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Digital techniques for the representation of virtual tours of urban architectural heritage

The study illustrates the creation of a mobile App usable, above all, by laypersons, to create a virtual tour of the historical architecture that is being visited. The evolution of the historical center's representation for the enjoyment by a wider audience, especially young and tourist, must necessarily be conveyed through smartphones, of which the new generations have acquired the full potential.
Thanks to increasingly powerful devices, which can process complex 3D rendering in real time, it is possible to create an experience for the knowledge of the place with a 360° virtual tour. With the implementation of this App, we had tried to give back to the user a digital model full of useful information for the knowledge of the architectural place, but above all as much as possible immersive and intuitive in terms of navigation, using the gesture that today are rooted in smartphone users. The analyzed issues are many, including the implementation of technology for the creation of virtual tours targeted in teaching and tourism, it's possible use to preserve and make known altered or no longer existing environments. The case study focuses on the viability of the Old Town of Altamura (Ba), characterized by numerous dead-end widening areas, called Claustri. The study was focused on Claustro Tricarico which presents architectural values of the Middle Ages, typical of the Apulian territory.

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Key words:
Virtual Reality; Digital Representation; Virtual Tour; Geolocation.

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INTRODUCTION

In the past the documentation of cultural heritage was based exclusively on handmade drawings that required a subsequent interpretation, with on-site measurements and wooden models, which took a long time and had low precision. With the advent of the computer, everything has changed its appearance, the representation of architecture has had a considerable boost thanks to new increasingly precise and realistic representation technologies. The continuous evolution of technology has made even the representation of cultural heritage evolve as quickly, up to create three-dimensional photorealistic models that can be completely visited, both immersive, using Virtual Reality, and representative, using Augmented Reality (Fig. 1). In this constantly evolving field, we want to contribute, with this case of study, to adding a further piece to the evolution of the digital representation of architecture.

THE STATE OF THE ART

Virtual reality is certainly a good way to travel and understand architecture.
The difference between augmented reality and virtual reality is that in the first, the digital information is added to images and to real-life contexts, while the second one offers the user a new way to use where the is immersed, allowing, for example, to fly over a city without taking off (Guerra, Pinto and Beato, 2015).
The first VR presentation for cultural heritage goes back to 1994, by British engineer Colin Johnson, with the 3D reconstruction of Dudley Castle in England as it was in 1550. It was a laserdisc, computer controlled, present in a museum.
The use of these new technologies has a very positive feedback on users, whether it is conveyed by commercial advertising, or for cultural information. This leads to the use of VR (Virtual Reality) and AR (Augmented Reality) for the dissemination of any type of information.
The virtual and augmented reality can offer museums, heritage and tourism many useful applications, provide a sensory experience and allow culture to be accessible to the general public (2015).
The Swedish IKEA immediately viewed the potential of AR to advertise its products, creating an App that allows to view, on the screen, the furniture directly in the environment where the consumer wants to place it. This allows you to view the final appearance of the environment and be able to order the object directly from the App and receive it at home.
In museum sphere, virtual tours have been organized to visit the Louvre Museum in Paris and allow to admire Leonardo's Mona Lisa, the Venus of Milo, and other artistic beauties simply through an App or by AR headset for a completely immersive experience.
Many art cities such as Florence and Rome, have equipped with appropriate App that, exploiting the AR and framing a monument, recognizes the place and displays on the screen some icons, overlapped on the monument, which allow you to get more information about the surroundings (Fig. 2). This App is just for tourist purpose, it has a section for restaurants and doesn't allow to navigate the historical architecture framed.
In Portugal there are several projects that use virtual reality to convey cultural tours such as the case of the Palazzo of the Regaleira (2015), registered in the SIPA (Information System for Architectural Heritage), which allows you to visit the historical site remotely simply through a web link.
Linking history and heritage, culture and tourism, capture and visualize digital images of historic buildings, cultural heritage and city centers that are recreated in the app Rewind Cities Lisbon, is an application that opens the door to new possibilities for the discovery of the Portuguese capital on tablets and smartphones Android, iOS and Windows Mobile (2015).

