

The “PROMETHEUS” European Project: Gdańsk Fortress Route (Poland) †

Daniele Bursich ^{1,*}  and Sandro Parrinello ²

¹ Department of Cultural Heritage Sciences DISPAC, Università degli Studi di Salerno, 84084 Fisciano, Italy

² Department of Architecture (DiDA), Università degli Studi di Firenze, 50122 Florence, Italy; sandro.parrinello@unifi.it

* Correspondence: daniele.bursich@univr.it

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Abstract: Starting in 2018, the PROMETHEUS H2020 project has been involved in the establishment of analysis methodologies for Cultural Heritage Routes (CHR) associated with historical architectural heritage. The project’s research activities have primarily focused on examining various itineraries, ranging from the regional scale of Russian churches in Upper Kama located in Perm (Russia), to the provincial scale encompassing sites related to James I of Aragon’s conquest in the Kingdom of Valencia (Spain), and finally to the urban scale encompassing fortifications in the city of Gdansk (Poland). Throughout the project’s duration, digital technologies have been employed and tested to create archives and information systems that aim to devise storytelling strategies for defining, representing, and promoting these routes. This endeavor involves the collaboration of more than 35 researchers from three European countries, who are implementing interdisciplinary synergistic actions to develop knowledge-driven approaches and formulate effective designs for digitally narrating intricate architectures.

Keywords: digital documentation; informative systems; 3D database; cultural heritage route; PROMETHEUS H2020; photogrammetry; UAV; TLS



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1. Introduction

A cultural phenomenon manifests itself in each territory through a series of events that follow one another over time. The cultural route seeks to re-establish the link between space and time. It investigates the relationship between tradition, matter—understood not as physicality but as existence—and the critical analysis of the qualities that could characterize every single event within the analyzed system. However, the study of cultural routes requires in-depth research to delimit the object of study, define boundaries and limits, and subsequently establish descriptors to schematize its singularities. An image should emerge from this analysis, or rather a drawing, in the deepest sense of critical interpretation and elaboration of signs. These signs—rewritten according to a specific narrative—can represent the entire route. Defining a cultural route also means shaping a landscape. It is a question of delimiting something indefinite, which includes fragments of a mosaic that is initially unclear, but of which the beauty can be guessed. Each piece of this mosaic must be framed, studied, and defined to then be positioned to create a design which, although it does not have the same beauty as the real phenomenon, allows us to highlight some characteristics of its complexity. This simplification favors communication and generates greater awareness and interest, thus promoting wider participation in the route; this leads to the emergence of a significantly greater number of more conscious and profound individual experiences. The PROMETHEUS H2020 [1] project involves numerous researchers working on the theme of cultural routes. The heterogeneity of their skills and the particularity of their research fields contribute, within the framework of the project,

to bring together a multiplicity of perspectives and identify individual experiences and distinctive narrative paths [2], ultimately shaping the real-ideal landscape of each cultural route [3].

During the project, three case studies were examined, which were different in terms of geography, history, and architecture. These included the churches of the Upper Kama region of Russia, the sites associated with James I of Aragon’s conquest in the province of Valencia, Spain, and the fortifications in the city of Gdansk, Poland (Figure 1). These case studies varied in size, ranging from the expansive Russian territories to the more compact urban space of Gdansk. Together, they encompassed complex architectural phenomena that showcased the full value of cultural routes. In these case studies, the historical and cultural legacies played a crucial role. The sites were influenced by a series of historical events that led to cultural exchanges and transformations, whether it was the influence of pre-existing Tartar and Moorish cultures or the impact of German knights. These cross-contaminations resulted in changes in language, decorations, and stylistic motifs, giving rise to new forms, shapes, patterns, or the emergence of distinctive symbols that rejuvenated and personalized the landscape. These signs became an integral part of the cultural identity, leaving an indelible mark on the place and shaping its future socio-political and economic context. Additionally, it is important to consider the factor of time in these case studies. This includes both the period of construction of these architectural traces and the duration over which cultural phenomena spread. The stability and persistence of these cross-contaminations throughout time are significant. Time serves as a crucial reference point for classifying the route, as it establishes boundaries and categorizes the events that shaped the history of these landscapes (Figure 2).

