

Virtual tour through the towers of the defensive system in the province of Salerno

The coastal towers of the defensive system in the province of Salerno are architectures developed over time; they are buildings belonging to an extended strategic plan of the coastal territory useful to defend populations and cities from the ancient enemy attacks. Hence, their location comes from careful studies in which the orographic characteristics of the place and the visual connection between a tower and another played a fundamental role.

The aim of this work is to focus the attention on the visual communication between the towers, or on the “dialogue” that the different artefacts entertain each other. In order to pursue this objective, a virtual tour that connects the different ancient buildings was generated. Operating in this way, in fact, it will be possible to relate the different sites where the ancient buildings are located, through hotspots or directly on the map, and to move in different points of observation.

The attention, therefore, will be focused not only on the single tower but also on the visual connections that existed between the different structures in order to understand the communication strategy that was at the base of the defensive system project. In addition, it is possible to include additional information panels to query, according to user needs, for the virtual visit. The sharing on internet of the virtual tour allows to transmit information and to live experiences in any time and in any part of the world, as well as, to increase the interest to the fascinating places of our territory often unknown.



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INTRODUCTION

The territories are rich of historical evidences and lesser-known architectures that, despite their great value, often pour into a state of abandonment and, in some case; they are not even notorious to the majority of the community. The technological diffusion and the great improvement of digitalization, could positively contribute to broadening the tools of knowledge and to favour greater disclosure.

To identify alternative methods to the simple on-site visit could increase interest in little-known architectures as well as to increase the accessibility of structures difficult to reach. In particular, the case study will focus on the defensive system

of the coastal towers of the province of Salerno, a territory rich in history and a crossroad of people and civilization; a good example on which to experiment with new digital method the representation and protection of Cultural Heritage (fig. 1). To study and to understand the evolution of the events that followed on the coastal territory of Salerno is of considerable interest to comprehend the historical evolution of the province. The coastal towers of the defensive system that characterizes this territory, in fact, are buildings that preserve important historical evidences. Focusing the attention, however, on the single buildings would be limiting in order to comprehend the grandiose and complex defensive system that arose to secure the populations and the coastal territory. In

this regard, the attention of this study more than analysing the single towers, aims to restore what was the ancient visual link that existed in the past between one architecture and another. Hence, based on a previous study focused on the analysis and comparison of ancient maps with the actual landscape (Talentì & Morena, 2016), we want to focus the attention on the visual communication between the towers, or on the "dialogue" that the different structures entertain each other. In this way, we could try to reproduce the "looks" from sixteenth-programmed project and those granted by the remains of the defensive system in the Salerno area through the generation of a virtual tour to give the possibility to navigate from a tower to another, through spots or through georeferencing on the map.

BRIEF HISTORICAL BACKGROUND AND MAIN DEFENCE PLANS

The development of flourishing cities, that characterized the ancient province of Salerno, has inevitably increased the attention of enemies and looters, also favoured by the orographic characteristics of the place with briefly stretches of sea that are easily navigable and the presence of jagged coastline that guaranteed an easy hiding place for ships. Since the Roman times there are traces of some towers on the territory to monitor the coast but it was around the middle of the VII century that the hostility from the sea worsened. The death of Mohammed, in fact, that generated the sudden Islamic expansion and then the incursion from the Saracen enemies intensified more and more and the sea became a treacherous theatre of fight between the Christian and Muslims. Furthermore, pirate attack increased and became institutionalized, around the XVI century, with the name "Privateering", a practice that will run rampant for the next three centuries.

