fiorita, Colonia Villa Savini, Colonia Baciccia, Colonia Bel Sito, Colonia Adriatica, Colonia Mater Divinae Gratiae, Colonia Speranza, Colonia La Conchiglia, Colonia Città di Legnano, Colonia Domus Paci, Colonia Soggiorno Don Trombelli, Colonia Solatia, Colonia Madonna di S. Lucia, Colonia Mare del Sud, Colonia Santa Maria al Mare, Colonia Regina Mundi, Colonia S. Marino, Colonia Pantera Rosa, Colonia Mare e Pineta, Colonia Del Pineto, Colonia De Gasperi, Colonia Nullo Baldini, Colonia Del Savio, Colonia Italia, Colonia Mazzanti, Colonia Città D'Aosta, Colonia Bimbi al Mare, Colonia Città di Vigevano, Colonia Ex Patronato scolastico di Fidenza, Colonia Comune di Modena, Colonia Basevi Madonna del Pino, Colonia Comune di Mordano, Colonia Valle Camonica A. Taglierini, Colonia Argentesi, Colonia Dante, Colonia Villa Sacro Cuore, Colonia Centro Climatico Marino, Colonia Fior di Loto, Colonia Banca Popolare di Bergamo, Colonia Ostigliese, Colonia Varese, Colonia Balducci, Colonia VI Novembre, Colonia Chiara Daniela, Colonia Comune di Lentate sul Seveso, Colonia Comune di Tirano, Colonia Centro di Vacanza Mopoli di Stato, Colonia Sole e Mare and Colonia Mediterranea.

Among the numerous colonies, the Varese Colony (figure 1, figure 3), the subject of investigation in this research, stands out in importance and size.

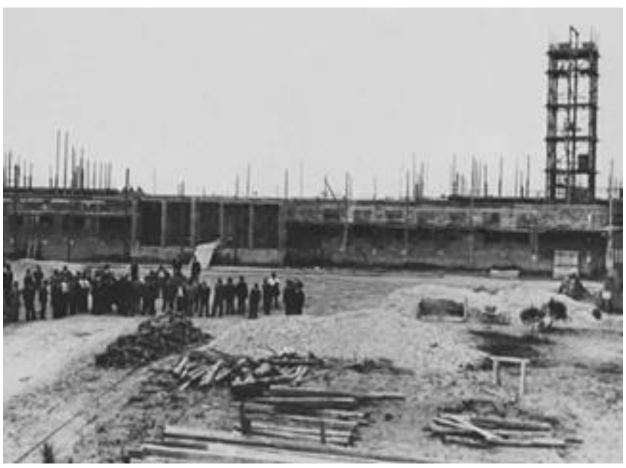

Figure 1. Construction site of the Varese Colony, 1938.

