Demonstrating the use of the alphabetic telegraph through a collaborative AR activity

Iason Panagiotis Diakoumakos
Department of Informatics and Telecommunications
National and Kapodistrian University of Athens
Athens, Greece
sdi1100009@di.uoa.gr

Akrivi Katifori, Vassilis Kourtis, Manos Karvounis, Yannis Ioannidis
Athena Research Center
Athens, Greece
{vivi, vkourtis, manosk, yannis}@di.uoa.gr

***Abstract*—**Augmented reality (AR) has been extensively used in different contexts, including tourism and cultural heritage, in both commercial and research applications, and they are well known for their ability to capture the attention of their potential users. On the other hand, collaboration among groups in a museum context is proven to engage the visitors and offer a more personal experience. The combination of these two technics has not yet been thoroughly explored. In this work, we present a card-based AR application with the objective to engage the visitors in a collaborative activity designed to showcase on-site the use of a 19th century's alphabetic telegraph, exhibited in the History Museum of the University of Athens. The users are able to manipulate photorealistic 3D models that simulate the operation of the telegraph transmitter and receiver and use them to send messages to one another. The application has been evaluated with 19 pairs of teenage students with very promising results.

Keywords—augmented reality, collaborative experience

I. INTRODUCTION

Augmented reality (AR) has been extensively used in different contexts, including gaming, sports, marketing, commerce, even military applications and it has been gradually being turned into a common technological approach accessible even to the wider public through devices like their mobile phones.

Tourism and cultural heritage has been a field where AR has been applied in both commercial and research applications, and has been a major focus and research direction in projects like Mesch[1] and CHESS[2].

Collaboration among groups in a museum context has also been proven to engage the visitors and offer a more personal experience. People typically visit museums and heritage sites in social groups, either in conjunction with organized parties, or with family or friends [1][3]. The value of social interactions taking place in such visits has long been recognized as important in museum studies [2][4], and a growing line of research now focuses upon digital technologies as means to enhance this social context [5].

The combination of these two technics, AR and collaboration, in a cultural heritage context is an approach that has not yet been thoroughly explored. In this work we present a collaborative AR application with the objective to engage the visitors in a common activity designed to showcase on site the use of the alphabetic telegraph, exhibited in the History Museum of the University of Athens.

Section II offers an overview of related approaches in the field of cultural heritage, whereas Section III presents the objectives of this work, IV provides implementation details and V the evaluation details. Section VI concludes the paper.

II. AR IN CULTURAL HERITAGE

AR may offer different views of an artefact or cultural site, visualizing its original state or different states of its preservation and thus providing to the visitor a more in depth view of the artefact.

An example of an AR application on a 3D exhibit with the purpose to present its original state has been the one developed in the context of the EU funded project CHESS and presented in [6]. The visitors were offered the possibility to view status of Ancient Greek women ("Korai") through their mobile device and see them in their original colourful state. They also could interact with the augmented view of the statue and listen to information for specific details and parts that were not directly evident or visible in the original statue.

Mesch also explored the use of AR in a museum context [7] by experimenting with its use removing the intimidating association in the example of a pilot that run in the Allard Pierson Museum. The museum made use of iPhones in a purpose-built case in the shape of a loupe or magnifying glass so that visitors could hold the device with one hand. Any association with a specific device or technology was removed to avoid that visitors automatically try a fixed gesture vocabulary. The loupes were presented hanging from a display, directly connected with the objects. Visitors saw the outline of the object they had to look for and had to tilt the loupe in order to move on and see new content.

As already mentioned, our approach attempts to introduce a new aspect into the use of AR in this context, that of collaborative applications. Our hypothesis was that bringing the visitors together in a common task, which directly and interactively showcases the use of an actual exhibit, would enhance their engagement with the object and their

[1] http://www.mesch-project.eu/
[2] http://www.chessexperience.eu/

understanding of its function. The following section presents our objectives and approach.

