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Augmented Reality Technology Spreads Information about Historical *Graffiti* in Temple of Debod

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Abstract

Learning can occur at anytime and anywhere, even when you are travelling. In this article, we explain how augmented reality (AR) can be used to better educate tourists and visitors about the sites they choose to visit. Using the Temple of Debod in Madrid and its structures as an example, we focus on applying AR to the engravings on the walls of the temple. Through AR, these engravings take on a new life, giving visitors a more interesting and interactive experience that better educates them about the temple itself and about the different historical periods in which the 'graffiti' were engraved. Augmented reality, combined with audio commentary in different languages, will help visitors to locate the different graffiti more easily and appreciate the true wonder of the site and the motives behind the engravings.

Keywords: Augmented Reality; apps; video tours; museums; education

1. Introduction

This paper describes a didactic tool, based on a recently developed piece of technology that is relatively unknown. This technology will be made available by the team signing this article to help disseminate information about the Tahut scientific research project called Proyecto Tahut[1]. This project focuses on studying the surfaces, inscriptions, engravings and graffiti in the Temple of Debod and, by extension, the body of documentation about the

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structure.

The Universidad de La Laguna and the Museo de San Isidro in Madrid are the institutions spearheading this project, which has also been financed in two phases by the Government of the Canary Islands through public calls for proposals.

It is a well-know fact that the temple was located in the town of Debod, 14 kilometres south of the first cataract of the Nile. As a sign of gratitude for the help Spain provided Egypt in the 1960's in its campaign to save the monuments and archaeological sites of Nubia, this temple was given to the people of Spain by the Egyptian government. It was reconstructed stone by stone in a public park in Madrid, and has been standing in the same location since 1972. According to recent statistics, it has become one of the city's leading tourist attractions and museums, receiving over 400 thousand visitors every year. This places the Temple of Debod one of the most-visited monuments in the city, together with the Prado Museum, the Reina Sofia Museum and the Royal Palace.

For several reasons, the temple presents itself as the perfect site in which to test didactic projects such as ours. Firstly, there is a clear social interest in providing reliable information about the structure and its history; secondly, the sheer volume of visitors allows us to gain more relevant data sets for later analysis; and thirdly, the diverse socio-cultural demographics of visitors allows us to study the effectiveness of our methodology and dissemination methods across different cultures and languages.

From its earliest stages, the Tahut Project was characterised by a methodology based on the use of new technologies for the recording and epigraphical documentation of Debod: digital epigraphy, RTI and 3D reconstructions, amongst others. Since the methodology used to date has been technology-based, it follows that the dissemination phase is also based on the use of the latest state of the art computer technology.

This project has been possible thanks to a multi-disciplinary team and collaborations between Egyptologists, architects, graphic designers, I.T professionals, and specialists in image processing. In its beginnings, the project began with a team of Egyptologists - one of whom is specialised in museology, however, new professionals have joined in response to the project's changing demands that arose in response to expanding objectives. So, what was initially solely a team of Egyptologists transformed into a multidisciplinary team.

2. Augmented Reality Technology

Augmented Reality (AR) involves creating a combination of images in a device, such as a smartphone, tablet, or pair of glasses, that has a camera. Applying AR through said device allows the user to simultaneously perceive the real-world environment and complementary virtual elements in real-time.

This paper describes an AR app designed, created and used to explain the temple's graffiti to visitors. The use of AR technology has proven a great opportunity for our work group to explore more attractive and appropriate tools for disseminating information about our work and research projects. In this case, it has allowed us to focus on an almost unheard of aspect of the history of Debod, which had not been studied previously. The wealth of historical information this could potentially provide is astounding; in other words, the use of AR provides us with a tool through which it is possible to present visitors with new and interesting academic information stemming from our research in a format that is easily accessible to them. The key concepts here are 'user-friendly design' and 'engagement'. The advantages of AR in comparison to more traditional dissemination methods are:

   a) exploiting new mediums offered by digital technology to communicate information and engage with
       users;

b) integrating the different types of information collected about Debod through the course of the project (old and new photographs and videos, ancient illustrations, documents from archives, virtual reconstructions) in a single easy-to-use modern format;

c) reaching visitors in a wider age bracket;

d) making the visit more attractive and entertaining by providing visibility to an aspect that is otherwise difficult for non-experts to identify;

e) giving visitors more freedom to access updated information without having to depend on a guide. The app is available 24 hours a day, 365 days a years, though the temple obviously has specific opening hours. The current version of the app can also be activated outside the temple as the visuals are based on the brochure and the content is stored in the Cloud, which means that it can be accessed before, during and after visits to the temple. In the coming months, there will be a version that will only be accessible within the temple because all the data in the app will be geolocated information.

