

Talking City: Voices of Hidden History in the Architecture and Urban Places of Rome

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Abstract

Our cities today represent a complex intersection of material and immaterial culture, which can be described and promoted through possible heritage itineraries. Among the various topics of these itineraries, a topic of great interest for us is the writings traced throughout history on the wall surfaces of the city's buildings to convey messages and opinions for the most diverse purposes. Their value is not only in the quality of the single artefact but also because they can serve as unique keys to understanding the society that produced them in depth, i.e., to comprehend the culture, customs, and ways of communication of a specific historical period. From this point of view, the inscriptions produced by the ruling classes, the secular and religious power are less exciting than those traced by single or common people. Therefore, these traces of the past are a fundamental historical resource since the people's voice resides in them; they are an intangible heritage transmitted through the materiality of the supports and architectures on which they were traced or placed. Unfortunately, many of these inscriptions are hidden or barely visible within cities. Besides, their decoding is related to the type of handwriting, the engraving technique, and the content conveyed. Finally, in today's society, there is a prevalent dominance of the image with clearly conveyed content, relegating these kinds of cultural products to an omitting background. The study presented in this paper, at an early stage of development, is developed within Rome, a city characterised by a complex and deep cultural stratification. The research aims to map some graffiti and 'minor' epigraphs (i.e., non-monumental or particularly solemn) and build narrative itineraries throughout the city, starting from a study of these particular traces within the architecture. By enhancing these historical sources through these routes, the architecture will become a narrative system capable of telling stories, giving voice to real-life stories and the immaterial culture condensed in those places, and rediscovering a stratified and hidden intangible heritage in the city.

Keywords

Graffiti; Image acquisition; Invisible traces; 'Minor' Epigraphs; Past voices; Storytelling

1. Introduction

Wall surfaces have always been an effective medium for communicating. Since ancient times, different people have traced sketches and writings on these surfaces to convey various types of content. The variety of cases is vast, even limiting the scope to ancient and, more generally, historical 'writings,' and therefore excluding figural elements. They

can be authorised, official, clandestine, and transgressive. There are those signed and those anonymous. Some are an expression of secular or religious power, others of social or cultural movements, and still others of single individuals; some have celebratory and commemorative purposes of events or characters, and others are informal and extemporaneous writings made to leave a sign of one's presence in that

place and time. Men of culture trace some with particular executive care. Others are traced in a disordered and confused way by semi-alphabets. Sometimes, they are made in places open to the public to allow a collective reading (called 'exposed writings' (Petrucci, 1985)). However, they can also be created in places that are not easily accessible, with unusual writing codes, and are therefore difficult to understand (called 'introverted writings' (Felle, 2022, p. 8)).

These writings, whatever their forms, supports, executive techniques, and purposes, are a valuable source of information on the culture, customs, and modes of communication of the period in which they were produced. They express the society that produced them; therefore, they are a singular access key to its understanding. Moreover, as the essays by the paleographer Armando Petrucci already stated in the 1970s (Petrucci, 1978) and then more extensively demonstrated in the 1990s (Petrucci, 1996), the relationship between writing and society is very close. Therefore, the value expressed by all forms of writing on the wall surfaces is a fundamental document for reconstructing the history of society, not only that of the ruling classes but also that of the people.

In this context of great richness and complexity, our attention has been directed exclusively to those ancient and historical writings on the wall surfaces of the buildings in Rome that tell individual stories (Bianconi, 2014). From this point of view, we have therefore considered both the graffiti executed with any technique (scratched, engraved, painted or in charcoal) and the 'minor' epigraphs, meaning by this term, the epigraphs whose content concerns a single individual, not they are therefore neither monumental nor particularly solemn and neither an expression of secular or religious power.

Such written documents—graffiti or 'minor' epigraphs—are fundamental testimonies of intangible culture, because they tell individual stories that allow us to understand the society that produced them. However, they are also testimonies of material culture because of how they are made and the architectural and urban spaces in which they are located. In our opinion, another characteristic that these

types of writings have in common is, in fact, that of the "spatial dimension" (Felle, 2022, p. 10), of the strong link they have with the context in which they are placed and, in the specific research, with the architectural and urban space. A powerful relationship in the case of graffiti which "derives their *raison d'être* from a given place, a spot that lifts them above the arbitrary and saves them from the status of random scribbles or mere elements of decoration" (van der Vliet, 2021, p. 91). However, it is the same for the epigraphs that "articulate space in its meaningful aspects and may reshape and overwrite it" (van der Vliet, 2021, p. 91). Therefore, these historical testimonies are a heritage of inestimable value, even if they are mainly known only by insiders, being unknown to a broad audience. It also happens in Rome, and the phenomenon is mainly present for different reasons. First, they are difficult to trace. Their location is almost unknown, hidden by a morphological complexity or limited accessibility. Furthermore, they need help understanding. Their decoding is linked to the type of handwriting, engraving technique, and content conveyed.

The rediscovery of these historical testimonies thus becomes a challenging theme, which led us to open a new research path without any funding. Enhancing this material heritage (artefacts and places) as well as the immaterial one (stories and values of individuals, communities, culture, society) and the network of related relationships can be an exciting action to carry on. Therefore, to identify a possible concrete action to enhance it, we started a preliminary study to evaluate the case study consistency and test a communication project of these written documents in Rome. The valorisation of cultural heritage continues after preserving its materiality. However, it is only fully realised on the condition that the cultural asset and the knowledge about it can be enjoyed and used by the community.

The Talking City study, presented in this paper in the first preliminary stage, aims to build narrative itineraries that accompany a broad and non-specialist audience through the city of Rome in the rediscovery of a stratified material and immaterial heritage, i.e., messages of these scriptures and the stories of those who wrote them. A perspective in which the buildings of the city of Rome become narrative

palimpsests¹, capable of telling and giving voice to lived life stories. The project, presented in the article in an early stage, aims to build knowledge itineraries within a certain number of case studies. We mapped their geographical distribution and location in this process, classifying the typologies and related themes. The first results allowed us to set up a first communication project, testing the possibility of scaling it in similar situations.

2. A Multidisciplinary Approach: Research Experiences

Several disciplines with different interests and objectives deal with such historical evidence. Among these are palaeography and epigraphy. The first concentrates its studies on writing forms (especially manuscript and non-monument) made on any material, thus also including painted, engraved, or scratched writing on walls. Epigraphy often deals with inscriptions made on 'hard' support materials and, therefore, durable materials. In particular, palaeography aims to reconstruct the history of the graphic forms of writing (decoding, interpreting, dating, and locating them) and to establish genres, types, and graphic styles of writing through executive techniques. The comparison among different examples allows investigating the socio-cultural contexts of their use (Istituto della Enciclopedia Italiana fondata da Giovanni Treccani S.p.A., 2023). Epigraphy, conversely, "deals with what is written to communicate a message or some simple information element to an audience theoretically as large as possible and for as long as possible" (Lambert, 2004, p. 13). Therefore, it studies both the texts of the epigraphs and the monuments or objects on which they are written and, above all, the society that produced both (Panciera, 1998).