III. Objectives

The History Museum of the University of Athens showcases the alphabetic telegraph as part of its collection of scientific instruments. The alphabetic telegraph operates in essence like the traditional telegraph. The communication requires two instruments, a transmitter and a receiver. The transmitter consists of a disc with the letters of the alphabet and other useful symbols and an indicator. It is used to select letters by moving the indicator and transmit them one by one. The receiver receives the letters, which are displayed through the automatic movement of an indicator on a disc identical to the one the transmitter has. This telegraph was used for educational purposes, to train the operators to the telegraph concept and operation before switching to the training on the Morse telegraph.

Fig. 1. The alphabetic telegraph transmitter and receiver exhibits in the Scientific Instruments Gallery of the History Museum of the University of Athens.

Both the transmitter and the receiver are in a very good state of preservation and are exhibited side by side inside a glass case of the Museum, alongside several other instruments. It is easy for the visitors to ignore this interesting exhibit amongst all the rest of the scientific instruments on display, a fact confirmed by observing the young high school students which regularly visit the Museum. The visitors are able to observe the exhibits inside the glass case but are not able to interact with them.

Our approach attempts to highlight the use of the telegraph through engaging pairs of visitors in a card-based AR activity. Each of the two visitors is assigned, through her mobile phone, one of the two cards, the transmitter or the receiver. By scanning a card marker, a photorealistic detailed 3D model of the corresponding instrument appears on the screen of her mobile and the user has a chance to interact with it (Fig. 1). The transmitter's user may move the telegraph indicator over the desired letter, then close the circuit by touching the transmitter's switch and thus send the letter to the receiver. The receiver indicates that a letter has arrived by the sound of its bell which the user may see and hear ringing and then she may see the receiver's indicator moving to the letter that was sent. At any point the two users may change roles by swapping their cards.

Fig. 2. Example use of the alphabetic telegraph – Scanning the marker

The objective of this interactive exhibit is to introduce the visitors to the use of the telegraph as an instant text message approach of the 19th and early 20th century and to guide them to reflect on how technological progress has revolutionized modern communication.

IV. Implementation

The application was developed using Unity3D[3] and Android Studio.

The Vulforia AR[4] framework has been used to support the AR aspect of the application. Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that enables the creation of Augmented Reality applications. It gives the possibility to recognize and track planar images (Image Targets) and simple 3D objects, such as boxes, in real-time. This image registration capability enables applications to position and orient virtual objects, such as 3D models and other media, in relation to real world images when these are viewed through the camera of a mobile device. The virtual object then tracks the position and orientation of the image in real-time so that the viewer's perspective on the object corresponds with their perspective on the Image Target, so that it appears that the virtual object is a part of the real world scene. The Vuforia SDK supports a variety of 2D and 3D target types including 'markerless' Image Targets. For the purposes of the particular application two images have been created to represent the telegraph transmitter and receiver. The framework was selected for the particular application as initial testing showed that tracking of the images was easy and quick and once tracked, tracking was stable and the 3D model remained stable on screen to be manipulated

WiFiDirect[5] was utilized for the implementation of the collaborative aspect of the application, ensuring the synchronous communication between the mobile devices in a context where WiFi access was not stable. WiFiDirect is a Wi-

[3] https://unity3d.com/
[4] https://www.vuforia.com/
[5] https://www.wi-fi.org/discover-wi-fi/wi-fi-direct

Fi standard enabling devices to easily connect with each other without requiring a wireless access point. One advantage of Wi-Fi Direct is that only one of the Wi-Fi devices needs to be compliant with Wi-Fi Direct to establish a peer-to-peer connection that transfers data directly between them with greatly reduced setup.

While the whole application logic and the UI was build using the Unity3D framework, Android Studio was a prerequisite in order to add the WiFiDirect support.

The 3D model of the telegraphs has been created using the Autodesk Maya 3D[6] tool through using high resolution images and measurements of the objects. Emphasis was given on photo realism and attention to detail as apart from the demonstrating the use of the telegraph, the user has the possibility to explore the object by rotating it and zooming in (Fig 2 and 3).

