

# Atalaya3D: making universities' cultural heritage accessible through 3D technologies

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## Abstract

*This work was carried out over the past eight years through the Atalaya3D project, which aims to make the cultural heritage of the ten public Andalusian universities accessible. Since 2010, the project has been a pioneer in the field of 3D scanning of sculptures and historical sites, opening up restricted areas virtually through 3D web displays. Moreover, in addition to the website, a mobile app allows visitors to browse these institutions' vast heritage and examine it before visiting the campus in a 3D environment. More than 70 artworks and historical buildings have been accurately scanned using the latest 3D scanning technologies, so that we now have the geometry and colour of the pieces documented in detail. QR codes make it easier to reach the relevant information about our universities' heritage via any mobile device (phone or tablet).*

## CCS Concepts

•Information systems → World Wide Web; •Computing methodologies → Virtual reality; Mesh models;

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## 1. Introduction and aims

Cultural heritage is usually an unknown side of higher education institutions, not only for the members of the universities themselves, but also for the general public. This heritage is often closely related to the history of the university entrusted with it, bringing together scientific, artistic and historical values for teaching, research or management purposes. Many of these collections are spread throughout the buildings that make up each university campus, even as decorative features in the main areas' nobler rooms, so their availability to the general public is generally very limited.

Universities' heritage is a topic of interest in several international institutions. The European Academic Heritage Network (Universeum) [uni18a] was created in 2000, for example. In 2001, the International Council of Museums (ICOM) also set up the Committee for University Museums and Collections (UMAC) [uma18], whose mission is "to contribute to society, for the benefit of all, by sustaining the continued development of university museums and collections as essential resources devoted to research, education, and the preservation of cultural, historic, natural and scientific heritage".

Some universities manage their own museums, such as the University of Oxford's Museum of Art and Archaeology, founded in 1683, one of the first examples that can be found in the literature.

In Spain there are some classic museums like those belonging to the University of Alicante (MUA), the University of Navarra (UNAV), the University of Valladolid (MUVA), the Complutense University of Madrid and the University of Salamanca. More related to our project, in 2010 the University of Barcelona inaugurated its virtual museum [VdA18], this being the first initiative of its kind on a Spanish university.

Some of Andalusia's public universities were founded in the 15<sup>th</sup> and 16<sup>th</sup> centuries, and with the aim of making their cultural heritage accessible to society as a whole the Atalaya3D project concentrates on four main tasks:

- To highlight the most significant artworks among Andalusian universities' cultural heritage, including sculptures, paintings, scientific material and spaces, via a visually attractive website and activity in the social networks;
- To precisely document the main pieces and buildings in 3D, keeping a very faithful record of their current state of conservation, using the latest 3D scanning technologies
- To make a high quality 3D visualization of the selected artworks available so that any observer may examine them with a common computer or mobile phone;
- To create a community of experts in the universities' heritage.

The rest of this paper is structured as follows: firstly, we will analyse the previous works that have tackled this topic. In Section 3 we will briefly describe Andalusian public universities' historical and geographical context. Section 4 will describe the different

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approaches used since 2010 in scanning the ten universities' main artworks among their cultural heritage in 3D. In section 5, we will describe the dissemination tools used in the project: the website and app, as well as their performance. Finally, we will summarise the results and propose future work to improve the project.

## 2. Background and related work

Today, digital resources are a basic feature in any museum, and when they are wisely developed and used they become a fundamental learning and engagement tool for exhibition purposes. Rather than substitute the pieces and physical displays in an exhibition, they enhance them so that the content is widely accepted and understood. Dyson and Moran [DM00] provided a pioneering study on how to design a museum's website by focusing on the different visitor profiles and the more elementary web design standards. Since then, many other studies have been made assessing e-museums' websites and visitors' behaviour, as describe extensively by Kabassi in [Kab17].