These testimonies are generally studied in archaeology, philology, historical disciplines, and art history. For this reason, some scholars have made them their main subject of expertise (Susini, 1982). The heterogeneity of knowledge demonstrates the complexity of the subject and its multidisciplinary nature. As a result, the research projects are equally numerous and diverse.

First, these include those aimed at creating open-access online archives. In this context, a large-scale project launched in 1997 is represented by EAGLE – Electronic Archive of Greek and Latin Epigraphy (<http://www.eagle-eagle.it>), an international federation of epigraphic databases that aims to collect all the Greek and Latin inscriptions published up to the 7th century AD based on the best existing editions, attaching, when possible, further essential data. The Epigraphic Database Rome – EDR, the Epigraphische Datenbank Heidelberg – EDH, the Epigraphic Database Bari – EDB, and Hispania Epigraphica – HE are part of EAGLE. In particular, EDR (<http://www.edr-edr.it>) aims to collect the whole epigraphy of Rome and the Italian peninsula, including Sardinia and Sicily, except Christian inscriptions (under EDB jurisdiction).

The EAGLE Federation has initiated the EAGLE Europeana project (<https://www.eagle-network.eu>), co-funded by the European Commission (under its Information and Communication Technologies Policy Support Programme; Amato et al., 2014). The specific objective is to create a single user-friendly portal to collect and catalogue images and other digital objects, with various textual information, relating to hundreds of thousands of Greek and Roman inscriptions. The more general objective of the project is to disseminate, i.e., to make Latin and Greek epigraphy known, understood, and appreciated by a broad audience.

The Ancient Graffiti project – AGP (<http://ancientgraffiti.org/Graffiti>) also fits into this context, which, coordinated by Washington and Lee University with the collaboration of many universities and experts in digital humanities and ancient epigraphs, is a contributing member and works in collaboration with the Epigraphic Database Rome and EAGLE Europeana. The AGP is a collaborative and interdisciplinary research project that aims to create a digital resource (repository and search engine) for locating and studying handwritten inscriptions (messages and sketches) of the early Roman Empire, especially in Herculaneum and Pompeii. It offers a window into the daily life and interests of people

¹ Here the use of the term palimpsest is in its metaphorical meaning, a very common use in the literature, architecture and history of cities. In this very important work, Gérard Genette (1982) examines the multiple relationships that a text can have with previous texts. A palimpsest is a parchment which contains two superimposed texts, and in which the original is not completely erased but remains visible in transparency. It is the hypertext relationship. Moreover, as in a palimpsest, it is not just a matter of writing, but also of reading.

who lived in the ancient world by providing information on the economy, religion, language spoken, literacy, and activities within the city (Benefiel & Sypniewski, 2020). The search engine allows for different types of searches. Indeed, it is possible to search for graffiti based on text (Latin terms, English translations, toponyms, bibliography), by their location (city map or city block), or by specific characteristics (for example, figural graffiti).

Therefore, the objective of sharing this cultural heritage has accelerated multidisciplinary collaboration, particularly between the humanities and computer science. In recent times, digital and interactive media have favoured its dissemination to a broad audience by creating narrative and multimedia paths and paying particular attention to the user experience. For example, the EAGLE Europeana Portal offers several resources in this direction. Among them is a storytelling platform (The Flagship Storytelling Application – FSA, <https://www.eagle-network.eu/resources/flagship-storytelling-app>), which is a web-based tool designed to allow users to create multimedia narratives on epigraphic content and share them on the web. Another resource is the EAGLE Mobile Application, which allows users to get information about one visible inscription by taking a picture with a mobile device and sending it to the EAGLE portal (<https://www.eagle-network.eu/resources/flagship-mobile-app>). This app, realised explicitly by CNR-ISTI-AIMH, is free, available on Google Play Store for Android smartphones, and can visually recognise approximately a million inscriptions collected by the EAGLE project (Bolettieri et al., 2015).

Another exciting project is the Venice Squeeze Project (<https://mizar.unive.it/venicesqueeze/public/frontend/index>), aimed at enhancing and disseminating the Ca' Foscari University collection of squeezes of Greek inscriptions preserved at the Laboratory of Greek Epigraphy. Within the project (made in collaboration with the E-stampages project of the École française d'Athènes and the HiSoMA Laboratory of Lyon, and the Digital Epigraphy and Archeology – DEA Project of the Florida University), the database was designed, the online archive created and 3D models of the squeezes made using the software designed by DEA based on the shape-from-shading method (Antonetti et al., 2017).

DEA is an interdisciplinary project initiated by the Digital Worlds Institute and the Department of Classics at the University of Florida. The project aims to develop new open-access scientific tools to service and promote epigraphic and archaeological research by applying information technology and digital and interactive media (<https://research.dwi.ufl.edu/projects/digitalepigraphy.org>). In this context, the researchers have developed several open-source tools and applications. Initially the team worked on developing an online tool for the 3D reconstruction and analysis of epigraphic squeezes (<https://www.digitalepigraphy.org/page/shape-from-shading-3d-reconstruction-tool>), which can help scholars understand the structural characteristics of artefacts, based on the shape-from-shading method using two scanned images of the squeezed papers (Barmpoutis et al., 2010). They initiated the development of the Digital Epigraphy Toolbox (<https://www.digitalepigraphy.org/legacy/toolbox/info.html>), which integrates 3D reconstruction software with a dynamic online library of three-dimensional inscriptions for the practical study and comparative analysis of Greek and Latin inscriptions (Bozia et al., 2014). In the following years, they improved the Digital Epigraphy Toolbox by focusing on developing a graphical interface that includes user-friendly options for multi-modal visualisation of 3D model inscriptions (<https://www.digitalepigraphy.org/page/digital-epigraphy-toolbox>). They devised a new interface to allow users to browse through 3D databases of inscriptions and visualise the inscription within their actual physical space. Using head-mounted augmented reality displays (such as Microsoft's HoloLens), users can browse 3D databases of inscriptions, select an inscription, place its hologram in physical space (e.g., on top of a desk), study the inscription by naturally walking around the hologram, zoom in on the hologram using natural hand gestures. In addition, users can rotate, scale, and move the hologram in real space and open multiple holograms simultaneously for a comparative study of inscriptions (Bozia & Barmpoutis, 2017). More recently, they have been improving interaction design by looking for solutions to use the sensors in popular portable devices, such as tablets and smartphones. The developed interface allows the users to naturally hold digitised inscriptions, interact with them in order to relight or manipulate them as if they were physical

objects and interact with metadata or other multi-modal data, such as text and images (Barmpoutis & Bozia, 2017).