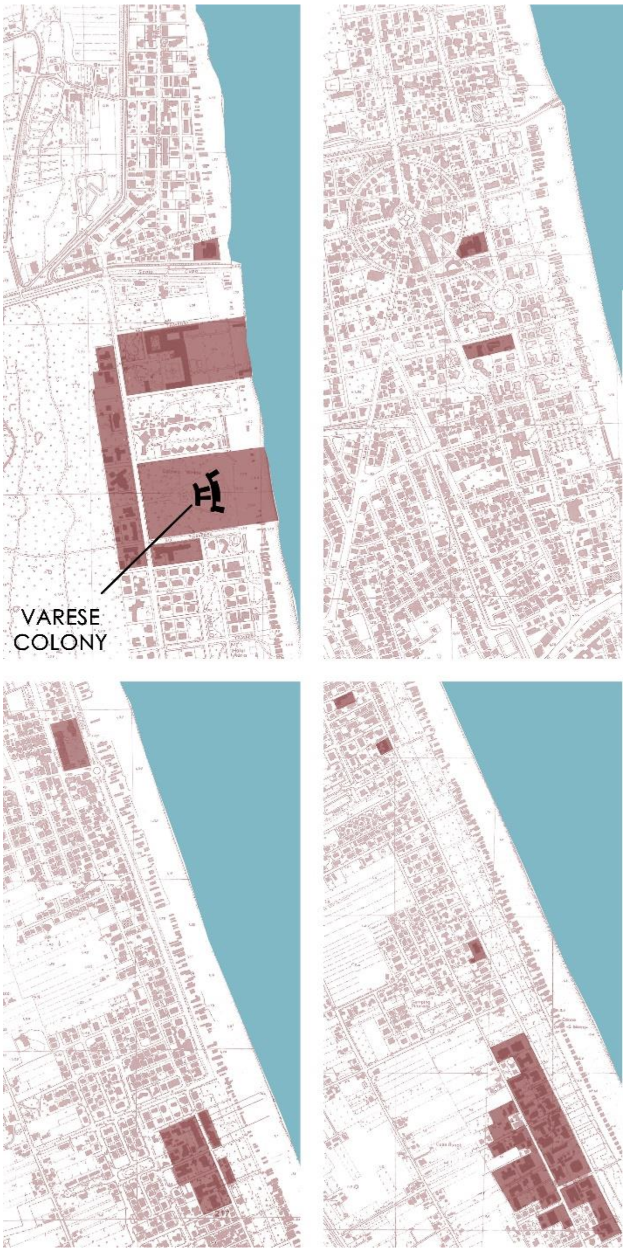

Figure 2. Highlighting of colonies in Cervia area.

Figure 3. Varese Colony in 1940.

2. VARESE COLONY

The Varese Colony (figure 4, figure 5, figure 6, figure 7), currently in a state of decay, was built between 1937 and 1938 on the initiative of the “Federazione dei Fasci” of the Province of Varese.

The purpose of the Federazione dei Fasci was to provide the children with their own seaside colony by the Adriatic Sea. The colony was opened in 1939 with the name "Colonia Costanzo Ciano". The design dates back to 1937 and was by Mario Loreti, while the construction was assigned to the Cooperativa Muratori & Cementisti of Ravenna.

The colony was designed to accommodate about 1,000 male and female children.

Figure 4. Varese Colony in 2022.

Figure 5. Varese Colony in 2022.

Figure 6. Varese Colony in 2022.

Figure 7. Varese Colony in 2022.

From June 1940 for a full year, the colony housed a group of children of Italians living in Tripoli who were forced to repatriate due to the war emergency.
Closed after two years due to the outbreak of World War II, it was used as a prison and war hospital for German troops.
The colony was partially damaged during the conflict and had minor restoration in the immediate postwar period that included reconstruction of central ramps. Since 1950 the Colony has been abandoned but is protected and preserved for its valuable construction features, which marked an era.
This structure, an icon of rational Italian architecture, is characterized by a rigidly symmetrical form.
The building stands on a plot of 60,928 m² for a full volume of 62,176 cubic meters located over five floors.
The central body is a monumental concrete grid supporting ramps, on the sides are two-floors service bodies and, in connection with the central body, two five-floor wings in which dormitories were located (figure 8, figure 9, figure 10, figure 11, figure 12, figure 13).
From the project plans, it is possible to deduce the destinations of the various rooms that made up the complex.
A large park leads to the colony's main entrance, located in the centre of a two-storey volume that formed its front, protected by a shelter.
There is a portico with eight columns of circular section in reinforced concrete, through which one reaches the trapezoidal-shaped inner courtyard bordered laterally by two-storey bodies and, on the seaside, by the complex of ramps.
Inside the entrance body were, to the east, the director's offices, the bursar's office, the parlour, the laundry, the cloakroom, and the services, while to the west were the deputy director's office, the caretaker's flat and some staff rooms.
The first floor was reached by two stairwells mirroring the main axis of symmetry of the project, which led to further staff quarters, infirmaries, and services.
The two lateral bodies of the courtyard were used as follows: the one on the right housed the showers on the ground floor and the staff refectories on the first floor; the one on the left housed the coal storehouse, oven, depot, workshop and services on the ground floor, and the kitchen on the upper floor, connected to the depot below via a freight elevator.
In addition, the ground floor housed two large recreation rooms facing the sea and separated by gender, while the upper floor respectively contained two other rooms of the same size that constituted the refectories.
Ramps provided access to the five floors of dormitories via separated paths for boys and girls.
All the floors of the side volumes facing the sea were symmetrical and equal to each other, comprising two adjoining dormitories with the possibility of accommodating 40 children each and, at the entrance, a bedroom for the assistant and a dressing room for the guard.

