

Possibilities and Requirements for AR Applications in a Complex Heritage Landscape

An analysis from a technician's and a curator's perspective

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Motivation & Introduction

The Orkhon Valley in Mongolia has been a cradle of important nomad polities such as the Great Mongol Empire which had a huge impact on the history of our world. Not only the Mongol Empire had its capital in the first half of the 13th century – Karakorum (Hüttel 2016) – in this area, but also in earlier steppe empires, such as the Xiongnu, Göktürk and Uyghur, the Orkhon Valley was a focal point in the itinerary of the court of the Great Khans. The landscape of the Valley is dotted with the archaeological traces of these times, such as deserted cities, smaller settlements, burial mounds, memorial complexes and the like. In the tradition of the nomads of the Mongolian steppe, the whole area around the Orkhon was a sacred landscape, the possession of which provided the legitimacy to rule over the steppe (Allsen 1996, pp.124–128). It is thereby well justified, that the whole landscape of the Orkhon Valley is inscribed as an important heritage of mankind in UNESCO's world heritage list.

The research on the sites of the Orkhon Valley began in the late 19th century and was conducted by Russian, Soviet and Mongolian researchers during the 20th century. After the fall of the iron curtain, interest in research on these sites widened and international expeditions together with Mongolian scholars contributed to the improving of knowledge about the Orkhon Valley and its sites. The Mongolian-German Karakorum-Expedition (Mongolian Academy of Sciences, University of Bonn, German Archaeological Institute) started work in 2000 and focused on the site of Mongol Karakorum. In 2007 the Mongolian-German Orkhon-Expedition was launched to explore the site of the ancient Uyghur capital Karabalgasun (ca. 745-840) and its surroundings (Franken et al. 2020).

The decades of research have yielded a rich knowledge about the sites, their history and the archaeological landscape of the area. Already in 2011, a museum was opened to present the findings to the public. However, the presentation in a museum has limitations, as the archaeological

heritage of the Orkhon valley is extremely rich but widely dispersed. One of the specialties of the region is, that, due to the sparse settlement and the extensive and gentle land-use by the Mongolian herders, the archaeological sites are generally well preserved in-situ and invite the visitors to explore the regions heritage. The evolving possibilities of Augmented Reality (AR) applications combined with the availability of cheap, yet powerful handheld devices allow to explore new ways to convey the deep history and archaeological richness of the Orkhon Valley in the museum and right in the landscape, at the sites themselves. However, this is a non-trivial task and the prerequisites and demands have to be considered carefully from the technical and also the curator's side.

Methodology & Results

This article describes central aspects of a curatorial and technical requirement analysis related to museum AR applications and defines decision criteria with which museums can evaluate the use of AR applications for their exhibitions. For this purpose, basic information on AR and museums will be presented. Various AR devices and tracking methods will be considered and methods are named that contribute to making AR applications more robust, more real-time capable and more immersive. Museums are viewed from the perspective of decontextualization in museums and a society that has changed in the course of digital change. This gives rise to challenges that museums must face in order to continue to serve the task of acting as places of education and the mediation of the heritage of mankind and its environment.

The curatorial analysis starts with the envisioning of different possible applications of AR in the context of the Heritage Site and its Museum. It then describes the principle that AR is used as a supplementary but not as a substitute information medium and should primarily serve to convey knowledge. The entertaining character should not lead to knowledge being conveyed incorrectly or the museum's or heritage objects being shifted out of focus but above all should serve the motivation and the easier absorption of knowledge. Therefore, pedagogical, didactic and scientific aspects must be included in the decision-making and development process. AR is described as a suitable tool for the recontextualization of objects. AR enables a new type of interaction with the museum object while the important connection between reality and additional virtual content must be retained. Consideration can be given to other visitors and the existing exhibition.

The technical analysis discusses four aspects which influence the decision-making process as well as the selection and development of the AR application significantly: The choice of the AR system, the choice of the tracking method, location-based factors and illumination concepts.



Fig. 1. The original stone tortoise in the Orkhon Valley (© Hendrik Rohland).

Based on the discussed decision criteria, potential AR applications in the UNESCO World Heritage Site Orkhon Valley are examined as examples with regard to the choice of the tracking method and the choice of the AR system. For one of the envisioned applications – the visualization of a famous but long-gone inscription stele on the back of an impressive, preserved stone tortoise – a prototype, based on a test object was implemented. markerless-model-based tracking is thereby justified as a suitable method for this application.



Fig. 2. Screenshot of the experimental version of the AR application for the use case: “Tortoise and inscription stele” (© Lukas Suthe)

The results of the requirements analysis are the basis for an AR implementation such as the exemplarily made application “tortoise and inscription stele”. It was tested whether the result of the theoretical analysis could be also confirmed in practice and whether the tracking despite, of changes that may occur onsite remains stable on the tortoise. This could be confirmed in the evaluation. Both

the analysis and the experimental implementation help to plan a real implementation on site and create a basis for it.

+ ribbons around neck



still stable
tracking result

+ color differences



still stable
tracking result

+ stones and strong,
direct light



still stable
tracking result

Fig. 3. Result of the tracking test. Despite various changes on the turtle, it stays easily identifiable as a 3D anchor every time and the tracking remains stable (© Lukas Suthe).

Overall, it is shown that AR can meet the needs of the digital generation and can therefore be a suitable tool for achieving museum educational goals. Dealing with the topic of museum AR applications ultimately requires an interdisciplinary analysis for each museum in order to be able to individually weight the decision-making criteria for AR applications based on the technical quality, the educational mandate and the given resources. In the future, it is planned test the prototype with the real object on-site and to further develop the cooperation with the local museums, the research partners and other stakeholders to develop an integrated App, that will provide multimedial information to visitors of the museums and the world heritage site.

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Please disclose any financial or personal relationships with other individuals or organisations, such as sponsors, that could make your work appear biased or influenced.

Author Contributions

Please list the contributions of the project participants here, according to the CRediT system. See specific descriptions of the role here: (<http://credit.niso.org/>). You can omit non-applicable roles.

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