Based on the projects reported, it is evident how the study, learning, and dissemination of artefacts such as ancient and historical epigraphs and graffiti passes through the balanced integration of communication and dissemination technologies. For this reason, the *Talking City* research presented here at an early stage aims to experiment with different technologies for acquiring, modelling, and visualising digital data to understand them better. These will define thematic and content-related inferences and relationships within the city, building knowledge paths aimed at giving voice to little-known but significant traces of the past for understanding the place’s culture.

3. The Research Project and the Communication Project

The prototype of our communication project aims to propose an approach that favours access to information for non-expert users interested in knowledge of the cultural heritage and attracted by lesser-known and less frequented itineraries. This project focuses on ancient and historical graffiti and ‘minor’ epigraphs of the city of Rome, whose different characteristics are accurately described but always concerning the context in which they are located—the architectural space and the city. Through this heritage,

visitors are guided to discover the architecture and the city of Rome from different points of view: people who inhabited or passed through those places at a particular time. Having clarified the target and the general objectives, we defined what content to disseminate, how to access it, and, consequently, the most effective tools and channels to adopt.

Considering the target, the communication models chosen are visual—maps, plans, photos, virtual tours, embedded with applications in AR—because they are more engaging and, therefore, can interest a broad audience. The visual content will then be coupled with textual information: from the meaning of the written document to contextual information to understand its cultural value. The primary way of accessing the content is thematic (geographical, historical, and typological). By choosing a theme (Figure 1), several unusual but reliable itineraries will be proposed to the user concerning the quality of the data processed and the content produced. Relevant maps will be displayed, highlighting thematic objects and, in some cases, suggesting proximity itineraries (proposing visits to a nearby place at a defined time).

Another way of accessing content will be through stories. This option allows the user to choose from several proposed

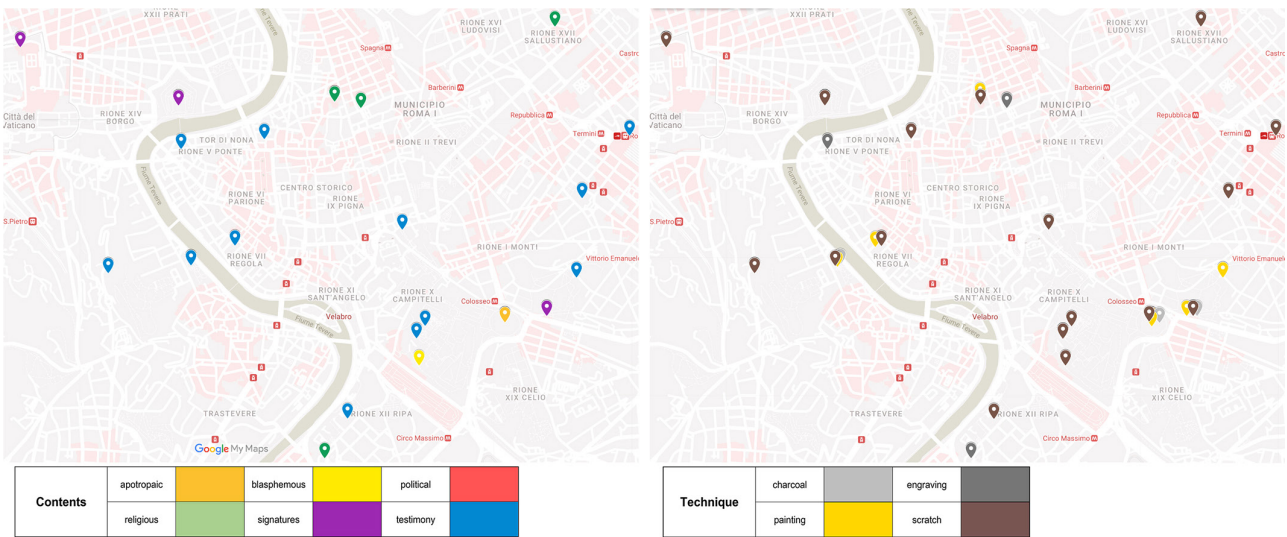


Figure 1. Examples of some thematic maps from which the thematic itineraries are derived.

stories constructed from graffiti and epigraphs. Stories of everyday life or excellence that aim to be deeply involved, establishing a profound relationship between content and audience, acting not only on cognitive-rational aspects but also on affective-emotional ones. Another access mode is exclusively geographical; the user can view points of interest distributed within a 1 km radius around his or her location. Finally, the last level of access is the classic searching instrument whereby it will be possible to find thematic objects in a building, a church, or a street.

After extensive research, it was decided that the most effective channel to convey this content is a Progressive Web App (PWA), a hybrid between a website and a mobile app (Figure 2). It can be used from a mobile device without

downloading and can access the device's tools, such as a camera, microphone, GPS location, and push notifications. In addition, thanks to the PWA's responsive design, the user's perception of the app's interface (the so-called 'Look and Feel') is similar to that of a native app. Finally, AR technologies can also be integrated into a PWA so that mobile and web applications can be designed using the same source code base.

Among the advantages of PWA is the Service Worker, which is installed when the application is accessed for the first time, responds to events sent to it from the web page and saves and retrieves cached data. Thanks to this feature, PWA can also be used offline, data can be accessed much faster, and, above all, updates made on the website are



Figure 2. The prototype of the *Talking City* PWA.

always available on the mobile device. This last feature is the most relevant for the research project because although the objective is the dissemination of cultural content, in order for communication to be reliable, it must be based on an information system that can be implemented over time. It must be correctly structured, starting from the elementary units constituted by the written documents. Therefore, the project envisages that structured data collections organised in relational and geographic databases, metadata, and a set

of links, will be related to each geographically contextualised elementary information unit. The data set will be made available by uploading it onto a platform (characterised by integration, interoperability, and scalability of data and technologies) precisely customised for the project, allowing access to and exploration of the entire heritage of resources.

In detail, the main challenges that need to be solved are summarised below:

- The definition of the information structure of relational databases: elementary information units (the writer documents) and related attributes—texts, 2D images (sketches, drawings and photographs), AR and Virtual tours; the geo-referencing on the map of the written documents—points of interest (POI)—and determining which cultural contents can be displayed according to the predisposed modalities;
- The configuration of the relationship system to interface by querying the database, the contents inserted in the Content Management System (CMS) with the browser;
- The design of the graphic interface, from the choice of visual language to layouts.

As mentioned, although the project envisages free navigation through textual and geographic queries, the preferred mode of use is guided to facilitate access to the objects, which will be from the icons on the map. Clicking on the icon will open a first page showing a synthetic plan of the architectural or urban space, with the locations of the historical writings highlighted (graffiti and 'minor' epigraphs) and for each scriptural document, a photographic image and a brief textual description. In addition, through links, it will be possible to explore the scriptural document in AR and, through a virtual tour, the architectural and urban space. In particular, AR is used to improve the legibility of inscriptions by superimposing images on the target object and

incorporating historical information or written translations.

Another significant aspect is the introduction of audio files that would provide a voice to the people who created these inscriptions or to whom these inscriptions were made, making previously invisible and incomprehensible signs comprehensible to the public.

