

Augmented Reality for the Enhancement of Archaeological Heritage: a Calabrian Experience

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Abstract. Cultural tourism is one of the main activities for the enhancement of archaeological heritage. Information and Communications Technology (ICT) is largely used in the domain of cultural heritage, to provide the visitor with specific and complete information about tangible culture (such as buildings, monuments and artifacts). This work is a contribution in this direction: it describes a mobile application for the enhancement of points of interest (POIs) in the archaeological park of Castiglione di Paludi. For each of these POIs, a 3D model shows its original structure.

Keywords: Augmented reality · Archaeological heritage · 3D model.

1 Introduction

Innovation, tourism and enhancement represent an important system useful for satisfying needs related to the willingness of individuals and to know and deepen information about the history of a given place. There are various activities that can be carried out for promotion, one of these is the development of cultural tourism, which, in addition to an economic return, could represent a valuable opportunity to promote cultural heritage, attracting a large number of individuals coming from all parts of the world throughout the year and not only during peak tourist season. Cultural tourism encourages the growth of the territory by enhancing areas that are more marginalized or less known. It is important to preserve the surviving traces of the past for the future generations: one way to know the past testimonies is represented by the heritage, which relates material artifacts as well as traditions and beliefs linked to a community or a place. From a social point of view, the term recalls the need to rediscover one's own cultural identity and to pass it on to posterity. Therefore, the word heritage, can be closely connected to the practice of a form of tourism linked to values closely related to the territory. The ruins are a memory through which it is

possible to know the history and civilizations that preceded the current one, as well as the evolution of traditions and cultures and its for this reason that they become deserving of protection by man and institutions. Ruins are a symbol of people who made history, keep alive the memory and the value of civilizations and arouse a collective feeling. In this context it is quite evident the necessity of enhancing a cultural asset by highlighting its potential, improving its knowledge and making it accessible to the community [8]. The objective of this paper is to disseminate information about a territory, Calabria, famous for being one of the regions belonging to Magna Graecia and rich in archaeological heritage. Specifically, it presents a project proposal that uses ICT technologies and augmented reality in the domain of cultural heritage, to promote new keys of reading and knowledge of the territory so that providing the visitor (also the disinterested one) with specific and complete information about tangible culture. It describes a mobile application for the enhancement of points of interest (POIs) in the archaeological park of Castiglione di Paludi.

2 Archaeological heritage: parks and archaeological sites in Calabria

Over the years, and often even today, many believed that Magna Grecia included, as well as southern Italy, also Sicily. In reality it is not so, since the name of Megale Hellas refers to a limited context (Calabria, Basilicata, Puglia and Campania). Initially, Magna Graecia indicated only the part of Calabria and a piece of Puglia up to Taranto [1]. Magna Graecia becomes important thanks to the flowering of the Greek cities from an economic, cultural, social point of view and due to the famous philosopher and mathematician Pitagora [4], that, as known, settled in the city of Crotona a school of thought that was not open only to scholars, but also to indigenous peoples. The historical events of Calabria began from the era of prehistory, precisely from the Paleolithic period, which dates back to graffiti still existing at the cave of Romito, located in Papisidero, the famous Bos Primigenius: for this reason it is considered one of the most ancient of Italy [5]. Its importance is given primarily by its geographical position, by the climate and by the abundance of fertile lands. The region acquired several names over time: among these we recall the name of Enotria, whose meaning in Greek is “land of wine” (in fact it derives from ‘oinos’ which means wine and from ‘oinotron’ that recalls the stick that holds the vine). Finally, before being defined with the current name, the region took the name of Italy, attributed to the son of Enotrio, Italo, who succeeded him to the throne at his death. Calabria is famous mainly due to the “bronzes of Riace”, but besides this it offers a wide range of archaeological sites and parks dating back to different eras, but mainly belonging to the Greek era. The most important among these are:

- The site of Sibari that shows the overlap of three urban plants dating back to different historical periods: the first city was founded in 720 BC by the Sybarites and then destroyed in 510 BC; the second city, having the name of

Thurii, was founded in 444-443 BC by Pericle; finally, the third city, having the name of Copiae, was founded in 193 BC by the Romans.

