

From a survey the current state to a hypothesis of the former state. A digital trip in augmented reality into the ‘deleted history’ of the Capo d’Uomo Tower on Mount Argentario

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Abstract

The Capo d’Uomo Tower in Monte Argentario is one of the case studies that are the subject of an ongoing university research project aimed at investigating and elucidating the Cultural Heritage of the State of Presidî. Information and Communication Technologies, including latest digital reality management techniques, are of particular interest for such research. In fact, one of the aims of the study is to broaden the knowledge of the population and the visitors, who will have to be drawn to attention, involved, and oriented along a flow of scientific information which is conventionally regarded as possible to dedicate only to specialists. Numerous fortified structures for sighting, communication, and defence remain from the State of the Presidî, a former Spanish military enclave on the Tuscan coast. At present, the status of the Capo d’Uomo Tower, erected between the 15th and 16th centuries under rule of the Republic of Siena and renovated during the Spanish regency, appears critical. Despite its long period of existence, no graphic documentation about it can be found today. Between the 18th and 19th centuries, with annexation of the Presidî to the Kingdom of Etruria, the French drafted several surveys of many of the remaining fortalices, some of which were similar to the tower. The working group has recently documented and published the actual condition of the tower, processing TLS and photogrammetric acquisitions in an integrated digital survey. This paper pursues an extension of the above-mentioned research – also for popularization – and digital integration of the status of the tower with reconstructions of its missing elements, which will be the result of careful studies on the previous surveys of typologically similar coeval buildings.

Keywords: Augmented reality, Capo d’Uomo Tower, digital reconstruction, integrated survey, architectural heritage communication

1. Historical background

The Capo d’Uomo Tower is a structure in the medieval defensive system on the promontory of Mount Argentario in Tuscany. The structure dates to the dominance of Siena, pertains to the ‘light signal’ type of tower (Cassi Ramelli, 1964), and is situated on the western coast of the promontory atop the Argentario cliff about 350 metres above sea level (Fig. 1). With the fall of the City of Siena in 1555 following a siege by the army of Philip II of Spain, all territories in the Republic of Siena fell under the government of Cosimo I de’

Medici, then Duke of Florence, and his ally, except for a band along the coast between the Island of Elba and Capalbio. This remained under the direct control of the Spanish crown and was called the State of the Presidî. Following an upsurge in piracy and the spread of new weapons (Faglia, 1974), the Capo d’Uomo tower was probably restored, together with many other defensive structures in the territory, by the Viceroy of Naples, Pedro Afán de Ribera, during the decade of his mandate (1559–1571). With the



Fig. 1- Image of the Capo d'Uomo Tower from the north-west.

passing years, the tower lost its strategic importance as a military bastion and began a slow decline that led to its abandonment and then ruin.

2. From a survey of the current state to a hypothesis of the former state

The Capo d'Uomo Tower is one of the case studies in ongoing university research aimed at understanding and disseminating the cultural heritage of the State of the Presidi. After an initial stage of bibliographic/archival consultation, a survey campaign was designed and carried out to document the current consistency of the structure and reconstruct its evolutionary history. The survey made use of a combination of active-sensor instruments such as a total station (TS) and terrestrial laser scanner (TLS) and passive-sensor instruments, i.e. via digital photography from the ground and aerial films taken from an unmanned

aircraft system (UAS). The results of the data processing included a detailed digital model (Fig. 2) that, together with the archival documentation, represented the basis of the study in order to formulate the most plausible reconstruction hypotheses to reveal and communicate/disseminate the original Vitruvian properties of *utilitas*, *firmitas*, and *venustas*.

3. Method of architectural reconstruction

The Capo d'Uomo Tower is a medieval building about 8 m x 8 m at the base, small even compared to other towers on the Argentario promontory. Today, only the truncated pyramid-shaped base and part of the south-east façade of this rubble masonry building remain, both of which are very damaged. Documentary sources, full of gaps and discontinuities, prevent the original layout of the building from being defined. The archival documents include a report from the sixteenth century by the architect Gabrio Serbelloni, dated 18 December 1572, which defines the tower as 'meagre' due to its small size and construction with materials of little value. He also notes the purpose which, in his opinion, the structure could serve in the future, writing: '[the tower is] so high on the top of the mountain that it could serve for something other than a lookout' (1). For the Capo d'Uomo Tower, the historical background of the Renaissance and particularly the reorganization of the defensive system on the Italian coasts - second half of the 1500s - outlined a future continuous with its original function since its particular location placed it outside the range of

