FieldGuide: Smartwatches in a Multi-display Museum Environment

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Abstract

Deciding on what to see in a large museum can be overwhelming. We present FieldGuide, a smartwatch based system designed to facilitate museum gallery exploration. We discuss our design and implementation, followed by an evaluation conducted with twelve visitors in a natural history museum. Our findings describe how smartwatches can fit into a multi-display museum environment and strike a balance between personal and public interactions.

Author Keywords

Museums; smartwatch guide; glanceable interactions.

ACM Classification Keywords

H.5.2. [Information Interface And Presentation]: User Interfaces – Interaction styles.

Introduction

Modern museums cater to visitors with diverse interests while striving to ensure a personalized and memorable experience. Additionally, collections-based institutions such as natural history museums have many cultural artifacts and specimens distributed across expansive spaces, where the popularity of an artifact often correlates with its visual appeal. For example, a large dinosaur fossil might attract more visitors than a chipped earthen pot of historical and cultural

Figure 1: Upon walking into a museum gallery with interactive displays (a), the visitor receives prompts on their smartwatch about *select* artifacts in the gallery (b).

significance. To tackle these issues, and to make it easier to appreciate cultural artifacts, museums have long employed guided or electronic tours [1]. More recently, museums have been experimenting with interactive digital displays that serve as proxies for static labels or paragraphs of text.

Coinciding with the proliferation of interactive displays in museums, there has been a large increase in personal computing devices – mainly in the form of smartphones – carried by visitors. Museums are fast evolving into display rich environments that create new challenges and opportunities. Smartphones, though ubiquitous, are often criticized for their disruptive nature in a social context [7, 9]. And while researchers have investigated the efficacy of smartphones working in conjunction with NFC tags or Bluetooth beacons embedded across a museum gallery [2, 5], the potential of smartwatches has not been explored to the same extent.

In this paper, we focus on the problem of personalizing a museum visit, and explore how smartwatches may fit into a multi-display museum environment. We present the design and evaluation of FieldGuide, an interactive system that pairs a smartwatch worn by a visitor to the museum's exhibit displays (Figure 1). We discuss the theoretical underpinnings of our design, and present findings from evaluating FieldGuide with twelve museum visitors.

Background
FieldGuide builds on the following areas of prior research: (1) multimedia guides for museums and (2) multi-display interactions in museum settings.

Multimedia guides for museums.
Museums have made use of emerging technology to engage audiences for many decades. In the 1950s, Acoustiguide [1] developed an audio tour of Eleanor Roosevelt's home using tape players as the underlying technology. In the 1990s, researchers started experimenting with PDAs as multimedia museum guides. Hyperaudio [10] pioneered mobile guides by linking the physical layout of the museum gallery with the visitor's location. Since 2009, there has been a large increase in museum-related applications for mobile phones. For example, the Brooklyn Museum introduced a mobile tour for smartphones called BklnMuse [2]. BklnMuse used a community sourced recommendation system to nudge visitors towards certain exhibits.

Multi-display interactions in museum settings.
With the PEACH project Stock et al. [11] built a collection of adaptive and interactive technologies for museum visitors: (1) animated digital agents seemingly migrated onto a visitor's PDA from a large display at the beginning of the tour to help motivate the visitors and focus their attention when necessary, and (2) automatically generated post-visit summaries that reflect the individual interests of visitors as determined by their behavior pattern.

In 'The Immersive Museum' [4], Hakvoort combined smartphones with interactive displays to support user interaction with artifacts. Participants preferred using personal devices, as tools to manipulate museum interfaces over directly manipulating public displays. The system also allowed visitors to save interesting information by touching an NFC tag placed next to exhibits using their smartphones.

FieldGuide is built upon ideas from all these projects. It combines features such as nudging visitors towards curated artifacts using a smartwatch, information exchange between a public (exhibit case display) and a private (smartwatch) device, and the ability to collect information as one travels through a museum.

Design Rationale

Many museums are exploring how interactive technology can be used to foster visitor curiosity and engagement around the artifacts that make up museum collections. With FieldGuide, we want to explore how smartwatches fit into that puzzle. More specifically, whether smartwatches can work in conjunction with interactive digital technology already deployed in museums. We had the following design goals and constraints:

Augment existing digital infrastructure
FieldGuide was developed for a large natural history museum that has a 7,500 sq/ft gallery on Chinese history and culture. The gallery includes over 45 interactive displays spread throughout the hall. These are custom-formatted touchscreen surfaces that are similar in size, shape, and position to the traditionally printed "reading rails" often placed in or outside of a museum display case (Figure 1a). We wanted to use these digital rails to communicate with the smartwatch application we built.

