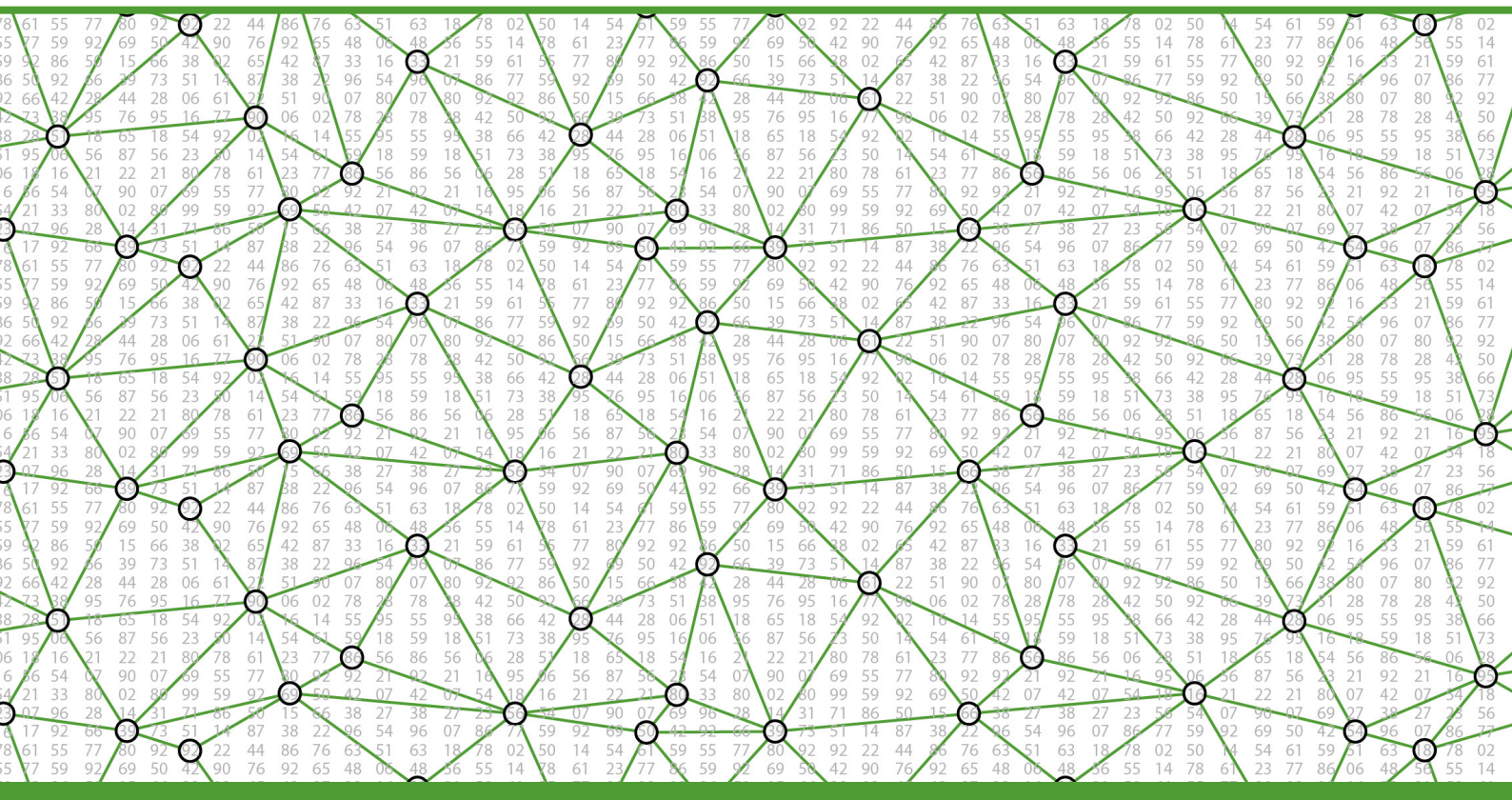
REPRESENTATION CHALLENGES

New Frontiers of AR and AI Research for Cultural Heritage and Innovative Design

edited by

Andrea Giordano
Michele Russo
Roberta Spallone



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Fragments of Stories and Arts: Hidden and not so Hidden Stories