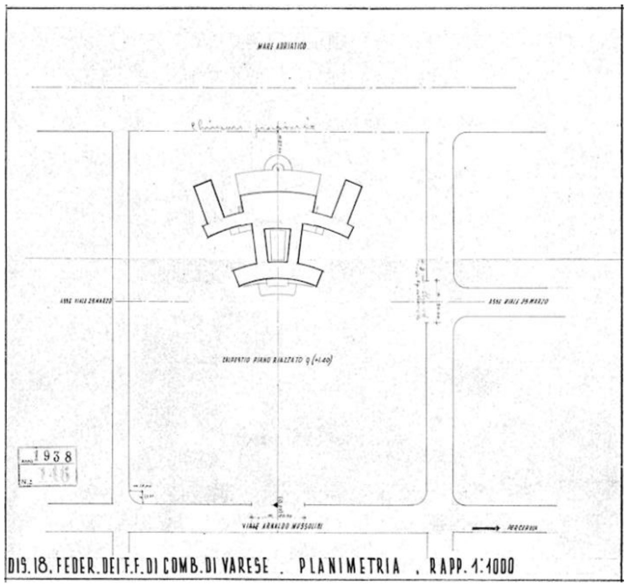

Figure 8. Project drawing. Overall plan.

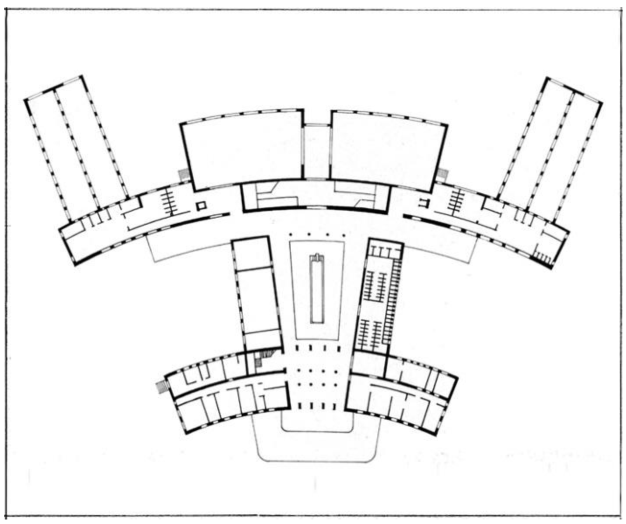

Figure 9. Project drawing. Ground floor plan.

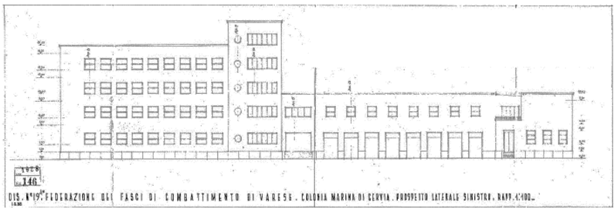

Figure 10. Project drawing.
Left-side elevation.

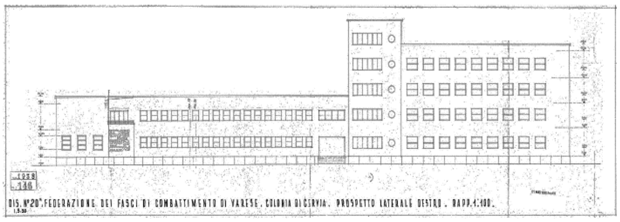

Figure 11. Project drawing.
Right-side elevation.