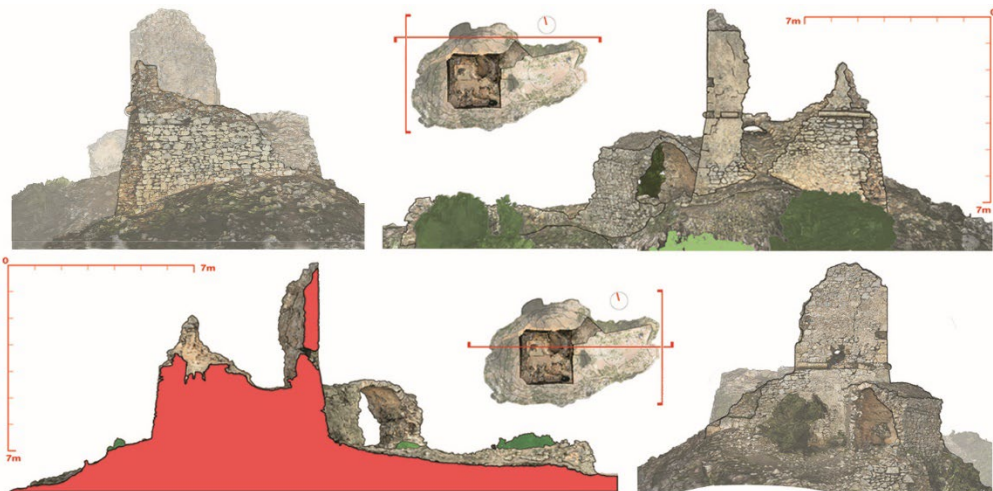


Fig. 2- Orthoimages of three elevations and longitudinal section processed from the mesh model.

the new weapons. As mentioned, the reconstruction of the Capo d'Uomo Tower was made using results of the tower survey campaign and considering archival materials pertaining to buildings in the sighting system and defence of the promontory. With regard to documentary sources, the survey drawings of sighting systems coeval with the tower made between the late 1700s and early 1800s by French military engineers after the State of the Presidi was annexed by the Kingdom of Etruria represented, even in the absence of specific drawings of the building, valid help in formulating the reconstruction hypothesis (2). The synergistic interpretation of the results of the digital model and related two-dimensional graphical renderings using archival graphics enabled the analysis and consequent identification of a careful, plausible reconstruction hypothesis for the missing parts of the building. The reconstruction hypothesis is therefore based on the rationale underlying the drawing. Having defined the objectives, the analysis was used to investigate the technological aspects, geometry, proportions (Fig. 3), metrology, type, and distribution with recourse to measured interpretational freedom for the reconstruction steps lacking useful indications. The awareness remains that possible validation of these hypotheses cannot overlook the results of the studies supported by archaeological excavations. Nevertheless, both the medieval matrix of the architectural system, which can still be recognized in the remains of the tower due to that sort of 'theorem of sign permanence' and the construction materials with which it was built,

bring to mind an essential construction technology used by professional figures with construction capacities in this particular area. The study resulted in the image of a building that is interesting with respect to the art of war, albeit simple in the architectural/functional composition and construction technology. The building likely consisted of three storeys topped by the sighting terrace, the 'miradero'. Proceeding upwards from the base, the survey results and direct observation of the remaining masonry partitions highlight the existence of at least three vaulted environments featuring rounded diretrices. The two environments situated perpendicular to each other were probably connected and realistically destined to house weapons and cured food (Licino, 1994), while the third environment was used to store water (Fig. 4a). The environment used for storage, situated on two contiguous sides of the cistern, was probably accessed from the first floor of the tower through a hatch situated in the floor via a wooden ladder, like all the interior vertical connections depicted in the archival drawings. The simple construction of the tower suggests that the room to access this storage area was located in the zone common to the two arms of the warehouse environment and that the ceiling in this area consisted of a small wooden slab to further simplify the construction. The interior of the tower was accessed on the first level and reached via a light wooden ladder that could be drawn within as needed (Luisi, 1979). The outside door on the south-east façade was situated to the left of the elevation axis of symmetry