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Ylenia Ricci
Andrea Pasquali

Abstract

Any city with a long and articulated past has buildings, squares and monuments linked to its history, the built heritage is its more evident direct link to the historical and artistic events that characterize the present urban asset. In between this main feature, there is the possibility that a myriad of a minor, medium or minimal sized elements may be present, creating a network of evidence, sometimes difficult to catch, but strongly connected to past events and valuable stories. It brings to light details that are often ignored or misinterpreted because of their historical peculiarities. The present research is focused on a structure based on an AR solution to make these traces in Florence downtown more accessible and discoverable. This paper base is the starting point for a special and fascinating exploration of the Florentine downtown, passing by a series of "secondary" but highly intriguing traces. In addition to the most important places and monuments, known and desired by tourists, there are details and trivia that further enhance the uniqueness of the experience in the historical and cultural city.

Keywords
augmented reality, Firenze, maps, storytelling, photogrammetry.

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Introduction – Hidden and not Hidden

In the contemporary city, the presence of the sedimentation of historical eras is present and very strong. The urban fabric that presents itself to observation is characterized by distinctive features with the presence of elements with specific relevance, mostly characterized by a high historical value, which determines the physical appearance of the Cultural Heritage connected to that contemporary society. This heritage consists mainly of architectural works and art objects that, by communicating with the place they structure, create an urban identity by interfering and integrating the city environment. The presence of this heritage connotes the place but it also receives back the influence of the place itself, which creates the complete scenography and makes the artistic / architectural work readable. So there is the definition of a system of shapes, spaces, colors, etc... that become the specific essence of the Cultural Heritage. In this, the single artwork may be the protagonist, but not the unicum, alone and isolated, to constitute the identity of the Place.
Having declared this interpretation of the Cultural Heritage, considered to be the most complete and sufficient to summarize the term Heritage, it is emphasized how necessary it is to extend the observation to two further groups of cultural-artistic emergencies affecting the Cultural Heritage: the so called "minor works" and the "histories" linked to each of them. The "small", medium or minimal artworks are distinguishable as a subset of architectural and artistic objects which present themselves with their qualities, but are not directly recognized as eminent components. When they are noticed or observed, they are recognized and distinguished for their value, but, because they are not part (by fate or past events) of the documented and promoted (and then somehow transformed into a mainstream content) Cultural Heritage, they are not part of that "Olympus" of identity presence that are subject to the tourists' massive pilgrimage.
The history of these works is distinguished by a subset of legends, curiosities, anecdotes, etc... that creates an intangible, but extremely present, environment around them. These overlays are passed on through more or less official channels, starting from more or less popular roots. They constitute an increase to the official events connected to the Architectural-Artistic object.
The history of the work is a component on which it is opportune to structure a more articulated reasoning, which is synthesized in two really relevant syntheses. The first one is the result of observations and collections, and it is the evidence that the presence of stories, legends and anecdotes is more relevant when the work belongs to the first mentioned subset. That is, when minor works are studied and investigated, it is possible to find a more rooted and varied popular tradition.
This is mainly considered a symptom of a less marked historical interest on the object, which has left its scientific documentation and sources at a more verbal level, thus opening up to a more popular and "dynamic" " treatment" of the time. To this, one can add the direct rela-

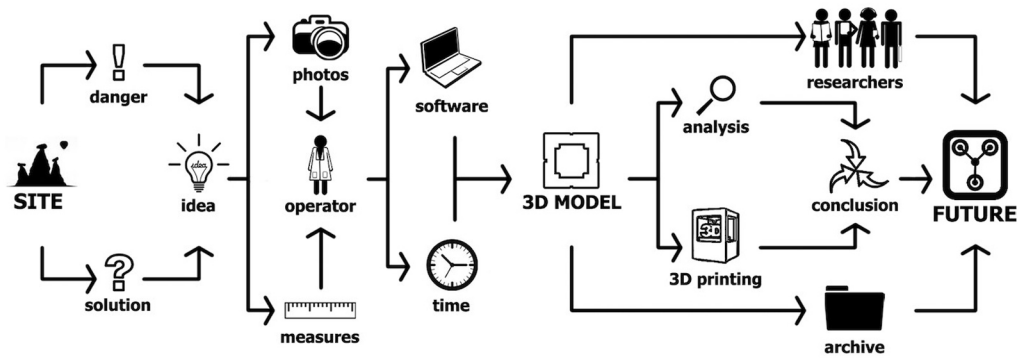

Fig. 1. Diagramming of the research process and the work plan.

