

## Urban digitalisation

### The survey of Bertinoro

Andrea PASQUALI, Dipartimento di Architettura – Università degli Studi di Firenze, Italy

Stéphane GIRAUDEAU, Dipartimento di Architettura – Università degli Studi di Firenze, Italy

Francesco CAPPARELLI, Dipartimento di Architettura – Università degli Studi di Firenze, Italy

**Keywords:** *Photogrammetry—Drone—Digitalisation—Historic Fortress—Aviation regulation*

**CHNT Reference:** Pasquali, A., Giraudeau, S., and Capparelli, F. (2022). 'Urban digitalisation. The survey of Bertinoro', in Börner, W., Rohland, H., Kral-Börner, C. and Karner, L. (eds.) *Proceedings of the 25<sup>th</sup> International Conference on Cultural Heritage and New Technologies, held online, November 2020*. Heidelberg: Propylaeum.

doi:[10.11588/propylaeum.1045.c14516](https://doi.org/10.11588/propylaeum.1045.c14516)

The paper proposes the steps of study and elaboration carried out on the historical village of Bertinoro. Bertinoro is a town in the province of Forlì, on the Italian Adriatic coast. The work carried out on this historical town consists of three phases.

A first phase was that of the survey, executed in situ with digital technologies. In this phase laser-scanner survey and photographic survey aimed to perform digital photogrammetry. The most interesting component of this first phase was the photographic survey. The survey aimed at photogrammetry was organized both on a terrestrial campaign and an aerial one structured on various flights performed by drone. For the ground shots a full frame Nikon D610 camera with Nikkor 24–120 mm f3.5–5.6 lens was used, while for the flights the drone used was a Parrot Anafi. The drone weight was reduced to 300 gr. in order to perform non-critical operations in an urban context, as required by current legislation. This organization is due to the morphological characteristics of the urban system. Bertinoro is a small village, perched on Mount Maggio at an altitude of 328 meters and about 20 kilometers from the Adriatic Sea. Its position and urban structure allow to connect the village to a military past. The organization of the defensive structures and the position on the hill allow to identify the village as a sighting component towards the coast. The urban morphology is structured with a very compact historical architectural system because it is organized within the defensive walls. The road system and the urban voids are very limited and with rather small dimensions. For this reason, it was necessary to resort to the abovementioned organizational strategy for the photographic survey. Several portions of the urban fronts were poorly acquired with aerial photographs, the risk of obtaining an unclear survey or with a strong error was considered high. Therefore, a terrestrial photographic survey campaign was implemented in order to complete the data with closer and more controlled shots.

The second phase concerns the collection of documentary information. Carried out with archival research and interviews on the population, it has allowed to deepen details and events related to the history of Bertinoro. The survey phase and this last one make up the cognitive component of study

subject. These two phases have made it possible to outline a complete documental picture, collecting different types of documentation in digital format and generating a potential archival component for future studies.

The last phase was the processing of the collected material. The main focus of this contribution is on the processing phase of the digital survey data. The primary operations of control and indexing of the data acquired by laser-scanner are part of usual operational practices. These operations have given the result of the global point cloud of the historicized urban system. The data collected is organized on 515 scans done with a scanner FARO Focus 3D X330. We opted for variable instrument setting choices, depending on the characteristics of the environment to be detected. In general, we have chosen to give priority to the completeness of the data, with a more number of scans, rather than their accuracy. This has allowed us to have faster scansions in larger numbers. obtaining monochromatic point clouds. the most interesting part of this phase is the processing of the photographic images. This step involved software operations for digital photogrammetry with the main target to obtain a 3D model with texture. The digital images processed were 5426, divided into 3302 obtained from flights and 2124 from ground shots. This component of the work was the most relevant, both in terms of work and observations found in the process. The processing required a significant amount of time and the results obtained formed a vast group of results. The accuracy of the results and the timing made us choose to structure the calculations functional to the results to be obtained. By composing a set containing both a total model of the whole urban nucleus and secondary models of smaller portions. The latter are smaller in size and therefore more accurate and denser in detail.

