

Using Augmented Reality and Social Media in Mobile Applications to Engage People on Cultural Sites

Silvia de los Ríos¹, María Fernanda Cabrera-Umpiérrez¹, María Teresa Arredondo¹, Miguel Páramo¹, Bastian Baranski², Jochen Meis², Michael Gerhard², Belén Prados³, Lucía Pérez³, and María del Mar Villafranca³

¹ Life Supporting Technologies, Universidad Politécnica de Madrid, Spain
{srios, chiqui, mta, mparamo}@lst.tfo.upm.es

² GeoMobile GmbH, Dortmund, Germany
{b.baranski, j.meis, m.gerhard}@geomobile.de

³ Patronato de la Alhambra y Generalife, Granada, Spain
belenprados@wonderbrand.es,
{luciam.perez, mariamar.villafranca}@juntadeandalucia.es

Abstract. One of the toughest challenges that curators and professionals in the heritage sector face is how to attract, engage and retain visitors of heritage institutions. The current approaches have only limited success since they still follow the same centralized strategy of producing and delivering cultural content to the general public. This paper provides an overview of current trends in information technology that are most relevant to cultural institutions, and investigates how augmented reality, gamification, storytelling and social media can improve visitors' experience by providing new means of participation, proposing a radically new approach in defining cultural content and creating personalised experiences with cultural heritage objects. The paper considers actual use cases provided by the European research project TAG CLOUD to define the functional range of suitable applications and proposes a set of system components that are being implemented in TAG CLOUD.

Keywords: Augmented reality, social media, gamification, storytelling, mobile applications, cultural heritage, TAG CLOUD.

1 Introduction

Many Europeans consider cultural heritage a highly valuable social asset. However, reality shows that actual engagement with cultural heritage by the general public is low [1]. In an attempt to meet the main challenge of curators and professionals in the cultural sector, that is to attract, engage and retain visitors of heritage sites, institutions have already been applying and deploying a wide range of digital technologies, ranging from static kiosk systems and multimedia websites to on-site location-based systems. More recent trends in mainstream information technology such as augmented reality, mobile geo-social networks, big data and cloud computing have not yet a big impact in the area of cultural heritage, but they have a great potential.

Augmented reality allows users to see the real world through the smartphone camera, with virtual objects overlaid upon or composed with the real world image. Social network platforms such as Facebook and Twitter have already attracted hundreds of millions of users and are still growing [2]. They help sharing stories and connecting people based on common interests or common activities. From a technological perspective, augmented reality and social media are promising ways to attract, engage and retain visitors of heritage places [3-7]. Through augmented reality, visitors are able to interact with cultural artefacts in a more natural way. They can explore, touch and manipulate virtual representations of artefacts what otherwise might not be possible. Extending the real-world environment with historical photos and pictures allows immersing visitors in past times. Social media can help to realize the vision of the participatory museum [8] by attaching user-generated impressions to curated content. Additional techniques such as ‘Gamification’ and ‘Serious Games’ can help cultural heritage institutions to educate as well as to entertain, which is important for dedicated target audiences.

The use of these technologies applied to the cultural heritage sector through mobile applications is being explored within TAG CLOUD (Technologies lead to Adaptability & lifelong enGagement with culture throughout the CLOUD) [9], a European research project co-funded by the Seventh Framework Programme of the European Commission addressing the issue of lifelong engagement with cultural heritage through social media, augmented reality and storytelling applications based on the cloud.

Within this project, some studies carried out during the first months show that people that tend to visit cultural sites frequently, in most cases, do not prepare their tours in advance. Instead, visitors often prefer a spontaneous experience. They enjoy discovering new environments for themselves. Studies also show that most visitors carry personal smartphones and that people would benefit from mobile applications providing additional information about the cultural site.

As a first proof of concept, TAG CLOUD has implemented augmented reality modules and proposed new concepts for integrating social media within a mobile application that guides and attracts visitors of the Monumental Complex of Alhambra and Generalife, a famous historical palace and fortress complex located in Granada, Spain.

2 Current Technologies in Cultural Heritage

2.1 Augmented Reality in Cultural Heritage

Thomas Caudell and David Mizell [10] point the term “Augmented reality (AR)” in 1992. This term is defined as a “combination of real and computer-generated digital information into the user’s view of the real world in a way that they appear as one environment [11]”.