The gravity of the situation inevitably involved the planning of adequate signal system (sound of the bells or warnings of fire and smoke visible to sailors along the coast) and defence plans; however, at the beginning only punctual towers were built



Fig. 1 - Marina di Vietri, 16th century; 88 x 114,5 cm, oil on canvas, unknown author, Coll. Villa Guariglia, Raito di Vietri sul Mare (SA).

with alarm function and in the inhabited areas. It was only in the Angevin era, around the end of XIII century, that it is possible to speak of the first defensive plan with the building of a chain of cylindrical towers for anticorsair sighting and signaling, but always along limited section of maritime frontier. Subsequently around the XV century with Aragon family the previous defensive system was increased further by building new towers and incorporating some of those already existing adapting to new needs and in particular to new defence techniques that is the firearms (Russo, 2009). Nevertheless, at the beginning of the XVI century, despite the presence of some towers located on the coasts, the Salerno territory was without an efficient sighting system and enemy attacks continued to invade the cities' coasts. The necessary control, in fact, was not guaranteed, above all, because there was not a real communication between the buildings in order to have a global vision of the whole territory.

In this regard, around the 1532 during the Spanish Viceroyal dynasty, with a series of pragmatics the settlement plan began. The need to defend from enemies' attacks led the viceroy Don Pedro de Toledo to design a well-planned barrier system along the coast of the Kingdom. Nevertheless, the first ordinances sent by the viceroy, due to economic impossibility, were never fully implemented. On 22 February 1553, Don Pedro de Toledo died and the realization of the defence system was entrusted to his successor Don Parafan de Ribera intent on completing the plan (Santoro, 2012). The enormous orographic variety of the territory entailed a careful study of characteristics of the site before proceeding with the construction of the buildings, so that a specific technical service of engineers was established. Their tasks were about not only the planning but also the direction of the works and the maintenance of the same. The construction of the towers involved a careful study both of geology of the place but also the type of towers to be built in relation to the type of defence to be guaranteed and the type of artillery to be supported (fig. 2). As reported by Russo in each critical point of the coast the officer proffered his

opinion on the vulnerability of the sea, the artilleryman on the calibre of the weapons required, the engineer the size of the tower in relation to the weapons and the contractor the relative cost. The whole were compiled on cards, which reported information about architectural drawing of the tower and a topography reference, as well as, the estimated cost.

The last step was the executive project during which checks were carried out to verify what had been done (Russo, 2009). After about six years the coastal defence system was active, even if, it was never really completed, but despite the less number of towers compared to the planned ones, it was possible to monitor the entire coastal perimeter. According to Pasanini in the 1590 the number of the towers were 339 (Pasanini, 1926), which of 111 along the coast of the Principality of Citra [1].

THE IMPORTANCE OF THE VISUAL CONNECTION

Born as an ingenious defence project to protect populations stretching from Positano to Policastro along the coast of Salerno, is today for us, a fascinating testimony of a distant past. Observing the

orography of the Principality of Citra we can see its vast heterogeneity that has certainly influenced the edification of the individual towers, characterizing them and making them different from each other. However, in order to understand a population and a territory, it is necessary not to limit ourselves to the study of the single buildings but to question oneself on those careful strategies that often underpinned such projects. The organization of the defensive system was a really network of "gazes" in order to closely observe and monitor the entire coastline. The choice of the location, as previously reported, was not only related to its accessibility or the presence of viable roads; but it was the consequence of careful studies of a group of technical staff (Cardone & Carluccio, 1999). In fact, they did not analyse only the punctual settlement of the tower but the whole plan, and so it is strongly conditioned by a reticular scheme of visual relations existing between them. Hence, based on a previous study, it is interesting to know what today are the towers still existing realizing a comparison between the current visual relations and the connections foreseen by the ancient towers of the viceroyal period. The study was conducted on the basis of the cartography written in 1613 by