Fig. 2. Pointcloud from photogrammetry in Reality Capture.

tion to the dimension of the work. Imposing and significant works, which mostly constitute the known Cultural Heritage, are realized or come to be the identity representation of the Social Place on a large scale. Urban macro-portions, if not the totality, recognize themselves in them, relating to them with a form of respect, elevating them to divinity, and receiving from above the historical narrative concerning them, handing down the key points and arriving at a historical simplification and a sifting of the contents that allows them to take root. Differently, the "minor" works take root in the urban sub-systems, becoming for those who live the places daily the identifying sign.
The works therefore become "part of the family" and their history is characterized, furnished with curiosities or peculiarities. Oddities that are most often invented or unprovable but often based on true facts lost in time.

Fragments in Florence Downtown

Any city with a long and articulated past has buildings, squares and monuments linked to its history, the built heritage is its most obvious direct link to the historical and artistic events that characterize the current urban layout and in it society finds and structures its identity. In the midst of this main feature, there is the possibility that there are a multitude of smaller, medium or minimal elements that create a network of testimonies, sometimes difficult to grasp, but strongly linked to past events and valuable stories. These elements and related stories form with the artistic-architectural component the true and complete Cultural Heritage. Bringing to light details that are often ignored, misinterpreted because of their historical peculiarities or left in the background becomes the main topic of this study. The present research focuses on a framework based on the use of AR to make these traces in the center of Florence more accessible and discoverable.
The position in the history of the city of Florence, the durability and recognizability of the Grand Duchy of Tuscany, lead to the varied and complete panorama of architectural works and artistic elements optimal for the description and development of the present virtualization project. The social characteristics frame the population as superstitious and strongly tied to traditions and historical symbols. Thus arriving at an ideal system for research.
The urban fabric presents various elements, fragments of major works or evidence of larger projects. Fragments that arrive in Florence or that take part in wider systems. Evidence of the historical and compositional complexity of architecture and art and proof of the economic, political and social dynamics that are physiologically proper to art and architecture but that often the "tourist" does not know (or forgets), stopping at the simple aspect. As said, components of historical reading that complete the work, giving it an added value that often determines a deeper character and interest. In the development of the research, the

works taken in analysis have been chosen following two main criteria: their distribution in the historical center of Florence, in order to create a uniformly diffused mesh; the morphological characteristics of the works, in order to present models differentiated by geometric and colorimetric characteristics, creating a more varied panorama of examples of the survey and photogrammetric restitution.
The subjects of the study are: the bas-relief of the Nave, decorative portion of recovery grafted in the external wall face of the Baptistery of San Giovanni; the Bull's Head, sculpture applied to the external wall of the Cathedral of Santa Maria del Fiore; the "Faccia di Uomo", engraving on a rustication of Palazzo Vecchio, also in the external wall face; the Fountain of Sala Grande (Fagiolo Dell'Arco), destined to Palazzo Vecchio and today preserved in the Bargello Museum (Faletti); the Fountain of Sea Monsters (Cresti, Ghadessi), artistic element positioned in Piazza Santissima Annunziata (Francini).