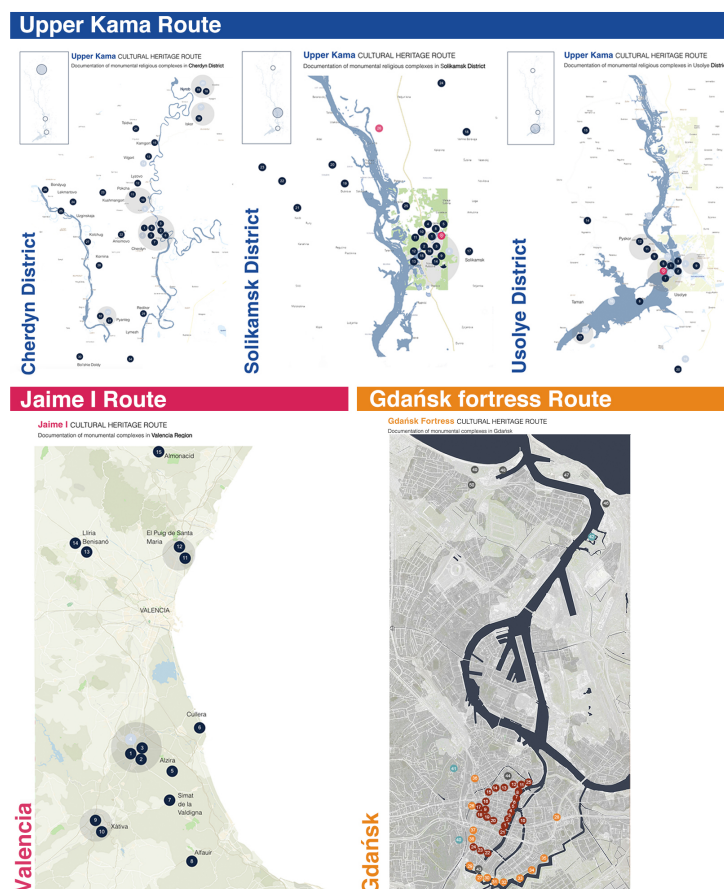


Figure 1. Summary of the historical sites and impressive architectural structures found along the three cultural routes investigated as part of the PROMETHEUS H2020 European project.



Figure 2. A compilation of images featuring the selected landmarks examined along the three cultural routes. The top section showcases churches located in the Upper Kama territories of Russia, the central portion features fortresses and sites associated with James I of Aragon in Spain, and the bottom section presents fortifications and military architecture in Gdańsk, Poland.

The researchers' objective in documenting and preserving cultural heritage is to visualize the cultural route they are passionate about at its highest cultural value, creating successful examples that represent and promote it. In a sense, the cultural route embodies a utopian nature. Utopia is a conceptual space that is not predetermined but evolves and expands beyond the limitations of the present reality. It projects human vision from the finite toward the infinite, surpassing obstacles that hinder the pursuit of utopian transcendence. The architectural structures examined in establishing a cultural route paradigm and aiming for an ideal heritage status engage in a dialogue with utopia, fueling its imaginative scenarios. While storytelling is essential in expressing the cultural route, it inherently possesses a structure and order that opposes utopia. However, within this framework, creativity has the power to reshape the boundaries of authenticity and address more complex social issues, fostering a receptive mindset for awareness. Consequently, defining actions and cultivating the right mindset for documenting a cultural route can be exceedingly challenging.

Conversely, when it comes to the Gdańsk fortifications, there was no previous comprehensive study that systematically analyzed the defensive heritage within the city's evolutionary matrix. Collaboration with archives and colleagues specializing in the history of architecture at the Polytechnic University of Gdańsk played a crucial role in organizing and standardizing each monument. This included establishing a common communicative language, as well as developing a nomenclature system for the sites and elements, dating, and categorizing them based on different periods of the defense system related to the city. The production of maps, which served as reference systems for research, required several months of post-production. These maps not only facilitated planning and fieldwork, but also conveyed the complexity and extent of the assets under investigation, serving multiple functions. To illustrate the research conducted on Gdańsk's fortified system, various types of data were acquired. These included point clouds acquired by TLS (terrestrial laser scanning) and MLS (mobile laser scanning) instruments, covering the entire urban section of the historic center, suburban areas near the Renaissance bastions to the south of the city, and several fortresses along the course of the Vistula River [4], particularly near its mouth (Figure 3). Water plays a significant role in connecting the fortifications, with the river