These days a website is a must for any museum, academic institution or cultural stakeholder. We can find many examples of basic presence websites geared towards classic visitors. These include timetables, fares, maps and information about temporary exhibitions. What is not so common is to have a museum's website that includes a complete description and documents about the pieces, or at least a selection of pieces, which can be visited *in situ*. Under the mistaken term of *3D visits*, what one usually finds is a panoramic photographic tour like Google Street View through the museum's actual spaces. However, this cannot be conceived as a 3D visit, as the point of view in each pano is fixed and the interaction is very limited (e.g. the Smithsonian National Museum of Natural History [smi18b]). Obviously, this approach is very interesting as a preliminary view of the museum to display the quality of the exhibitions and the general atmosphere, but the website's visitors cannot freely move around the exhibition. More recently, under the auspices of the Google Cultural Institute, several institutions have begun to display 360° panos as the first step towards making their content virtual. Others such as the Louvre [lou18] still depend on the discouraged Adobe Flash technology to display their panoramic tours. The Met 360° Project [met18] adds an extra interaction to these panoramas by displaying 360° videos, which are more dynamic and attractive.

Closer to the features of our Atalaya3D project, the Petrie Museum of Egyptian Archaeology at University College [pet18], has been creating 3D models of objects since 2009 and displaying them on a website using ThreeJS as the rendering engine. The Smithsonian X 3D project [smi18a] is a top world project whose goal is to bring hidden collections from the 19 museums, 9 research centres and the National Zoo that belong to the Smithsonian Institute into the virtual world via 3D scanning and web displays. The African Fossils' virtual laboratory [afr18] is creating a growing repository of 3D models of significant fossils and artefacts, thus making them freely accessible to all, with the support of Autodesk and some universities and companies.

In [SFKP09], the authors provide a complete survey about virtual museums and show the benefits of using 3D models to create

and disseminate virtual models of cultural artefacts to a wider public, to experiment with various arrangements of 3D objects inside the gallery, to provide worldwide publicity and many other useful applications for the digital models.

## 3. The context of the Atalaya3D project

Andalusia is an autonomous region in southern Spain with the largest regional population in the country. There are ten public universities, two of them dating back to the 16<sup>th</sup> century: the University of Seville founded in 1505 and the University of Granada in 1531. Some of them have all their buildings and offices in a single campus, like Almería and Huelva, while others are distributed among several campuses in a city (e.g. Seville, Málaga and Córdoba) or even in several cities located hundreds of kilometres from each other (Cádiz, Jaén, Granada and the International University of Andalucía). We can thus consider the cultural heritage of Andalusian universities to be a *geographically distributed collection* that is not possible to visit at a glance in a single week's journey, as seen in figure 1.



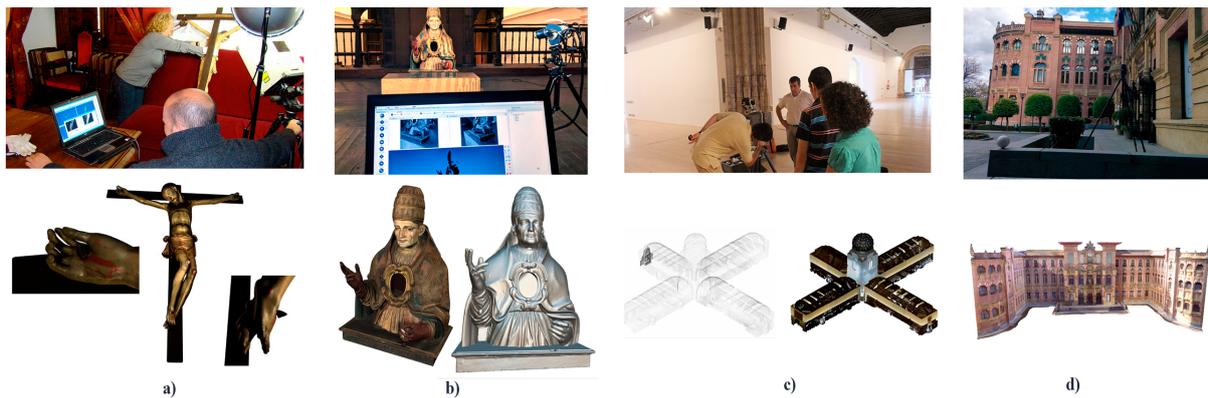
**Figure 1:** Geographical distribution of the campuses of the ten public universities of Andalusia.