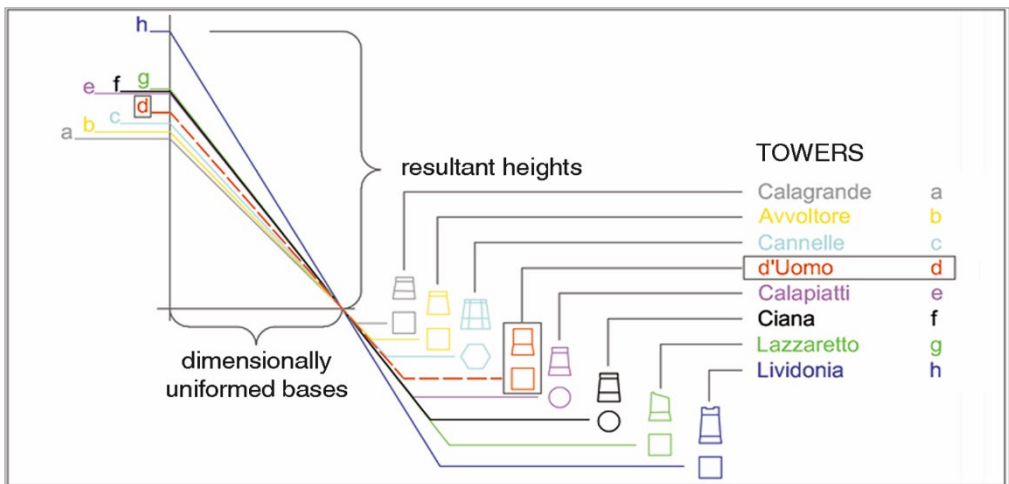


Fig. 3- Proportional comparative diagram of some of the coastal towers on Mount Argentario.

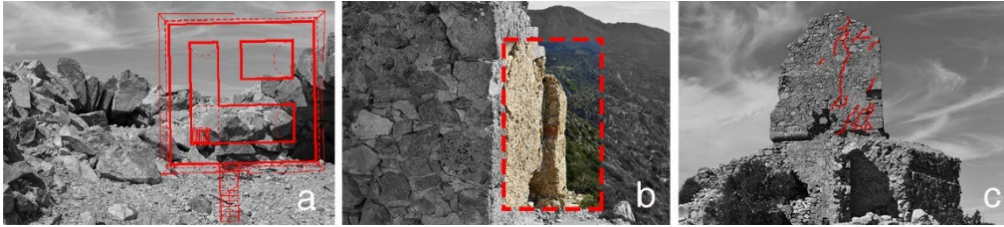


Fig. 4a- Image of the arches of the vaults in the basement. Fig. 4b- Image of the remains of the entrance to the tower. Fig. 4c- Image of the main elevation of the Capo d'Uomo Tower.

(Fig.4b). Upon entering this storey, there was a fireplace to the right of the door, as is evident from the structure of the masonry and small areas blackened due to fire. To the left, continuing with the connection to the lower level, was the access to the second storey. On the opposite wall beyond the well, which can still be seen today, it is reasonable to hypothesize that there was a small window at the centre, a pattern that in all probability was also repeated in the other two walls. This arrangement would have allowed the men at arms to observe the surrounds while remaining protected, a solution that we have brought from other similar structures on the Tuscan promontory. The same models of reference also lead to the idea of the wooden floor for the second storey, consisting of primary and secondary framework as well as the plank flooring. The environment at this height, probably used for soldiers to rest, had two openings to the outside, one situated at the centre of the north-west wall and the other to the north-east in line with the entrance. From this level, the sighting terrace could be reached through a niche carved into the masonry via the usual wooden ladder. Following the construction methods of other towers, the ceiling of this environment likely consisted of a barrel vault with segmental arches presumably resting on the north-west and south-east walls. Supporting this hypothesis is the clear crack structure present in the remaining masonry, compatible with the outward thrust generated by the dynamic movement of the structural collapse (Fig. 4c). On the rooftop terrace, only a structure protecting the stairway was likely present, with the upper end of the chimney next to it, while there was a simple parapet that was not very high, based on the surrounding towers. Finally, we comment briefly on the external structures situated at the foot of the tower, which round out the architectural layout. From aerial snapshots of the tower (Fig. 5), we can discern not only the residual above-ground masonry on which a

partially destroyed vault is connected to the tower, but also the trace of a wall situated parallel to the first at the edge of the cliff. Observation of the model from above also reveals the horizontal layout of this alignment, which is substantially symmetric with the remaining masonry. Compared to the surveys of other constructions, the geometry would seem to show the same axis of symmetry, as with the possible entrance to the protected area of the tower in the original configuration dating to the sixteenth century (Della Monaca et al., 2000). As mentioned above, a partially destroyed vault abuts the tower but is not technically attached to it, breaking the continuity of the wall facing the north-east. The construction method and archival documentation showing adaptations and additions made in many of the strongholds during the period of Spanish dominion may indicate that this element was added to the original structure. In particular, the vaulted structure could have been used as a new entrance to the fortified area (Fig. 6). In fact, its small size, construction methods, the particular doorway cut in the wall of the original perimeter,