Of course, our aim is not develop an app that could act as a substitute to an actual visit to the monument, but rather to complement any visit made by tourists. As such, one of the questions we need to be able to answer is: To what extent will the app attract more visitors or generate more virtual visits to the project website, which will feature all the information available via the AR app?

It is clear that this system also has its limitations:

a) The visitor must have a mobile device, i.e. a smartphone or a tablet with 3G data connection. However, such devices are quite commonplace today.
b) Persons of a certain age who are not used to such digital systems might be a bit apprehensive about using them, in part because they are unfamiliar with modern technology, and in part due to physical limitations such as visual impairment.
c) You must have mobile data connection. Due to expensive roaming fees, foreign visitors generally do not activate their data connection whilst travelling. The solution, in this case, could be for the Temple of Debod to provide free local Wi-Fi.

The information and customer service personnel at the temple will require some basic training to be able to assist visitors to install and use the app, as and when needed.

3. The brochure as the medium for AR

To visualise the AR, it is necessary to have a medium that will activate the app, that is, something that will make the visual elements appear on screen.

The most-frequently used system in museums or cultural heritage sites is activation by the image of the very object upon which the virtual element is to be incorporated: the image of a painting, for example, activates the app, which then displays additional information about said painting. The app essentially recognises a pattern, in this case the image of the painting, and displays information about it from a core database.

Initial discussions revolved around using the joints between the individual stones where graffiti is located to trigger the app, thus the image recognition system would use part of the existing environment.

Firstly, the user would launch the app, activate the device's camera, and then focus the camera on the joints surrounding the graffiti. This in turn would lead to virtual elements - in this case videos or pictures of the graffiti - to be projected onto the image. However, this form of recognition, which uses the real environment, could not be implemented at this point due to two issues: one being a problem pertaining to visitors' general knowledge, and the other pertaining to technological difficulties:

a) **Knowing where to look**: It is not always easy to spot the graffiti on the walls of the temple at a simple glance; far too often, too much light or too many shadows obscure the engravings on the exterior or interior of the temple. Many graffiti are difficult to see and lurk undiscovered in museum.

When most of these graffiti were engraved in the stone, those carving them could see the lines more easily, either because the engravings were a different colour when compared to the stone surface, or, in the case of the graffiti made by travellers in the 19th century in the interior chambers, the area was well-lit because there was no roof at that time. The roof that was installed much later on plunged many graffiti into darkness, and now specific lighting conditions are needed to see most of the specimens. For these reasons and quite simply the fact that many graffiti are not in plain sight, visitors have no way of knowing where to find them.

b) **Image recognition**: The surface of stone and the corresponding joints where the graffiti are located is very flat and uniform. The engravings have not been carved into uneven surfaces, but instead they have been carved on smooth walls. What this means is that it is nearly impossible for the app to distinguish one joint from another, and thus they cannot be used are markers for image recognition. The technology, after all, recognises and distinguishes between patterns and in this case, since the differences between the joints are so minimal, recognition would be very difficult. It was found that when the mobile device is aimed at a certain joint, the current version of the AR app is unable to identify it as a specific joint and assign the corresponding virtual content to it.

It is important to add that we have already entered a new phase of development and experimentation in the project to resolve this issue, either with QR codes on the floor or on stands, or via the use of GPS.

Therefore, in this initial phase of the project brochures will be used to overcome these limitations, as at this stage they are the most well suited medium for the dissemination needs of the project for the following reasons:

a) Brochures and leaflets are easy for visitors to use;
b) They allows visitors to explore the temple in an enjoyable way;
c) They help visitors get accustomed to using new technology and new apps via a more familiar media when accessing information about the temple. Our aim is to progressively extend this method to other aspects that we are studying: the surfaces, the inscriptions, the individual exposed joints in the terrace, all of which will be incorporated through parallel developments in historic research and the app itself.
d) After visitors have been to the temple, they can pass on the printed content (brochure/leaflet) to others potential visitors, showing them how the AR adds an element of interactivity because the visuals are not based on the physical environment of the temple but rather on the brochure. We believe this word-of-mouth marketing made possible by the app will be hugely important when it comes to generating interest in visiting the temple.

