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INTRODUCING AUGMENTED REALITY IN CULTURAL HERITAGE STUDIES

Luis Villarejo
Francesc González Reverté
Oriol Miralbell
Joan Miquel Gomis

New Tourism Laboratory,
Universitat Oberta de Catalunya
{lvillarejo, fgonzalezre, jmiralbell,
jgomisl} @uoc.edu

Introducing Augmented Reality in Cultural Heritage Studies

ABSTRACT

Augmented Reality is a technology that allows overlaid digital content into our view of the real world through the camera of a Smartphone or a tablet. Video, audio, 2D and 3D images, web and text are just some examples of the type of content that can be overlaid on our perception of the real world. This content can be associated with real world elements by means of geolocation or image recognition. Such technology has great engagement potential and is used in many fields to augment the users' perception of the world. Cultural heritage is one of the fields that could benefit more from this technology. This paper describes how augmented reality has been used in an educational context in order to support learning for cultural heritage students. The students taking part in this experience built landscape units in several locations in Catalonia and augmented them with digital information, creating digital Points of Interest distributed throughout Catalonia and Spain. These Points of Interest, which constitute a mix of digital and real world information, were then published through an augmented reality browser, making them freely available to the public. Today there are more than 5,000 freely available Points of Interest that have been created by the students. The results of the experiment show that students appreciate the use of augmented reality in this particular context and find it useful both from a pedagogical and a technological point of view.

KEYWORDS

Augmented Reality, Cultural Heritage, Education, Digital Contents, Geolocation

INTRODUCTION

Digital information is increasingly becoming part of our everyday life. This used to happen only in specific and static moments of our life (working with the computer, getting a bus ticket from an automatic machine...). However, due to the rapid spread and adoption of mobile devices like smart phones or tablets, digital information can be present in our day from the moment we wake up until the moment we go to sleep. In 2012 it was estimated that 13 million people in Spain can access the Internet through their smart phones or tablets (Europapress, 2013). Our pockets therefore now store devices that are able to retrieve digital information very easily, regardless of the physical context around us. We mean that most of the information these devices retrieve is not interested in the user's physical location unless the user explicitly indicates it. This is now changing because of the addition of GPS and image recognition capabilities into our mobile devices. These capabilities provide our mobile devices with automatic information that allows the user to contextualize the information given to him or her. In this sense, Augmented Reality (AR) is rapidly gaining momentum as a very practical way of tying together our physical context (our real world) and the digital information we can retrieve through a mobile device. The use of such a technology as a bridge between the digital and the physical world (Henrysson, 2004) constitutes a very good resource for educational purposes (Klopfer, 2002).

The Open University of Catalonia is an entirely online higher education institution which relies on technology to support the learning and teaching processes of their students and lecturers. Cultural heritage is part of the tourism studies curriculum at the Open University of Catalonia. In this subject, the study of heritage sciences and the changes it has recently undergone is set out. This includes the analysis of new heritage concepts like spoken heritage, historical memory, landscape and its relation to culture and how information technologies can support its tourism and recreational interpretation. In addition, the maintenance of sustainable tourism uses of heritage and sustainable strategies to prepare cultural tourism products also constitute important curricular topics.

It is in this academic context that the New Tourism Laboratory of the Open University of Catalonia has launched an educational experiment introducing AR as a way to support learning and teaching regarding landscape as a form of Cultural Heritage.

In the following sections, the concept of augmented reality is further introduced and developed. Then, the learning scenario in which this experiment has been developed is explained. After that, we describe the experience and, finally, we discuss its outcomes and explain our conclusions.