serving as the engine and defense system for the city, linked to the extensive harbor on the Baltic Sea. Throughout history, the construction of artificial canals and subsequent changes have altered the city's structure, creating islands and neighborhoods bound by water. The fortifications are positioned along a line and are challenging to relocate, except for the perimeter of the old medieval walls [5]. Today, the heavily fortified landscape appears fragmented, lacking visible signs of continuity [6]. The waters of the Vistula River, once connecting the capital of the Teutonic Order to Gdańsk, now dissipates into swamps beyond the Renaissance bastions on the landward side. On the other side, toward the river's mouth, the industrial area of Poland's main harbor acts as another perceptible boundary.

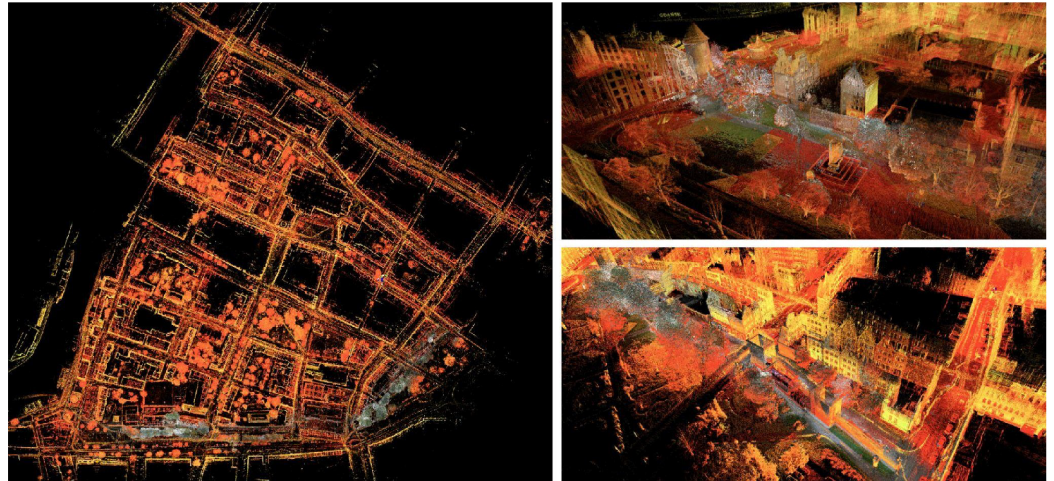


Figure 3. Point cloud of the historic city center of Gdańsk.

Within the project framework, an information system is being developed to systematize the analyzed data, resulting in two types of drawings: one focused on restoring and improving the existing landscape, and the other aimed at illustrating the image of the cultural route. The creation of a cultural route involves bridging distances through atlases that visually represent shapes and patterns. The heritage database [7], enriched with historical and technological details for each monument, will develop its own visual representation, encompassing technical drawings, models, and multimedia data. This multidimensional portrayal will enhance knowledge and facilitate the integration of heritage into the digital age.

2. Survey of the Ancient Military Architecture of the Urban Context of Gdansk

As mentioned above, Gdansk is a city built on water and in constant dialogue with this element. The fortifications, in fact, extend from the historic center and continue to the mouth of the Vistula River. From the moment of its foundation until the Second World War, all the military defense systems of the city were concentrated here, which on the one hand protect the mouth of the river, and on the other hand surround the old city. The historic center is surrounded by canals and rivers which make it almost an island surrounded by two lines of fortifications which were built around the 14th and 17th centuries [8]. The innermost one is characterized by brick walls and towers, while the outer one is recognizable by an imposing succession of bastions which give the city a star shape (Figure 4).



Figure 4. The ancient military system of Gdansk. The left side of the map of the city and the mouth. The star shape of the city can be recognized below.

The first round of walls, the innermost one, is near the historic center and is the oldest in the city and basically consists of three elements: the towers which can have a rectangular or lobed section, the crenellated walls surrounded by canals, and finally the city gates which, in some cases, also had secondary functions such as, for example, the large crane which overlooks the river directly. The medieval crane of Gdansk, one of the symbols of the city, is structured on two lobed brick towers, with a complex black wooden structure in the center [9]. Today, it is considered the largest harbor crane in medieval Europe.