4. Brochure and App Content

The brochure has some very brief written information: a few paragraphs on Debod at its original location, the transfer process to Madrid, and information on the temple's graffiti in general. Then there is a series of photographs that represent the specific types of graffiti. Each image is accompanied by a number, and, save for a few exceptions, they are in chronological order from the oldest engraving to the most recent. In this way, the brochure offers a suggested route for visitors to take through the different parts of the temple and types of graffiti, whilst still allowing them the flexibility to enjoy the experience as they see fit. Again, in terms of providing visitors with freedom and flexibility, the brochure also contains a map of the temple showing where the mentioned graffiti are located, thus allowing the visitor to decide on their own route if they want to.
Though there may be more than one graffiti on each wall, the photograph in the brochure and the accompanying images and information in the AR help the visitor to identify the specific engraving that is being described. This, in

a way, forces a degree of interactivity: the visitor has to look for the graffiti on the wall, thus making the visit more participative, and in theory, more engaging. Each photograph in the brochure activates specific information in AR, which is presented to the visitor in the two components that essentially make up this audio-visual AR: different types of new images (including videos) and a commentary in Spanish or English, as selected by the user. We believe that it is easier to listen to the commentary than to read the same information and that it is also more didactic.

The information is divided into eight sections linked to eight photographs in the brochure that activate a corresponding audio-visual block in AR (except for the image on the front cover):

- Block 1 is about the construction of the Temple of Debod.

The AR includes a map of Nubia with the location of the temple, a video with a virtual tour that takes you back in time from the current structure to the central chapel in the era of the Nubian king Adikhalamani. The commentary provides a short explanation of the historic context within which the different phases of construction were carried out, from the central chapel to the conclusion with the last of the Ptolemies, and also the Roman decoration in the vestibule.

- Blocks 2 to 8 feature seven types of graffiti.

Of the 130 graffiti and fifty anthropic erosions identified on the building that were previously grouped by type for the purpose of study, we have selected the ones that we believe to be the most significant graffiti for a range of reasons: the historic information they provide, their visibility, and their uniqueness. It was not possible to include all categories of graffiti, however those selected are the most representative.

The commentary for each of the categories has a similar structure: historic context for the type of graffito; where this type of graffiti is to be found in the temple; if they are located in specific areas or on specific walls, which is quite frequent; and an explanation based on the concrete example that is shown in the images.

Although the complementary images are different for each type, they all include a picture of the specific graffito that is explained in detail, together with other additional images:

* Greek graffito: toproskynema;
* Blemmyes dromedaries on the northern wall of the temple;
* Coptic cross pattee on the door of the second pylon;
* Spindle-shaped domes from an unidentified period on the external walls;
* Islamic graffito on the door of the first pylon;
* Name and date of a European traveller to the Naos chapel;
* Raised drawings of Egyptian gods on the rear wall with a string of circular domes.

Fig 1. Brochure for the Temple of Debod Augmented Reality App

5. **App development and functions**

The app was developed using the Metaio Creator 6.0 augmented reality authoring tool.

The most labour-intensive part of any AR app is creating the virtual content; in this case, the labour intensive work involved creating a virtual video tour of the building that combines images and graffiti, and then linking this with the commentary in not just one, but two languages: Spanish and English. Before recording the audio, the information that needs to be included was selected and translated into English. The audio commentary has been further enhanced with background music, making it more pleasant to listen to.

Once all the virtual material to be shown was generated, the images that were to serve as patterns for recognition were programmed in Metaio; in this case, the photographs of the graffiti that are in the brochure. From this point on, each pattern was linked to the information to be shown virtually - a video or image of the graffiti and two additional images (a Spanish flag or a British flag). These two images are built as interactive images so that the audio assigned to the graffiti in question is activated when you click on the flag. The commentary can be stopped at any time by clicking on the *Pause* button. If the users wishes to change the commentary language at any point, they can just click on the other flag to swap languages.

On recognising the pattern, the app displays the virtual element and the two interactive language buttons for the commentary.

To avoid the user having to use a specific AR app together with this brochure, we decided to store the content in the Cloud and use the free the augmented reality browser **Junaio**[2], a generic app that allows you to view any AR content. App developers create channels so that each channel is an AR app. Thousands of developers have created channels in Junaio which is where all of these apps have been made available. All the user has to do is indicate which channel he or she would like to watch and access will be given to all the AR content associated with that channel.