Digitization – Interaction between Disciplines of Study and Diffusion

In the field of Architectural survey, the process of integration of digital techniques and instrumentation is now consolidated. The knowledge and development of computer science has reached a high level and now allows to consider digital techniques as the main applicable solutions, thus fully overcoming the traditional method.
The field of informatics provides the world of research and communication with a new way to enable non-industry communication. The digital products of research and studies can be read and interpreted by different figures from distant fields, but who participate in common studies. Information technology and its application are today the most stable bridge for communication and exchange of information and results. Digital survey and study techniques provide speed and precision and, when carefully managed, the possibility of creating reliable and faithful archives. Parts of these qualities are applied and emphasized in this study. The rapid and precise work of the acquisition phase and the correct management in the choices of digital formats of interchange between software led to flexible and secure conclusions (Fig. 1).
The artistic and architectural objects presented in the work have been surveyed and processed with the attention of scientific research, producing useful results, archived and made available. However, the final product is an arrangement that relates to the world of tourism and education. The choices implemented in the software have been aimed at the augmented reality product, trying to guarantee quality levels useful for the final use. In conclusion, it is useful to highlight the possibility of managing a work that begins with the scientific method, produces data that can be archived and is useful, as much as it is managed in a futuristic key, and leads to elaborations that look at areas collateral to the scientific world. Therefore, creating easy-to-use and up-to-date means of dissemination that encourage the diffusion of culture and knowledge.
Therefore, the digitalization of Cultural Heritage is today the optimal strategy for the fruition of the heritage. With the survey, the object is recorded and transported into virtual space, which allows its maximum use.
Cultural Heritage is thus: available for research and study to the entire scientific community; usable for the publicizing and dissemination of knowledge at all levels of tourism; recorded in its current state for an archive that photographs our present.

Survey and Restitution – Digital Photogrammetry

The digitization of works of art and architecture is developed starting from the survey of the subject in the studio. The survey applied in the work presented here is digital photogrammetry (Pucci), an indirect survey based on the techniques of traditional photogrammetry and whose digital component is the instrument used to "record" shape and color, the SLR or MILC camera, and consequently the software used to process the data.

Fig. 3. Photogrammetry reconstruction in Reality Capture.

As the traditional photogrammetry is a technique of indirect survey, which facilitates the practice on goods of cultural significance by excluding physical contact with the object and favors the recording of the entirety of the object when it is not approachable, for safety or shape. The objects focused by the study were taken with the Fujifilm GFXN50s camera, a mirrorless digital camera with a medium format sensor (43.8x32.9 mm), producing 50 Mp images, equipped with a Fujinon 32-64 mm f4 zoom lens. The characteristics of the various shots were in line with the optimal choices for digital photogrammetry. The camera was set in semi-automatic program with aperture priority, stopping down from f5.6 to f11. Additional priority was keeping the ISO at low values, so to reduce any possible digital noise. The tripod was used only where required for low light conditions. For saving the images it was chosen the JPG format, not the optimal format for quality, because based on destructive compression, but chosen in order to contain the weight of the full dataset and to streamline the timing of the processes of calculation and restitution (Figs. 2, 3, 4).

Augmented Reality, from the Digital Model to the AR Contents

The excellent results obtained thanks to the data processing have led to the obtainment of textured 3D models, whose optimization has characterized the last phases of this research. The models obtained all have a high number of polygons that are not compatible with the use in augmented reality, not only for the difficulties that can be found within the software used for the creation of AR (Ricciardi) content but also later for its use through mobile devices.
The choice was therefore to decimate the digital models with the software Geomagic by 3DSystems (Fig. 5), setting an average of 500k polygons for each object under consideration, then concluding the process through the baking of textures with xNormal.
The model thus optimized is ready to be imported into software dedicated to the creation of content for augmented reality [1].
The creation of the first beta version of this application was carried out using a software that is easy to use and therefore also defined by the developers as user friendly, and this is the entire package of Ios developer tools, ARKit Software, within which you can find 3 software that implement each other, and that allow you to quickly create augmented digital content.
The software in question is Reality Converter, which allows you to import and apply various textures to models and export them in the .usdz format, it can also modified other basic settings such as the environment and the scale.
Subsequently the model is imported inside the Reality Composer and thanks to the support of X Code it is possible to create the interactions that the user will then have with the model and the various information and contents that with it must be disseminated. All the models have been processed and made ready for use in augmented reality, and this has made it pos-

sible to create a map of Florence (Lanier), with certain markers corresponding to the various points of interest of the secondary heritage dealt with in this paper, which by framing it with a mobile device gives access to this augmented digital content and the information it brings with it (Fig. 6).
The second phase of this research is currently underway, as the ultimate goal is to create a definitive application compatible not only with IOS devices but also with Android, and to do this it is necessary to use an additional software, namely Unity.