- Timpone Motta located in Francavilla Marittima (CS), is a very important area also mentioned in the Homeric poem the Odyssey. It is said that tools, consecrated to Athena, and then used to construct the Trojan horse are buried in the site. The site is due to the population of Enotri: here it is possible to see remains of an enotouric village. The Sybarites drove out the indigenous population and marked the boundaries they conquered by building a sanctuary dedicated to Athena, which testifies to the presence of the Greeks on the territory, of which almost nothing remains today except for the stones.
- The archaeological park of Scolacium, a Roman colony, in which there is the presence of artifacts from different eras (prehistoric, Greek, medieval) [9].
- The archaeological park of Capo Colonna, so called because of the presence of a column of a Doric temple dedicated to the Goddess Hera Lacinia and dating back to the fifth century BC. Near the theater it is present a building today called B, a Roman villa and the ruins of a thermal building dating back to the III century.
- In the province of Ciro' Marina there is an archaeological site of a sanctuary dating back to the pre-colonial era (IX-VIII century BC). In the site there are the ruins of a Doric temple dedicated to Apollo Aleo in which Filottete consecrated his arrows to Heracles after the victory of the Trojan war [11].

Cosenza is one of the few Italian cities crossed by two rivers, the Crati and the Busento. According to the legend the Visigothic King Alaric and his faithful horse were buried in the rivers. Cosenza was founded by the Pelasgians, pre-Hellenic peoples, or by the Enotri, an ancient population of Italic origin who lived part of the Calabrian territory. Since the IV century BC Cosenza is known as the metropolis of the Brettii, a very important population of strong warriors that occupied the hinterland of Calabria. There are several important archaeological evidences in Cosenza: Corso Telesio and Piazzetta Toscano [2], located in the historic center of Cosenza. The latter is the most important site in the city by extension and presents several archaeological ruins dated back to the Brettia era [3] (IV century BC) and the domus belonging to the Roman period (II century BC - III century).

One of the most important archaeological sites for extension and finds belonging the Brettia era is represented by Castiglione di Paludi, located in the municipality of Paludi in the province of Cosenza. The first news concerning the site was dated between 1870 and 1880 and was provided by the Calabrian scholar Vincenzo Padula [7]. The entrance to the city took place from the so-called East Gate, with a monumental entrance and a rectangular plan: from the courtyard to which the door led you could access some stone stairways that led to a roundabout, through which it was possible to enter on the main street of the city. The northern part of the entrance presents two towers called respectively Alfa and Beta, constructed perhaps to increase and strengthen the protection of the urban center. The main road that crosses the ancient city is about 10 meters wide

and 330 meters long and oriented towards north-south [10]. The site is endowed with a fortified settlement dating back to the IV century BC, and therefore of Brettia foundation, which followed the typical trend of the Hellenistic cities. A theater of type ekklesiasterion was discovered between the 50s and the 80s along with other monumental buildings. Since the scenic area was not identified, most probably the building was used to host assemblies aimed at the election of magistrates or at public meetings held at the time of the Brettii family. In a flat area near the theater, the public area was identified, the agora and of a wall, called “Lungo Muro”, 42 meters long and 4 meters high, that divides it into two distinct parts and also served as a settlement for the main street of the city, since the territory presented irregular morphological characteristics [6]. Castiglione di Paludi is unique in the area of southern Italy as regards the city walls: very impressive, today they are visible as far as 400 meters in length.

Figure 1 shows a map reporting all the Points of Interest of the park.



Fig. 1. The map.

3 ICT: new ways to enhance cultural heritage

ICT technologies are used today in the enhancement of cultural heritage, to provide specific and complete information about buildings, monuments and artifacts and become a must in the case the artifacts are in a degraded state. The use of these technologies contributes to transform any cultural heritage conservation center into a center of innovation and experimentation: this, however, requires an high cost that often cultural associations are not able to sustain. There are several ICT technologies that are used by cultural organizations:

- *Website.*

In order to be effective, it must represent the identity of the cultural heritage (an archaeological site, a monument, etc.) guaranteeing access to all types of information and making the activities related to it clearly visible. The website must also be constantly updated in order to guarantee the user to receive real information and should allow the reservation of access tickets.