Of course, the user must have the Junaio app installed on their device; those who have not installed it must do so. Junaio is available for Android and iOS devices and can be found in the PlayStore or the AppStore (depending on the type of device).
If the user has installed a QR code reader, this app can be used to read the QR code on the brochure, which will lead directly to the download, without having to search in the PlayStore or the AppStore, and the installation process will take less than a minute.

Fig. 2. Downloading Junaio and launching the TDebod app

Once Junaio has been installed, the user must launch the app and search for the **"TDebod"** channel or use the "SCAN" option to read the QR code given on the brochure, which will lead directly to the AR content for Debod.

The name of the channel (Debod) and its logo will appear on top of the screen. The camera will now be activated and the only thing the user has to do is focus it on the numbered images on the brochure and the virtual content will appear superimposed over it.
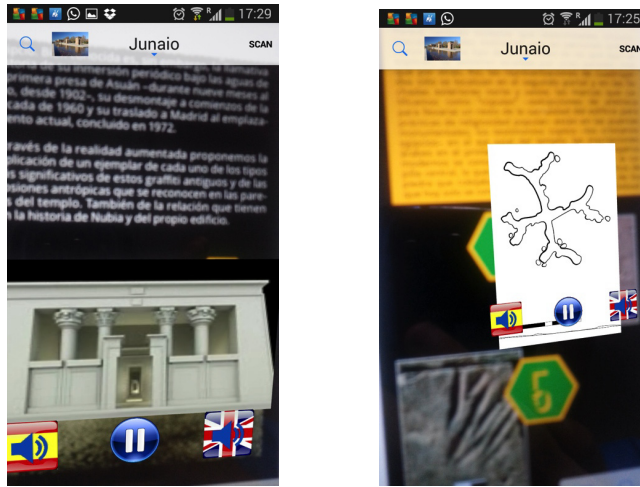

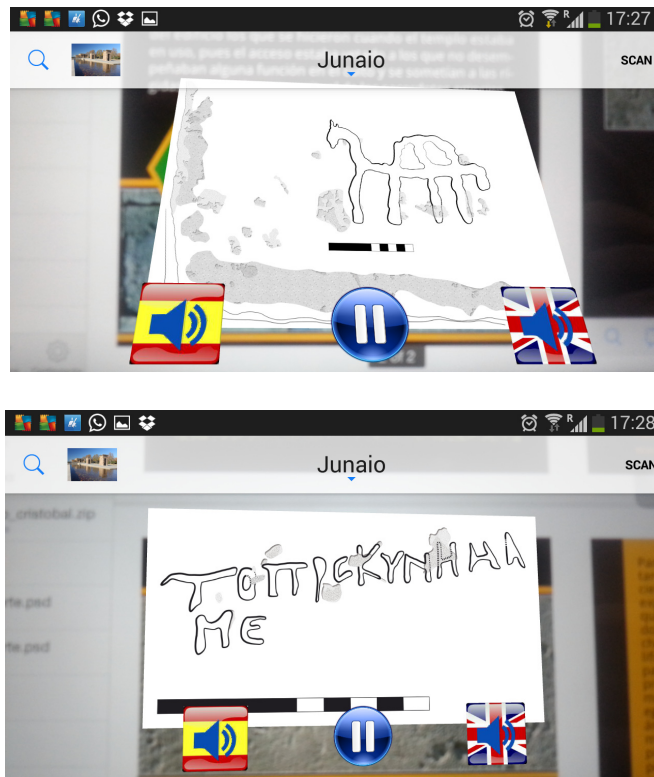Fig. 3. Smartphone screenshots (vertical position): Video display and graffiti

Fig. 4. Smartphone screenshots (horizontal position): Graffiti

6. Feedback from users on the app aimed at dissemination

The app has been favourably received in the academic settings in which it has been presented.

The brochure will be available at the temple to be used by visitors by the end of the August. In September, a publicity campaign will be launched for the app at the temple itself as well as on its website and on social media. The purpose of the publicity campaign is to introduce the app to visitors and potential visitors, and to encourage them to learn more about the building's historic graffiti. In addition, a short questionnaire has been produced to evaluate how well the tool functions. It will be tested using the data collected from real users and is designed to judge user satisfaction levels with regards to the app.

References

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