The 13th International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST (2012) *Short and Project Papers*
D. Arnold, J. Kaminski, F. Niccolucci, and A. Stork (Editors)

Mobile Technologies and the Use of Augmented Reality for Saving the Immaterial Heritage

D. Gheorghiu[1] and L. Stefan[2]

[1] National University of Fine Arts Bucharest, Romania
[2]Institute for Computers ITC Bucharest, Romania

Abstract

The present paper discusses the importance of immaterial heritage in the contemporary world and its preservation and transmission using AR techniques. A special case of immaterial heritage is represented by traditional technologies, currently undergoing rapid extinction all around the world.

One case study presents a series of educational experiments with mobile-learning carried out by the authors in Vadastra village, in southern Romania (project Time Maps – PN II IDEI). Here, with the help of experimental archaeology, technologies such as weaving, ceramics and glass making were recreated under the form of digital films, which were later mixed with VR reconstructions of the ancient geographical and architectural contexts to allow the viewer's immersion into the cultural formative contexts of the immaterial heritage. The educational results of this IT experiment suggest that AR techniques and mobile-learning can be successfully used to preserve and transmit the immaterial heritage.

Categories and Subject Descriptors (according to ACM CCS): H.5.1 [INFORMATION INTERFACES AND PRESENTATION]: Multimedia Information Systems - Artificial, augmented, and virtual realities

1. Introduction

The concept of "tradition" in a world undergoing rapid changes and seeking a new identity is very topical today.

It is a known fact that modern European dwelling designs originate in local and national arts and crafts traditions.

In order to rebut a current view that considers tradition an obsolete phenomenon, no longer supporting societal progress, we are proposing a functional project that uses tradition with the double aim of revitalizing it, and using it as a source of new inspiration for modern creations.

In Romania, the onset of modernity had a devastating effect on the rural culture. The Romanian village has nearly lost the continuity of its cultural and craftsmanship traditions due to the changes imposed by a Modernity too quickly assimilated. The disappearance of the autarchic economy, the opening to the EU community, and the free movement of the labour force, all led to a depopulation of villages, a process which overlapped with the natural aging of the rural population, creating an imminent gap in the transmission chain of traditional knowledge. All new constructions try to copy cultural models which are decontextualized, and subject to kitsch, due to substitutions of the original materials and the subsequent loss of aesthetic value. As a consequence, all the immaterial heritage of the traditional dwelling or *habitat* is at risk of being completely lost during the next decade. The Law No. 26 of Immaterial Heritage of 29.02.2008 states the importance of the revitalization, conservation and transmission to future generations of the national immaterial heritage.

That is why a project dedicated to the cultural memory and the salvation of the immaterial heritage of the Romanian village represents an acute necessity for the Romanian rural community. Thus, it is in this perspective that we applied our experience in experimental archaeology and IT to develop an exploratory research project (*Time Maps – PN II IDEI*) whose preliminary results are presented in this paper.

2. Project objectives

A main objective of this project is to confront and educate a contemporary audience with the immaterial heritage problems of postindustrial society, and ancient ecological technologies respectively. Another principal objective is the preservation/recovery and transmission to future generations of the immaterial heritage of the traditional technologies, thus revitalizing the arts and crafts and re-stimulating the high culture art inspired from the folk creations.

The goals of the project are to:

- Create a complex platform to study through experimentation the technologies of the traditional habitat.
- Collect the data resulted from field research and from experimentation.
- Process the data to generate educational materials.
- Transmit the preserved knowledge into folk culture and high culture by using innovative IT instruments of communication.

In spite of the massive destruction of its traditional heritage, Romania still possesses a significant amount of ancient technologies, but their know-how was not recorded

DOI: 10.2312/PE/VAST/VAST12S/021-024

with digital technology, in order to be preserved and disseminated. Also the educational value of this heritage was completely ignored.

For these reasons we believe that an initiative to save, preserve (under the form of an *e-memory*) and disseminate the knowledge of the immaterial heritage, i.e. the traditional technologies, represents a novel approach, and could be highly topical for contemporary science, humanities and arts.

Complementing the approaches of the traditional technologies through experiments (see [Ghe05]), there will be a process of data gathering under the form of an *e-memory*, which will document the technical and aesthetical real values of the past.

The third original aspect of this heritage project is its advanced educational strategy relying on the use of an *e-learning* platform (see [MVF*06]; [BAT05]) with *mobile learning* components (e.g. smart phones and PC tablets).

The new digital technologies to be used both for *teaching* and *learning*, will supplement the students' *learning-by-doing*, thus enriching the classical educational system, and expanding its reach even to persons with disabilities.