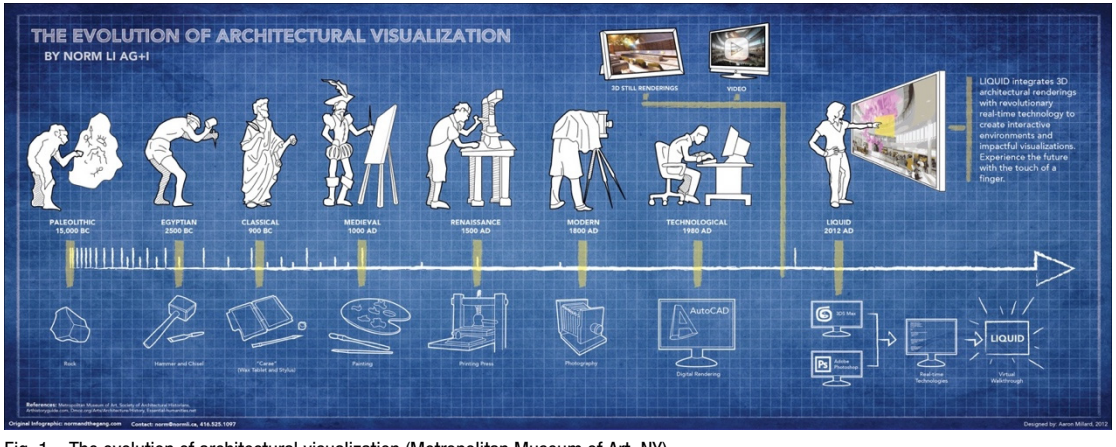

Fig. 1 – The evolution of architectural visualization (Metropolitan Museum of Art, NY)


Fig. 2 – Florence, "Ponte Vecchio" (© Edipsmobile).

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The projects developed exploiting augmented reality through portable devices, such as mobile phones or tablets, are numerous in the world and have as purpose the architecture popularization of the historic centers. Thanks to these portable devices, more and more powerful, augmented reality is starting to take new forms, thanks to devices using GOOGLE TANGO (Mongiello et al. 2018).
In our recently paper, we used GOOGLE TANGO, to create an AR App to visualize a digital architecture in the real environment with a tablet (Fig. 3).

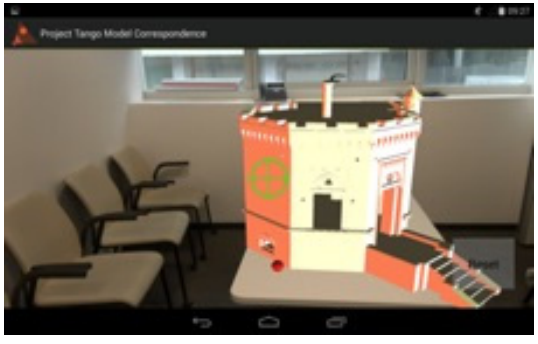

Fig. 3 - 3D model in AR experience.

This App allows you to show digital reconstructed of destroyed or damaged architectures and display it in the same place they were in. This App can be used either to show any new 3D project, giving in-place graphics and analytics data in real time to support construction site works, than to support learning and teaching and also to interact and visit the handiwork using device with TANGO technology.
In fact, the TANGO platform by GOOGLE, using various sensors, allows you to approach the model to cross section it and visualize the interior or study its structural characteristics.
The model can be viewed from infinite perspectives, for a detailed study.
In the historical architecture contest, there is an App called The House of Olbrich, home of Kosef Maria Olbrich in Darmstadt. This App recognizes every picture taken at this house then displays on it the points of interest giving information on that particular architectural detail. Even this application represents the architecture statically, in a picture, making the experience less stimulating.
Many designers or real estate agencies have adopted VR technology to show customers how their future home will be or how they are buying.
More professional applications have been developed thanks to modern WebGL-based browsers, storing point clouds of laser scans of historical architectures on a central server, to view them remotely through Oculus Rift viewers, directly displaying the rendered digital model of the site.
Using the Oculus Rift with point cloud rendering software, researchers will feel as if they really are in the archeological site and will be able to interact with other researchers while they're exploring the virtual model, thanks to the excellent head-tracking capabilities of these new Virtual Reality headsets (Mures et al. 2016).
The idea behind most computer applications is to improve the user interaction with the real world, adding information through the use of tools and techniques that were confined to the digital world.