Cultural heritage sector has done an increasing digitization effort during the last decade. That makes AR applications perfect showcases of any kind of cultural artefact (objects, building, etc., but also, ceremonies, music or stories). Augmented reality

improves the visitors' enjoyment during the visit, enhancing the sense of being present in the place and obtaining additional information about any object of his interest, offering an efficient communication with the user through multimedia presentations, natural and intuitive techniques and low maintenance and acquisition costs for the museum. It also improves the experience in the in site environment as the information is shown in real time according to the user's physical location, mitigating confusion in large spaces and improving the sensation of having the information controlled and under demand.

The necessary technologies for augmented reality (mobile processing, image recognition, object tracking, display technology and location) have already been available several years ago in mobile devices: a camera, a relatively fast internet connection, accelerometers, gyroscope, digital compass and GPS. The main mobile platforms, Android and iOS have recently started to gain third party AR-like applications. Thanks to the smartphone popularity, and the increasing maturity of AR technology, the number of potential users is increasing and, consequently, the number of available AR applications.

Currently, there are two main approaches of commercial AR applications: AR browsers based on geo referenced positioning and image-recognition-based AR. The technologies below are different but support the same principle, both of them follow a magic lens configuration [12] that means the user sees the augmented space directly behind the display.

AR browsers are able to delivery points of interests (POI), notations or graphics based on GPS locations superimposing the captured image by a mobile camera view (Geo-Tagging) [13]. This type of applications usually shows information resources from several data storages and webs. They use a combination of the digital compass, accelerometers and GPS to identify the user's location and field of vision, to retrieve data based on the geographical coordinates and overlay that data over the camera view. One successful commercial example of a good AR browser is Layar [14]. It is available for Android and iOS, the developers can contribute by an application programming interface that sets up "layers" in the browser. Other very used AR browser is Aurasma [15]. There are also a lot of AR applications able to use these browsers. Wikitude Me [16] is an Android, iPhone and Symbian compatible application that pulls the information from Wikipedia [17] and Qype and in which the user can also create his own POIs and location-based, hyper-linked digital content that is show through the Wikitude browser application, and Junaio [18] information about POIs and supports 3D animations and share images via the social networking sites. Each user generated geo-tagged POI is then visible by all the other users. Tagwhat4 also allows the sharing of information.

An interesting use of AR browsers for cultural heritage initiatives is made by the Museum of the City of London [19] that allows superposing old photographs of London over real images. Other examples can be Lights of St Etienne [20] a commercial application that uses the AR-browser Argon in order to create an embodied, location-based experience, St Etienne Cathedral in Metz, MoviAr a research project that assists users who need touristic information about a city, Historypin [21] that allows sharing of images of the past between other members of the community. However, most of

the applications and research projects related with culture heritage are tourism focused applications that do not take care of the engagement of the people living in those places. On the other hand, new apps basically overly information onto a screen with no relationship to the real world, or personalization of content or interaction.

The other type of AR, image recognition-based AR applications, establishes connections between surrounding physical targets and digital information through image recognition. The mobile identifies QR codes, barcodes or other graphical markers that trigger the desired action (e.g. information search). There is a huge amount of this type of applications, some of the most popular are ShopSavvy [22], pic2shop [23], StickyBits [24], Google Goggles [25] that after gaining maturity will show relevant results about any object in the user's vicinity, GoodGuide [26] based in scanning barcodes, and Vuforia [27] that is an SDK for augmented reality image recognition that support iOS, Android and Unity 3D.

Most of the AR applications for cultural proposes use AR browsers and rarely explore the image recognition-based AR like Google Goggles as engagement mechanism.