Smartwatch instead of phone application
As mentioned earlier, museums have employed portable electronic guidebooks for many years. However, it has been shown that the use of the phone can be disruptive in social contexts [7,9] and partially diminishes the engagement with the objects on display [12]. Researchers observed many visitors looking at the screen instead of the objects thus potentially missing out on engaging with original objects. Prior research has demonstrated that Smartwatches can be judiciously used to avoid some of the obvious pitfalls of a smartphone [12]. Smartwatches are inherently personal devices that are used for glanceable information; interactions are measured in seconds [12] and attention can be directed back to the exhibit quickly. Additionally, a smartwatch is less distracting, especially in low-light conditions, for other visitors in a gallery.

Implementation

The FieldGuide system consists of: (1) a web application running on an existing touchscreen display in the museum gallery, and (2) an Apple Watch application.

Apple Watch Application
We built an application for a 38mm Apple Watch Series 2 running Watch OS 3.0 framework. We sent notifications to the smartwatch from an iOS device. Initially, we had experimented with using Bluetooth beacons that tracked visitor location to trigger notifications on the smartwatch, but our pilot testing showed them to be less accurate and reliable than we required. The watch application has three distinct states:

NOTIFY AND PROMPT: The prompts screen (Figure 2a) allows a visitor to swipe through interest-provoking questions related to artifacts in the exhibit case. When the visitor entered the relevant gallery, a researcher pressed the "Enter Exhibit Area" button on the companion iOS app (Figure 3b). This triggered the prompts screen to appear on the smartwatch. Since watch interactions are supposed to be short, we
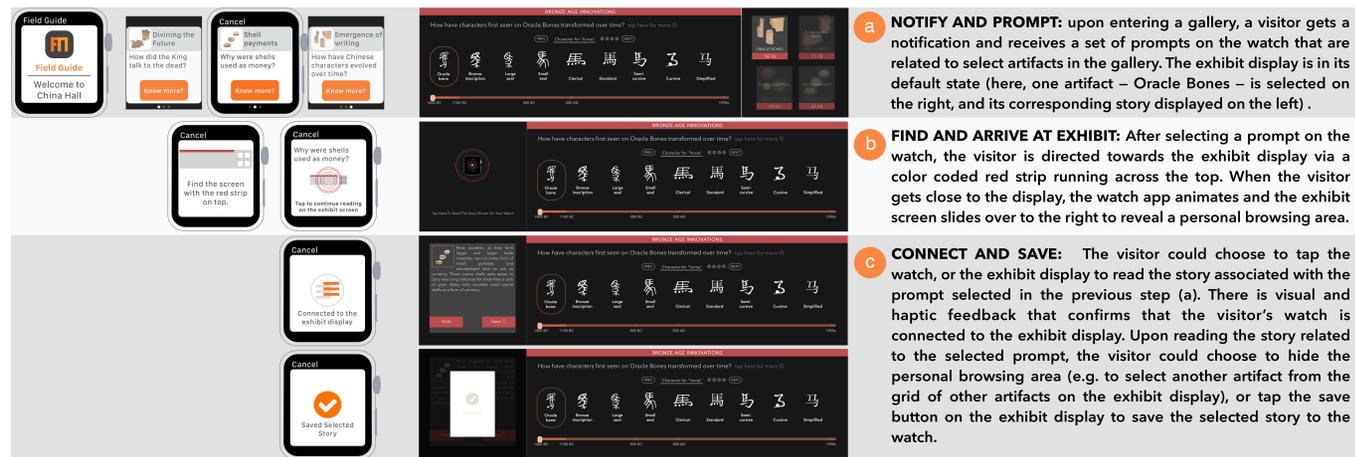
Figure 2: The interaction stages for the smartwatch (left) and the exhibit display (middle).

curated a list of three prompts instead of trying to have an exhaustive (in this case, 17 artifacts) list.

FIND AND ARRIVE AT EXHIBIT: After a visitor selects an artifact from the Prompts screen, the system had to direct visitors to the relevant exhibit case. The Find screen asks the visitor to look for "…the screen with the red strip on top" (Figure 2b). When the visitor was close enough to the relevant exhibit (a 1.5m x 1.5m area), an animation appeared on the smartwatch and, at the same time, the exhibit display running the web application slides over to the right to reveal a personal browsing area (Figure 2b). Again, in the absence of indoor location tracking, a researcher pressed the "Arrive at Digital Rail" button on the companion iOS app to make this happen (Figure 3b).

CONNECT AND SAVE: Once at the exhibit, if the visitor taps either the smartwatch display or on the personal browsing area (Figure 2c), relevant information is

displayed on the exhibit display. Since several museums have been experimenting with ways to extend the museum experience even after the visit (summarized by Kostoska et al. in [9]), the visitor has an option of saving/collecting this snippet of information by tapping a button on the display.

Study

To test the efficacy of this approach, we tested FieldGuide over a period of five weeks. In the first week, we pilot tested with 5 visitors to iron out minor bugs in the software and practice recruitment. In the subsequent three weeks, we conducted twelve testing sessions.