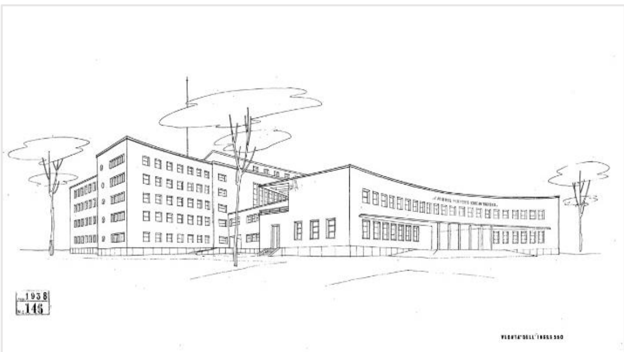

Figure 12. Project drawing.
Overall view. Entrance.

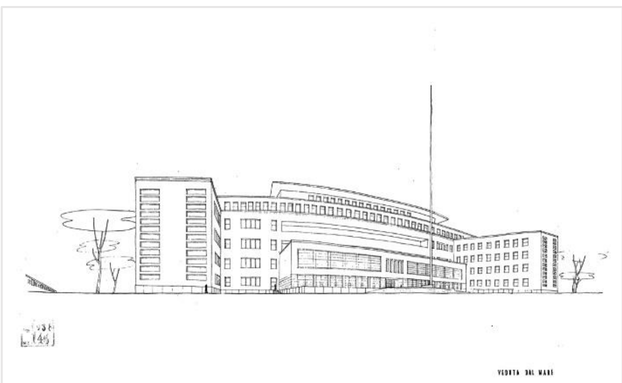

Figure 13. Project drawing.
Overall view. Seafront.

3. SURVEY

When surveying a building, the choice of surveying technique plays a fundamental role, and is closely linked to the level of detail to be achieved.

Whenever a high level of detail is required to characterise buildings, it is possible to choose between different techniques, such as direct surveying with a total station, the combined use of terrestrial photogrammetry and total station and Terrestrial Laser Scanning (TLS), or, for works with difficult access, such as the case of study, set within a dense pine forest, the use of photogrammetry with drone image acquisition.

However, not all techniques may represent an optimal solution and the best choice must be evaluated on a case-by-case basis. The total station, for example, is very time-consuming: every point must be surveyed with the instrument, and it is almost impossible to survey everything. When façades have a higher level of complexity (e.g. decorations, ornaments, projections) the combination of terrestrial images and total station measurements can provide additional information. This could have been a good solution but it was preferred to opt for a survey characterized by a shorter acquisition time.

Due to the unsafe condition of the building and the surrounding area, it was decided to proceed with a photogrammetric survey using UAVs.

The UAVs and drones systems are now considered suitable for an incredible number of potential application fields such as aeronautics system such as geomatics, geology, astronomy, mining, cultural heritage, archaeology and, such as in the case in example, the geometric survey.

The integration of low-cost drone’s survey and structure from motion algorithms (SfM) simplify the documentation of architectural heritage and buildings by providing greater flexibility and more extensive coverage.

Low-cost UAVs, such as the one used in this case, make low-altitude image acquisition accessible and manageable for users with limited budget. The combined use of drones and SfM enables 3D modeling of large-scale and complex architectural heritage sites using low-cost, highly flexible collections of acquired imagery.

Three factors most influence accuracy: the camera’s calibration, the camera's network, and ground control points with known geographic locations.

Cameras used on UAVs/drones can be calibrated using images collected either during a flight mission or on the ground with the camera where possible.

Calibration from aerial photographs near the horizontal (near-nadir) is not always convenient, as it typically requires the use of ground control points and GPS positions of the camera station. It may also be impractical to attempt to calibrate a camera mounted on a portable drone, where the drone's operability does not allow the drone's camera to be positioned/aimed to form the desired network geometry of converging camera angles, mixed scale imagery, and camera rotation diversity.