After defining the communication project prototype, we examined some of the main issues that will be described in the following paragraphs. In particular, they concern: the study and analysis of a significant number of examples of ancient and historical graffiti and 'minor' epigraphs found in Rome, the classification of these artefacts—the metadata, the recurring formal, material and dimensional characteristics—the correct methods of photographic shooting and the most effective forms of visualisation for the user-experience, also using AR applications.

4. Historical Writings in Rome: Graffiti and 'Minor' Epigraphs

The investigations first concentrated on identifying cases that could be considered relevant to the studies, proceeding methodologically in two ways. On the one hand, through the online application Google My Maps, a map was constructed to quantify the distribution of the places on Roman territory in which several examples have been found (Figure 3). It served as a helpful tool for consultation and progressive updating



Figure 3. Multiple examples of ancient graffiti in Rome, showcased on a map created using My Maps, with the analysed samples highlighted in red.

among the authors. This aspect immediately highlighted the number and breadth of historical periods to which the examples refer and their typological variety in terms of creation and associated communication content. Besides, this process emphasised the complexity of identifying routes of access and appreciation for artefacts dispersed across distant locations and situated within diverse architectural contexts. Furthermore, some are found in inaccessible areas, presenting varying conditions for viewing and appreciation. Therefore, on the other hand, and in parallel, it became necessary to identify typological-technical categories and content categories for classifying the cases. We considered 25 places where several examples are present for research purposes. All the cases are in diverse architectural-urban contexts: six churches/ecclesiastical complexes, three catacombs, five villas/historical palaces, two town gates and archways, one town monument, one private house, and seven archaeological areas. Most are examples of graffiti (21 places), and only in four locations are 'minor' epigraphs. The documentation showed that the religious and archaeological sites are those for which it was possible to find bibliographical references in the historical-archaeological or palaeographical and epigraphic domain. Conversely, information about the cases in historical villas, palaces, and catacombs is scarce, primarily traceable on online sites or framed in more general studies (Keegan, 2014; Solin, 2008).

The examples span from the first century to the first half of the seventeenth century. As a result, they present a range of characteristics influenced by the artistic sensitivity of the authors and the cultural context of their time. The content of these examples further contributes to their distinctiveness, showing glimpses into the life, beliefs, and concerns of the people who inhabited the city.

A comprehensive table (Table 1) was created to facilitate the analysis of the identified examples in the Roman area, categorising them on their type, technique, content, dating, and accessibility.

Three primary types were subsequently distinguished:

- **Scratches:** Scratches encompass etching surfaces such as walls, columns, or wood using pointed objects. This category comprises the most abundant examples of

ancient graffiti, exhibiting a broad spectrum of content that ranges from simple personal names to more intricate and elaborate communications.

- **Painted or charcoal signs:** These graffiti were created using paint or charcoal to trace symbols, messages, or images on surfaces. These signs served various purposes, including political communication, religious expression, or simply leaving a mark to signify one's presence. While these signs were more prevalent in ancient times, fewer examples have survived due to the perishable nature of the materials used.
- **Engraving:** Typically found on marble or stone, these consist of concise texts in prose or verse covering many topics, from dedicatory messages to political statements. Many epigraphs are associated with funerary contexts, serving as memorials or epitaphs, while others express religious devotion, as exemplified by the case of San Lorenzo in Lucina (Brandt, 2012).

Once the main types were established, a further classification was applied based on the contents of these communications, resulting in the identification of five distinct subsets:

- **Signatures:** This type is prevalent and serves as evidence of an individual's presence in a specific location;
- **Messages:** Typically, these phrases are engraved or painted on walls. The topics can be diverse, ranging from messages directed at specific individuals to those of a more general nature. In many cases, ongoing exchanges or conversations have been found within graffiti.
- **Politics:** This category includes political slogans and satirical expressions. These types of graffiti offer insights into the political and social climate of the respective time (Morstein-Marx, 2012).
- **Religion:** Religious graffiti are abundant in Rome, showing the coexistence of different religious practices in the city. These inscriptions often depict symbols, prayers, and invocations. Within this category is a subcategory called Blasphemous graffiti. This particular graffiti mocks religious beliefs and is often accompanied by caricatures.
- **Historical events:** This group encompasses all graffiti that provide information related to historical events (of various kinds) or insights into the lifestyle of the society in question.

Sites	Type	Technique	Contents	Dating	Accessibility
Arco dei Banchi	graffiti	engraving	testimony	1640	✓
Basilica Argentinaria	graffiti	scratch	testimony	1st – 3rd century AD	✓
Basilica di Santa Maria Maggiore	graffiti	scratch	testimony	3rd – 4th century AD	X
Casa di Augusto	graffiti	scratch	- signatures - testimony	43 BC – AD 17	✓
Castel Sant'Angelo	graffiti	scratch	- testimony - political - signatures	6th – 7th century	✓
Catacombe di Santa Domitilla	graffiti	painting	religious	4th century AD	✓
Catacombe di San Callisto	graffiti	painting	religious	3rd century AD	✓
Catacombe di San Sebastiano	graffiti	scratch	- religious - testimony	3rd century AD	✓
Colosseo	graffiti	painting charcoal scratch	- testimony - signatures - apotropaic	3rd century AD	✓
Cryptoporticus degli Horti Sallustiani	graffiti	scratch	religious	3rd century AD	✓
Domus Aurea	graffiti	painting charcoal scratch	- religious - testimony - signatures	2nd century AD	✓
				16th century	
Domus Tiberiana	graffiti	scratch	testimony	2nd century AD	✓
Musei Vaticani	graffiti	scratch	political	1527	✓
			- testimony - signatures	17th - 19th century	
Palazzo Altemps	graffiti	scratch	testimony	1496	✓
Palazzo Farnese	graffiti	painting scratch	testimony	18th century	X

Pedagogium	graffiti	scratch	blasphemous	2nd – 3rd century AD	✓
Pontificio Ateneo S. Anselmo	epigraph	engraving	religious	3rd century AD	✓
Porta Maggiore	epigraph	engraving	religious	AD 11 – AD 53	✗
Privachaus graffiti at Stazione Termini	graffiti	scratch	testimony	2nd century AD	✗
San Lorenzo in Lucina	graffiti	painting scratch	testimony	2nd century AD	✓
	epigraph	engraving	religious	12th century	
San Silvestro in Capite	epigraph	engraving	religious	9th century AD	✗
Santa Sabina	graffiti	scratch	religious	2nd century AD	✗
Terme di Traiano	graffiti	painting	testimony	2nd century AD	✓
Villa Farnesina	graffiti	painting charcoal scratch	testimony	1527	✓
Villa Lante	graffiti	scratch	religious	2nd century AD	✓
			testimony	1527	

Table 1. Summary of the main examples in Rome.



Figure 4. Some accessible rooms in the basement of the Basilica.