Augmented Reality for "Secondary Heritage"

In this case, Augmented Reality makes it possible to make more accessible and appealing a type of heritage (Pescarmona), known as secondary heritage, present in every city, which usually attracts less interest among tourists and scholars.
The possibility of sharing information about the existing architectural and cultural heritage with tools that are not innovative in their means of use but in the purpose they serve, should be considered as an option to always take into account in the field of dissemination of the heritage and education. Augmented Reality was born as a tool to expand the reality in which we find ourselves in a slightly more immediate and less articulated way than Virtual Reality, and this makes it a tool more within everyone's reach and easier to disseminate.
The hard part is to understand what can be disseminated, what data and information to disseminate in AR so that it is clear and accessible through mobile devices, and so that the data is not misinterpreted.
It is a tool that makes content of great historical and architectural value accessible, thus enhancing the secondary cultural heritage, which is not sufficiently supported in Italy.

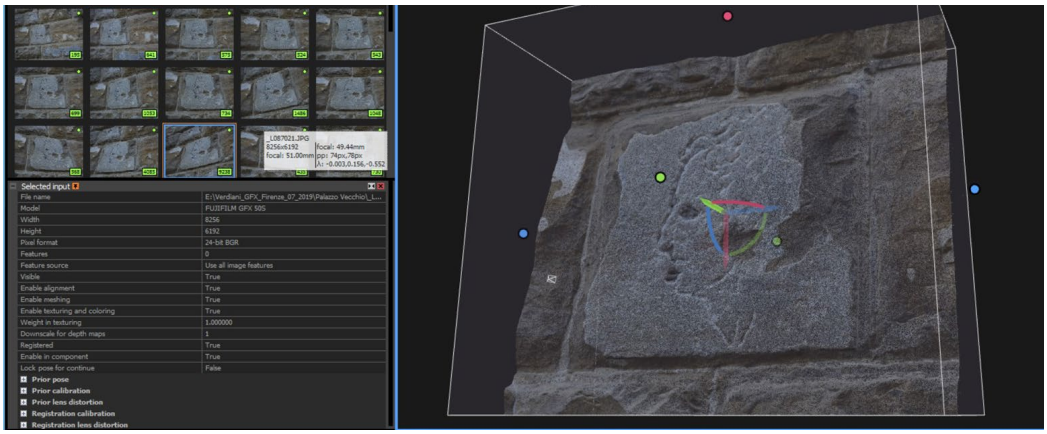

Fig. 4. Mesh 3D model from photogrammetry in Reality Capture.

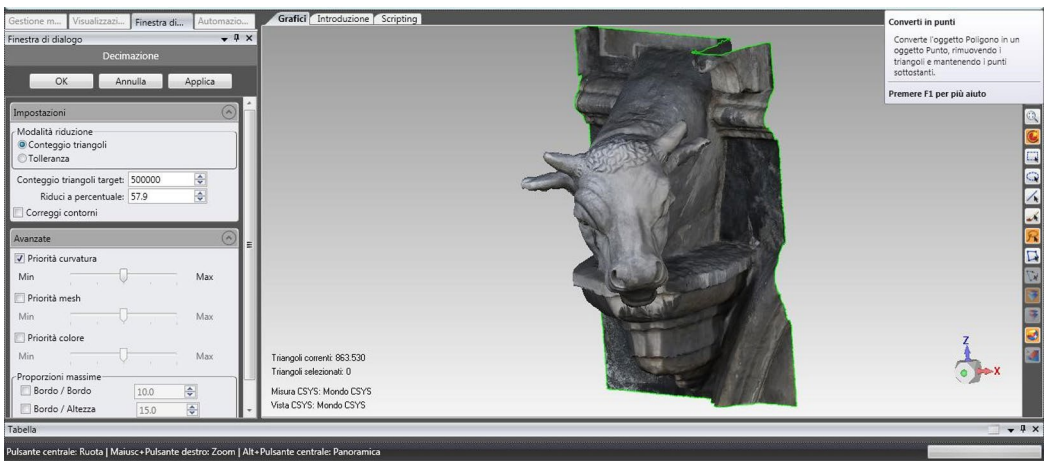

Fig. 5. Mesh model control and manage in Geomagic Studio.

