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Blending customisation, context-awareness and adaptivity for personalised tangible interaction in cultural heritage

Elena Not[a,*], Daniela Petrelli[b]

[a] Fondazione Bruno Kessler, Via Sommarive 18, 38123 Povo-Trento, Italy
[b] Art and Design Research Centre, Sheffield Hallam University, 153 Arundel Street, Sheffield S1 2NU, UK

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ABSTRACT

Shaping personalisation in a scenario of tangible, embedded and embodied interaction for cultural heritage involves challenges that go well beyond the requirements of implementing content personalisation for portable mobile guides. Content is coupled with the physical experience of the objects, the space, and the facets of the context—being those personal or social—acquire a more prominent role. This paper presents a personalisation framework to support complex scenarios that combine the physical, the digital, and the social dimensions of a visit. It is based on our experience of collaborating with curators and museum experts to understand and shape personalisation in a way that is meaningful to them and to visitors alike, that is sustainable to implement, and effective in managing the complexity of context-awareness. The proposed approach features a decomposition of personalisation into multiple layers of complexity that involve a blend of customisation on the visitor's initiative or according to the visitor's profile, system context-awareness, and automatic adaptivity computed by the system based on the visitor's behaviour model. We use a number of case studies of implemented exhibitions where this approach was used to illustrate its many facets and how adaptive techniques can be effectively complemented with interaction design, rich narratives and visitors' choice to create deeply personal experiences. Overarching reflections spanning case studies and prototypes provide evidence of the viability of the proposed framework, and illustrate the final effect of the user experience.

1. Introduction

In a scenario of digital content delivery for the cultural heritage sector—either online or onsite—to adjust what is presented to the visitor is seen as essential to accommodate different visit motivations, expectations, and needs (Falk, 2009). Within the meSch project,[1] we addressed the challenges of supporting a personally meaningful, sensorily rich, and socially expanded visitor experience through tangible, embedded and embodied interaction (Petrelli et al., 2013). We envisage a cultural space filled with smart objects, each with their own stories embedded therein. Content will be revealed if and when conditions are right, e.g. visitors have picked up an object on display to inspect it, or a group has reached a certain location, or another smart object is close by. Visitors can continue their visit online—via a personalised interaction—to experience heritage in a novel way that combines the material and the digital. To create such a hybrid experience requires a personalisation infrastructure able to span the digital-physical divide. This in turn requires reconsidering how personalisation is done, which features should be applied and when—e.g. on-site or on-line—and, overall, how multiple contact points of the same institution can be orchestrated in a seamless extended and memorable experience.

'Personalisation' is a broad term that encompasses three types of system behaviour (Fink et al., 1998; Gellersen et al., 2002): *adaptability* (also called *customisation*, the term we use hereafter) offers users a number of options to set up the application/system the way they like it; *context-awareness* is the ability of the system to sense the current state of the environment and to respond accordingly; *adaptivity* implies the system maintains a dynamic model of the on-going interaction and dynamically changes its own behaviour to adapt to the changing situation. When applied to a scenario of tangible interaction, the concept of personalisation widens, as the interaction between the user and the system expands to include smart objects and networks of sensors, e.g. visitors hold smart objects or move in reactive spaces. The meaning of customisation, context-awareness and adaptivity must then be extended to include physical aspects. A visitor choosing a smart replica that holds one of many stories makes a choice of customisation—the visit is shaped

* Corresponding author.
E-mail addresses: not@fbk.eu (E. Not), d.petrelli@shu.ac.uk (D. Petrelli).

[1] meSch, Material Encounters with Digital Cultural Heritage was a EU funded project (2013–2017) www.mesch-project.eu.

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by the replica that triggers specific content. A system that senses the presence of the visitor and their current visit preferences shows context-awareness that combines the physical and the digital. Finally, a system that offers tangible interaction shows an adaptive behaviour when it uses the dynamic model of the visit to craft a personalised souvenir tailored to what that specific visitor did. These few examples show how personalisation must be reinterpreted when the physical aspects become part of the experience.

This paper presents a multilayer framework to support personalisation across the physical and the digital. In collaboration with curators and museum experts, we set out to understand personalisation in a way that is meaningful to heritage and its visitors, that is sustainable for curators to implement, and effective in managing the complexity of hybrid experiences. To deliver such a complex personalisation service the overarching framework has: (i) to reuse the main functionalities in different contexts (e.g. onsite vs. online interaction); (ii) to facilitate porting applications to different sites, hardware devices, and heritage domains; and (iii) to implement personalisation for both content and interaction. It has to be an easy-to-use tool for curators who can, autonomously, create new stories and interpretations, as well as modify current exhibitions (Not and Petrelli, 2013). The paper is structured as follows. Section 2 gives an overview of the field of personalisation for cultural heritage and the new opportunities offered by tangible and embodied interaction. Interventions in museums and outdoor cultural heritage sites developed as part of the meSch project are illustrated in Section 3; they show a breath of multisensorial personalised experiences in both content and interaction. Section 4 reports a collaborative study with curators that questions the meaning of personalisation and the different features that must be taken into account. Section 5 discusses the personalisation framework and how complementary approaches allow for content creation to be controlled by curators while the delivery in context is controlled by the system. We also discuss how exhibition design choices that grant visitors some control on tailoring their experience (customisation) can be more effective than automatic logging and complex events processing (adaptivity). Section 6 concludes the paper with reflections on how different forms of customisation, context-awareness and adaptivity are supported by the proposed framework and their effect on the user experience.