2.2 Social Media in Cultural Heritage

The first personal systems for cultural heritage were desktop applications which automatically generated hypertext pages with text and images from different cultural items repositories, according, somehow, to information of the user (interest, knowledge, age, physical abilities, etc.). With the extensive use of the web, the online web sites were extended to the majority of the cultural places. The evolution of these groups of technologies offers very attractive solutions to present information to the users in a more attractive fashion and it is one of the preferred technologies to engage new visitors. In parallel, the reduction in the cost of devices and internet access has provided users with information off the cultural site as well as the access to multimedia resources, personalization of the routes, bookmark interesting content or the creation of a personal collection of cultural items. The creation of social virtual spaces (for instance Second Life [28]) and 3D virtual cultural sites have revolutionized the interaction ways and have provided new personalized content. The web 2.0 approach added some new services, such as blogs, wikis, social networks, and they turn visitor into an active part in the creation, management and conservation of cultural heritage and allow the active sharing of information between users. Some museums are pioneers in the use of Web 2.0 applications, for instance:

- Brooklyn Museum [29] was one of the first museums actively participating in Facebook and Twitter.
- TATE Museum [30] was pioneer in the use of user generated content as source for creating new cultural experiences.
- OMEKA.NET [31]. Omeka is an open-source platform and it was created for the storage and display of library, cultural space, archives, and scholarly collections and exhibitions. It was thought to bring to the cloud museum's collections and exhibitions. The system is similar to the micro-blogging structure of Wordpress

(wordpress.org) helping to publish online cultural web-site or texts. The Omeka team decided to contribute to a movement that is helping to standardize data about digital objects. While there are different standards available, the Dublin Core Metadata Initiative is the most widely adopted and offers users more flexibility.

- ARTBABBLE.com [32]: The Indianapolis Museum of art created ArtBabble in late 2008 an on-line video website dedicated to art related content that runs entirely in the cloud and allows streaming of high definition video content in a scalable and cost-effective manner.
- STEVE Project [33]: STEVE is a collaboration of museum professionals and others who use the social tagging to describe and access cultural heritage collections and encourage visitor engagement with collection objects. This activity includes researching social tagging and museum collections; developing open source software tools for tagging collections and managing tags; and engaging in discussion and outreach with members of the community who are interested in implementing social tagging for their own collections.

In addition, nowadays, there is a wide variety of content that is shared using social networks or application based on social networks, for example Twitter, Instagram, Flickr, YouTube, Facebook, etc. and the most important museums, cultural events and archaeological sites have an account in Facebook, Twitter and other social virtual networks, but despite this virtual presence, the involvement of the general public and consequently the engagement of the population with their cultural heritage are low.

3 Engaging People with Culture through Mobile Technologies

With the aim to promote engagement of people with cultural heritage TAG CLOUD takes advantage current technologies to promote cultural adaptive experiences ubiquitously using low cost personal devices and technology for the general public and cultural institutions.

TAG CLOUD aims to engage both visitors and people living in their home cities, in order to introduce cultural heritage in their life style, so the developed system will not only show information with tourism purposes, but also information to include cultural events in daily life of the people.

Within TAG CLOUD, the type of content delivered to the user is also adaptable based on the user choices, past and social networking content. By integrating with social networking sites, such as Flick, Facebook, Twitter or Foursquare, the information about the user likes, dislikes and areas they visit can be found.

TAG CLOUD explores augmented reality for creating personalized AR based experiences according to the context (community and cultural site) and the dynamic user profile (from the social web and current wishes and needs) that combine both, AR browsers and image recognition-based AR, to offer adaptive experiences to each user. In that way, TAG CLOUD uses AR browsers to offer personalized information, content and interaction mechanisms (voice, text, video, user's opinions, friends previous experiences, games, intelligent itineraries, etc.) according to the user profile and the preferences at that time, in combination with image-recognition AR that allows the

users to interact physically with the cultural digital artefacts, during the experience in a personalized fashion.

Social web modelling is a new discipline that is not highly explored in cultural heritage engagement projects because cultural heritage experiences are usually social. It has revolutionised the participation of the users on Web providing their users with the means to generate and share content. TAG CLOUD takes advantage of social web modelling in order to predict user interests and preferences and thus, engage users with their cultural heritage environment.

These social networks have the goal of linking people with common interest and needs. The active role of the users provides rich information about their preferences and needs, they choose their friends and colleges in the network, publish and share their content, rate and tag content from other users and participate in online activities and events. This rich interaction with the system requires a wild need of personalization, because it will affect what the user will generate, participate, consume, create, and, consequently, all this activity will affect the structure of the community and the interaction with other communities.

Collaborative filtering and recommendation (User-based Collaborative Filtering) have been the most widely adopted type of personalization in traditional social communities. According to this, the personalization is based on the interest shown by other similar users, they assume, in fact, that similar users are interested in similar items. In the case of social networks, this approach is frequently used in behavioural profiling recommendations filtering [34] that monitors and collects data about user's activities and tailors user experience based on those activities. In social web, the profiles are based on sites visited; product pages viewed, emails sent, keywords in comments published, etc.