Thanks to the generosity and availability of the local authorities, to better understand the evolution of this medieval defense system, we had the opportunity to scan the maps and etch watercolor drawings and ancient prints preserved in the city archive (Gdansk Library of the Polish Academy of Sciences) (Figure 5). The archive was bombed during the Second World War and many documents before the 17th century were lost [10]. However, there are still several that represent the city during the medieval period. The scan was performed using gigapixel technology. This technique allows for capturing every small detail of a work, which is photographed from different points and planes with very high-resolution sensors. The photographs obtained are processed and joined together using an algorithm which sorts and organizes them according to the distance from the subject. The result is a giga photo, a “pyramidal” image that does not lose resolution even at high zoom levels, because they reach up to 700 million pixels. This intervention has allowed us to expand the digital database that was built specifically for the enhancement of this cultural route and will also be very useful for study purposes, not only for the project itself, but also for the future [11].



Figure 5. Digitization of historical maps of Gdansk at the Gdansk Library of the Polish Academy of Sciences.

The second intervention carried out inside the medieval walls was aimed at the relief of the walls and towers. We mainly operated via ground and drone photogrammetry [12]. The scans made from the ground were then aligned with those from the drone and with points detected next to each structure with GPS (Figure 6).

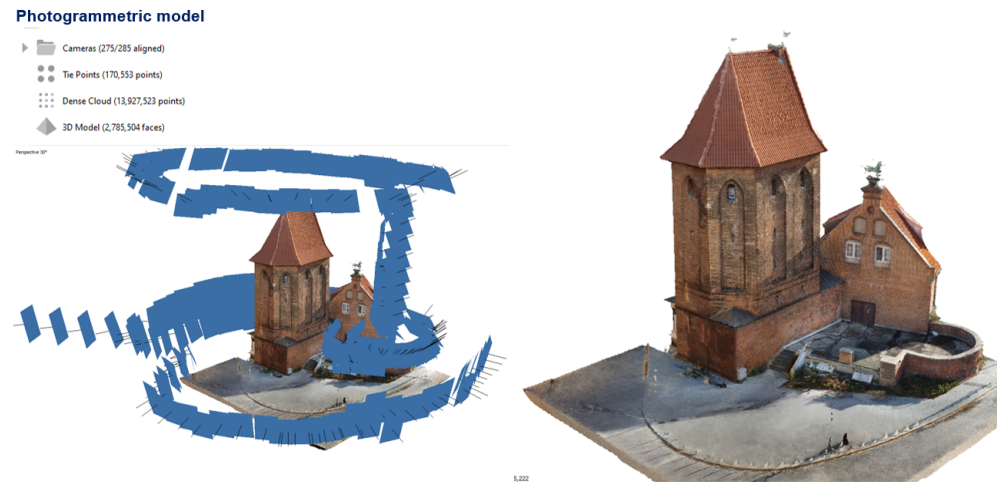


Figure 6. Three-dimensional models of a tower connected to the city walls.

In parallel with this operation, an abacus of three-dimensional models was also built which semantically describes the historic buildings of the historic center. This database made it possible to sample various types of windows, door sills, and architectural elements (Figure 7). The acquisition was also carried out on a 2D basis to create a texture dataset which then led to the generation of shaders useful for texturing ideal 3D models (Figure 8).



Figure 7. The abacus, 3D models of some buildings, roads, and CH features.

This abacus can be used to generate buildings that can adhere to the morphology and texture of the urban layout present in the historic center. The application could be useful for future building planning or even for virtual restoration [11].