BACKGROUND AND METHODOLOGY

Prefacing that Virtual Reality (VR) can be wrongly thinking of as a precursor of Augmented Reality (AR) (Albortae, Armenakis and Kyan, 2017), VR technologies use a fully digital simulation and users are immersed in a non-real environment. In contrast, AR allows users to see the real world in real time adding overlapping information about objects. For this reason, in this study, the key element was the analysis of architectural spatiality, by checking the historical documentation to be used for the restitution of the architecture object of the study, creating a digital model in 3D.
Subsequently, the geometries created were optimized with the UV mapping for textures and lighting and, using the Digital Sculpting and the Displacement Mapping, have been drawn up all the architectural details. Borrowing the rendering and navigability technologies of the three-dimensional model from the film and gaming world, it was possible to realize the geo-localized model of the building run through the App. Once the 3D model of the architecture was completed, it was possible to combine it with the UTM (Universal Transverse of Mercator) coordinates and with the insertion of a Dome Light and HDRI (High Dymanic Range Imaging) to simulate sky and global illumination with real atmospheric conditions site. At the end of these process, PBR materials have been created with Mapping Photo Textures. Then the 360° panoramic views were made (Fig. 4), acting on the FoV (Field of View) and adopting a conventional angle of 360°, like a spherical video camera. Then the virtual tour was compiled, inserting interconnected hotspots to allow movement within the three-dimensional model. Everything was summed up on a mini map (Fig. 5) to allow the user to navigate contextually to the movements of the device that uses the its gyroscope to adapt the model display to the 360° overview. The complete tour was exported in HTML5 format and converted by an open-source software into an application installable on ANDROID device.

RESULTS

The result of this study is the creation of a virtual architectural model, fully interactive and immersive, geo localized, developed and compiled to be used with a special APP by current mobile devices with OS ANDROID. The same 3D model can be displayed either normal than VR mode (Fig. 6) allowing a first-person mode (with a viewpoint of the player's character), even remotely. This choice was fundamental for the entire study, because it made possible the experimentation of geometric and polygonal synthesis methodologies, for the use of such virtual environments on all types of terminals. The reproduction of the architecture becomes an analysis and reduction process to generating geometries, transcribed in a digital environment, preserving the architectural and representative environment syntaxes unaltered.

INNOVATIVE AND ORIGINAL ASPECTS

The innovative aspect of this research consists in the creation of an App for the ANDROID operating system,

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usable by non-professionals, for the knowledge of the attractiveness of the three-dimensional navigable model and geo localized on the territory. The App uses gesture input mode to make the experience more similar to a videogame than to a video lesson. By the navigation and interaction it is possible to know the history and architecture of the place represented using metadata and media linked too.
The representation of historical environment by immersive experience makes the content more attractive than a static photographic that, by its nature, is a still image which can only stimulate the eyesight. The App proposes a new approach, integrating the 3D, GIS and the new representation solution (AR and VR), by providing a low cost alternative product with use of common mobile devices instead of specific and cumbersome solution.
Therefore the App, would act like a showcase and offers the opportunity of studying the entire spatiality of an architectural context, which is not possible with partial and static views such as pictures, satisfying aesthetic, hedonistic and functional information as it emerges from the studies of Vogt and Fesenmaler.

At last but not least, the used technology stimulates the interaction between users and architecture. Our goal was a multidisciplinary research using information technology to enhance the cultural heritage and using technology for digitization, representation, documentation, conservation and communication of knowledge of cultural heritage. The experience can be further implemented to be an effective way to storing physical spaces so that they can be stored digitally, as in a museum environment, allowing remote viewing of those spaces that are difficult or not physically accessible or that do not exist more.

CONCLUSIONS

This experience aims to be an interface paradigm between mankind and historical architecture, represented through the App. Modern devices with touch screen allows to interact at high level with architectural spatiality which by its nature is static and defined in its appearance and physical space. Through a GUI (Grafic User Interface), based on the architecture representation and on the device touch screen, a dashboard was created and maked available to the user in which all the peculiarities of the represented space are present.

Fig. 4 - 360° overview of the “Claustro Tricarico” digital model.

Fig. 5 - Fusion between the digital model and the final rendering with the icon for the virtual tour (bottom right).

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The study experience has led to the creation of an App, with the graphics and the interface used as a matrix for the App development for the knowledge of the architectural speech of the historical centers. With a QR code placed on the site it will be possible to download the App for the knowledge of the specific Architectural field.
Virtual Reality, just like any innovation, can transform our future, allowing new experiences, knowledges and skills for a complete analysis and improvement of the real world perception, allowing to visit, discover and study architectural heritage.

Fig. 6 - VR mode, image from the App.

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