This approach is effective in large e-commerce applications, but in social web, the users provide much more information about their needs, preferences, wishes and relationships than logs in a traditional web server, and User-based Collaborative Filtering become ineffective because data is sparse with few co-rated items and being purely statistical does not make use of the structure of the data. That is knowing someone has an interest in Napoleon would now allow us to say they would be interested that his troops used Sphinx's Nose for target practice, unless a statistical relationship is established by the users.

The following general characteristics of Augmented Reality technologies and applications are also important benefits over the digital technologies that are already established in cultural heritage.

- *Uniqueness* – Both AR browsers and image recognition-based AR applications are bounded to a specific location and are unique for an actual cultural heritage site/object. Compared to classic mobile tourist guides, it offers not only valuable curated information about places and artefacts but also gains new experiences of the surrounding. In TAG CLOUD the possibilities of AR are explored for cultural heritage only, any new IT developments are expected to achieve further exposure.
- *Interactivity* – AR applications allow to virtually interact with historical places and artefacts (e.g. touch and rotate the environment). Studies have shown that receiving and interpreting visual inputs, coordinating motors skills even in virtual environments

and involvement with symbols, stories and experiences foster emotions, which is potentially highly entertaining and stimulating for users [35].

- *Personalization* – Depending on the use case and the actual implementation, the utilization of AR technologies allows to integrate self-generated content from users (e.g. self-portraits or paintings) as an overlay into the virtual representation of the environment. That helps to create highly personalized media while being at the heritage, which is more engaging to visitors than presenting plain text, image or video.
- *Virality* – Such self-generated and personalized media can be shared perfectly within social networks, which helps other people to receive a more personalized impression of the possibilities on-site what most likely attract them to visit the cultural heritage themselves. The element of surprise that is achieved by sharing individual content about cultural heritage can also result in a so-called viral loop.
- *Content* – By creating their own content in AR applications, such as making pictures on-site or telling their own personal stories about places and artefacts, users are able to create a quality piece of content that wouldn't otherwise exist. Thus, integrating such user-generated content into the curated exhibition at the cultural heritage (even if only through social media channels) would mean a substantial step towards a more engaging cultural experience.

Although AR and social media have not yet a big impact in the area of cultural heritage, it seems to have a great potential to foster the engagement of people by means of innovative interaction possibilities to bring history alive.

4 An Example in the Monumental Complex of Alhambra and Generalife, in Spain

“Experiencing culture in Alhambra Gardens in a group” is a scenario that has been developed for the Monumental Complex of Alhambra and Generalife. In this scenario, TAG CLOUD offers Maria (teenager tourist) and her family several sightseeing tours for the heritage institution. Maria is a teenager, who is in Granada for two days. When Maria arrives at the Alhambra, she logs into TAG CLOUD from her mobile phone in order to receive up-to-date information about what she and her family can do on-site, because the ticket “Alhambra General” is not available today (Thursday).

As mentioned earlier, the TAG CLOUD system shows several opportunities to visit the Alhambra: Alhambra Other Look (includes areas generally closed to the public in the Monumental Complex and other selected places in Granada city), Alhambra Experiences (evening visit to the Nasrid Palaces and a morning visit to the Alcazaba and Generalife Palace and Gardens on the following day), Alhambra Gardens (visit all areas of the Monumental Complex open to the public, except the Nasrid Palaces) and Alhambra Night (the night visit around the palaces) .

Maria explores the possibilities that TAG CLOUD is offering them to visit the Alhambra.

She explores about the interactive routes of “Alhambra Other Look”, by checking images, photographs extracted from Flickr, comments from other visitors (social media),

videos from YouTube, etc. This is a type of visit focused on special subjects. Maria deeps in a special route: the Alhambra and Charles' Granada: The Emperor's dream. She likes it so much, because in this case it is possible to visit the Palace of Charles the Fifth. TAG CLOUD App shows her this information. But this activity will be offered: Mondays and Sundays between 9:30 and 14:00, with a duration of four hours.

So, they decide to buy Alhambra Experiences, because they can visit the gardens in the morning and the Nasrid Palaces at night.