The University of Seville created a complete database available through a website [pat18], where visitors can search and consult the records including a photograph and all the fields required by an expert. Since 2010, the Andalusian Institute for Cultural Heritage and the International University of Andalucía (UNIA) have been coordinating a project [uni18b] whose aim is to publish all the universities' cultural heritage records in a single database, following the regional standard database *Mosaico* [mos18].

All of the three platforms described above are just an online database, with no kind of visual effort to attract the general public to their content. To bridge this gap, since 2010 the University of Granada has coordinated the Atalaya3D project [ata18], to disseminate the Andalusian universities' most valuable artworks and historical sites to a wider public by offering a selection of pieces and buildings, displaying not only archival records but also multimedia content such as videos, audiodescriptions, photographs and interactive 3D models from high quality 3D scans.

## 4. Digitizing the cultural heritage

In July 2010 we started to scan the first artworks from the University of Granada. In figure 2.a we show the scanning process and the result of a sculpture dating from the 16<sup>th</sup> century. We used a



**Figure 2:** 3D scanning (top) and result (bottom) of: a) Crucified from University of Granada (2010), b) Reliquary of Pope Saint Gregory from University of Seville (2017), c) Royal Hospital from University of Granada (2011) and d) Rectorate of the University of Córdoba (2016).

Konica Minolta laser scanner to produce the high fidelity 3D models of sculptures in this first phase. In 2010-2012, we scanned 30 artworks and 5 historical sites, using a Faro LS scanner for the mid-range scanning processes (figure 2.c).

Since 2012, we have been using a Breuckmann Smartscan HE structured light scanner to do all the short range digitizations, due to its very high accuracy and highfidelity colour capture, which may produce better visual quality for the 3D model, such as for the Reliquary of Pope Saint Gregory from the University of Seville depicted in 2.b. Up to 2018 we digitized 56 movable heritage pieces from almost all the universities and 24 rooms and buildings, as depicted in Table 1.

Movable heritage includes not only sculptures, but also scientific and academic resources and ancient furniture. All the movable pieces have been scanned using a resolution of 0.3 mm and an average mean error below 0.03mm. Immovable heritage has been scanned since 2012 using a Faro Focus device (figure 2.c, providing an accuracy of 1mm at 25m. The highest resolution models ( 10M polygons for movable items, 40M for immovable ones) are kept for documentation purposes, and we use low resolution versions ( 1 million polygons) for the multimedia production and web visualization.

To ensure the visual quality of the final 3D models, we always

University	Movable	Immovable
Almería	3	
Cádiz	4	
Córdoba		2
Granada	25	11
Jaén	2	
Málaga	1	2
Sevilla	19	5
UNIA	2	4
<b>Total</b>	<b>56</b>	<b>24</b>

**Table 1:** Number of 3D virtual models available from each university

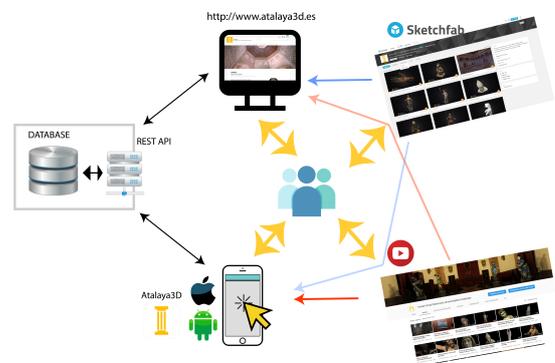
take photographs in an environment with controlled lighting so that if the scanner does not capture good colour (e.g. due to variation in the lighting conditions during scanning) we can texture the final models by mapping the high resolution photographs onto the high resolution 3D models [CCCS08].

### 5. Making the heritage available to the public

The main purposes of Atalaya3D include highlighting the top artworks from Andalusian universities' cultural heritage through a visually attractive website and activity in the social networks.

The whole system is structured as depicted in figure 3. Our database, implemented in MariaDB (free alternative to MySQL), is handled through a REST API that encapsulates the inner data structure. This will allow us to easily add or change data sources without reimplementing the web or mobile applications.