All the products of the research and work have formed a set of new digital information accessible by scholars, the municipality and local associations. At the head of this research work there were two main purposes: the first, more relevant for scholars and intellectuals, is the creation of materials

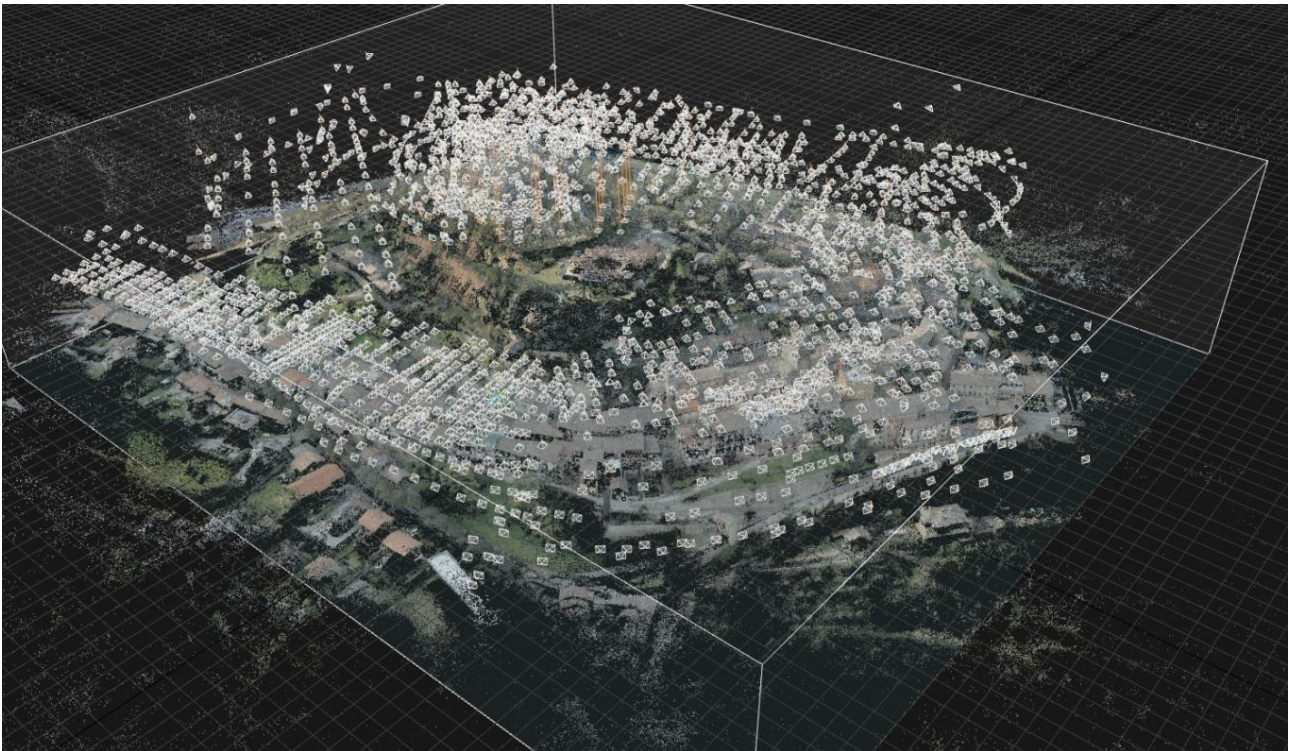


Fig. 1. Screenshot 3D Bertinoro (© Giraudeau, Pasquali, Capparelli).

useful to the knowledge of the relevant historical elements, the Fortress and the Wall System; the second, of public interest and useful to the consolidation of a security system of citizenship, was to provide the documentary basis for the drafting of the CLE document. The Italian national document for the analysis of the Limit Conditions for the Emergency, useful for the evaluation in the drafting of operational intervention plans and the improvement of actions in case of seismic events.

## References

- Guidi, G., Russo, M., and Beraldin, J. A. (2010). *Acquisizione 3D e modellazione poligonale*. Ed. Milano: McGraw-Hill.
- Piva, A. (2010). *Architettura e cultura del progetto*. Editor Gagliani, ed. Roma: Gangemi.
- ENAC. (2019). *Regolamento mezzi aerei a pilotaggio remoto*. Ed. Rep. Italiana 3.–11. novembre 2019.