In the case of study, the camera has been set with the following parameters: photo - single shot, image size - 4: 3, image format - RAW + JPG, white balance - auto, color - D-Cinelike.

High-performance network cameras also play an important role in supplementing any type of drone survey solution. A prerequisite are cameras capable of operating under extreme conditions of light, distance, and environment.

Basically, the camera system technology must be able to provide a platform where drone detection technology can be integrated to provide irrevocable evidence of a drone.

In fact, visual confirmation is something that should be considered a priority in the design of any drone detection solution in the future.

In addition, it is important to have ground control points (or GCPs) with known geographical location. Although placing ground control points can be time-consuming, it takes less time than redoing a design to improve accuracy. At least five ground

control points are recommended. Eight of them were placed in this survey.
The UAV used was a DJI Mavic PRO drone equipped with a camera with the features shown in the figure (figure 14).
The main feature of this drone is that it is a foldable drone and small in size, such features make it an easily transportable drone.
The rotating wing equipment allows for take-offs and landings in confined spaces and a single-operator photo capture campaign. The battery allows a maximum flight time of 30 minutes.

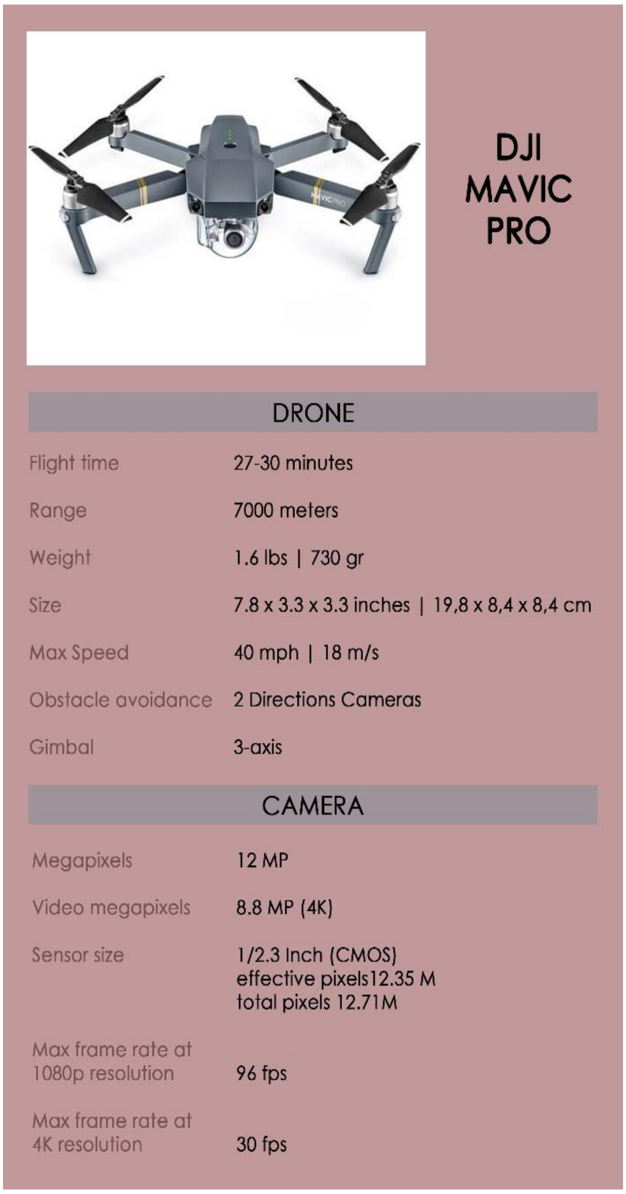

Figure 14. DJI Mavic Pro - specifications.

Since it is a vertically oriented object, it was necessary to supplement the nadiral photographs with images acquired with cameras tilted at angles from different inclinations and with cameras placed parallel to the facades.
A high number of photographs had to be taken due to the numerous occlusions and presence of a high number of pine trees around the building, specifically 325 photographs were acquired: 55 nadiral photographs, 117 tilted photographs and 153 parallel to facades photographs (figure 15).