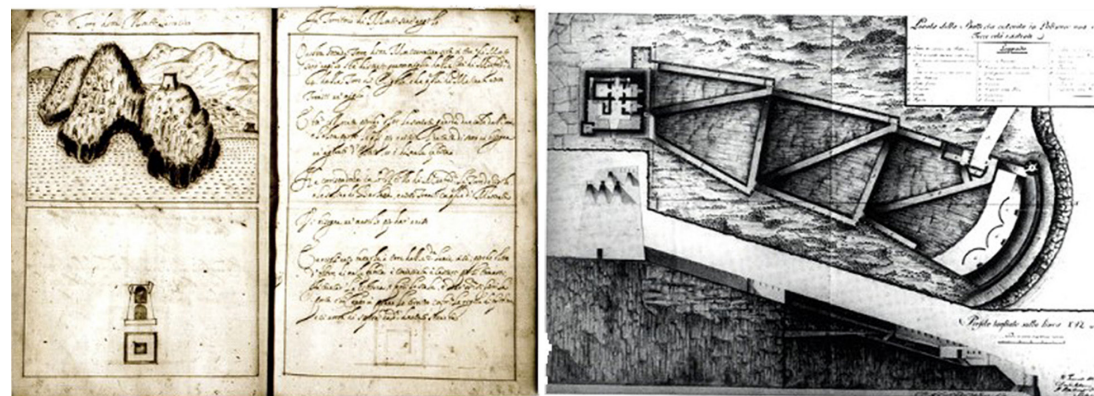


Fig. 2 - (from left to right) Survey of the Torre Monte Sant'Angelo by Gambacorta around the end of 1500s and Plan of the battery constructed behind the Torre di Palinuro. (Russo F., 2009)



Fig. 3 - Principato Citra, N. A. Stigliola, M. Cartaro, 1613. BNN, Private Collection

Nicola Antonio Stigliola (1546-1623) and by Mario Cartaro (1540-1620); as visible in the fig. 3, this is a representation in which significant geographic data and toponyms – both internal and external – of the towers are contained (Soprintendenza, 1994). Following an initial graphic analysis and subsequent cataloguing, it was found that of the 111 towers present along the Salerno coast 34 have disappeared or only a few traces are found, 22 are in ruins, while the remaining part is in good condition or completely restored (Talentì & Morena, 2016).

TECHNOLOGY FOR THE CULTURAL HERITAGE

In the time, the use of the photography for the knowledge, the documentation and valorisation of cultural heritage has grown increasingly. Constantly evolving it has changed its function over the years from a “simple” tool useful to the representation of the reality, until a true form of art. From the XIX century the use of camera spread widely also in the field of architecture, as a support in the project, above all, in the field of survey and restoration. Over time, in fact, the photography has found great development in the photogrammetric technique for the graphic documentation of

historical monuments (Aliberti & Iglesias Picazo, 2019), but also support for the generation of HBIM digital models or for the new digital technologies through ICT (Fazio et al. 2019). However, beside its great use in the field of architectural survey, it can also be used not only for the metrical and geometrical aspects of architectures but also for understanding the spatial relations between them and the surrounding space (Cardaci & Versaci, 2013). The use of photography, therefore, has proved to be very useful also in the field of knowledge, dissemination and valorisation about the cultural heritage for facilitating the public enjoyment of such historical buildings. Virtual tour is an example because makes possible a dynamic view of sites; in this way it is possible an interactive tour of the places quite similar to reality but also adds some additional data to the visit like the latest conservation report (Napolitano et al., 2018) or historical information.

The aim of the following work, in fact, is to deepen the cognitive analysis of the coastal defensive system of the province of Salerno in the viceregal era. As explained previously, it is a dense network of towers, located in careful strategic points. In this part of the project, we want to concentrate the attention on the virtual restoration of the visual connection between the towers. The idea, therefore, is to restore the ancient gazes through the creation of different panoramas take near the various towers and, subsequently, to guarantee iterative actions between one building and another, in addition to enrich this virtual tour with further historical and informative links.

In short, the whole process aims to promote a different experience of the coast of Salerno helping to spread the knowledge of the defensive system and its strategy by focusing attention on an aspect of the system difficult to understand and often forgotten. A panoramic photography is a technology for the creation of seamless stitching of multiples images with the use of appropriate instruments and software in order to return high quality panoramic images with high number of pixel. The word “panorama” comes back to 18th century when the painter Robert Barker coined this word for his new

form of painting, the word derives from the Greek “*πᾶς*” (all) and “*ὄραμα*” (view) and it was used to refer to a broad view of setting. They generally were painted on the wall of some buildings specially designed for such art, called rotundas; the aim is the same of today, create the illusion of being on the place (Lescop, 2017). With the invention of the camera, the interest in the panoramas was also directed in the field of photography. Already around the 1843 the Australian Joseph Puchberger patented a camera with rotating optical system where the lens was rotate through a manual crank while shooting, the angle of view was 150°. Successively, other photographers continued to improve their cameras following almost the same concept (Frich, 2007).