4.1. Analysed Examples

The five case studies were selected according to several criteria. First, we considered two cases of each type (graffiti and epigraphs), differing in historical-temporal location and the wall surface (stone, fresco, and plaster). Therefore, we compared different digitisation methods, i.e., identifying the most appropriate ones for the types of artefacts identified by the research.

In San Lorenzo in Lucina, two cases were selected, which differ in type and location. In the underground Basilica,

accessible according to specific visiting hours, there are parts of a building from the 2nd century AD on which walls fragmentary graffiti was found (Figure 4). Among the analysed cases, we present in section 5.2 some epigraphs in the rooms of the underground Basilica (Figure 4 A–B) and graffiti on the east wall (Figure 4 C–D). The latter, which is more extensive and partly damaged by several holes (Figure 4 C and 9), consists of four lines written ‘in scratch’ with letters varying in height between 10 mm and 30 mm, even slightly different in shape and depth of the inscription. Palaeographic readings have recognised the presence of



Figure 5. The main wall in the portico of San Lorenzo in Lucina.

some names (Victor, Agatemerus, and possibly Strenuus). The other graffiti is placed lower (about 15 cm) and next to a large hole in the plaster; it features a group of apparently disconnected figures (XV, IX, V, I, III, IIIXX) (Blennow, 2012).

The second case is a 12th-century epigraph, probably placed initially as a decoration inside the church, which is currently located in the entrance portico of the Basilica (Figure 5). It consists of a 0.68 m × 1.10 m marble slab, and the height of the letters is 25 mm to 35 mm high, regular with classical forms, sometimes with serifs. The inscription contains characteristic features of mediaeval orthography. It has no ornamentation except for an initial and final cross-placed between the Greek letters α and ω (Blennow, 2012).

The third case under consideration is a group of graffiti located in the Basilica of St. Sabina discovered following excavations carried out in the last century. These led to the discovery of an archaeological complex comprising a section of the Severian wall and a series of rooms that were used as a meeting place and place of worship for an Isiac community in the 2nd century AD. The series of graffiti (at least 8) is located on an *opus incertum*² wall in a connecting passage between these rooms. Traces of residual colour testify that they were traced on a plaster decorated at the time. They are partly overlapping and graphically different, written in Latin except for one in Greek, which is also executed with a relatively coarse tool (Volpe, 1982).

² *Opus incerta* (opus incertum) is a Roman building technique that concerns the way in which the face of a concrete wall is built. Stones of unequal size were used, placed with their faces matching each other, resulting in an irregular and random pattern.

The fourth case is an epigraph under a vaulted passage called the Arco dei Banchi that connects via del Banco di Santo Spirito with Via Paola. Under the arch on the right is a tall and narrow stone slab, placed initially under the portico of the church of St. Celso and Giuliano, which, in semi-gothic characters and abbreviated words to save space, bears the oldest engraved inscription relating to the flooding of the Tiber on 7 November 1277. A horizontal line placed under a supporting iron bracket indicates the flood level. However, the most exciting aspect of this case is that in the upper part of the slab, a further inscription was engraved in 1640 that can be traced back to the typology of the testimonies.

The last case is located in Palazzo Altemps. Since 1997, it has been one of the four sites of the Museo Nazionale Romano and was named after Cardinal Marco Altemps, who bought it in 1568. However, its original core dates back to the 15th century when Girolamo Riario, nephew of Pope Sixtus IV, commissioned Melozzo da Forlì with its construction and decoration. Several frescoes remain visible from this older phase. They include the one painted on the *piano nobile* (1st floor) on a wall of the Sala dei Notabili, also known as the Sala della Piattaia, because of what the fresco depicts. Against a background simulating a colonnade set against a wall of coloured marble slabs and a tapestry with floral-vegetal motifs placed at mid-height, a sideboard or platter is depicted on which are arranged, on a tablecloth, candelabras, plates, cups, and another crockery, perhaps the tableware (or wedding gifts) used for the wedding of Girolamo Riario and Caterina Sforza in 1477. It is precisely on the Piattaia fresco that there are some graffiti dating between 1496 and 1498, probably made after the Riarios abandoned the palace, having fallen into disgrace after the death of Sixtus IV, i.e., before 1911, when Cardinal Francesco Soderini purchased the palace. Other graffiti can also be found on the wall jambs—also frescoed—of the two windows on either side of the Piattaia.

5. Methodology

5.1. Data Acquisition: General Considerations

The digital survey of the artefacts discussed in this research deserves general consideration before considering the specific case studies and specific activities in situ. The

critical analysis allowed us to identify the best digitisation approach. Generally, there are two main variables to consider: the specific artefact (dimensional and material aspects) and the environment in which it is framed (Table 2). Both these elements lead to significant variations in a digital documentation campaign. As mentioned in the previous paragraphs, considerable distinctions between graffiti and epigraphs must be considered. These include dimensions—i.e., engraving depth, surface coverage, and character size—as well as material type and content intricacy, including text structure and meaning.

A difference, however, concerns the context in which the artefacts are placed. As will be inferred from the different characteristics of the two types, graffiti and epigraphs, their location and relationship to architecture also change. The important matter is represented by visibility. In Roman times, ancient graffiti in Rome are usually barely visible and often hidden within architecture, as they are defined by people's desire to leave a trace that does not necessarily need to be read by many people. Also, many of these scratches have been negatively affected by the passage of time, leading to their abrasion, removal, or being covered by other structures. In contrast, epigraphs are created to leave a trace that is evident and can be read by passers-by, so their visibility is more pronounced and highlighted by their larger size, different material, and location, often in observable areas (facades, narthex, or walls on passage areas within buildings). Furthermore, the different location of these artefacts within the architectures also implies a significant difference in their context and lighting conditions. The graffiti considered by the *Talking City* project are fleeting traces often in poorly visible (crypts, catacombs) or hidden parts (secondary walls, plinths), in which the absence or reduced amount of light or space for use makes them even less accessible. Epigraphs, on the other hand, precisely by their visible location, are often well-lit and have vast space that allows full fruition of the artefact.

A final distinction is the deterioration of these works over time. Graffiti is subject to the same conservation issues as the masonry in which it is embedded. Graffiti, having almost no thickness, is mostly subject to trace transformation.

Conversely, material deposits can more easily cover it. Finally, the fact that they are often in barely visible or inaccessible places sometimes preserves them from both anthropogenic and climatic conditions, even if the same external conditions prevent the visibility of artefacts. In contrast, epigraphs, especially those outside buildings, are subject to more significant deterioration due to weathering exposure and anthropic presence. The result is a progressive loss of detail in both the edges of the stems and the edges of individual letters, which change and lose their recognisability.