FUNDAMENTALS OF AUGMENTED REALITY

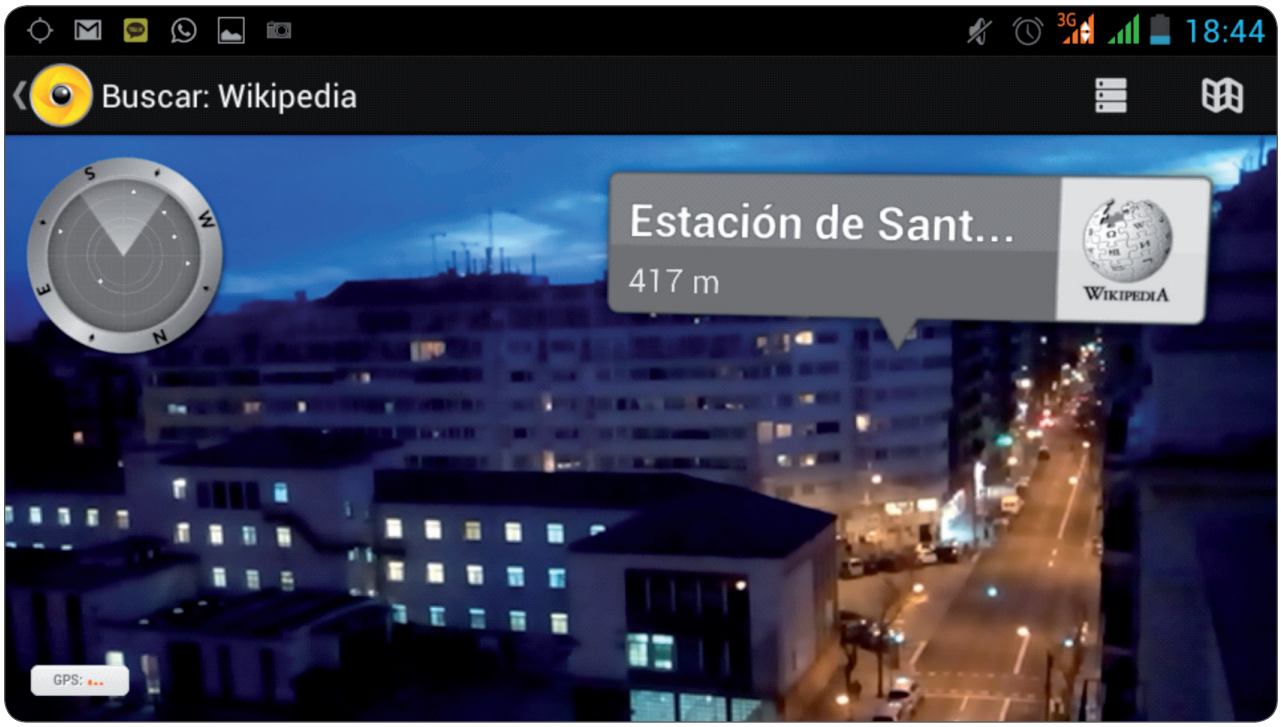
Augmented reality is a technology that allows digital content to be overlaid on our view of the real world using the camera of a smart phone or a tablet. According to (Azuma 1997, p. 2), *"Augmented Reality is a variation of Virtual Environments, or Virtual Reality as it is also called. Virtual Environments technologies immerse users inside a virtual environment. While immersed, the user cannot see the existing surrounding real world. In contrast, AR allows the user to filter the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it".*

Video, audio, 2D and 3D images, web and text are just some examples of the type of contents that can be overlaid into our perception of the

real world when using AR. These contents are associated to real world elements by means of geolocation or image recognition and are visualized through an AR Browser that uses the camera of his or her mobile devices. In this way, a particular location in the real world (or a particular object or place) that has digital content associated with it becomes a so-called *Point of Interest* providing a mix of digital content and real-world view to the user, as can be seen in figure 1.

The amount of digital information that can be added to our physical reality is almost unlimited. Take, for example, the tourism sector (see Yovcheva, 2012) for a complete overview of AR applications for the tourism sector). Imagine a tourist who has just arrived in a city and wants to spend the whole day there. He will be interested in a lot of topics regarding the city he is visiting. And our tourist will surely be interested in information regarding the particular location where he is at all times. At the beginning of the day, our tourist is bound to be interested in getting information concerning the nearest means of transport he has to reach a location he is interested in. Our tourist can then open an AR browser and look for means of transport around him. Later in the day he will be interested in getting information about a particular place he is visiting. Some hours later, our tourist will probably be interested in getting information regarding restaurants near the place he is visiting. And we could continue with a long list of information our tourist will be interested in. In an urban context, wherever we point with our mobile phone we will get hundreds of Points of Interest. One of the risks that AR systems must take into account is information overload, as mentioned in Vlahakis (2001). How can all this information be organized so it can fit on the screen of a smart phone or tablet? The answer is organizing information in layers. Layers can be seen as filters inside an AR browser that show only Points of Interest belonging to a particular

Figure 1. Screen capture of a mobile device running the Wikitude app and showing a Point of Interest at the Sant Pau public transport station in Barcelona.



category. Public transport, for example, is a layer. Whenever users are interested in getting information just about public transport, they can activate the Public Transport layer and the Points of Interest shown on the screen of the mobile device will only be related to public transport. Similarly, there are layers about museums, restaurants, shops, cultural heritage sites, libraries, events, nightlife, hospitals, etc.