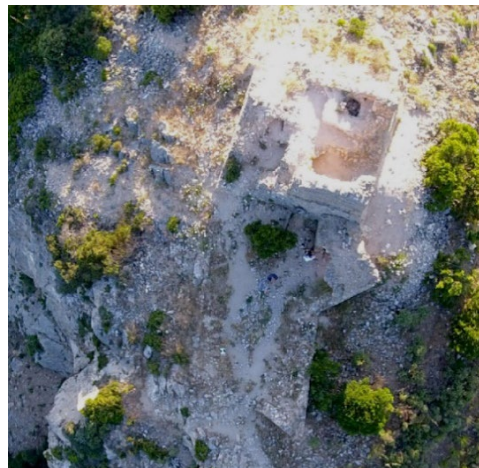


Fig. 5- Zenith image of the Capo d'Uomo Tower taken from a UAS.

and the approach to the building, as shown in the panel of the fortress of Cala Piatti made in the early 1800s by French military engineers, seem to confirm this hypothesis.

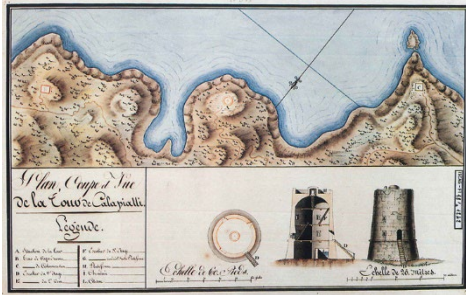


Fig. 6- Survey drawing of the Cala Piatti Tower made by French military engineers. Above left, the Capo d’Uomo Tower and related entrance route (ISCAG: FT18/A1242).

4. Analogue and digital communication

The information that emerged during the survey and the reconstruction hypothesis came together in communication products designed to convey the characteristics of the case in question in the best way possible considering the targets of communication. As a result, the products were designed to reach as wide a public as possible to spread knowledge about this heritage, which is so characteristic of the history and appearance of the Argentario promontory. The targets were therefore not only scholars, but also the wider public — tourists and the local population — because they are often, particularly the younger generations, unaware of these discoveries, which also represent particular value for the cultural heritage of these places. All of this makes necessitates communication designed for different types of users. In designing the communication project, we needed to decide whether to use new technologies — innovative and very attractive to users — or traditional analogue tools (Cicalò, Valentino, 2023). The former undeniably represent great innovation in the field of cultural communication; in fact, projects based on them are able to create very involving experiences. On the other hand, while traditional analogue tools may be considered ‘old’, their reliability in terms of transmitting the message should not be overlooked. It often happens that the simplest tools most familiar to the public are more effective due to a more direct approach not mediated by technological learning,

which, with some new systems, may come between the content and target of communication, i.e. the public. There is also another aspect related to the temporal duration of the two methods: when speaking of technological products, it is important to consider obsolescence of the systems, while the products of analogue communication clearly last longer. For these reasons, both approaches are equally valid and should be pursued for effective communication. It is also important to underline how these two methods are not viewed as opposing each other, but as complementary, by which one contributes to and provides for the other to achieve the greatest spread and understanding of the information.

5. The digital model for knowledge and communication

The communication products rely mainly on three-dimensional models that depict the tower in its current state and according to the reconstruction hypotheses. The model was therefore made with reference to the considerations developed on the basis of the investigations and comparison with similar cases (Fig. 7). Two versions of the reconstruction model were made to represent the main historical phases, differentiated according to the presence of the entrance vault situated to the north. It is necessary to specify the two historical periods because the entrance vault in the current state is a very characteristic element, as well as being one of the few components that a non-expert observer can easily recognize and trace to the original form, architecture could read the vault as an whole a person with knowledge of excrecence (Fig. 8). However, it should be observed that construction of the tower model only holds partial value if it is limited to the conformation of the building and not also traced to its original function as a sighting tower. For this reason, the full value of the tower must be rendered through its insertion in the landscape where it was built, thereby also providing a possible perception of what the skyline might have been like in the seventeenth century. To convey this aspect, appropriate ‘views’ were constructed that play an important role in transmitting the idea. To solidify this aspect, it was deemed useful to create overall views from a bird’s-eye view, from the sea, and approaching the tower on land over paths that can still be walked (Fig. 9).