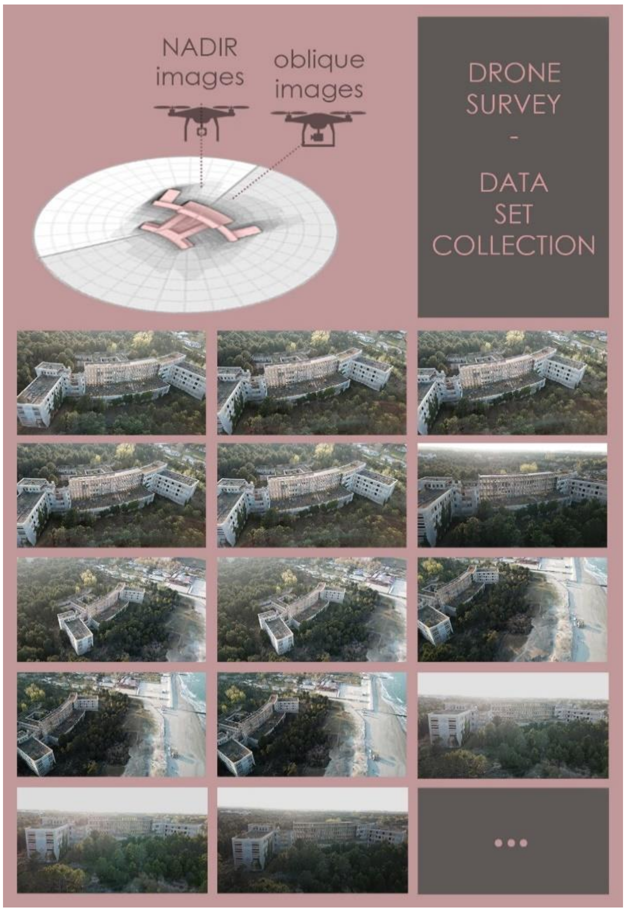

Figure 15. Drone survey - data set collection.

4. DATA PROCESSING

The images acquired by drone were processed through the new release of the Photoscan software: Agisoft Metashape.
The alignment of the aerial photographic set within the Agisoft Methashape software was carried out by working on separate chunks with common targets. Thanks to this software, it was possible to obtain polygonal models and a model composed of Tie Points. First, the sparse cloud was generated, then the dense cloud.
Next, referencing and scaling of the model were done using measurements or known points taken in the field, with meshing and projection of the oriented HD image onto the obtained mesh model (figure 16).
The number of images that have been processed in Metashape for the creation of the Model of the Varese Colony is 325 aerial photographs.
The point cloud obtained was used as the basis for the construction of a three-dimensional model. The modeling phase is still in the process of execution (figure 17, figure 18).

5. CONCLUSION

With the point clouds obtained by processing the images acquired by these instruments, it is possible to get geometric and colorimetric information, thus being able to have a model that defines the state of the structure to be used as a basis for design or maintenance of the work.