In this fashion the digital information recording the immaterial heritage can be disseminated online not only within the academic milieus, or the educational system, but also directly within the folk culture and abroad.

The information for the village and urban users will be structured on several levels of technical-artistic complexity to facilitate access and use for children, teenagers, and adult craftsmen. All the students of the arts and crafts schools will be the obvious first beneficiaries of the platform, but various experts, such as ethnologists, ceramists, or archaeologists will also benefit from this practical and useful tool.

3. Project implementation

Due to the fact that the educational information regarding the immaterial heritage is remote and geographically distributed, the mobile technologies play the most important role in delivering the information to the end users. The m-learning [CB10] paradigm describes a learning and teaching form, taking place on site and in a contextual manner, while adjusting to a user's mobility. The m-learning can also be seen as a modality to fight existing social and digital divisions.

In order to implement our educational applications based on the m-learning paradigm, the decision was made to use *Augmented Reality* (AR) as a facet of the underlying IT technology. AR can enhance and stimulate the perception of reality by means of engaging the user through interactive interfaces, thus having a high potential for applications which involve cognitive and educational processes.

The new paradigm of Mobile Augmented Reality (MAR) brings AR closer to contextual information relative to the user's position. MAR allows for interactive interfaces in which information can be filtered by "location, direction, focused object, user's personal time or interest" [KZL*10], the applications acting like information browsers. The MAR technology also has the merit of making sophisticated technologies such as Virtual Reality, commonly used in IT systems for archaeological and cultural applications, more accessible to the common user, while also providing user mobility and contextual information delivery. We based our research on a rich literature covering outstanding AR projects both in archaeology and cultural heritage and in mobile educational AR (see [VIK*02], [Ear07], [M-TFPY07], [STBB11]).

We conducted all our experiments with smart phones using the Android operation system, which we judged to be a very performant mobile platform. For application development, we evaluated several commercial AR platforms, such as Layar, Junaio, Wikitude, finally settling on the Layar platform, mainly because of its stability as an AR platform with performant implementation of the 2D image tracking algorithms, its provision of convenient tools for rapid application development and testing, and its 3rd-party content management tools.

The basic scenario for the proposed AR educational applications for immaterial heritage had as a first step the capture of the environmental data: we recorded the geographic coordinates and took geo-tagged images of the localities where the traditional technologies have disappeared (in our case those related to the manufacture of ceramics, glass, textiles and metal). These were organized in "points of interest" (POIs) associated to a Layar information layer. These points are displayed by the AR mobile client when the user conducts a search within a defined, surrounding area.

We performed experiments leading to the re-making of the old technologies, using experimental archaeology and ethno archaeology, and created a multimedia database (images and videos) which contains all the elements necessary for understanding the old techniques. The information from this database has been organized and post-processed in order to be used as augmentations and actions in the Layar AR layer, and managed by means of an AR content management platform.

Beside the in-situ experimental reconstructions based on archaeological excavations (see [Ghe10], [Gud08], [OPB04]) and the archaeological record available from the local museums, we created static and dynamic 3D VR historical reconstructions from different local contexts and two different historical periods (prehistory and Iron Age) using Autodesk® 3ds Max® tools.

The static models are simplified 3D reconstructions, showing buildings' façades, some objects and instruments, and are stored using the Wavefront Technologies® .OBJ format for the graphic data and .MTL format for the material textures maps.The dynamic models are a set of 3D renderings of different views of the model, saved as a video recording. The static models are presented superimposed on the real experiment, while the video tours are played outside the camera view, taking advantage of the full screen. All the videos are compressed with the MP4 video standard and are optimized for the web at a dimension of up to 5 Mb.

For the AR software application we had two implementation strategies:

a. The augmented information is triggered by the user's geographic position. In this scenario the AR browser application makes use of geographic search functions, which results in a list of points of interest in the user's vicinity, defined by a searching area. The points representing different technologies are further filtered by historical period and explored by browsing the attached augmented information.
b. The augmented information is triggered by the material types, i.e. the form, colour and texture of the objects

crafted with traditional technologies. In this scenario the application makes use of 2D image recognition and visual search functions, resulting in the visual identification of a technology by triggering specific information related to it (Figure 1).

We made use of the Layar tools for: preview and further optimization of the 3D models in terms of overall dimensions (up to 3 Mb) by reducing the number of vertices and polygons and using simple textures; precise positioning and relative orientation of the 3D models using a Google map; dimensioning of the models relative to the real surrounding objects and saving the model along with this information.

We also made adjustments of the virtual tour movement speed; and, in order to create a more realistic atmosphere and an immersive user experience, we tried to create a lifelike illumination of the different architectural features. We also created iterations in order to correct the triggering position of the augmentations due to the GPS errors, and iterations to adjust the dimension of the images and of the 3D models relative to the real object.