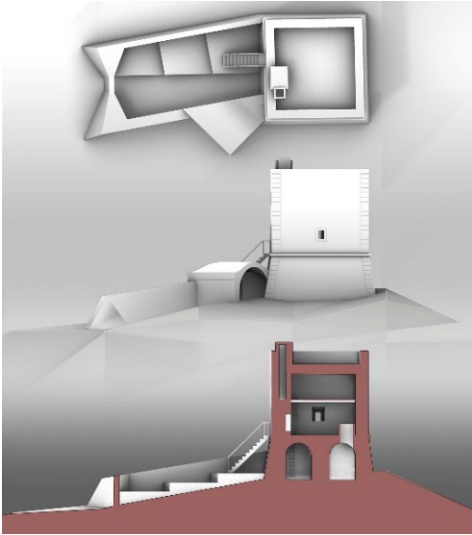


Fig. 7- Views of the three-dimensional model developed according to the reconstruction hypothesis.

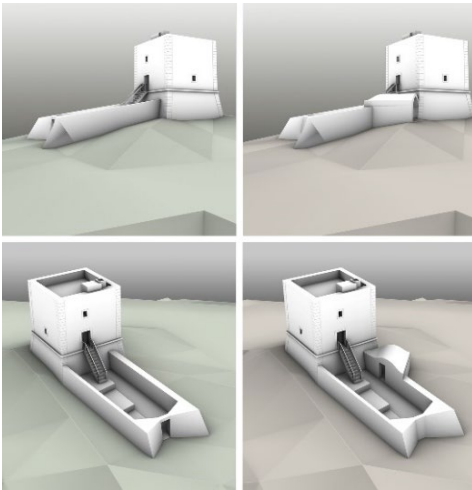


Fig. 8- Historical periods specified for the communication.



Fig. 9- Views of the original tower inserted in the landscape.

6. The Capo d'Uomo Tower, heritage to enhance

To pursue the objectives of communication as set out above and with the variety of information available, the information must be organized and systematized to guarantee the effectiveness of the communication. Amid the current digital context, an important transformation has emerged in the way in which cultural assets are experienced. On the one hand, a new approach is being seen in which cultural assets are experienced remotely through the opportunities provided by web-based technologies. On the other hand, there is a possibility for physical immersion in cultural sites, even through the use of analogue and digital applications that help users to understand the building. It is therefore necessary to include these two methods of experiencing cultural assets - remotely and on site - in the communication process, examining the dynamics and implications of the two paradigms. While the web platform allows for unprecedented access to the overall cultural heritage, the live experience of cultural sites in their original setting establishes a deep personal connection with the past. Direct perception of the work of art and monuments offers the possibility to understand their greatness, complexity, and originality in a unique way, including in relation to the landscape. Remote and in-person enjoyment of cultural assets is therefore a delicate challenge in balancing accessibility and authenticity; both approaches offer different advantages and should be considered complementary. The crucial objective lies in harmoniously integrating them to preserve and enhance the cultural heritage. While the above is applicable to the general context, the same principles were adopted in the specific case of the Capo d'Uomo Tower, dividing the products by means of enjoyment: either remotely or on

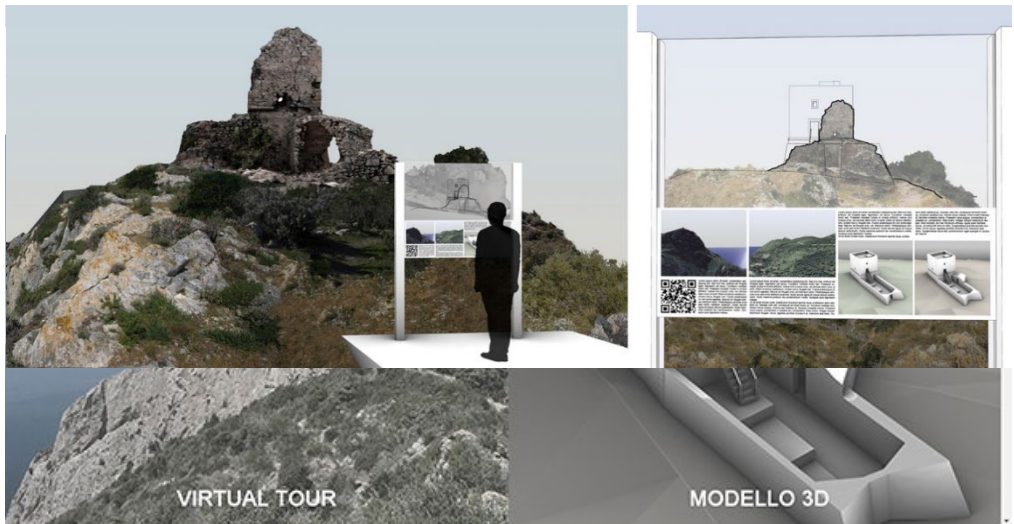


Fig. 10- Web interface with panoramic tours and circumnavigable models.

