AR coupled with localized simulation technology for Cultural Heritage

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Introduction

Cultural heritage sites have started capitalising on the possibilities of AR and improving their visitor experience as more and more applications influence users' field applications [1], [2]. The use of AR technologies in a real case scenario has been investigated in other locations [3]. Considering that large-scale archaeological sites face unique challenges compared to museums and exhibition areas SLAM technology has been previously used to superimpose virtual reconstructions at real scale [4]. The lighting and user confidence with AR highly influenced their results to achieve matching between existing evidences and 3D reconstructions. In addition, their application depended heavily on data exchange and the lack of wireless connection constituted a major drawback. Finally, SLAM technology is energy consuming for the used devices.

Problem Statement

Archeological sites are typically locations that their old view and appearance have undergone major changes and they pose certain characteristics, such as, the demand of large-scale 3D reconstruction, lack of internet connection, inability to do anything in the surroundings such as install sensors, variations in lighting and textures (flora changes a lot), visitors of these sites have smartphone devices with low processing power, have very little existing information to obtain via edge tracking techniques..

Research Statement

An AR mobile app (i.e. CirculAR) has been developed focusing on state-of-the-art localization technology, aiming to address bottlenecks that previous efforts faced, such as large-scale 3D artefacts representation utilizing low energy and power from smartphone devices and perform offline. CirculAR aspires to support the visualization of 3D large scale content, including information (text, audio, and video) in an accessible and inclusive manner; to use localization technology to reposition the 3D artifacts at their original position as accurately and as stable as possible; to seamlessly localize the 3D artefacts at field conditions with varying lighting, textures, possible absence of internet connection; to perform at common smartphone devices that have low performance in terms of energy and power.

CirculAR solution

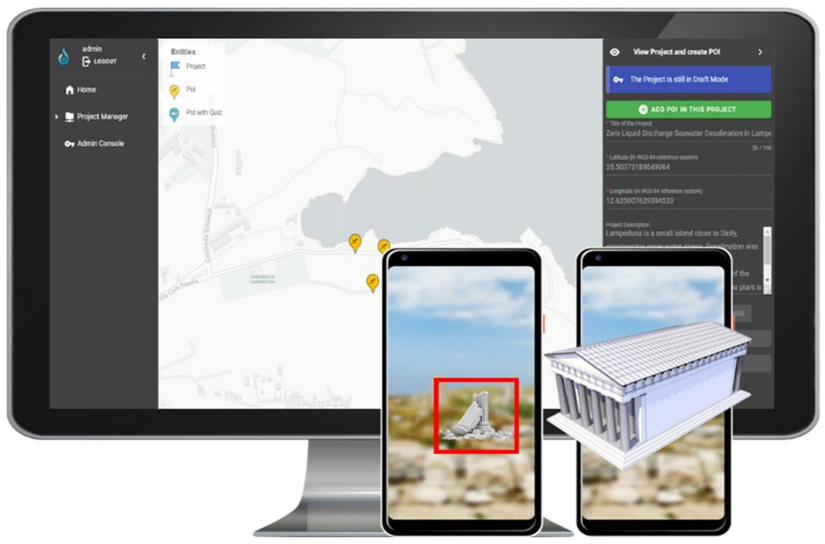

Figure 1. The CirculAR 2-part-solution for content owners (Content Management System) and visitors (mobile app)

CirculAR provides a gamified experience through an average smartphone enhanced with AR content in real-world locations, primarily targeted to Cultural Heritage sites. A Content Management System (CMS) enables curators, archaeologists, and other content creators to create campaigns consisting of multiple geolocated points of interest (POIs) with attached related multimedia files (text, images, videos, 3D models). The app is equipped with image and object trackers that recognize targets that are either precompiled or added in the runtime. The application is equipped with three main views for the end-user:

1. The main AR mode where the user views the world augmented with the 3D content and a series of buttons enable the end-user to: content manipulation, animation viewings, read information and instructions, toggle the narrational Text-To-Speech system for audio guidance, start a quiz associated with a POI to assess their knowledge and understanding, reset the 3D model in case the anchoring has degraded or has accumulated calculation errors, and exit to the map view mode.
2. The view via a 3D viewer, where the POI's model is rendered in the centre of the screen, and the user can use swipe gestures to rotate it and view it from any angle. The mesh has first gone through a sequence of model management calculations (colliders and bounding boxes) to assure it is scaled down so as to appear in its entirety.
3. A mobile VR mode that imitates a first-person camera where its rotational three degrees of freedom are controlled by the camera's gyroscope, while its translational three degrees of freedom are handled by corresponding UI buttons (forward, backward, left, right, up, down). This mode allows the user to examine and walk through the real-scale model without having to physically move; an extremely helpful functionality in archaeological sites where some locations are not traversable or they extend beyond the limits of allowed visits.

Figure 2. The different user views through the CirculAR mobile application, a) Viewing the 3D model in real scale, b) Walking inside the 3D model, c) Model in the 3D viewer, and d) Mobile VR mode.

Case studies selected for demonstration

Two archeological sites and one museum have been selected for the demonstration of CirculAR as shown below.

Figure 3. The three demo sites to experience digital heritage via CirculAR

Evaluation activities

All functionalities have been tested against a set of pre-defined metrics by a team of beta testers (12 participants) at the Athens Epigraphic Museum. The testers were able to assess the functionalities of object tracking, extended tracking, etc. At the same time, the testers successfully finalized the AR flow consisting of: profile editing, tutorial and demo experience, selection of campaign, object spawning, manipulation, rotation, scaling and viewing in 3 different modes, as well as, the gamification functionalities, including quizzes, scoring and rewards.

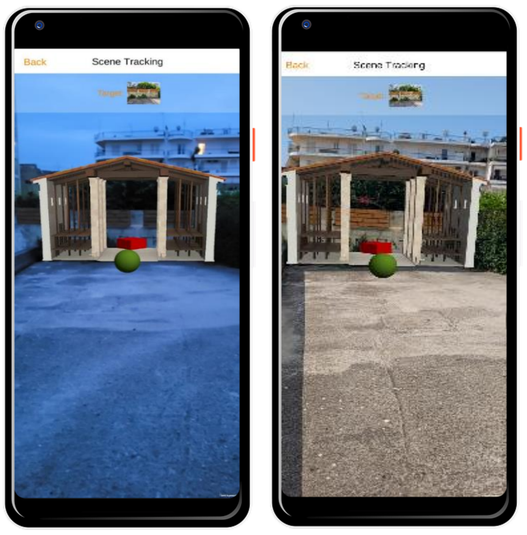

Figure 4. Testing activities for the evaluation of the light effect

References:

1. Caridakis, G & Aliprantis, J. 2019. A Survey of Augmented Reality Applications in Cultural Heritage. International Journal of Computational Methods in Heritage Science 3(2), 118-147.
2. Katika, T., Karaseitanidis, I., Tsiakou, D., Makropoulos, C. & Amditis, A. 2022. Augmented Reality (AR) Supporting Citizen Engagement in Circular Economy. Circular Economy and Sustainability 2, 1077-1104.
3. Pierdicca, R., Frontoni, E., Zingaretti, P., Malinverni, E., Galli, A., Marcheggiani, E. & Costa, C. 2016. Cyberarchaeology: Improved Way Findings for Archaeological Parks Through Mobile Augmented Reality. International Conference on Augmented Reality, Virtual Reality and Computer Graphics, 172-185.
4. Dragoni, A. F., Quattrini, R., Sernani, P. & Ruggeri, L. 2019. Real Scale Augmented Reality. A Novel Paradigm for Archaeological Heritage Fruition. 1st International and Interdisciplinary Conference on Digital Environments for Education, Arts and Heritage, 657-670.

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