Maria's Twitter account is associated with TAG CLOUD, so she can publish on Twitter a comment about her decisions directly from TAG CLOUD system.

Once TAG CLOUD learns that Maria has decided to take the Nasrih Palaces night visit, the system shows her the itineraries that she will be able to experience, and other digital resources available, such as: the basic guide from iTunes Play Store and Augmented Reality application of the Monumental Complex of Alhambra and Generalife.

Maria and her family are at the entrance of the Alhambra ready for their visit. They decide to join the "Gardens guided tour" at 12:00 because they are very interested in the complex and do not want to miss any detail. Alhambra offers devices for rent with TAG CLOUD system installed. Guides create specific "group visits" in the system so that the whole group can enjoy the same experience along the route. Maria uses her smartphone to introduce in TAG CLOUD the code that identifies the tour. She logs into TAG CLOUD as "guest".

At 12:00, the guide join together all the tour participants and ask them to select the option to "join a tour" in the system, and to enter the respective code to start the visit.

During the guided tour, TAG CLOUD App combines augmented reality and the basic guide with its functionalities in order to offer an adaptive experience to Maria and the rest of the group: the interesting places nearby, information of the Point of Interest (POIs), and the way to go there by GPS. When she is near the Palace of Charles the Fifth, she remembered the beautiful rooms in this palace that she saw before, so she decides go to the Court of the Palace of Charles the Fifth; when she is inside, she discovers with the AR application a "virtual guardian" near a pillar, which gives her more information about this actual place.



Fig. 1. TAG CLOUD App using AR in the Palace of Charles V, Monumental Complex of Alhambra and Generalife, Spain

After the Palace of Charles the Fifth, Maria and the rest of the group go to the Palace of the Lions. Once there, at the Court of the Lions, a place that she had seen lots

of times in books and TV series, she is amazed by its beauty. So, she decides to point out with her smartphone using the TAG CLOUD App, and clicking on the Twitter icon that appears when TAG CLOUD detects her location, she decides to let her friends know that she is there by sharing her location on a Tweet.

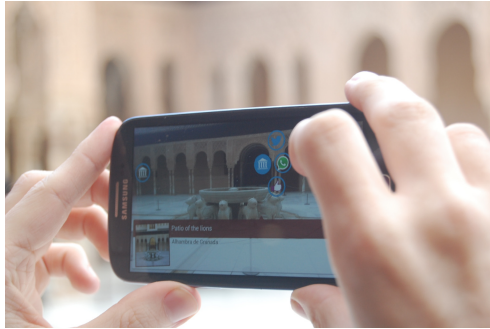


Fig. 2. TAG CLOUD App using AR combined with social media in the Court of the Lions, Monumental Complex of Alhambra and Generalife, Spain

5 Conclusions

As explained within this manuscript, there exist several approaches of cultural heritage institutions that attempt to attract their visitors using new technologies, such as augmented reality and social media. Although these technologies have not yet a big impact in the area of cultural heritage, they provide a huge range of possibilities to offer new ways to interact with cultural artefacts, personalise the cultural experience, share content and experiences and interact with the social environment. Thus, they have a great potential to foster the engagement of people on cultural heritage sites, not only tourists but also residents.

TAG CLOUD is advancing the methodology of developing adaptive systems that will form the basis for personalised interactions between users and cultural resources, before, during and after the visit to a cultural site. For this purpose, the system provides both virtual and real experiences which engage users to take part and be involved with cultural heritage, at home, during the course of their daily life activities and, of course, when visiting a heritage institution. TAG CLOUD is taking advantage of social communities where users and experts create, share, change and add content and personal experiences, building together a huge culture framework which allow the generation of personalised and unique culture experiences for each user. This will promote users to actively participate in their own cultural environment, and integrate culture in their lifestyle.

Acknowledgements. This work has been partially funded by the EC FP7 project TAG CLOUD (Technologies lead to Adaptability & lifelong enGagement with culture throughout the CLOUD); <http://www.tagcloudproject.eu/>, Grant Agreement No. 600924.