2. Personalisation in cultural heritage: looking for new opportunities

The call for personalisation for cultural heritage has mostly been applied to content adaptation, i.e. to dynamically change the amount or type of information conveyed to the single visitor to fit what they like or know, and how they behave. However, an analysis of personalisation in cultural heritage over the past 25 years opens up possibilities and offers new challenges (Ardissono et al., 2012).

From mobiles (Stock et al., 2007b) to the most recent augmented reality (Damala et al., 2012), personalised interaction with digital information has been designed for individual use. But personal devices do not really immerse people in the space and the social context (vom Lehn et al., 2007; Martin, 2000): strong personalisation might end up isolating the visitor within a hyper-individualised experience, which is somehow unnatural in a museum context where it is most common to visit with family and friends (Lanir et al., 2013). In this way, personalisation misses out on the fundamental fact that the context affects the experience more than the visitor's cognitive and psychological status. Tangible, embedded and embodied interaction (Hornecker and Buur, 2006), in which digital content is revealed in synergy with the sensorial experience, has the potential to keep the exhibition at the centre of visitors' attention and strengthen the sense of "being here" (Dudley, 2009; Petrelli et al., 2013). In our research we investigate how tangible interaction combined with personalisation can support new forms of personal engagement where visitors are offered tailored experiences (both in content and interaction) "in place" (Ciolfi, 2015).

The visit is generally done in self-organised groups (family, group of friends, class, couple) or as a casual group (guided visits or in-place activities), but even when visiting alone, individuals move in a shared space and compete for the same exhibition resources. Personalisation of interaction according to proxemics and social context has recently gained attention, with some solutions taking advantage of projection facilities or situated public displays (Wecker et al., 2011; Stock et al., 2007a; Belinki et al., 2011) as well as screens and portable devices (Greenberg et al., 2011). Research that directly addresses the social dimension is still limited, e.g. group conversations around a context-aware table (Stock et al., 2011), sharing partially missing content to foster discussion on exhibition topics (Callaway et al., 2014), or sharing tablets among family members (Rennick-Egglestone et al., 2016). Exhibitions designed to engage visitors into shared interactions have proved very effective, even between strangers that just happened to be close to the installation at the same time (Heath et al., 2002; vom Lehn et al., 2007). These interactive pieces build upon the surprise triggered by the unexpected and the physical engagement that follows when trying to understand what happens. However, most of the time these interventions are individual artistic expressions not intended to bring the visitors closer to and engaged with the heritage and its stories. They are limited and understood as performances. Design can be used to amplify the physical engagement with the artefacts on display and foster social interactions (Wakkary and Hatala, 2006). Within this articulated research domain, we investigate how different personalisation techniques can be integrated to support a variety of experience patterns (e.g., very energetic and interactive vs. contemplative and emotional) that fit different social dynamics. The aim is to accommodate different motivations, emotional attitudes and expectations.

Finally, sustainability should be a founding principle for personalisation in cultural heritage (Not and Petrelli, 2013). For personalisation to become the norm it is essential that the system is conceived for: reusing the same functionalities in different contexts (e.g. onsite vs. online interaction); porting an application to different physical sites and to different heritage domains; supporting the preparation of content and the definition of adaptivity strategies; and enable easy maintenance.

3. Case studies

This section briefly describes the installations and prototypes based on tangible, embedded and embodied interaction used later in the paper to illustrate the multilayer personalisation approach. It intends to give a sense of the type of experiences enabled by the new Internet of Things (IoT) technologies as well as to show some of the design choices relevant to the discussion that follows. While these examples were developed to different degrees of refinement (some were just prototype, some one-point installation, some spanned across several stations, some moved from the physical exhibition to online content), they were all fully developed and were evaluated with participants in a series of studies. All the examples were created in co-design, that is to say museum professionals, computer scientists and designers collaborated in the concept ideation while later each expert focussed on their own specific area. When the concept was agreed, then work split: the content was always selected and curated by the museum while the designers refined the interaction and the computer scientists developed the hardware and the software (Petrelli et al., 2016a). The examples are given to support the discussion of the personalisation framework, readers interested in the single case studies could refer to published papers.

Narratives in the Trenches of WWI was an exploratory prototype designed to test, in the wild, the concept of the place itself telling the many stories of the people who lived there (Nagià Grom, Trentino, Italy).[2] It is composed of a set of Bluetooth-enabled loudspeakers encased in wooden lanterns positioned at points of interest in the trenches and for-

[2] https://www.youtube.com/watch?v=hLORDVpivhM (accessed 6.9.2017).