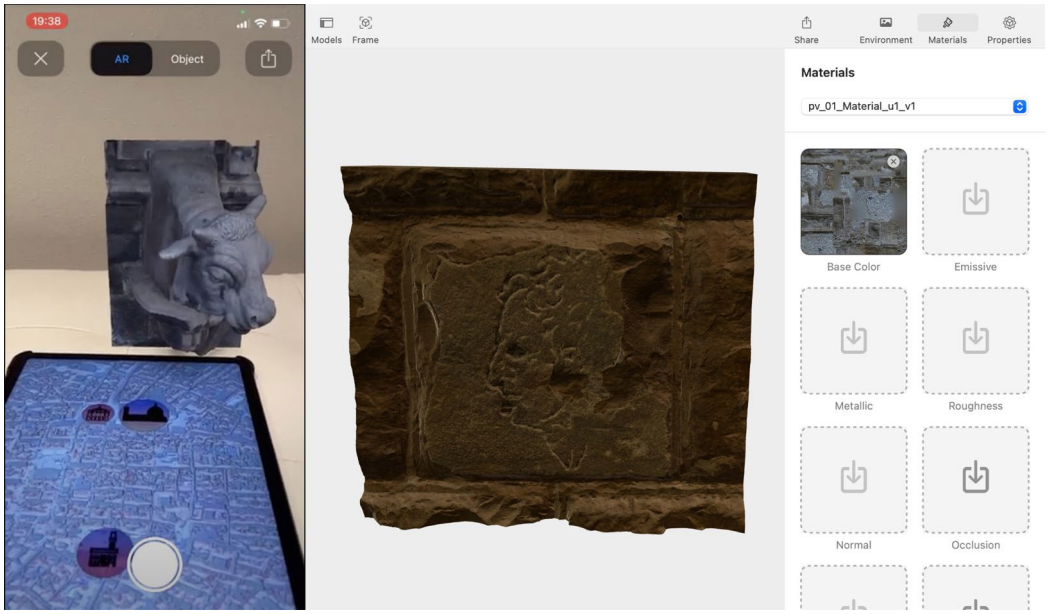

Fig. 6. IOS developer software and IPhone visualization.

Conclusions

The concept of "minor" for artworks is feeble and difficult to frame in a society more and more focused only on mainstream elements, but it represents a rich and various context that contributes to the complexity of the puzzle of components connecting the world of the arts, the town, the people living and visitng the urban area enriched by historical traditions. They represent a specific approach where the artist has operated for the benefit of the town, sharing his productions with the will to show to others an idea, an element of historical value or even moved by the intention of making a bad taste joke. Keeping these elements alive in the memory of people and promoting them as a part of a possible, alternative route, is a step towards a more sustainable approach to visiting, reconnecting the cultural environment of different periods and testifying both a continuity and a variety. The elements, in the end, need this kind of approach, to keep their role in the urban context and remaining correctly known in the mind of people, avoiding fake or superficial interpretations. This mosaic of separated artwork is not dispersive in front of the masterpieces, but may work a robust glue between places. It got all the quality and the potential fascination that may attract and justify a special visit, something that may work extremely well in combination with digital technologies, bringing them a significant contribution in terms of contents, with a worthy challange between the proper reading of the artwork, its interpretation and the choices taken to propose it to users.

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Notes

[1] The 3D models of the Marine Monsters' West fountain and the Marine Monsters' East fountain are available in sketchfab.com at the URL: https://skfb.ly/oqyqv and at the URL: https://skfb.ly/oqy7

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