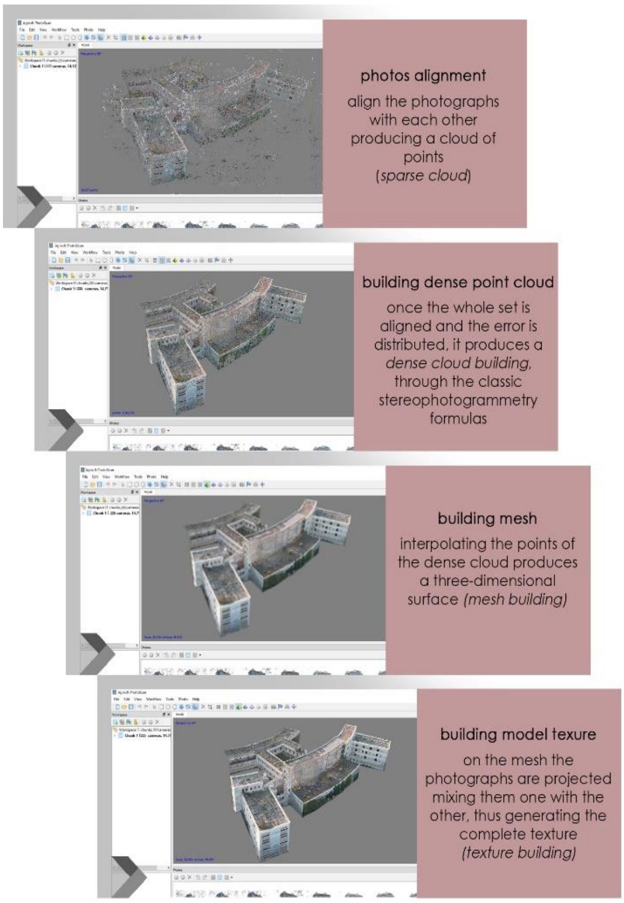

Figure 16. Modelling process.

This experience shows that drone acquisition and 3D image modeling is an effective way to achieve fast and accurate results. In this way, it is possible to create models that can be constantly updated, models that can become an informative basis of information about the structure and useful for future interventions.
This study is the starting point for creating a useful modality as a basis for developing a project to give new life to this abandoned building. A methodology that can be applied to the many other abandoned colonies present on the Romagna Riviera.

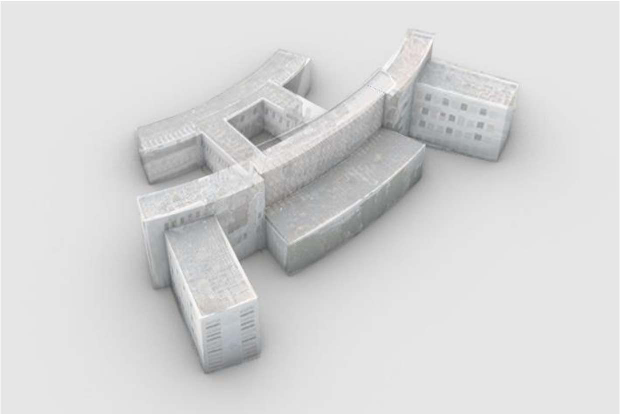

Figure 17. 3D model.

The use of photographs obtained from drone surveys makes it possible to document situations located in contexts that are difficult to explore, even at considerable distances and with a level of detail that would escape classic aerial or helicopter shots. The versatility and speed with which large amounts of visual information can be retrieved make high-altitude footage an ideal graphic reference for communicating with immediacy the configuration and location of architectural elements, decorations, states of decay, temporal stratifications, and superfetations, even for intervention projects.
In conclusion, this research evaluates the accuracy of the UAV-SfM method for surveying the Varese Colony, illustrates the steps performed to obtain the three-dimensional model, and presents how the results can be processed in subsequent analyses and used for artifact management.

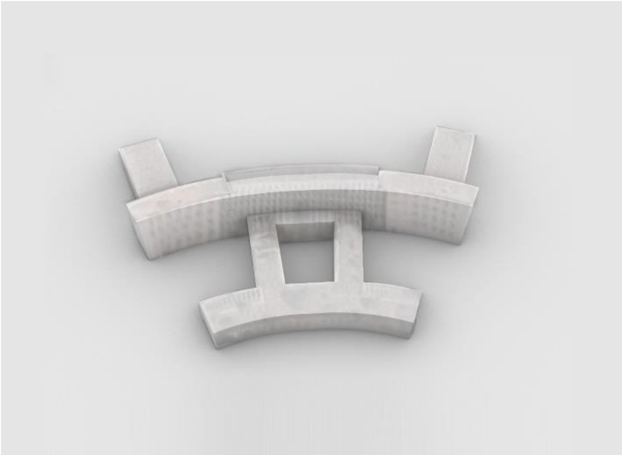

Figure 18. 3D model.

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