We created "surrogate" POIs from similar POIs, having different values for the altitude, in order to avoid the overlapping of multiple augmentations (images and 3D models) at close POIs. We had to orientate the 3D model with 180 grades in order to appear on the camera view.

Although the 3D models are automatically scaled with the distance, we also used images as augmentations for some POIs when viewed from a distance of 100 m relative to user's position, in order to prepare the user for the information to be viewed.

A test scenario would consist in selecting in the AR mobile client interface the historic period and then explore the POIs either on a map, on a list or on a camera view (the AR view). For example, in order to display the textile technologies, we started with the most archaic ones in a reconstruction of a prehistoric village. This is delivered to the user as 3D static transparent model, superimposed on the real camera view of the real experiment, supplemented with the virtual tour played as a short video.

Another scenario, for example for the technique of glass blowing (Figure 2) introduced to the region by the Romans almost 2 millennia ago, was presented in an augmented context by means of a video recorded re-enactment [Figure 4], in which present day artists/technicians interpret the roles of past craftsmen.

During the month of August 2012 and at the beginning of September 2012 we presented these AR scenarios to a target group of 10 children from the local primary school at Vadastra village, a relatively poor community from Southern Oltenia, Romania. The children were accompanied by one teacher who assisted the experimentalists.

Equipped with the project's smart phones, the children accompanied the experimenting team on a village tour, which comprised the interest zones, i.e. the prehistoric settlement, the Roman settlement and the area where the experimental reconstructions had been built. In those areas, the children were instructed to search the available interest points within an area of 5 km, and browse the attached information, while being aware of the changing contextual information, linked to their (and their phone sets') movements in different directions and orientations.

In order to recognize the weaving technology, the children scanned a textile texture (Figure 5) related to the Neolithic dwelling, and a VR reconstruction of the cultural context of that technology was triggered (Figure 3), as well as a link to a video Layar action.

4. Concluding remarks and further work

By means of Mobile AR applications which can be considered a new class of multimedia applications, the children learned about the AR technology and accessed relevant information, otherwise almost inaccessible to them.

They made use of the mobile technology and took advantage of the possibility to explore their rural outdoor environment during an informal educational experiment. Following the experiment, the children were asked to take a simple survey, which inquired if they thought they learned something, and if they would consider repeating this experiment. The majority stated the experiment was very interesting and instructive and were impressed by the augmented reality accessed; even those who initially had issues in understanding the application, finally succeeded in using it, and participated fully. The teacher saw the experiment as a useful educational tool and remarked on the fascination power AR had on the children.

The experiment presented the technological benefits of the approach, but also highlighted an important limitation of the Layar platform, namely a lack of authoring tools that would allow us to create a scenario-based, or a timelined, application in which the content would be better interconnected and result in an improved and guided educational application.

Going forward we shall explore other AR platforms with a higher degree of data standardization, which will allow us to deploy the application on multiple mobile platforms (Android, iOS). We also intend to create AR application prototypes and further extend the application to other geographical areas.

Finally, we plan to process the content with AR tools which make use of Mixed Reality (MR) or Augmented Virtuality (AV) techniques ([KZL*10],[CKF09]) in order to implement more immersive and also more complex user experiences and educational tools, by means of which the users will be able to perform a closer study of the immaterial patrimony.

5. Acknowledgements

The authors wish to thank the anonymous reviewers whose comments helped us improve the argument of the text, and Mr. Bogdan Căpruciu for his inspired suggestions. The experiments were possible due to a PN II- IDEI Grant.