Currently there are some cameras which allow to capture a picture with high resolution in a single exposure, however, there are also more economical ways to get into panoramic photography. In the last few years, indeed, exist special software can marge conventional photos taken with simple cameras, obviously realized with a certain overlap, in order to create a digital panoramic image (Jacobs, 2004). Moreover, on the market also panoramic heads were appeared which are supportive for the acquisition of more images with the camera and that will be stitch later for the realization of one higher resolution photo. The last one, after, could be printed out on photo paper or converted to interactive panoramas for viewing on a computer display. In any case, panoramic images are the typical data necessary for the generation of a virtual tour and as known, through the use of special viewer software, the users can move with the mouse in different directions of the picture. These photos thus obtained can then be linked to each other and enriched with additional information data (video, text or drawing). Generally, the creation of a virtual tour consists of three phases: photographic survey, post-processing for the photos stitching and finally the creation of link between the different panoramic photos and add information data. At the end, the work could be share on online platform and it will be available to everybody.

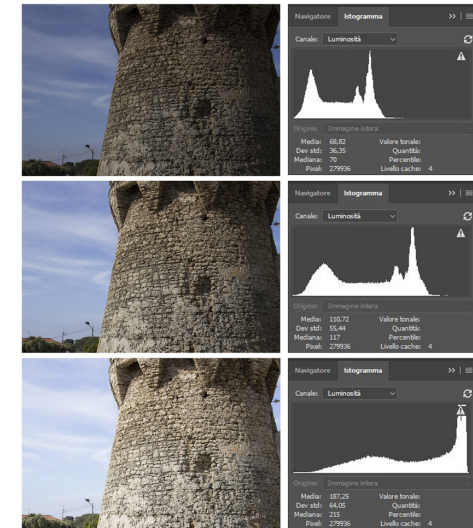
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Fig. 4: (from left to right) Gigapan Epic Pro, Nodal Ninja 4 and HDR acquisition with Canon EOS 600D

INSTRUMENTATION

During the acquisition phase, several instruments were used (fig. 4). One was the Gigapan Epic Pro, it is a robotic panoramic head, but although it is an automated tools, it requires some previous settings with the purpose to find a correct configuration between the camera and the instrument. First of all, in order to eliminate the parallax error[2], it is necessary to translate the camera horizontally until it is positioned in the precise pivot point[3]. Successively, one of the most important stages is setting the time required to take a photos in each rotation. It is conditioned above all by the area to be detected, as well as, the time needed to take the single picture. Outlining the FOV (Field Of View), therefore, Gigapan Epic Pro automatically calculates the value of the angle of separation between one shot and the next. Finally we set the area to be covered, instead of operating at an angle of 90° in the lower transverse direc-



tion and 90° in the upper vertical direction, it was decided to work with 80° and 80°, that is 160° instead of 180°, avoiding repetitive shots in the last rotation. As in each survey, it is important to be clear in advance of the aim of the project in order to operate correctly for its realization. In the case studied, a balance was made between the quality and the resolution of the photo given that it will be shared on the web and for the sole purpose of visualization.

Generally, during the shooting phase we worked with Canon EOS 600D that is a Digital Reflex characterized by a sensor CMOS APS-C 18 Megapixel and used with a lens Canon EF-S 18-200mm. The shots were taken operating with a focal length of 35mm to ensure an overlap of 30% shots and, having to work outside with different exposures, we have acquired in HDR; this involves triples the number of photos calculated from the FOV. The second tool used is the Nodal Ninja 4 from FANOTEC. Differently from the previous one

this hardware is a manual panoramic head so, the calculation of the optimal overlap between the shots is not automatically evaluated by the instrument. As in the case of Gigapan Epic Pro, the fundamental stage is the placement of the instrument on the entrance pupil to avoid the parallax error and differently from the previous case, if you only modify the lens or the focal length you have to reset the instrument. In this case, we operated with a Sigma EX DG FISHEYE mounted on Nikon D60 a Digital Reflex camera with a sensor Nikon DX 10 Megapixel, taking shots every 45° horizontally and vertically. Working in this way the quality of the panoramic picture is not maximum but sufficient for our purpose, and above all it allows to operate in much faster times, generating panoramas that are easily navigable and shared on the web.

