

# AR-TagBrowse: Annotating and browsing 3D objects on mobile devices<sup>†</sup>

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## Abstract

*We report on the development of a novel interactive augmented reality app called AR-TagBrowse, built on Unity 3D that enables users to tag and browse 3D objects. Users upload 3D objects (polygonal representation and diffuse maps) through a web server. 3D objects are then linked to real world information such as images and GPS location. Users may optionally segment the objects into areas of interest. Such objects will subsequently pop up in the AR-TagBrowse app when one of these events is detected (visible location or image). The user is then capable of interactively viewing the 3D object, browsing tags or entering new tags providing comments or information for specific parts of the object.*

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## 1. Introduction

Augmented Reality (AR) intends to offer richer interactive user experiences by overlaying text, images, video or 3D objects over a scene rendered through a camera. Powerful mobile devices with advanced graphics hardware have recently enabled photorealistic interactive rendering of 3D objects or even of the entire 3D scene.

Several AR applications offer the functionality of tagging places (inserting labels or annotations) observed through a camera [Lay, Wik]. This is accomplished with combined GPS and gyroscope information along with computer vision techniques for indoor applications [eHQRLCPG10].

Labeling 3D objects is a novel area of research that is important for providing a sustainable crowdsourcing paradigm for annotating 3D models of digitally reconstructed artefacts, or other reverse engineered objects that have been destroyed or removed.

The HarvANA [HG10] system is an annotation platform for annotating/tagging entries of a digital library of 3D objects. This is a powerful conventional system for annotating/tagging that does not offer the capability of tagging cer-

tain areas of a 3D object nor the functionality of augmented reality based detection of points of interest.

Regarding tracking, [WTA11] uses panoramas instead of live cameras for detecting points of interest, a method that can potentially be used also for indoor applications. However, this approach does not work in unprepared scenes.

In this paper we report on the development of a prototype (AR-TagBrowse) that consists of: (i) a cloud service and a 3D object base for uploading, processing and indexing 3D polygonal representations and (ii) a mobile AR application for annotating and browsing 3D objects that pop up in a scene observed by a mobile camera.

AR-TagBrowse makes the following technical contributions:

- Presents a novel technique for efficiently visualizing object annotations.
- Provides practical solutions for 3D object processing, indexing and segmenting.
- Introduces a social media inspired crowdsourcing paradigm for annotating 3D objects that can be used in museums, archaeological sites and other places of cultural interest.

## 2. System Overview

AR-TagBrowse consists of three parts:

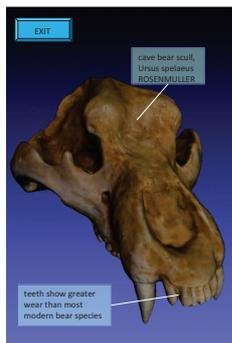
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- A 3D object base where all information regarding 3D objects is maintained: polygonal representation, texture, mesh segmentation information, annotations/tags, link information (images, locations).
- A cloud computing platform that facilitates uploading and storing polygonal representations and textures in a 3D object base. It also provides state of the art services for: mesh segmentation, image feature extraction and indexing, 3D object format converter by employing both opensource (Meshlab [CCC\*08]) and custom software.
- A mobile augmented reality app built on Unity 3D [Uni] using the Qualcomm Vuforia plugin [Qua] for browsing and annotating 3D objects that pop up when an image or a location is detected in the mobile device camera.

Figure 1 illustrates a snapshot of browsing an annotated cave bear skull (annotations are turned on, while the camera background has been turned off).

The AR-TagBrowse app has also the following functionality: use the device control buttons for moving/rotating/zooming the camera, animate the object (by automatically rotating the object around the three axes), insert new tags, and a number of preferences (such as sort tags by channel, date, size etc). The application illustrates as many tags as possible and the next batch of tags can be shown by using the volume up, down keys.



**Figure 1:** Browsing an annotated cave bear skull that was reconstructed using a 3D laser scanner and uploaded on AR-TagBrowse.

### 3. Annotation Visualization

To facilitate efficient real-time and user friendly tag browsing, it is important to develop a fast, flexible and robust method for visualizing tags. The goal is to show as many annotations as possible without cluttering the small screen. To simplify this process we have pre-determined that:

- the font size of the annotation text is fixed.
- the size of each annotation is implicitly set by the user through the number of lines (height) and the longest line (width).

- there is a predetermined ranking (sorting) criterion for tags (currently available options are: date, channel and overall size).

Tag visualization is performed through a simple process that can be summarized by the following rules:

- tags are placed one at a time based as they come (according to the sorting criterion).
- a tag is placed as close as possible to its anchor point (the point to which it is related to).
- a tag may be placed anywhere outside the virtual convex hull of the pixels that render the object (this gives much more available space than axis aligned bounding boxes).
- if a tag cannot be placed then we attempt to place it first in the next batch of tags, if still it cannot be shown then we show a truncated summary of the tag.
- only tags that refer to visible parts are shown.

We have performed a preliminary user study to optimize the tag visualization process. The user study has determined that: users prefer not to overlap tags with the rendered object (even when using semi-transparent tags) and that users are confused when tags of hidden surfaces are shown. Finally, it was inconclusive whether users prefer tags that partially overlap each other and come in front when the user taps on them.

### 4. Conclusions

We have reported on the development of AR-TagBrowse, that introduces a novel paradigm for tagging and browsing virtual 3D objects in an AR setting.

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