Mem. S.A.It. Vol. 94, 55

Memorie della

Technological evolution for accessibility to cultural heritage

The opportunity of the Interreg I-ACCESS project

A. Scianna[1], G. F. Gaglio[2] and M. La Guardia[3]

[1] ICAR-CNR (High-Performance Computing and Networking Institute - National Research Council of Italy), Via Ugo La Malfa 153, 90146 Palermo, Italy
[2] Dept. of Engineering, University of Palermo, Viale delle Scienze, Edificio 6, Palermo, Italy
[3] Dept. of Engineering, University of Palermo, Viale delle Scienze, Edificio 8, Palermo, Italy
emailandrea.scianna@icar.cnr.it

Received: 17/01/2023; Accepted: 30/01/2023

Abstract. This paper concerns the work carried out within the Interreg Italia-Malta I-Access project, dedicated to the accessibility of Cultural Heritage. The technologies adopted for the improvement of the fruition of the artistic and cultural heritage within the historical centers of Palermo and Valletta (Malta) are described, with particular reference to the possibilities offered by Virtual and Augmented Reality and technological advances in geomatics.

Key words. virtual reality, augmented reality, accessibility, cultural heritage, WebGL, IoT

1. Introduction

In recent years, geomatics has further evolved thanks to advances in computing and electronics, as well as to technologies related to virtual reality (VR), augmented reality (AR), and 3D printing. The evolution of these technological solutions has made the development process of highly immersive VR and AR applications faster and more effective. At the same time, matters related to the accessibility to cultural heritage and solutions to the problems in these research areas have become widely discussed. Depending on the context, a solution may be preferable and more effective (Bekele et al. (2018)) than another. Consider, for example, the use of virtual reality devices in museums during a pandemic. After each use, the devices should be disinfected or even replaced before allowing the next visitor to use them. Solutions involving the use of a personal device, such as one's own smartphone or tablet, would be safer in this case. Similarly, the virtual enjoyment of an architectural asset via the web breaks down other types of barriers such as distance, unreachability, and further on. Therefore, the most appropriate solution must be found according to the situation, identifying the end user and the reasons why a cultural asset may be inaccessible.

2. Accessibility

The concept of universal design is also applied in the field of Cultural Heritage, indicating a design oriented towards total accessibility (Paladini et al. (2019)). Designers should always plan in order to make an architectural asset accessible to everyone, especially from the correct demand-efficiency perspective. And the term "everyone" includes people affected by a temporary or permanent deficit and therefore prevented from fully enjoying a cultural asset. This can be done in different ways. There are both architectural solutions and computer and electronic-driven technological solutions that currently extend the concept of accessibility, beyond its physical meaning. The physical accessibility of a site often requires additions and modifications to ensure the safety of visitors, especially those with mobility limitations. Architectural barriers can be overcome with temporary interventions or fixed structures which, if not properly integrated, can lead to a loss of heritage value. To achieve total accessibility, however, physical, technological, and psychological aspects must be considered. In many cases, further architectural additions or eliminations to achieve accessibility couldn't be implemented. On these occasions it becomes necessary to find solutions capable of breaking down barriers, which are not only architectural. Some simple tools, such as audio guides, have now become indispensable elements for a better fruition of cultural heritage, guaranteeing an immersive experience, but above all access to augmented information on a particular asset. Other tools, such as virtual and augmented reality or IoT sensor networks, provide even more effective and interesting solutions to different types of problems. These solutions can also broaden the possibilities of cultural fruition, providing additional multimedia information. The I-ACCESS project started with the objective of developing models and systems for the extension of accessibility to cultural heritage and had as its testing ground the historic center of Palermo and the city of Valletta in Malta. In the project, the ICAR-CNR research group developed technological solutions for both historic centers, demonstrating how it is now possible to bring cultural heritage to those who, for various reasons, cannot access it.

3. Inaccessible Cultural Heritage

The limited access to cultural heritage may depend on a variety of aspects: spatial planning, the architectural configuration of cultural assets themselves, their management, and the physical and psychological conditions of visitors during their lifetime (Kosmas et al. (2020)). From an architectural point of view, cultural assets are often poorly accessible due to the presence of large differences in height to overcome, due to the state of decay in which they are found, or due to architectural configurations linked to obsolete ways of thinking. The issue of accessibility is also quite modern and architectural barriers were not seen as a real problem in the past and were therefore not taken into consideration during the design phase. The presence of deteriorating conditions, whether natural or induced, can also limit accessibility. This is the case, for example, with uneven flooring, lack of adequate protective barriers - whose installation is often conditioned by the characteristics of the property -, or advanced structural degradation. Concerning location, for example, a large number of underwater findings are accessible only to qualified personnel or experienced divers (Scianna et al. (2021)). Moreover, the location of a cultural asset may be changed over time, compromising its original configuration. Poor property management, lack of guides and qualified visiting staff, and too little administrative/management capacity can also impede accessibility. Churches, museums and other cultural sites are often closed to the public due to the absence of dedicated personnel or inaccessible due to failure to communicate/publish the opening and closing times. Finally, in addition to the difficulties encountered by people with reduced mobility, hearing or visual impairment, accessibility to cultural heritage can also be limited by the existence of psychological problems (agoraphobia or claustrophobia, etc.), which therefore prevent some people from visiting certain places. Virtual reality,

augmented reality, 3D printing, software, and apps of various kinds can now overcome most existing barriers.