VIRTUAL TOUR

Once the photos have been made, it is possible to proceed with the stitching of them; the software used for this part of the project is Autopano Giga 4.2 version from Kolor Company. It is an image-stitching application and, despite the advanced algorithms used for data processing, it has a very simple and user-friendly interface. During the post-process phase, in addition the application gives the possibility to intervene and set manually the different options according to the needs of the operator, once the panoramic image has been generated, instead, it is possible to make some changes like revise positions, to check overlap, mistakes or remove single images that compose the panoramic photos. Once the different panoramas and information panels to be inserted

were created, the virtual tour could be generated. This stage of the workflow was carried out through the use of the software Panotour, once again of the Kolor company. It gives the possibility to add panoramas and manage the relationships between them, as well as, set the different kinds of hotspots to insert, each one plays a specific role; some upload another panorama, others a photo gallery but also video, 3D model or information sheets and map. Therefore, a virtual tour application allows also to have access to additional information further enriching the knowledge of the site (Fiorillo et al., 2013).

The idea is to generate a simple and intuitive interface, as visible in the fig. 5, in fact, the home page is characterized by an essential index in which you can select from several options available. In particular, the following breakdown is provided. A brief historical overview, where it is possible to briefly investigate what is the history that characterizes the defensive system of the province of Salerno. The aim of the project, within which the attention is focused on what is the main purpose of the virtual tour and then the restoration of the visual connection between the towers. Network of looks, the real virtual tour of the system, where it is possible to navigate from one panoramic to another. Panoramic photos, in which are collected all the panoramic photos taken showing the parameters used in the phase of taking. Historical information panels, where all the historical panels of the towers are collected. In addition, there is the possibility of correlating the panoramic pictures with the historical or information panels relating for example the setting of the panoramic photos taken or, again, insert panels on any projects for the restoration of the building (fig. 6). The virtual tour was set up considering three modes of exploration: the first using hotspots located in the "visual" direction between a tower and another, the second using a georeferenced on a map and, finally, the third using the links on the historical panels of the individual towers. At the bottom right of the historical panels, in fact, are shown in black the towers in visual connection still existing and in yellow those now disappeared, clicking on the

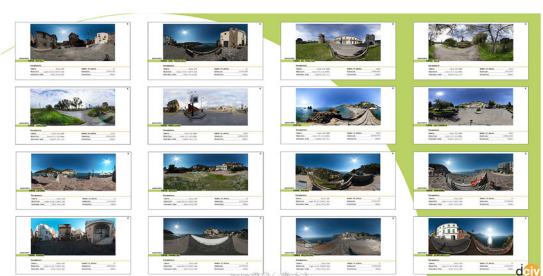
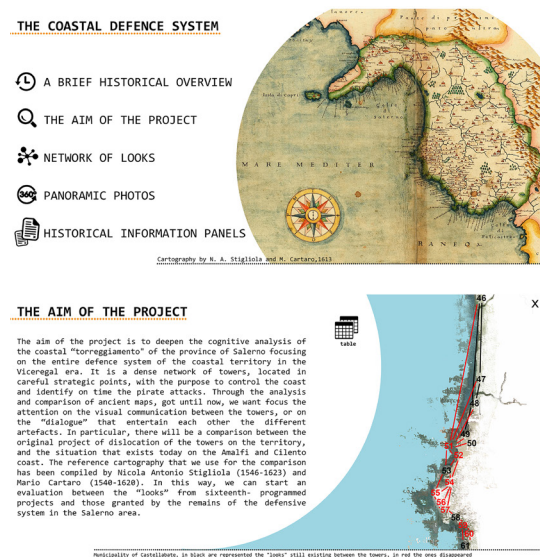


Fig. 5: Examples of panels included in the virtual tour

name you can reach the tower. The virtual visit of the site, therefore, can take place either in a sequential way following the visual connections between a tower and another or randomly identifying the site of interest directly on the map depending on the interest of the user.