These characteristics open a critical overview of the possible documentation techniques that can be applied to the artefacts. Regarding graffiti, their two-dimensionality implies that no 3D acquisition methodology needs to be applied; a

normal photo camera is sufficient. Instead, it may be helpful to superimpose images acquired with different cameras (visible light, near-infrared, multi-spectral) to investigate the characteristics of poorly visible artefacts better. In addition, graffiti is often placed in difficult acquisition conditions with low light and narrow spaces. Therefore, special attention should be paid during data acquisition, especially in the scene lighting and setup of the camera parameters. On the other hand, one must try to optimise the position of the camera with respect to the acquisition area, even in the absence of space.

Epigraphs may exhibit a three-dimensional shape, which implies the possibility of using 3D acquisition techniques consistent with the characteristics and level of detail of

Characteristics	Graffiti	Epigraph
Dimension	Small	Medium to large
Depth	None	Small
Material	Any surface	Marble/Granite
Visibility	Low/None	High
Illumination	Low	High

Table 2. Summary of the main characteristics of graffiti and epigraph which can affect the data acquisition process.

the artefacts, such as precision photogrammetry or active triangulation 3D laser scanner, preferably fringe projection, given the optical limitation of marble. The space for data capture is always guaranteed, as is the illumination of the artefacts. In the case of epigraphs, acquisition problems may be dictated by excessive grazing light, in case they are located outside the buildings, as well as by location, in case they have been placed in poorly accessible positions. Starting from this examination, only standard digital photo

cameras are employed in the research, highlighting the specific problems and solutions adopted for each individual type.

5.2. The Acquisition of the Graffiti and Epigraphs

In the present case, one of the four stems under the exonarthex of San Lorenzo in Lucina was considered. The shooting conditions are ideal since the light is diffuse. In addition, the space in front of it is very large, allowing for

optimal planning. The acquisition was divided into two different phases. The first one consisted of a single photograph at a distance of 3.5 metres and with a nadir optical axis more or less in the centre of the artefact to optimise the size of the acquisition area with the object shape. Next, the artefact's dimensions were measured, although some problems were encountered in precisely defining the boundaries, which were often poorly visible and blunt. In the second phase, we approached the distance of one metre, acquiring a mosaic

of 24 photographs with an optical axis nadir to the cultural asset and covering the entire area with at least 60 % overlap in both directions and a vertical and horizontal baseline of around 20 cm. The single photograph was rectified and scaled according to a geometric rectification process (RDF program), resulting in a ground-sampling distance or GSD of 1 mm. The photogrammetric set was oriented within Metashape (Agisoft) until an orthoimage with a GSD of 0.3 mm was extracted (Figure 6).

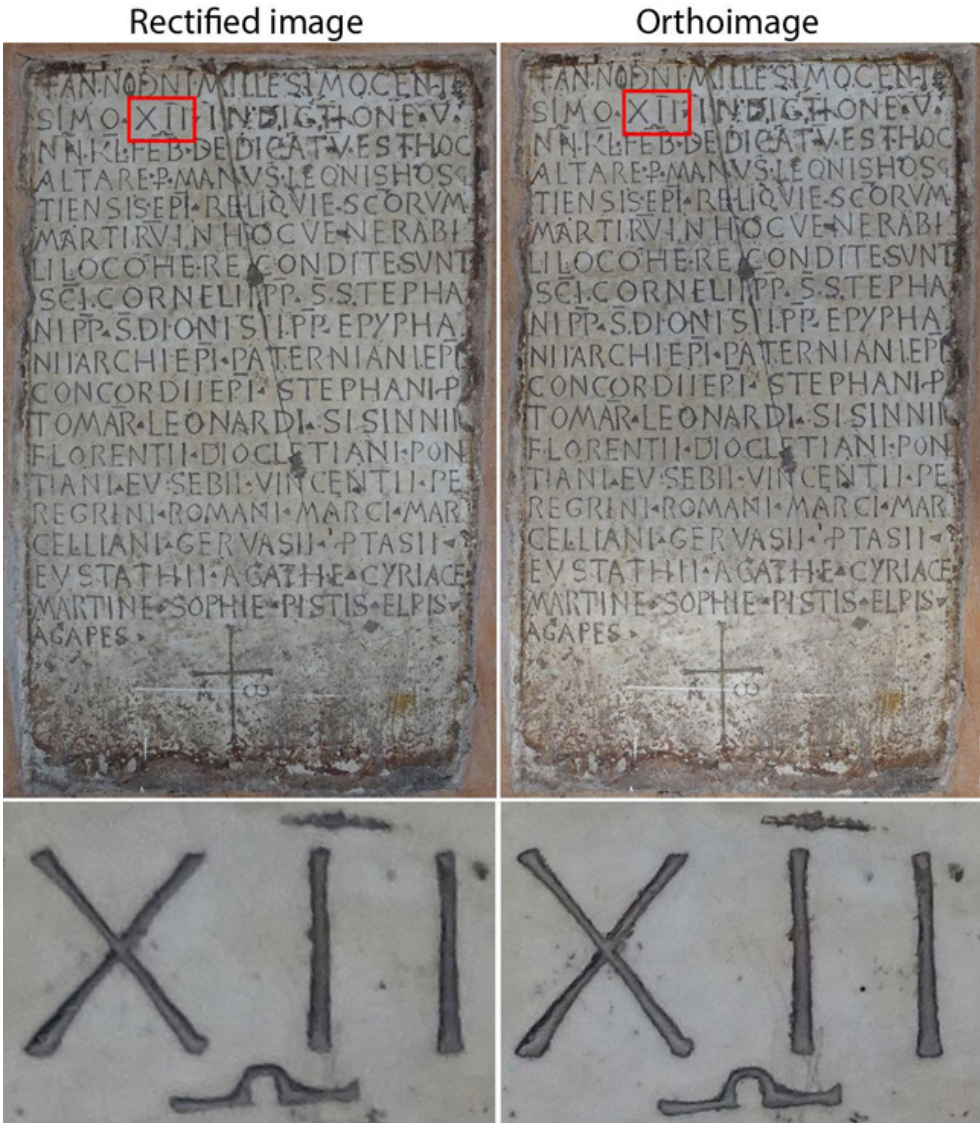


Figure 6. Comparison between rectified image and orthophoto with relative details.

The projection plane was easily identified on the plane of the stele. Evaluating the two results, the two products are comparable, dealing with a thin artefact, thus resulting in little significant topographic perspective distortion. On the other hand, having a smaller GSD, the orthoimage is more detailed, allowing for more meticulous product analysis (Figure 6). Thus, the choice of the two techniques is related to the purpose of the research: within a virtual itinerary, which does not involve interaction with the works, single photography is sufficient, perhaps using a ColorChecker to white balance the photographs. In contrast, the photogrammetric block allows for a datum to be analysed more thoroughly. One of the notable epigraphs we acquired is located on the papal throne at the centre of the apse wall (Figure 7). This epigraph pertains to the consecration of the church and

the deposition of the relics of St. Lorenzo in 1112 (Brandt, 2012). To capture it, we opted for two separate photos, one focusing on the inscription on the backrest and the other on the base. We encountered some challenges due to the inadequate lighting of the space and a spotlight positioned at the top of the throne, resulting in uneven illumination of the object. However, these issues can be solved during the post-production process. In order to compensate for the poor lighting, we utilised high ISO settings, which resulted in some noise in the image. Alternatively, it is possible to use a tripod if the ground is stable, using longer exposure times while preserving the stability of the camera. In terms of the environment, the space in front of the throne allowed us to frame the full subject without any significant distortion, using a lens set at a focal length of 55 mm.