4. Strategies adopted and results obtained

In the case of the I-ACCESS project, it was decided to start by identifying the needs of an ideal visitor walking through a historic center rich in cultural heritage, in order to design the right solutions for accessibility. It is assumed that the visitor is equipped with a personal mobile tool (smartphone or tablet). Such a tool, supported by both computer technology and digital telephony, will guide and support the user along the cultural route and will help overcome some of the potential barriers he or she might encounter during the visit. Elements/solutions that can support the visitor are: geographical positioning systems such as GNSS (whose sensors are present inside smartphones) and positioning via mobile phone base stations; the IoT (Internet of Things) sensor networks that provide location-dependent augmented information about the neighboring cultural object; software applications for assisted guidance along a cultural route. The visitor is thus always connected to the digital telephony and Internet network and can receive information, in real-time, on the assets he or she encounters along the way. The assisted-guidance application acquires the position of the user along the route and updates itself in real time, displaying icons and links to deepen the knowledge of the cultural good in the vicinity. If the cultural site within the route is closed to the public (a fairly frequent occurrence in the historical center under study), a virtual tour of the site is available. Moreover, the application allows people to connect to the web page corresponding to the site of interest. Through the use of graphic libraries based on WebGL technology, virtual navigation models were thus developed that allow the exploration of the site through the web browser, and without having to download any application. Within the I-Access project, sites of major cultural interest were thus virtualized and networked within a webGIS. To do this, the sites were surveyed using modern geomatic technologies (digital photogrammetry and terrestrial laser scanning) and subsequently modeled and refined to be easily accessible on the web from web browsers. Similar results were obtained through the realization of an application that exploits the signal of proximity sensors (Bluetooth Low Energy Beacons) applied to points of interest. This allows a smartphone, which detects the presence of a beacon, to display a link to the web page of a good encountered during one's walk. The advantage of this type of application is its scalability: just activate and register a new sensor, apply it to a point of interest, and let the app, already installed on users' devices, detect it. In case the allocation of the cultural site had changed in time, augmented fruition of the site, through AR technologies, tested in the I-Access route, allows the reconstruction of ancient configurations of the asset and allows its virtual use, thus leading to what is called historical accessibility. Thanks to the experimentation of AR applications in outdoor spaces, the virtual visualization from a mobile device of monuments repositioned in their original location was made possible. This procedure made it possible to increase the level of accessibility of the property by offering added value to the real enjoyment of the environment. The set of technologies fielded within the I-Access project was made usable, as mentioned above, through the development of a WebGIS platform that incorporated all the experiments within the historical route.

5. Conclusions and new scenarios

The opportunity offered by the I-Access project made possible the development of innovative solutions in the field of geomatics for improving accessibility to cultural heritage. Some difficulties in the development of such technologies were overcome through the use of technologies based on open-source standards such as the WebGL javascript libraries necessary for the online navigation of 3D models and the Open Layers javascript libraries that allowed the structuring of the WebGIS platform. However, limitations remain due to the

limited capabilities of web browsers for the online display of models. It is, therefore, necessary to find the right compromises to obtain realistic navigation models that are, at the same time, easily loadable on mobile networks. Integrating IoT technologies within visualization models and WebGIS systems is a strategic area of research in Smart Cities. This solution will become increasingly strategic by allowing real-time analysis of buildings for purposes related to improving the accessibility of environments, but also related to the monitoring and thus the preservation of artifacts.

The work carried out, described above, can be viewed at the following links:

https://www.i-access.eu https://geomatica.icar.cnr.it/webapps.html

References

Bekele, M. K., et al., 2018, A survey of augmented, virtual, and mixed reality for cultural heritage. Journal on Computing and Cultural Heritage (JOCCH) 11, 1–36

Kosmas, P. et al., 2020, Enhancing accessibility in cultural heritage environments: considerations for social computing. Universal Access in the Information Society 19, 471–482

Paladini, A., et al. 2019, Impact Of Virtual Reality Experience On Accessibility Of Cultural Heritage. Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci. XLII-2/W11, 929–936

Scianna, A., Gaglio, G. F. & La Guardia, M., 2021, Accessibility To Underwater Cultural Heritage: Interactive Web Navigation Of The Roman Submersed Vessel Of Cala Minnola. Presented at the ARQUEOLÓGICA 2.0 - 9th International Congress & 3rd GEORES - GEOmatics and pREServation, Editorial Universitat Politécnica de Valéncia, pp. 1–9. https://doi.org/10.4995/arqueologica9.2021.