

## Accepted Manuscript

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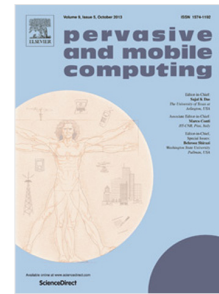
PII: S1574-1192(17)30513-8  
DOI: <https://doi.org/10.1016/j.pmcj.2018.05.002>  
Reference: PMCJ 933

To appear in: *Pervasive and Mobile Computing*

Received date: 25 October 2017  
Revised date: 4 May 2018  
Accepted date: 7 May 2018

Please cite this article as: D. Kosmopoulos, G. Styliaras, A survey on developing personalized content services in museums, *Pervasive and Mobile Computing* (2018), <https://doi.org/10.1016/j.pmcj.2018.05.002>

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# A Survey on Developing Personalized Content Services in Museums

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## Abstract

The personalized content services in museums are motivated by the need to enhance the visitors' experience through recommendations which consider the context of their visit, and by the need of curators to measure objectively the exhibition's impact. We survey the latest advancements in the fields of indoor localization, visitor profiling, content storage and presentation, as well as curator visualization tools, which are the main elements of such systems, and we highlight their strengths and weaknesses. We present an information architecture, which may offer useful insights to researchers and developers. Finally, we present the current challenges and the future trends.

*Keywords:* recommendations, museums, indoor localization, cultural heritage content, visualization, museum guides

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## 1. Introduction

Museums are learning spaces that typically offer large amounts of information, including the exhibited artifacts, as well as the supplementary material that accompanies the artifacts. Typically, visitors have limited time, and therefore especially in large museums, they need to decide whether to allocate most of their time to a few prominent artifacts and the associated digital content, or to view more of them in a more superficial manner instead. Very often visitors are overwhelmed by the excessive amount of information; that situation results into an experience which is far below their expectations. Furthermore, curators wish to measure in a reliable and objective manner the impact of exhibitions. This is crucial to decide which artifacts attract the attention, and if the supplementary material makes them more interesting; this is an essential part of a constant feedback loop that may lead to exhibition optimization.

The *recommendation* (or *recommender*) *systems* (RSs) are interactive software systems that maintain information about the museum artifacts and their properties. They employ representations of users' preferences, and can use context observations to suggest targeted digital content, so that it matches their expectations. That content can have various forms such as multimedia presentations, virtual reality (VR), augmented reality (AR) or games. Such a system cannot really solve on its own the problems of a poorly designed exhibition; however the automated and objective acquisition of visitor patterns and preferences that it offers, can help curators redesign exhibitions to maximize the time efficiency and the knowledge transfer to different groups.

Guidance systems are available for most museums worldwide. However, recommendation options embedded in the guidance systems are less frequent, and even fewer options exist for real-time RSs that exploit sensor data. Some museums develop their own guiding applications alongside audio guide systems. The Met Museums application [1] allows for recommendations on what to see, from artworks to architecture based on user preferences, but there is no indication about real-time recommendation features. The Louvre Museum's official application [2] offers a custom visit based on the visitors available time, art interests, and accessibility issues. ArtLens App [3] seems to be more sophisticated as it uses image-recognition software, which recognizes a selection of two-dimensional artworks, and provides additional curatorial and interpretive content. It also employs a localization system based on Bluetooth that helps also creating a recommendation subsystem and a personalized tour among the artifacts, while enabling the creation of personal collections. On the other hand, there are museums that exhibit prototype recommendation and guidance systems in cooperation with research institutes. In Cooper Hewitt Design Museum, a smart pen is used for creating and saving virtual notes about artifacts, and contributes in the museums RS that is based on association rules and collaborative filtering techniques [4]. Finally, the Mnemosyne project [5] exploits visitors' profiles for gathering personalized multimedia content that is displayed on an interactive table towards the end of the visit. The system also provides recommendations to visitors based on knowledge-based and experience-based subsystems.

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