- *Audio guide.*

The audio guide consists of a sort of radio and earphones that are usually provided to the visitor before starting a tourist visit on their own. The contents that are recorded inside tell the story, the details and all the information that must be provided to the user: moreover the information of the audio guide are usually translated into different foreign languages so that the contents are usable by tourists of each nationality.

- *Virtual reconstructions.*

This is a virtual reconstruction of buildings, objects, etc., which today are in a state of slight or intense deterioration. The goal of these reconstructions is certainly to offer the visitor a complete vision of the cultural asset and the opportunity to discuss scientific hypotheses regarding its original structure.

- *Augmented reality.*

Augmented reality applications are installed on mobile devices and represent one of the fastest ways to show information in real time. Indeed, to take advantage of augmented reality technology it is necessary to have a smartphone or a tablet: these devices allow the user to find information in an alternative way, through the use of 3D models, sounds and videos. The goal of augmented reality is to create a kind of overlap between the reality and the digital contents that are shown by the computer device. The application needs to ‘hook’ the contents to the context framed by the camera of the device.

The positioning operation can take place through the use of particular images that the application is trained to recognize (*markers*) or through the use of the sensors of the device (GPS, accelerometer, etc.). The result is that the scene framed by the device is enriched of objects that increase its informative value. The effect is convincing: it is possible to study the details of the virtual objects positioned in the scene simply by approaching the object with the device.

- *Virtual reality.*

This technology differs from augmented reality as in order to show the digital contents, special devices are needed: viewers, suits, gloves, glasses, etc. In this case, through the viewers are shown totally fictitious (virtual) contents. Thanks to virtual reality applications it is possible to reconstruct historical contexts that no longer exist and it is possible to compare what exists today with what existed long time ago. The user using devices such as gloves, suits, earphones or similar, finds himself in an immersive reality, where almost all his senses are fully involved, and is made part of the scene reconstructed by the system.

4 An Augmented Reality System for the Enhancement of Archaeological Heritage

Our project consists in a mobile app for the enhancement of points of interest (POIs) of the archaeological park of Castiglione di Paludi. For each of these POIs, we created a 3D model that shows its original structure. For the POI related to the main entrance of the ancient city (see Example 1), the 3D model reproduces the city gate and its two towers. The 3D model is extremely detailed and a photorealistic texture, reproducing the materials used to make the object - has been applied to it. Moreover, the 3D model is semi-transparent and it is located over the real object it represents: in this way it is possible to admire the ruins of the ancient structure and understand how it looked when it was in perfect conditions. The positioning of the 3D model over the POI is made by means of a particular image (*marker*), used by the app to recognize the geometry of the location: the final effect is of great visual impact.

The user, observing the POI through the mobile device, sees its structure and its materials as if time had never affected them. He is able to get closer to the POI, observe its details more closely and able to analyze them from different perspectives. The marker is located close to the POI that is intended to be enhanced. It is suitably protected by transparent plastics to prevent deterioration due to weathering.

It is important to note that the realization of the 3D model of an object requires the involvement of experts in graphic modeling as well as the advice of domain experts (historians, archaeologists, architects, etc.) who have to guide the modeling itself and validate the final result. Making a good 3D model can take several days of work and is normally quite expensive. Therefore, the number of POIs enhanced through 3D models in augmented reality cannot be to high.

Thanks to the support of experts of the domain, four POIs of greater importance to be enhanced through our mobile app have been identified:

- East gate (main city gate)
- Theater
- Building A
- Building III.

The app is now available for Android devices (but we plan to implement a version of it for iOS devices). Once installed, it does not require any internet connection because all the 3D models are downloaded on the device.

The app has been developed in Android Studio 3.2 [12] using Android SDK 9.0 [13]. Its implementation required a specific library for augmented reality. We have chosen one of the most performing and easy to use: Google ARCore [14]. ARCore is the official Google library for augmented reality. It is available for all developers of mobile apps. It allows to manage complex and even animated models. This library is extremely interesting because it is available for various development environments and platforms: Android, iOS, Unity and Unreal.