site. The design of the web platform dedicated to the Capo d'Uomo Tower presents a popular approach to remote exploration of this cultural and natural site of historical importance. With the use of advanced virtual-reality technologies, it presents a series of highly interactive panoramic tours and circumnavigable three-dimensional models, in addition to the complete system of traditional information. The panoramic tours allow users to explore the site virtually, offering 360° panoramic views of key points of interest. These immersive visualizations allow architectural, landscape, and historical particulars to be observed in detail, almost as if one were physically present at the site. In parallel, the circumnavigable three-dimensional models allow users to explore the Capo d'Uomo Tower from different perspectives. Here, the user can interact independently with the digital model, freely exploring it and observing it from different points of view. These two interactive systems were integrated with information, data, and documents that recount the history of the tower and surrounds (Fig. 10). The visual on-site experience that each observer can undertake independently is expanded with innovative solutions. The development of a 'digital augmented reality' application offers visitors the opportunity to explore the site with virtual elements overlaid on a view of the real world, thus enriching the understanding of the architectural construction. In addition, information panels allow visitors to examine the ruins from unique perspectives,

offering an analogous view enriched with the current cultural heritage (Carlevaris, 2014). Given the structure of the tower, a markerless augmented reality application was designed to project a digital model (translucent, evanescent) starting from the ruins. In this way, the hypothetical reconstruction of the tower can be enjoyed from multiple points of view through the use of a smartphone or tablet. With the transparency of the digital model, users can enjoy the reconstruction hypothesis without ever losing sight of the comparison with the current remains of the tower. This is particularly important because it offers a full visual context, allowing users to fully appreciate the historical and archaeological dimensions of the building (Fig. 11). With a view to using analogue and digital methods together, another possible and interesting application derives from the development of 'analogue augmented reality'.

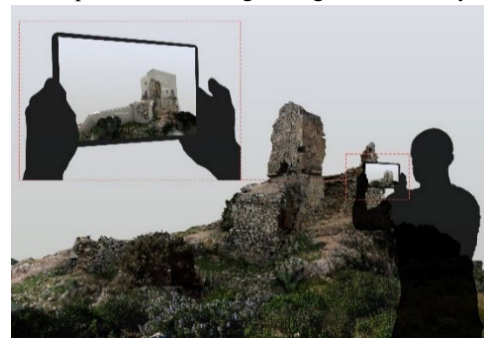


Fig. 11- Digital augmented reality application.

The application is situated on panels posted near the tower and along the path to it, constituting a physical arrangement suitable for communicating the reconstruction hypothesis of the tower without the need for IT devices. The informational panel has a transparent plexiglass window engraved with a drawing that shows the reconstruction hypothesis of the tower. Overlapping the physical remains of the tower, the drawing presents a perspective in analogue augmented reality. Visitors can therefore observe the original ruins while they view the drawing of the reconstruction hypothesis overlaid on the current state (Fig. 12). Overlapping actual remains with the reconstruction in either digital or analogue mode allows observers to trace a direct parallel between the past and present, facilitating greater detailed understanding about the transformations and evolution of the tower over time.

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7. Conclusions

Today, the sighting towers testify to the history and culture of Italy while characterizing the seaboard. Their protection assumes in-depth knowledge, enhancement, and broader use of their architectural and material specifics, as well as the territory where they were built. The communication system proposed, which consists of a web platform and digital and analogue augmented reality, must be understood not only as cognitive means relating to the Capo d'Uomo tower, but also as a prototype to use for the other towers in the State of the Presidî to convey the full complexity of the defensive/sighting system on Mount Argentario.

Notes

- (1) Archivio Generale di Simancas (AGS), excerpt, leg. 1065, f. 39.
- (2) Istituto Storico e di Cultura dell'Arma del Genio di Roma (ISCAG), cart. Torri Argentario.