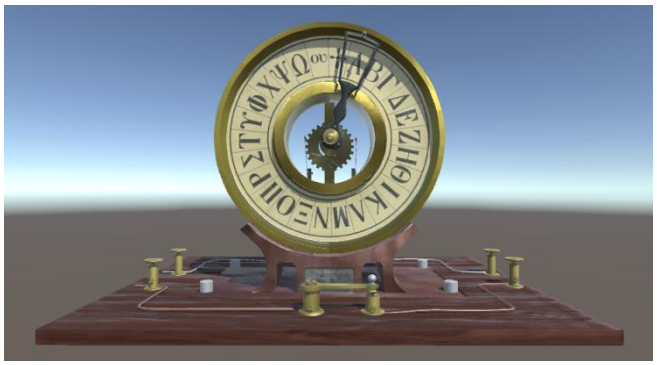

Fig. 3. Front side of the alphabetic telegraph transmitter 3D model

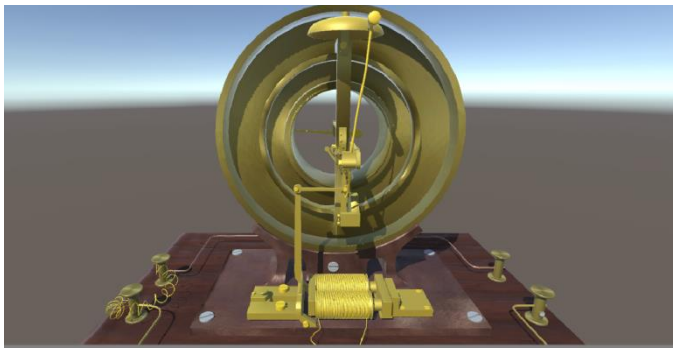

Fig. 4. Back side of the alphabetic telegraph receiver 3D model

V. Evaluation

For the evaluation of the AR collaborative app we presented the app and tested it during the Athens Science Festival 2017 event. The event was visited by several schools and individual families with their children and we thus had the chance to recruit participants for the evaluation.

A. Evaluation Group

Our targeted evaluation group has been high school students, male and female, between the ages of 13-18. 19 pairs of students tested the app, 22 males and 17 females.

[6] https://www.autodesk.com/products/maya/overview

Several adults also used the app or observed the children using it during the science fair, including high school teachers. They also provided their feedback, however the main focus of this evaluation has been with the younger student group.

B. Method

The evaluators recruited the participants among the students passing by the EMOTIVE project booth. The students were asked whether they are willing to participate in a brief evaluation and provide feedback. Their escorts, either teacher or parent were present. The escorts were very reluctant to allow video and photo taking of the children for the experiment although consent forms were presented. They only allowed photos from angles where the face of the participants is not directly visible.

The participants were briefly introduced to the objective of the app, which is the demonstration of the use of the alphabetic telegraph. They were then given the app and asked to use it with minimum instructions. Once they had managed to exchange a message between them, they were prompted to change roles, if they want. They were asked to comment out loud during the evaluation.

Once the evaluation was finished the students were briefly interviewed based on the following basic questions:

Did you think the app was fun?

Did you find the app easy to use?

Did you find app interesting?

What do you think about the alphabetic telegraph?

Their responses were audio recorded and then transcribed.

C. Results

The main positive result recorded is that the majority of the teenagers (18 out of the 19 pairs) were evidently engaged with the activity, wished to experience both the transmitter and the receiver perspective and demonstrated interest in the use of the telegraphs, making commentary and comparing to the modern day equivalents of the e-mail, sms or chat technologies: “It took forever to send messages this way!”

The app was easy to use. One noted issue was that it was inconvenient for the taller children to track the card markers on the table standing. In those cases they had the possibility to sit down. In general it was intuitive to handle the transmitter indicator and position it over the desired letter.