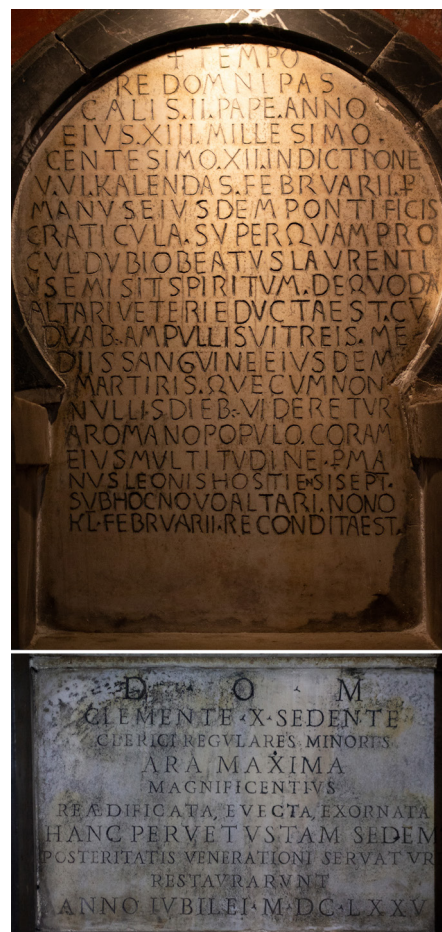


Figure 7. Epigraph on the backrest and base of the papal throne in San Lorenzo in Lucina.



Figure 8. Photos of epigraphs in the underground Basilica, showing the difference without and using grazing lights.

In other examples of epigraphs in San Lorenzo in Lucina, found in the underground Basilica (Figure 8), we conducted some experiments using grazing light. This technique proved effective in enhancing the relief via the creation of strong shadows and, consequently, increasing the contrast between the supporting surface and the writings. In this particular case, the epigraphs were relatively easy to identify compared to the graffiti, which we will describe below. Due to their small size, we acquired them with a single frame using multiple cameras (Canon EOS 1100D and Nikon D610). In Figure 8, it is evident how the utilisation of grazing lights during the acquisition stage allowed for an increase in contrast and, therefore, the legibility of the inscription. The first example was captured using a Nikon D610, equipped with a Nikkor AF-S lens with a focal length of 48 mm, while the second was captured using a Canon 1100D and an EF-S lens with a focal length of 45 mm.

Continuing within the context of San Lorenzo in Lucina, we encounter a particularly challenging case in terms of the legibility of the signs (Figure 9). Moreover, access to the underground Basilica is restricted to scheduled appointments, and locating the graffiti within it presents a difficulty. Additionally, the lack of natural light and the inability to descend to the level of the graffiti (as it is situated in an inaccessible area) posed some obstacles. However, due to the relatively small size of the graffiti area, it was possible to capture it within a single, good-quality photo.

Another interesting example of graffiti can be found in the crypt of the Church of Santa Sabina (Figure 10). The conditions here were quite different compared to the front portico of San Lorenzo in Lucina. In this case, the camera used was a Canon EOS 1100D. Due to the lack of natural light, we had to use high ISO settings (3200/6400) and relatively slow shutter speed (about 1/30 seconds). Furthermore, the

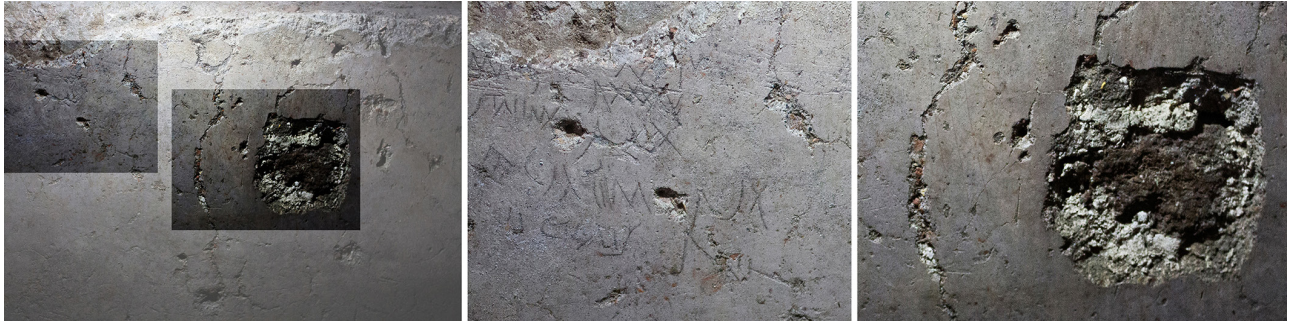


Figure 9. Overall photo and details of the graffiti in San Lorenzo in Lucina.

limited space made it impossible to capture the entire graffiti area without an ultra-wide-angle lens. However, this solution would have resulted in barrel distortions in the picture.

To overcome these challenges, we took photos in portions, ensuring that the optical axis remained approximately perpendicular to the wall's plane. We used a lens with a focal length of 23 mm. During the post-processing stage, we needed to combine the various partial shots.

Initially, we attempted photographic stitching, but it resulted in significant errors, particularly in the perimeter area of the

graffito. Consequently, we conducted a second attempt using the Metashape software.

We obtained a textured mesh model by aligning all photos (via a structure from motion approach) and extracting a dense point cloud (using a multi-view stereo approach). We appropriately oriented the model to approximate the wall's plane on which the graffiti was situated, resulting in a high-resolution orthomosaic (5713 x 6294 pixels).

However, it is worth noting that the conditions described



Figure 10. Orthomosaic of the graffiti-covered portion of the wall in Santa Sabina.

posed limitations, as neither the lighting nor the distance to the subject was optimal. While the Metashape workflow proved helpful in this particular case, it is not necessarily indispensable for studying graffiti and epigraphs since they are primarily two-dimensional objects with negligible depth.