Users can access the records by accessing the website or through the app. Both interfaces are collecting data from the REST API and retrieve 3D models and videos from external providers, such as Sketchfab and Youtube. By offering users public access to the Youtube channel or the Sketchfab homepage, we increase the au-



**Figure 3:** Atalaya3D system architecture.



**Figure 4:** During the eight years of the project, the *Atalaya3D* website has evolved in core programming architecture and style.

dience and the potential visitors. Up to now, we have produced 23 short videos and movies using the scanned 3D models.

Since 2010, the website has moved from the original Joomla! 1.5 dark style (figure 4.a) in 2010, to a Joomla! 2.5 light template in 2014 (figure 4.b) and upgraded to an ad-hoc customized website in 2016 by implementing our own content management system (CMS) in PHP (figure 4.c). Currently, the website stores a collection of almost 400 records, all of which have photographs and 74 of which have multimedia material such as 3D models, videos of the 3D models or educational resources. Moreover, 20 pieces from the University of Granada have audio descriptions to be able to listen to the content while examining the 3D model.

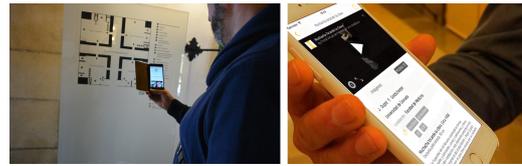
The project has a Twitter account (@atalaya3D) and a Facebook page (atalaya3d) to disseminate the Andalusian universities' cultural heritage, publishing the latest news and results from the project. It is also possible to access our videos via the YouTube channel (<https://goo.gl/mpjqSx>).

### 5.1. 3D Web visualization

The HTML5 standard was released in June 2010 [Hoy11]. This was the starting point from which 3D web visualization spread, thanks to the `canvas` element and the WebGL API specification. This technological advance allowed us to become more ambitious in terms of scope and technology. *Atalaya3D* was one of the first websites to implement 3D visualization for artworks [MGSH15] and we relied on the X3DOM library [BJK\*10] to render our cultural heritage models stored in X3D standard.

More recently, as Sketchfab is now becoming the world's leading platform for 3D visualization in the Internet, quite similar to Youtube for videos, we have decided to move all our 3D models to this platform and open up a second space to disseminate the universities' cultural heritage. Since 2016, all the 3D models have been accessible via the *Atalaya3D* website (<http://atalaya3d.ugr.es>) as well as via the Sketchfab platform (<http://www.sketchfab.com/atalaya3d>). Moving our models to Sketchfab allowed us to:

- Compare our project in terms of popularity to other world-leading museums like the British Museum;
- Allow our virtual visitors to easily share the 3D content in several social networks,
- Completely outsource the 3D rendering on web to a well-proven platform;



**Figure 5:** (left) Scanning QR code at Hospital Real of University of Granada. (right) Visualizing the 3D model of a piece in the app.

- Increase the audience for the 3D models by also increasing the input channels.

### 5.2. Mobile app and QR codes

As a complementary tool, we have developed the *Atalaya3D* app for iOS and Android platforms that allows users to navigate through the catalogue in their cell phones or tablets. The app has been developed to adapt the layout to the different devices so that the experience on a tablet is different from a mobile phone.

One interesting feature included in the app is QR recognition. We have developed a QR code for each piece in the website, and these QR codes are included on the panels for the real pieces and rooms, as depicted in figure 5. When the QR code is scanned through the app, the system displays the record of the item the visitor is looking at. If the QR code is scanned with the mobile device and the user has not installed the *Atalaya3D* app, then the device's web browser opens with the record. This means that the QR codes are independent of the mobile app, but when scanned with the app the user's experience is more satisfying.

### 6. Future works

The *Atalaya3D* project is still growing in terms of the number of 3D-scanned pieces and available records, but we are also introducing new technological features to make it more attractive to the general public. Summarising the next steps, we can state that in the following months we plan to:

- Translate the content into English
- Include 360° videos of guided tours through the universities' most emblematic spaces.
- Design tourist routes at each university, geolocating the pieces and guiding the user by the app.
- Complement the QR codes' information by placing beacons near each piece, so the app will launch the information without need for QR code scanning.
- Increase the social networks' activities to disseminate Andalusian universities' cultural heritage.

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