Procedure

For each session, we would stop a visitor after they had explored the first gallery (Figure 3a) in the China Hall and ask them if they would be willing to participate in a user testing session for a new smartwatch mediated
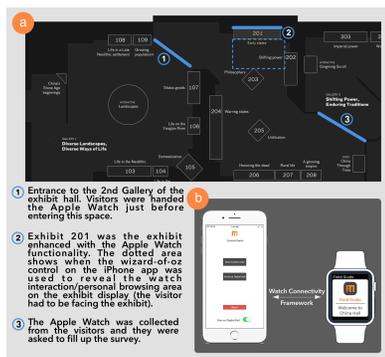
Figure 3: (a) Evaluation area in a selected gallery and an existing museum existing display modified to run our web application (b) the wizard-of-oz controls on an iOS device carried by a researcher (3).

museum experience. If the visitor agreed, we handed over the Apple Watch and followed this protocol: 1) the visitor was told that the smartwatch application was designed to 'communicate' with the museum exhibit screens, and 2) that the prompts and instructions provided on the watch were to be followed if it was convenient for the visitor to do so. Note, all paths in the watch application lead to the one exhibit display (Figure 3a) we had adapted for this study. But as far as the visitor was concerned, any exhibit display could potentially be the one of interest. Finally, after collecting the watch, the participant was asked to fill up a questionnaire.

Results and Discussion
Most participants looked at their watch as soon as they received the first notification (Figure 2a) upon entering the gallery. They spent a short duration of time before selecting an artifact that they wanted to get more information about. Thereafter, when the watch application asked them to look for the relevant exhibit case, most participants did a quick scan of the room to see if something caught their eye. Upon getting closer to the exhibit, all participants noticed that the interface on the exhibit displays changed to reveal a personal browsing area that invited them to connect their watch with the exhibit display. Table 1 has the results from the questions from the survey. The user testing sessions – though limited in number – revealed several constraints and recommendations.

Haptics as a discreet aid: We enabled haptic feedback for all the three interaction stages in the smartwatch application. A subtle tap on the wrist drew a visitor's attention, and the ergonomics of a wrist worn device meant that the visitor did not have to fish out a phone

from pockets or bags etc. While prior studies have shown that a smartphone takes the attention away from the exhibition and isolates a visitor from the group [3, 12], we think the smartwatch component of FieldGuide addresses those issues. The system strikes a balance between notifying a visitor of artifacts of interest (9 out of 12 visitors did not know going into the gallery which artifacts might be of interest, Table 1), while being less intrusive than a phone.

Short interactions on the watch, long interactions on the larger exhibit displays: With a smartwatch, the size of the digital display, along with the ergonomics of the wrist worn device dictate short interaction durations [12]. Therefore, even the most content heavy screen of the smartwatch application (Figure 2a) used a swipe-driven carousel with a photo of the artifact and a short question designed to invoke curiosity [10]. In addition, we made each stage actionable with a quick tap. When the visitor was close to the exhibit display and they saw the personal browsing area revealed on the exhibit display, a quick tap on the watch or the exhibit display signaled the intent to read or receive more information. This handoff between the watch and the exhibit display were designed to play to the strengths of each of them; short interactions on the watch, long form reading on the larger exhibit display. It was also overwhelmingly liked by the participants; 12/12 participants (Table 1) liked being able to connect to the exhibit display and many of them singled this out in our unstructured conversations with them after the testing session.

Collecting museum memories made easy
Researchers have highlighted that many museum visitors like to collect and share interesting tidbits from their museum experience [5]. With FieldGuide, just a

Survey Questions	% Y	% N	# of Y/N
Did you have an idea of which exhibits you wanted to visit in the China Hall	25	75	9 / 3
Did you notice that there were multiple prompts/questions to choose from?	66.7	33.3	8 / 4
Did you like having the app prompt you to explore particular exhibits of interest?	83.3	16.7	10 / 2
Did you like how the prompt guided you to find the exhibit?	83.3	16.7	10 / 2
Did you like the interaction screen on the exhibit case that notified you when you found the exhibit?	91.7	8.3	11 / 2
Did you like the experience of connecting with the exhibit and receiving contextual information?	100	0	12 / 0
Did you like the idea of collecting/saving content for your personal device?	100	0	12 / 0
Did you think that the smart watch app added (or could add) to the museum visiting experience?	91.7	8.3	11 / 1

Table 1: Questions from the survey collected at the end of a test session.

quick tap on the "Save" button on the exhibit display, confirmed via haptic feedback on the smartwatch, enables a visitor to do so. All the participants liked this feature (Table 1). This interaction was quite seamless because there were no NFC tags or QR codes that needed to be scanned, and has the potential to be personal because a visitor can easily collect the stories that they found interesting. A few visitors mentioned that they would use this feature while bringing guests to museum (or repeat visits), and use it as a personal must-see list.

Conclusion

With FieldGuide, we designed and built a system that helps visitors seek out and engage with historical artifacts and specimens in a museum. The system used a smartwatch application with existing interactive displays in a gallery. It seems promising that a smartwatch mediated museum experience can be both discreet [9, 7, 12] and engaging. A smartwatch can fit into a multi-display museum environment and strike a balance between personal and public interactions.

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