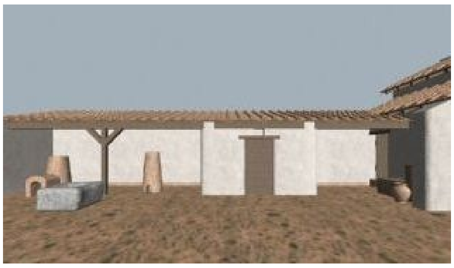

Figure 1: *A 3D reconstruction of a Roman villa*

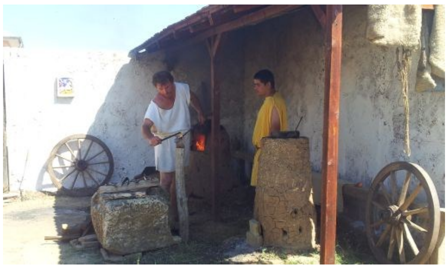

Figure 2: *The process of glass blowing*

Figure 3: *A 3D reconstruction of a prehistoric house with a kiln and a loom*

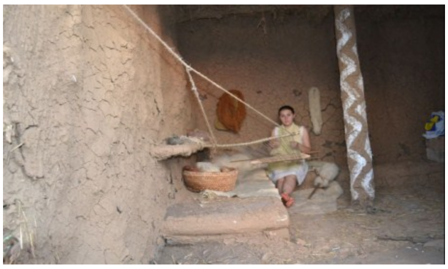

Figure 4: *Re-enactment of ancient weaving technology*

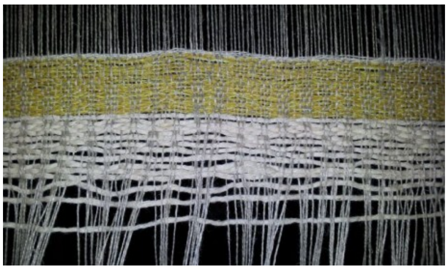

Figure 5 *Textile used for image recognition AR*

References

[Azu97] AZUMA R. T.: A Survey of Augmented Reality, *Hughes Research Laboratories*, (1997)

[Bat05] BATES T.: Technology, e-learning and distance education, *London, Routledge*, (2005)

[CB10] COCHRANE T., BATEMAN R.: Smartphones give you wings: Pedagogical affordances of mobile Web 2.0, Unitec New Zealand, *Australasian Journal of Educational Technology*, (2010), 26(1), 1-14

[CKF09] COSTANZA E., KUNZ A., FJELD M.: Mixed Reality: A Survey, invited book chapter in *Human machine interaction,* Springer LNCS 5440, (2009), 47-68.

[Ear07] EARL G. P.: De / construction sites: romans and the digital playground, *Electronic Visualisation and the Arts EVA London 2007 Conference,* (July 2007), (Proc EVA)

[Ghe05] GHEORGHIU D.: The Archaeology of Dwelling. Theory and experiment, *Editura Universitatii Bucuresti, Bucharest*, (2005)

[Ghe10] GHEORGHIU D. (ed.): Neolithic and Chalcolithic Architecture in Eurasia: Building techniques and Spatial organisation, *British Archaeological Reports International Series 2097, Archaeopress, Oxford*, (2010)

[Gud08] GUDEA N.: Asezari rurale in Dacia romana (106-275p. Chr.) Schita pentru o istorie a agriculturii si satului daco-roman, *Editura Primus*, Oradea (2008)

[KZL*10] KARLEKAR J., ZHOU S. Z., LU W., NAKAYAMA Y., HII D.: Mixed Reality on Mobile Devices, *Interactive Multimedia Lab., Dept. of ECE National University of Singapore*, (2010)

[Lam09] LAMANTIA, J. Inside Out: Interaction Design for Augmented Reality, retrieved http://www.uxmatters.com/mt/archives/2009/08/inside-out-interaction-design-for-augmented-reality.php, (2009)

[M-TFPY07] MAGNENAT-THALMANN N., FONI A. E., PAPAGIANNAKIS G., YAZLI C. N: Real Time Animation and Illumination in Ancient Roman Sites, *The International Journal of Virtual Reality, IPI Press*, Vol. 6, No. 1. (2007)

[MVF*06] MARTEL C.; VIGNOLLET L., FERRARIS C., DAVID J. P., LEJEUNE A. : Modeling Collaborative Learning Activities on e-Learning Platforms, *Advanced Learning Technologies*, (2006), 707-9

[MTUK94] MILGRAM P., TAKEMURA H, UTSUMI A., KISHINO F.: Taxonomy of Mixed Reality Visual Displays, *IEICE Transactions on Information and Systems,* (1994)

[OBP04] OWEN R., BUHALIS D., PLETINCKX D.: Identifying technologies used in Cultural Heritage, *The 5th International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST* 2004, (2004), (Conference proceeding), 155-163

[STG11] SPECHT M., TERNIER S., GRELLER W.: Mobile Augmented Reality for Learning: A Case Study, (2011), *Journal of The Research Center For Educational Technology*

[STBB11] STANCO F., TANASI D., BUFFA M., BASILE B.: Augmented perception of the past. The case of the Telamon from the Greek theater of Syracuse, *International Workshop on Multimedia for cultural Heritage*, (2011), (Proc. volume) 1-10

[VIK*02] VLAHAKIS V., IOANNIDIS N., KARIGIANNIS J., TSOTROS M., GOUNARIS M., STRICKER D., GLEUE T., DAEHNE P., ALMEIDA L.: Archeoguide: An augmented reality guide for archaeological sites, *IEEE Computer Graphics and Applications* 22(5), (2002), 52–60.