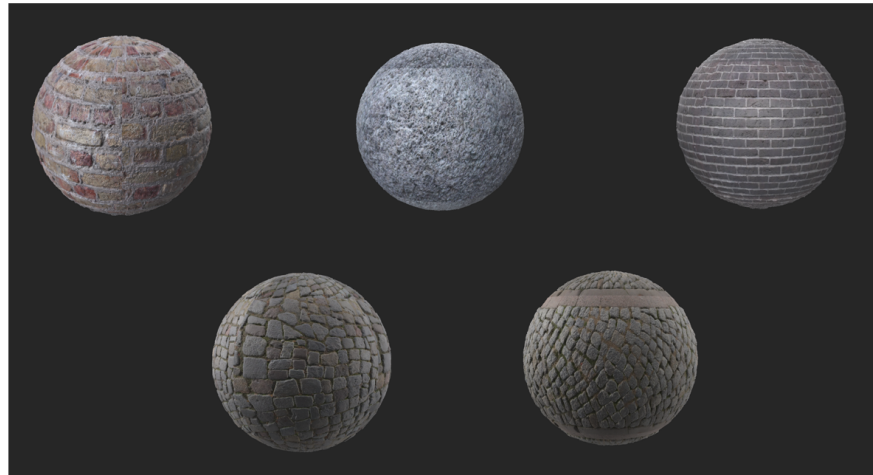


Figure 8. The abacus, shaders built from digital images captured in 8 k. Materials calculated using Adobe Substance Designer.

3. Conclusions

The envisioned information system within the project encompasses the creation of an organized and comprehensive data system. This system will serve the purpose of generating two distinct types of visual representations. The first type aims to facilitate the restoration and improvement of the current landscape, while the second type focuses on outlining the desired image of the proposed route. By developing a cultural route, the project aims to bridge geographical gaps by utilizing atlases that can effectively articulate shapes and patterns [13]. The inclusion of a heritage database, enriched with historical and technological details pertaining to each monument, will establish a distinct identity for the project. This database will evolve into a multidimensional depiction, consisting of technical drawings, models, and multimedia data, which will not only enhance knowledge, but also propel heritage preservation into the digital era.

The information system, as a pivotal component of the project, will revolutionize the way data are organized and utilized. It will provide a systematic approach to managing and analyzing information, ensuring that all relevant data are properly integrated and easily accessible. By streamlining the data management process, the system will contribute to a more efficient and effective decision-making process. The primary function of the information system is to generate two types of drawings that serve distinct purposes. The first set of drawings is focused on mending and revitalizing the existing landscape. By carefully analyzing the data collected, the system will identify areas that require restoration and propose appropriate solutions. These drawings will serve as visual representations of the proposed changes, providing a clear and comprehensive understanding of the intended improvements.

On the other hand, the second set of drawings aims to delineate the envisioned image of the route. Through the utilization of advanced mapping technologies and comprehensive data analysis, the system will create detailed visual representations of the proposed route. These drawings will not only showcase the physical aspects of the route, but also highlight its cultural significance and historical context. By capturing the essence of the route, these drawings will inspire a sense of curiosity and encourage exploration among potential visitors. Central to the development of the information system is the concept of cultural route drafting. This process involves breaking down geographical barriers and connecting diverse cultural sites through the use of atlases. These atlases serve as powerful tools that not only illustrate geographical features, but also uncover hidden patterns and connections between different sites. By leveraging the capabilities of these atlases, the information system will create an intricate web of knowledge, seamlessly weaving together various cultural landmarks and historical narratives.

To ensure the comprehensive representation of heritage, the information system will be equipped with a robust heritage database. This database will house an extensive collection of information related to each monument, including historical and technological details. By consolidating this wealth of information in a single repository, the system will provide users with a holistic understanding of the heritage sites, their significance, and their evolution over time.

Moreover, the heritage database will transcend conventional textual information by incorporating various forms of media. This multimedia integration will encompass technical drawings, architectural models, and interactive digital content. By embracing diverse forms of media, the system will create an immersive and engaging experience for users, enabling them to explore heritage sites from different perspectives. This multimedia approach will not only enhance user engagement, but also contribute to the preservation and dissemination of heritage in the digital age.

In conclusion, the information system envisioned within the project will revolutionize the management and representation of data. By generating comprehensive drawings for landscape improvement and route delineation, the system will facilitate informed decision-making and inspire exploration. Through the integration of atlases, the system will bridge geographical distances and uncover hidden patterns within cultural landscapes. Furthermore, the incorporation of a robust heritage database, supplemented with multimedia elements, will enhance knowledge and propel heritage preservation into the digital era. The information system will serve as a powerful tool in preserving and celebrating our cultural heritage for generations to come.

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