Our 3D models have been created in Google SketchUp and an archaeologist validated their final appearance.

Example 1. We report an example of a POI enhanced by means of our app: it is the east gate, the main entrance to the city. Figure 2 shows the gate and what remains of its towers.



Fig. 2. The east gate.

Figure 3 shows the marker installed near to the point of interest.



Fig. 3. The marker.

Figure 4 shows how the point of interest appears through a mobile device.



Fig. 4. The 3D model.

First of all, note the presence of the marker, the image that allows the application to identify the point of interest and to position the 3D model. Observe that, the 3D model is correctly placed on the ruins of one of the two towers. The model reproduces the tower itself and part of the wall showing its original appearance. Note that, the model is semi-transparent. This technique allows to observe both the 3D model and the ruins. Moreover, the model has a texture that reproduces the bricks used for the construction of the tower.

Figure 5 shows what a user would see using the app.

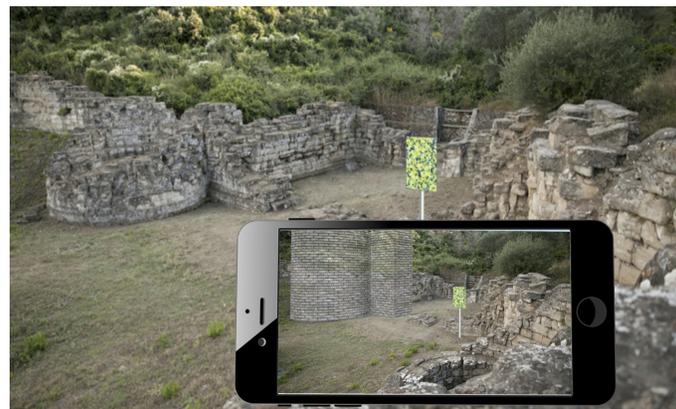


Fig. 5. The mobile app.

5 Conclusions and future works

This work is a contribution in enhancing cultural tourism. It presents a mobile application for the promotion of points of interest (POIs) in the archaeological park of Castiglione di Paludi. For each of these POIs, a 3D model shows its original structure. As for future work, we plan to extend the project to additional areas of interest, firstly involving sites in Cosenza such for example Piazzetta Toscano and to enrich the 3D scenes by audio and videos: a virtual guide describing the points of interests, actors reproducing scenes of everyday life.

References

1. BRACCESI L. - RAVIOLA F., *La Magna Grecia*, Il Mulino editore, Bologna 2008.
2. BROCATO P., *Note di archeologia calabrese*, Pellegrini editore, Cosenza, 2015.
3. GUZZO P.G., *I Brettii- Storia e archeologia della Calabria Preromana*, Longanesi & Co. Editore, Milano, 1989.
4. LA TORRE G. F., *Sicilia e Magna Grecia. Archeologia della colonizzazione dOccidente*, Laterza editore, Roma-Bari 2011.
5. LATTANZI E., *Storia della Calabria antica. Et italica e romana II*, Gangemi editore, Roma-Reggio Calabria 1994.
6. LUPPINO S. - E PAOLETTI M. (A CURA DI), *Il centro fortificato di Castiglione di Paludi*, AGM, Castrovillari (CS) 2011.
7. MAIERU P., *Castiglione di Paludi viaggio nella memoria*, Ferrari editore, Rossano, 2004
8. MANACORDA D., *Il sito archeologico: fra ricerca e valorizzazione*, Carocci editore, Roma 2007.
9. MOLLO F., *Guida archeologica della Calabria Antica*, Rubbettino editore, Soveria Mannelli (CZ) 2018.
10. NOVELLIS D. E TOSTI A., *Castiglione di Paludi- un centro fortificato Brettio nella Sibaritide meridionale*, Rossano 2008.
11. PARRA M.C., *Guida archeologica della Calabria: un itinerario tra memoria e realt*, Edipuglia editore.
12. <https://developer.android.com/studio/>
13. <https://developer.android.com/studio/releases/platforms>
14. <https://developers.google.com/ar/develop/java/augmented-images/>