CONCLUSION AND POSSIBLE FUTURE DEVELOPMENT

The following work is an example of how the technologies available today make possible to enhance sites of inestimable historical value but which unfortunately are often destined to be forgotten. Despite they do not allow a concrete intervention for the restoration and recovery of the ancient defensive system, ensure greater dissemination and knowledge with the aim of accentuating the public and private interest. Proceeding in this way, indeed, it will be possible to contribute at the diffusion of this historical patrimony. In addition, working in this way the level of accessibility of documents would increase intensely; sharing on internet of the virtual tour it would be possible to transmit information and to live experiences in any part of the world, as well as, to increase the interest to the fascinating places of our territory often unknown. Hence, the generation of virtual tours, as in the case studied, allows us to explore, navigate and interrogate in a personal way and according to own interests. It could also guarantee access to in-depth studies for expert users, research, 3D animations, virtual reconstructions, or even, technical investigations that could be carried out in the future on such architectures. Furthermore, the possibility of being able to achieve certain objectives also with economic technologies (Zonno, 2009), could turn more attention to the lesser-known architectures; recognizing value to them because, unfortunately, often are in a state of complete abandon. This is a different method of communication, a tool to deepen and at the same time communicate additional information of various kinds (historical or technical), it would also possible personalize the panoramic photo with the addition of some freehand drawn elements, in

order to reinforce the personality and the expressiveness (Cabezos-Bernal et al., 2019) of the representations at different levels of accessibility it could be also (experts or just tourists). Obviously, these systems will never be a replacement of the on-site visit, but they will certainly increase their understanding and stimulate the curiosity. In addition, today there are also 360-degree videos that have great potential of immersion and interactivity that offer to the users a greater sense of reality and allow viewers actively to interact with the con-

tent, it is possible, also in this case, to integrate the tour with other media (like images, audio or links) in order to navigate in a linear or non-linear way inside the virtual visit (Bassouss et al., 2019). The achievement of these objectives also include the multidisciplinary approach where the scientific aspect dialogues and enters into harmony with the humanistic aspect in order to be able to pass on not only tangible information such as volumes or technical drawings but also information difficult to transmit with the classic representations.

PROGETTO DI RIGUALFECAZIONE

Legend: Sala mensa, Sala convegni, Sala meeting, Sala bar

DESCRIZIONE	Quantità	Area (mq)	Volume (mc)
SALA MENSURA	1	100	100
SALA CONVEGNI	1	200	200
SALA MEETING	1	150	150
SALA BAR	1	100	100

TORRE DI VIETRI

Municipality	Vierti sul Mare
Locality	Vierti
Period	1568
Classification	Barrage
Type	Five embrasures
State	State owned

Visual connection: Torre di Panna, di Albori, di Cetina, di Erchia, di Sant'Amato

Macchina fotografica

Modello	Canon EOS 50D	Isospezzione	1/2500
Obiettivo	18-200mm	Diaphragma	f/14
Formato immagine	3:2	Sensibilità ISO	100
Formato immagine	3:2	Distanza focale	35mm

Panoramica

Metodo	colore	300	
Risoluzione	3840x3	Profondità	24bit

PARAMETRI

Obiettivo	18-200mm	Isospezzione	1/2500
Formato immagine	3:2	Sensibilità ISO	100
Formato immagine	3:2	Distanza focale	35mm

PARAMETRI

Metodo	colore	300	
Risoluzione	3840x3	Profondità	24bit

Fig. 6: Virtual tour with links to different information panels

NOTE

[1] Administrative unit of the Kingdom of Napoli during the 13th century.

[2] Parallax error is the perceived shift in the position of an object if it is view from different angles.

[3] Rotation point of the camera in order to avoid the parallax error.

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