

# Immersive Computing and Crowd Simulation Techniques in Modelling Urban Commons: The Case of Nicosia-Cyprus

Georgios Artopoulos, The Cyprus Institute, Nicosia, Cyprus

Panayiotis Charalambous, The Cyprus Institute, Nicosia, Cyprus

Colter Eugene Wehmeier, National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, Urbana, USA

## ABSTRACT

This article reports on the technical development and testing of the basic components of a virtual environment platform that could be used for the cross-disciplinary study of complex urban realities, such as the historic city of Nicosia, Cyprus - the last divided capital of Europe. This platform captures data of virtual visitors' movements in space, and the article suggests that these data could help better understand the impact of planning scenarios and design interventions in open public spaces that used to be popular among the citizens of the historic city. The article presents how this platform uses interaction and immersion opportunities to engage citizens and stakeholders in the management of public open spaces that are associated with built heritage. Crowd simulation is discussed as a computational technique that when is combined with the presented virtual environment platform, and under the right conditions, would contribute to a digital practice for small-scale urban modelling. However, it is beyond the scope of this technical note to provide a full empirical testing and validation of the presented immersive virtual environment.

## KEYWORDS

Crowd Analysis, Crowd Simulation, Heritage Documentation and Management, ICT, Interactive Environments, Spatially Distributed Narratives, Virtual Reality and Augmented Reality

## INTRODUCTION

This article presents experimental work that combines technical methods, such as immersive technologies of interaction, digital documentation and crowd simulations, with creative practices of design and co-management in order to apply them to the context of historic cities in the Mediterranean basin. This technical note is not intended to provide a full empirical testing and validation of the proposed immersive virtual environment. The main goal of this article is therefore to report on the development of a hybrid workflow that draws from urban modelling and heritage management. This

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workflow offers practical information regarding (public space) users' movement. This information could be used for re-activating historic urban sites that have been neglected. The article presents the application of this workflow in the case of Nicosia and the historic palimpsest of its urban environment. The article focuses on the technical aspects of an immersive virtual environment that doubles up, beyond its function as a visualisation tool for archaeologists, historians and architects (cf. Artopoulos and Bakirtzis 2016b), to also operate as a virtual stage for user engagement.

## **METHODOLOGICAL CONSIDERATIONS**

Co-occupation of public space and co-use of urban resources is a challenge that digital technologies can arguably respond to, and this article promotes the role of heritage as a driver for user interaction in ICT-rich urban environments, in the context of this challenge. The research presented here considers that the value of heritage is assigned in all types of culturally embedded commons of an urban environment, including squares, parks, sidewalks and riverbanks, buildings and monuments. Hence historic public spaces are considered as culturally valuable and therefore are spaces that offer opportunities for learning and social interaction – both of which are activities that facilitate engagement of their users and association with the space. The article intends to lay the grounds for using modelling tools to exploit this capacity of historic public spaces for user engagement with the commons.

The first step in the presented workflow involves the creation of a three-dimensional reconstruction of a historic site significant for the city of Nicosia. This reconstruction was produced based on archival material, photographs, as well as with the acquisition of data from the site by using laser scanning, Unmanned Aerial Vehicles (e.g., drones) and terrain Structure-from-Motion photogrammetric techniques. The synthesis of the various 3D modelling techniques that were employed in the workflow produced hybrid models of controllable levels of detail. Visualisation of previous (historically documented) phases of the site expands the representational capacity of the presented virtual environment, and goes beyond the documentation of the existing conditions of the site under study, in order to highlight the transformations of the historic area through time. Specifically, the virtual environment hosts two different models of the area, one that visualizes its current building context and one that simulates its urban fabric as it used to be in 1951, before the division of the city.

This virtual environment also hosts historical content, including texts, images and sounds, as well as pre-scripted 360 VR video sequences that are accessible by mobile devices (and complement the platform). These opportunities for interaction with new media allow the users of the platform to encounter with the history of this site – from its creation to the present day. The authors envision that through the integration of digital interaction booths, which will be installed on site and at the premises of the research organisations participating in this effort, the presented virtual environment will serve as a testing platform for the municipality, the stakeholders, researchers and professionals working in the field. Analyzing user data that will be collected through these interaction points/devices will hopefully enable a more informed understanding of site management scenarios and urban design strategies prior to their implementation.

## **Historical Context**

The Eastern Mediterranean preserves significant examples of cities whose continuous history can be traced all the way back to Prehistory and Antiquity. In particular Nicosia, the capital of Cyprus, is considered amongst the most contested urban environments having historically layered pasts and perplexing present-day realities in Europe. During 2013 and 2014, the part of the moat outside the Paphos gate was excavated by the Cyprus Department of Antiquities in collaboration with the Municipality of Nicosia, and co-funded by the EU, in an effort to not only preserve the history of the area and the medieval fortifications, but also to reactivate this neighbourhood of the city. The aim of the excavation activity was to unearth and promote the historical continuity of the place from the Middle Ages until today as the gate operated without interruption during the Venetian, Ottoman period

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