The case at Arco dei Banchi presented relatively few challenges as it was located outside, beneath a vaulted surface, so it is accessible to anyone. However, due to the elongated rectangular shape of the object, it was not possible to capture it in its entirety while maintaining a good image resolution. Therefore, we decided to take a series of close-up shots, which were later stitched together during the processing phase. In this case, we combined photos

taken by the previously described Canon 1100D and a Nikon D610. For the Nikon D610, we used a Nikon Nikkor AF-S 24–120mm f/4 G ED VR lens with a variable focal length. Different attempts were made, starting with a simple collage in Photoshop (Adobe) using the Photomerge tool, which was approximate from a metric standpoint but effectively gave back the image in its entirety with good definition. Subsequently, the frames were processed using Metashape. This involved aligning the frames through the identification of homologous points. Following this, a textured mesh model was constructed, appropriately oriented to approximate the wall's plane, which allowed us to create the orthophoto. In Figure 11, a discrepancy can be observed between the image processed in Photoshop and the orthophoto. In terms of the



Figure 11. From left: photo collage, orthophoto and comparison between the two methods.

metric aspect of the object, which is crucial for extracting measurements, numerous differences are noticeable, particularly at the bottom. However, while the first image is unreliable for measurements due to its inherent limitations, it remains equally effective for communicative purposes. Furthermore, it requires minimal resources for processing.

Regarding Palazzo Altemps, we captured both overall and

detailed photographs (Figure 12). We encountered some challenges during the process. Firstly, the fresco was quite large, so we needed to acquire detailed images to capture its intricacies. Secondly, the lighting coming from the side windows posed an issue, but we were able to correct it during post-production. Lastly, access to the site was only permitted through museum visits. Again, we combined photos taken by both camera bodies.



Figure 12. Overall and detailed photos of the graffiti on the fresco *della Piattia* (Palazzo Altemps).

5.3. Data Visualisation

Some procedures modified the image to extract significant information from the inscriptions. First, the image was contrasted to increase the readability of the letters. Next, a segmentation algorithm was applied to extract edges at which colour variation occurs. The instrument is called Trace Contour in Photoshop (Adobe) within the Stylize Filters. The Trace Contour filter finds the transitions between major brightness areas and thinly outlines them for an effect similar to the lines in a contour map. The user can set the level for evaluating colour values and specify whether to outline pixels that are below (Lower) or above (Upper) that level. The application of this filter made it possible to extract all the letters automatically. In the process, other incisions

with similar texture as the letters have been extracted. In addition, it is shown in this extraction that the letters that have suffered edge deterioration have an unrecognisable edge geometry (Figure 13). Therefore, manual cleaning was carried out at this stage to increase the letters' readability. Engaging in this regard could be the application of AI algorithms capable of recognising and extracting known shapes beyond the edge variation undergone over time. The image with the lettering served as a starting point for further processing.

Tests were conducted for the different case studies, employing various image-processing techniques to enhance the legibility of inscriptions. As depicted in Figure 14, we



Figure 13. Image processing steps: contrasted image, features extracted and outliers cleaned.



Figure 14. Before and after processing of the graffiti photos in San Lorenzo in Lucina.



Figure 15. Some examples of the techniques applied to increase the legibility of the graffiti at Palazzo Altemps.

adjusted contrast and brightness via the tonal curves, employing layer masks to selectively enhance the visibility of the graffiti marks, which were comparatively less discernible and legible than the epigraphs.

These techniques involved isolating the inscriptions in post-production and overlaying them with transparency onto the photos (Figure 15). Additionally, we experimented with placing the inscriptions against a white background to improve their readability further. Again, image segmentation algorithms were applied, specifically operating with the colour data, and followed by a manual cleaning step to refine the extracted shapes.

In summary, the operational steps involved the creation of a suitable photographic shooting plan, considering the environmental conditions. Next, the selected images were rectified or extracted via orthorectification. Finally, adjustments were made to parameters such as brightness and contrast, followed by text extraction.

Besides, AR stands out as one of the most intriguing tools we have encountered. It offers possibilities for improving the legibility of inscriptions by overlaying images onto the target object, as well as incorporating historical information or written translations. Another significant aspect we consider is the introduction of audio files embedded in the AR application. This latter can help in making the previously



Figure 16. Some images with AR experimentation from two specific points of view.

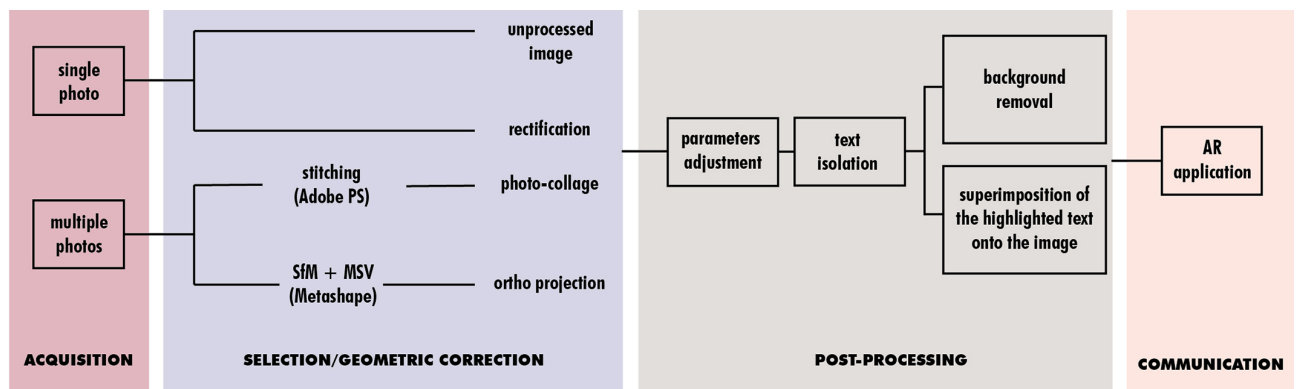


Figure 17. Workflow from the acquisition to the final image.

invisible and incomprehensible signs understandable to the broader public. Our goal is to further develop and explore the potential of AR applications, considering ways to enhance their capabilities (Figure 16).

The following is a workflow (Figure 17), the result of experimentation on a few examples, which can be replicated and scaled up in similar situations.

6. Conclusions

The research proposed here at the early stage covers the digital documentation and valorisation of ancient and historical graffiti and 'minor' epigraphs in Rome. These artefacts represent a valuable source of information about ancient society, as a thought, a voice, is frozen in them, with the desire or not to communicate it, depending on its private or public character. The presence of these traces on architecture is often faint and barely visible or known. The communication of an asset, to be such, cannot devote itself only to the material aspect but also to all the relationships and interrelationships that coexist between the assets, the people who live in them and the architectures that host them. For this reason, the current valorisation project first considers the elements of the project that are vital for the definition of a communication and valorisation system for these particular artefacts. Then, taking some significant sites as an example, it identifies and analyses some primary aspects related to the communication project: the acquisition of data, its processing and visualisation. It is why the research, once a few significant examples have been identified, focuses primarily on the problems of acquiring these elements, which present different bottlenecks. Constructing correctly rectified images with sufficient resolution for reading is difficult, as it comes up against difficult boundary shooting conditions. We then experiment with extracting certain features or elements that can facilitate their reading. Finally, through constructing some itineraries and using AR, some connections in the territory of Rome are suggested to highlight the importance of these artefacts, suggesting new knowledge itineraries, which gives a new voice to these often-hidden precious artefacts.

Conflict of Interest

The authors declare no conflict of interest.

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