LEARNING SCENARIO

The level of interaction that AR provides promotes constructivist notions of education where students take control of their own learning, and interact with the real and virtual environments. This way, students can manipulate digital objects, learn tasks and gain skills. The benefit with AR learning is that errors are not real. In general, AR training creates opportunities for authentic learning and accommodates multiple learning styles. For instance, there are educational experiences showing that the use of AR within the context of an immersive virtual learning process improves simulation, providing the experience with a greater level of authenticity, as shown by Rosenbaum, Klopfer & Perry (2007), as well as realism in educational games (Arnold & Geser 2008), while enhancing collaborative tasks, as shown by Billinghurst (1999) and in Morrison and colleagues (2009). AR supports different aspects of knowledge to be used in different areas, such as teaching, environment, museums, researching, learning, creating, or recreating (Arnold & Geser, 2007; Schmalstieg & Wagner 2007; Dunleavy, Dede & Mitchell, 2008). In this sense, AR represents an excellent opportunity to create learning experiences in a variety of fields, and cultural heritage, from a tourism point of view, is one of them.

Why focus on landscape as a tourism resource? Because landscape is a key tourism resource. In fact, landscape walking and contemplation is one of the most popular activities among tourists. There are studies showing that 46% of tourists consider landscape as a key factor for measuring the beauty of the location visited. Landscape constitutes one of the main touristic attraction factors. This is explained by the fact that the touristic experience is a geographical experience that needs tourists to move to the destination, which implies a change in the tourist's location. One of the variables that best show the change of location is landscape, as shown in Nogué (2004). Taking into account that landscape is an indicator of change and is actually the expression of the transformation that a particular culture causes in its location, we can better understand the central role that landscape plays as a heritage resource.

Focusing on education, as Carreras (2009) mentions, there are different aspects of AR that can be applied to the enhancement of cultural heritage, and particularly landscape. Firstly, using AR in education facilitates a more immersive learning experience that triggers changes into students' perceptions. As shown in Dede (2009), successful immersive experiences enhance students' learning, allowing multiple perspectives, enabling situated learning (in which the learning activities mirror authentic, real-world problem solving), and by facilitating transfer (the students' ability to apply what they have learned to other real-world problems or contexts). Secondly, AR facilitates the understanding of complex and dynamic processes (e.g. reconstruction techniques and simulation) that enrich the presentation of heritage for different levels of interpretation. And thirdly, AR allows for an expansion of any graphic item.

The idea of this learning initiative is to experiment with the use of AR as a way of supporting the tourist and recreational interpretation of landscape. In particular, we think that such an approach will allow us to increase students' awareness of the protection

and care of landscape and to improve academic results both in terms of competences developed and accomplishment in terms of evaluation and continuous assessment. The pedagogical goal of the initiative is twofold. Firstly, we wanted students to learn how to provide content for landscape units (which have an interest from a touristic or recreational point of view) taking geolocated information as a basis for their work. And secondly, we wanted students to experiment and learn on the possibilities of augmented reality applied to landscape. To achieve these goals, landscape data should be organized so that AR browsers like Layar, Wikitude and Mixare can retrieve it. These browsers are the tools that deliver the data in-situ through a mobile device like a smart phone or a tablet. As we have mentioned previously text, audio, video or web pages are the kind of information that can be incorporated in a Point of Interest to be retrieved and shown by the AR browser.

In this initiative, students are asked to work in teams in order to create a tourism product for the interpretation of a landscape of their choice. The target audience of this product is a potential visitor who looks at landscape but does not have value added information on it. In this way, students must design a project in which landscape interpretation elements are incorporated so that that landscape is described beyond visual contemplation. The project should allow for a tourist interpretation, integrating tourism information regarding the particular destination where the user is.

To support students in this project, three learning resources have been created. Firstly, a pedagogic guide has been written in order to support learning regarding landscape dynamics and its tourist interpretation. Secondly, a technical guide regarding augmented reality has been created to explain the mechanics of this technology and the software tools that must be used. And, finally, a collaborative working space has been created under the form of a wiki and a blog in which students and teachers communicate and coordinate the development of the project. In addition to that, we contacted Orange (France Telecom España S.A.U.) to participate in this project providing mobile devices for our students so they could validate *in situ* the visualization of the Points of Interest they were creating.

DEVELOPMENT OF THE INITIATIVE

Given the learning scenario, goals and resources described in the previous section, students organized themselves in groups of four people and distributed the work among them. The first step they had to take was to identify the particular landscape they wanted to work on and the items that make it up from their point of view. Once they identified the landscape and the particular items making up the landscape unit, the process of compilation or creation of digital resources began. Some of them compiled digital resources already available on the Internet, such as websites, Youtube videos, images, while others created their own resources in the forms of videos, documents or images.