Almost none of the children explored the 3D models of the instruments, focusing only on their function. They only zoomed in on the front to have better view of the transmitter disc and manipulate the indicator. It seemed that it was not clear that they can manipulate and rotate the whole object to view its back side for example.

The technological innovation factor of the app seemed to contribute to the enthusiasm shown by certain participants, however it did not seem to be the main factor for the interest and engagement expressed by them. Interaction with the app was natural to the children, already very familiar with touch

screens and mobile devices and allowed a transparent interaction experience with the virtual exhibit.

Fig. 5. Two students testing the aphabtic telegraph app

All pairs understood the function of the instrument. They were impressed by how slow and painstaking the process is and the fact that it does not allow to correct mistakes and made the natural comparison with modern day text messaging.

When asked about this, the students agreed that it would be interesting to see more 19th and 20th scientific instruments demonstrated in this way.

VI. Conclusions – Future Work

This work presented the development of a collaborative AR application for mobile devices for the demonstration of the use of the alphabetic telegraph. The evaluation of this app with its intended audience validated the objectives of the creation of the app, as students seemed to be engaged and interested in the instrument and its use.

The evaluation of the prototype app took place outside the context of the museum. The next step will be to evaluate it in the museum so that we can investigate how the app can complement the original objects on display.

This work serves as a proof of concept that the use of AR technology has reached a level of maturity where it can be applied successfully in a museum context and by a particularly difficult audience, that of teenagers.

However, AR technology for its own sake and without a careful design to ensure a close coupling with the exhibit interpretation aspects can advance only as much the specific educational objectives of the cultural institute.

This calls for AR applications that take advantage of the technology to highlight the exhibit function and details through interactive applications which give an active role to the visitor, in this case for example through re-enactment of the specific exhibit use and purpose.

Coupled with collaboration, AR can be a strong tool, as visitors almost never visit alone and social interaction effectively promotes emotional engagement through common activities and through the exchange of views and ideas.

Acknowledgment

The writers would like to thank the personnel of the History Museum of the University of Athens for the support in the development of the interactive AR app and Maya Lara for the development of the photorealistic 3D models of the alphabetic telegraph. EMOTIVE has received funding from the Horizon 2020 EU Framework Programme for Research and Innovation under grant agreement n° 727188.

References

[1] Falk, J. H. (2009). Identity and the Museum Visitor Experience. Walnut Creek: Left Coast Press.

[2] Hood, M. (1989). "Leisure criteria of family participation and non-participation in museums." In B. Butler & M. Sussman (eds.). Museum Visits and Activities for Family Life Enrichment. Philadelphia: Haworth Press, 151–167.

[3] McManus, P. (1992). "Topics in museums and science education." Studies in Science Education 20, 157–182.

[4] Petrelli, D., & E. Not. (2005). "User-centred design of flexible hypermedia for a mobile guide: Reflections on the HyperAudio experience." User Modelling and User Adapted Interaction 15, 303–338.

[5] Katifori, A., Perry, S., Vayanou, M., Pujol, L., Chrysanthi, A., & Ioannidis, Y. (2016). Cultivating mobile-mediated social interaction in the museum: Towards group-based digital storytelling experiences. In *MW2016: Museums and the Web 2016*. Los Angeles, CA, USA

[6] Keil, J., Pujol, L., Roussou, M., Engelke, T., Schmitt, M., Bockholt, U., & Eleftheratou, S. (2013). A digital look at physical museum exhibits: Designing personalized stories with handheld Augmented Reality in museums. In Digital Heritage International Congress (DigitalHeritage), *2013 (Volume:2)*(pp. 685–688). Marseille, France: IEEE. doi:10.1109/DigitalHeritage.2013.6744836.

[7] van der Vaart, M. and Damala, A. Through the Loupe: Visitor engagement with a primarily text-based handheld AR application. Proc. of Digital Heritage 2015. Granada, 2015, 565--572.