Mementos: A Tangible Interface Supporting Travel

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ABSTRACT
Tangible interaction promises interfaces with ready affordances, which embrace physicality and which naturally support collaboration. However, the complexity of the hardware required to produce tangible systems has typically constrained their operation to highly specialized application areas and particular physical environments. This paper argues that this has limited the scope of research into such systems and addresses this issue by presenting Mementos, a tangible interface for tourists and travelers and intended to support all stages of a trip: preparation, experience, and remembering and reflecting. In this way, it explores how tangible interaction can support a complex real world task spread across time and multiple contexts. The paper describes the design, implementation and early evaluation of Mementos. It concludes that such work takes an important step towards popularizing tangible interaction.

Author Keywords
Tangible interaction, context-aware, tourism, HCI.

ACM Classification Keywords
H5.m. Information interfaces and presentation (HCI): Misc.

INTRODUCTION

Tangible interaction is an increasingly prominent focus of research in the HCI community and a significant departure from the established Graphical User Interface (GUI) paradigm that has been dominant since the 1970s. In contrast to the generic approach of GUIs, in which many interfaces can be represented digitally on-screen, systems incorporating tangible interaction typically take the form of special purpose interfaces for specific applications that are reliant on well-defined physical forms [12]. These forms are physical embodiments of data, which users interact with using bodily movements. They are "simultaneously interface, interaction object and interaction device" [9].

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The physicality of the tangible interaction conveys advantages over conventional graphical interfaces in terms of its support for real world skills [6], natural affordances, learning and memorization [e.g. 14] and for collaborative activity [e.g. 11, 10]. However, a key disadvantage of tangible interfaces is that they are challenging to produce: the physical-digital coupling they require can only be realized with sophisticated sensing and display systems.

Consequently most tangible interfaces take the form of prototypes that function in specific physical environments (such as augmented rooms [e.g. 1]) or on particular surfaces (such as back-projected screens [e.g. 13]). Those that can be used outside of a fixed location (such as the Siftables [15]) are typically composed of a number of individual elements that relate only to one another. These essentially technological limitations have constrained the kinds of tasks and problems that researchers exploring tangible interaction have tackled – for example, there is a longstanding focus on tabletop interaction in specialized domains as diverse as architectural planning [e.g. 18] or music performance [e.g. 13]. Although these systems can be compelling, this paper argues that they have marginal applicability to most users and everyday tasks. For a more comprehensive review of tangible systems, interested readers are referred to Shaer and Hornecker's survey [17].

Addressing this issue, this paper presents the design, implementation and preliminary evaluation of Mementos, a tangible system supporting travel and tourism, a rich, complex and relatively mundane application domain. It serves as an exploration of how tangible interfaces might be created for complex real world scenarios, supporting multiple tasks and operating in multiple contexts. Mementos is based on a set of physical tokens that resemble either key tourist sites (e.g. the Eiffel Tower) or represent more general relevant locations (e.g. taxi stops or cafes). It supports a range of travel activities from planning, navigation and recording and remembering that take place before, during and after a trip. It achieves this through a range of capabilities built into the objects (tactile feedback, capacitive sensors, Bluetooth, RFID) and via interaction with infrastructure systems in public kiosks (while on the trip) and users' personal computers (after returning home).

The remainder of this paper is structured as follows: brief reviews of the literature on digital technologies to support travel and tangible tokens are presented; the Mementos system (design, implementation, evaluation) is described; conclusions and speculations as to future work are made.

RELATED WORK

Travel and tourism

Tourism and travel represent activities fraught with human-centric challenges and problems (see Brown and Chalmers [4] for an informative ethnographic description of the tourism experience). Independent travelers, in particular, are typically in unfamiliar surroundings, often grappling with unknown languages and dealing with unusual climates whilst they perform complex tasks such as navigation and the collaborative planning of spatial-temporal itineraries based on significant quantities of complex textual information from guidebooks and timetables.

Although many of these activities are arguably core aspects of the travel experience, the challenges they represent have attracted considerable attention in the HCI research community. Topics that have been studied include preference based itinerary suggestions [e.g. 5] and location and context-mediated recommendation systems [e.g. 7]. The dominant form factor for such systems has been graphical interfaces on mobile devices. However, this approach inherently suffer from drawbacks including a lack of availability or adoption of required technology (high-end smart phones), distrust (in terms of the privacy of tracking systems [3]), a lack of support for collaboration (most tourists travel in small groups of 2-4) [4] and the fact that dealing with digital information on a mobile device disrupts and distracts from the actual experience of travel [2].

Tokens as access to digital information

Holmquist et al. [8] defined tokens as physical objects that are attached to virtual information. By placing a token on different constraints in the interface (e.g. racks or slots), users can access different kinds of information. Examples of TUIs that support this kind of interaction include the StoryMat [16], a carpet that can play children's stories by detecting which toys that are placed upon it; and WebStickers [8], a system that allows users to tag objects with website bookmarks. Although these systems are compelling, this paper argues that their use of tokens is limited: they represent information of a single form used in a (typically) single context. It suggests that exploring tokens that have different but complimentary meanings and uses when deployed in different contexts may be valuable way to extend this interaction paradigm.

MEMENTOS

The Mementos system was designed to address these concerns and bring the benefits of tangible interfaces – the physicality, the seamless integration with the environment, the support for memory, epistemic action and collaboration – to the domain of tourism and travel. By doing so, Mementos not only offers a novel vision of how digital technology can support travel, but also provides a practical exploration of the main focus on this paper: how tangible interfaces, and token-based systems in particular, can be designed to support complex real world application domains involving multiple contexts and use scenarios.