Once each item in the landscape had a list of digital resources associated with it, students used an AR Content Management System (CMS) to create one Point of Interest for each item making up the chosen landscape. The AR CMS chosen to perform that step was Hoppala. Hoppala is a non-profit initiative that provides a completely online AR CMS. This CMS provides a Google Maps interface over which users can select a particular location anywhere in the world and associate digital resources with it. This information is then stored in a way that AR browsers can recover it and show it on the screens of mobile devices. Each student group

was given a Hoppala account, previously set up by the IT staff at the Community Initiatives department at the Open University of Catalonia. Once logged into this account, they created the Points of Interest and associated the digital resources they created or compiled.

Points of Interest created by the students could be displayed using the Layar AR browser as soon as they were created as the Community Initiatives department took care of all the technical details to make this possible so students could concentrate on the pedagogical part of the initiative.

During the whole the process, students could directly send their learning queries to their lecturers by e-mail and their technical doubts related to AR to IT experts at the Open University of Catalonia either by e-mail or using the blog specially developed for the purpose.

In order to compile evidence about the usefulness of the initiative and the attainment of its goals, we conducted satisfaction polls with the students at the end of each semesters when we ran these experiments over the last 3 years. Table 1 shows a summary of the satisfaction indicators we compiled. Values obtained for each item range from 1 (meaning total disagreement) to 5 (meaning total agreement).

OUTCOMES AND CONCLUSIONS

As we have mentioned before, the initiative described in this paper has been running now for 3 years. This means more than 200 students have taken part in it. Thus, the initiative has been consolidated both as an instrument and teaching resource for the subject of cultural heritage. The following are the conclusions we draw from this polls and our experience.

Firstly, despite the technical and pedagogical difficulties involved in the initiative, the academic results have been very good both in terms of competences developed and in terms of accomplishment in evaluation and continuous assessment. Evidence of that is the fact that, since the introduction of this initiative, the success percentage in the cultural heritage subject has been above the average for tourism studies subjects.

Table 1. Summary of satisfaction indicators extracted from the students' answers in the polls.

ITEM TO BE EVALUATED	AGREEMENT
The workload the initiative involved was appropriate	4.6
The initiative incorporates an innovative focus	4.6
I am satisfied with the learning outcomes of the initiative	4.1
I will recommend the initiative to other students	4.2
Overall evaluation of teamwork	3.3
The AR software used for the experience was easy to use	2.7
I have improved my abilities in the use of ICT for heritage management	3.9
I have improved my abilities in the creation of heritage-based touristic products	4
I have improved my abilities in the interpretation of heritage-based touristic products	4.1
Agreement Average Score	3.94

Secondly, one of the items this initiative allowed us to work on is cooperative work between students which, in an e-learning scenario, is always difficult to work out. As we will see later, this is an item that still needs improvement.

Thirdly, the project has allowed collaboration between different stakeholders related to the design, organization and implementation of the initiative. At an external level, private stakeholders like Orange, Hoppala and Layar have played an important role in the initiative. At an internal level, collaboration between teachers and IT experts has been further developed, giving rise to a variety of different activities that have been built on the mutual trust generated in this project.

Fourthly, the initiative has allowed us to increase students' awareness if the protection and care of landscape, especially on the aspects related to its central role in the tourism scenario. Students have been able to communicate their concerns, values and care for landscape in a professional environment. An indicator of this is the proposal for the creation of different tourism packages based on the application of AR to landscape.

Regarding the general use of AR for a tourist interpretation of landscape, we think AR introduces a series of opportunities that should not be ignored. The tourism experience can benefit from an improvement in availability of information regarding particular landscapes through the use of AR. Given the degree of familiarity that people have now with mobile devices, this rise in availability of information can lead an increased attraction for landscapes by incorporating this technology. At the same time, AR allows the generation of sustainable strategies towards landscape management, as it can be seen as a partial replacement of physical items offering information to visitors which require periodic maintenance due to physical degradation.

Finally, we would like to underline three limiting aspects that we think should be improved in future editions of the experiment. The first aspect is teamwork. The satisfaction polls we conducted reveal that teamwork has been one of the elements worst rated by students. It would be very good if we could provide students with a motivation for the teamwork. The second aspect is entrepreneurship. Despite the high potential for the to be transformed into a tourism product, none of the students have been interested on this. We should try to find mechanisms to link the initiative with the entrepreneurial capacities of students. The third aspect we would like to improve is the usability of the AR software tools we used for the initiative, as this is an aspect underlined by students. We should find ways to make these pieces of software more usable for users not specialized in ICT.

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