References

1. Eurobarometer 67.1 (2007), http://ec.europa.eu/culture/pdf/doc958_en.pdf (accessed October 14, 2013)
2. Digital Insights, <http://blog.digitalinsights.in/social-media-facts-and-statistics-2013/0560387.html> (accessed October 14, 2013)
3. Ardissono, L., Kuflik, T., Petrelli, D.: Personalization in cultural heritage: the road travelled and the one ahead. *User Modeling and User-Adapted Interaction* 22(1-2), 73–99 (2012)
4. Giaccardi, E. (ed.): *Heritage and Social Media. Understanding Heritage in a Participatory Culture*. Routledge, London (2012)
5. Gartner, Inc., *Gartner's 2013 Hype Cycle for Emerging Technologies Maps Out Evolving Relationship Between Humans and Machines* (2013); Online Published (August 19, 2013), <http://www.gartner.com/newsroom/id/2575515>
6. Azuma, R.T.: A Survey of Augmented Reality. *Presence* 6(4), 355–385 (1997)
7. Ellison, N.: Social Network Sites: Definition, History, and Scholarship. *Journal of Computer-Mediated Communication* (2007)
8. Simon, N.: *The Participatory Museum. Museum 2.0* (2010) ISBN-13: 978-0615346502
9. TAG CLOUD project, CN. 600924, 7th Framework Programme, ICT for access to cultural resources (February 2013), <http://www.tagcloudproject.eu/>
10. Caudell, T.P., Mizell, D.W.: Augmented reality: an application of heads-up display technology to manual manufacturing processes. In: *IEEE Hawaii International Conference on Systems Sciences* (1992)
11. Höllerer, T., Feiner, S.: Mobile Augmented Reality. In: Karimi, H., Hammad, A. (eds.) *Telegeoinformatics: Location-Based Computing and Services*. Taylor & Francis Books Ltd. (2004)
12. Kruijff, E., Swan, E., Feiner, S.: Perceptual issues in augmented reality revisited. In: *ISMAR 2010*, Seoul, Korea (2010)
13. Höllerer, T., Feiner, S.: Mobile Augmented Reality. In: *Telegeoinformatics: Location-Based Computing and Services*. Taylor & Francis Books Ltd. (2004)
14. Layar, <http://www.layar.org> (accessed February 7, 2014)
15. Aurasma, <http://www.aurasma.com/> (accessed February 7, 2014)
16. Wikitude, <http://www.wikitude.org> (accessed February 7, 2014)
17. Wikipedia, <http://www.wikipedia.com> (accessed February 7, 2014)
18. Junaio, <http://www.junaio.com> (accessed February 7, 2014)
19. Museum of London, <http://www.museumoflondon.org.uk/Resources/app/you-are-here-app/home.html> (accessed February 7, 2014)
20. Argon, <http://argon.gatech.edu/> (accessed February 7, 2014)
21. Historypin, <http://www.historypin.com> (accessed February 7, 2014)
22. Shopsavvy, <http://shopsavvy.com/> (accessed February 7, 2014)
23. pic2shop, <http://www.pic2shop.com> (accessed February 7, 2014)
24. Stickybits, <http://www.crunchbase.com/company/stickybits> (accessed February 7, 2014)
25. Google Goggles, <http://www.google.com/mobile/goggles> (accessed February 7, 2014)
26. Goodguide, <http://www.goodguide.com/about/mobile> (accessed February 7, 2014)

27. Vuforia, <https://developer.qualcomm.com/mobile-development/add-advanced-features/augmented-reality-vuforia> (accessed February 7, 2014)
28. Second Life, <http://secondlife.com/> (accessed February 7, 2014)
29. Brooklyn Museum, <http://www.brooklynmuseum.org/> (accessed February 7, 2014)
30. Tate Museum, <http://www.tate.org.uk/> (accessed February 7, 2014)
31. OMEKA Project, <http://omeka.org> (accessed February 7, 2014)
32. ARTBABBLE, <http://www.artbabble.org/> (accessed February 7, 2014)
33. Steve museum, <http://www.steve.museu> (accessed February 7, 2014)
34. Ben Schafer, J., Frankowski, D., Herlocker, J., Sen, S.: Collaborative filtering recommender systems. In: Brusilovsky, P., Kobsa, A., Nejdl, W. (eds.) Adaptive Web 2007. LNCS, vol. 4321, pp. 291–324. Springer, Heidelberg (2007)
35. Radoff, J.: Game On: Energize Your Business with Social Media Games. John Wiley & Sons (2011)