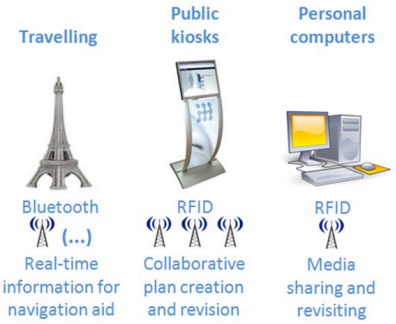

Figure 1. Overview of the Mementos system.

System Design

Due to the physicality and visibility of tokens, one of the key advantages of TUIs over other interaction paradigms is in support for collaboration. As most people do not travel alone, and in order to support the group tasks facing travelers (e.g. planning, navigating, and sharing media from their vacations [4]) the Mementos system is composed of three separate parts: a set of *tokens*, a *kiosk* interface and a *home* interface. These are described below and Figure 1 presents an overview of their use.

Tokens: The tokens are small physical objects intended to be held in the hand or stored in pockets and key chains. Two classes were used. One set of *concrete* tokens represented and visually resembled specific tourist sites. For example, such a token might be linked to the Eiffel tower and take the form of a model of this monument. The other class of *abstract* tokens represented more general tourist infrastructure such as a set of cafes and transportation points and appeared as neutral coin-like objects identified with graphical logos. We envisage sets of such tokens being distributed for particular locations or cities in much the same way as guidebooks are currently. A sample set of tokens can be seen in Figure 2.

The tokens were designed to provide information related to the object they represent through non-intrusive feedback. Most significantly, this was delivered via vibrotactile cues mediated by location awareness – the tokens would vibrate when approaching the location (or set of locations) they represent. Furthermore, in the case of the concrete tokens, they also responded to the proximity of transportation links leading to their location. This feedback could be silenced by touching or picking up the token.

The goal of this interface is three-fold. Firstly, it enables users to engage in a simple form of collaborative planning based on selecting a small number of relevant tokens to carry with them. For example, one of the users in a group might want to visit Musée du Louvre and connect his computer to a WiFi spot. Another might want to visit Musée d'Orsay and use a public telephone. Each will communicate their intentions by picking and carrying the corresponding tokens, collaboratively creating the plan for the day. Secondly, the tokens are intended to support

relatively undirected, exploratory travel experiences. For example, a tourist strolling a city with a token which responds to all restaurants featured in a particular food guide could use the feedback to opportunistically and discreetly highlight dining choices encountered during the course of their walk. Finally, if a tourist's goal is to seek out one particular destination, the vibrotactile cues will highlight appropriate transportation links (such as where to board or exit a bus) as well as proximity to the actual location, thereby providing vital navigation information.

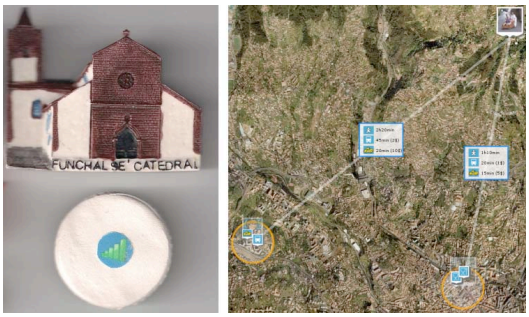

Figure 2. On the left, a picture of one concrete token (representing a famous church) and one abstract token (representing WiFi spots). On the right, part of the Mementos kiosk interface linking user location (leftmost) with a concrete token (top right) on the first sensing zone and another concrete and abstract token on the second sensing zone (bottom right).

Kiosk: The kiosk interface was designed as a public display showing an interactive map and capable of recognizing and responding to the tokens. Kiosks were intended to be distributed around a city and at key tourist sites. Interaction was highly constrained and based on three spatially ordered sensing zones – running from left to right in front of the display. Users can place one concrete token and one abstract token on each to visualize and communicate their plans. The goal of this interface was to create simple queries relating to the kiosk location and other areas or resources of interest and transportation options between these sites. For instance, placing a concrete token on the leftmost sensing zone caused transportation information between the kiosk and concrete site to be presented (e.g. estimates for travelling time and cost by taxi, bus and foot). Adding an abstract café token to the same sensing zone caused dining options to be displayed in the proximity of the concrete site. In a similar manner, the three zones could be used to create multi-leg travel plans. This interface is illustrated in Figure 3.

Home: The home system allowed users to quickly access photos and videos taken during trips on their home PCs. Placing one of the concrete tokens used while travelling on a sensing zone attached to a computer showed the media recorded in the associated site. In this way, the tokens take on a role not only of souvenirs, but also as true keepsake objects, holders of stories and memories. Users would also be able to distribute their tokens to friends and family as a personalized way of sharing mementos of their trips.

System Implementation

The Mementos system was functionally prototyped using a range of commercially available technologies. The tokens were based on the Bluetooth based SHAKE sensor platform [11]. Among other functions, this matchbox-sized device incorporates a vibrotactile actuator and two surface mounted capacitive sensors. Limited on-board processing enables a touch to the latter to deactivate the former. Location awareness was prototyped using a beaconing system in which PCs were placed in key locations and performed continuous Bluetooth scanning using a API included as part of the Processing program language (www.processing.org). When a user's SHAKE device was detected, a wireless connection was automatically established and a command to issue a vibrotactile cue sent.

The kiosk and home interfaces were reliant on RFID technology to identify tokens; three RFID readers were used to produce the kiosk, while the home interface was based on a single reader. In both cases, low-cost touchatag readers (www.touchatag.com), which use coin-sized stickers as tags, were used to develop the system. The kiosk and home interfaces were implemented in Processing and used online services to deliver multimedia content. Bing Maps, (www.bing.com/maps) was powered the kiosk map while Flickr (www.flickr.com) was used to show images in the home interface. Due to lack of availability, most of the RFID tokens did not incorporate the SHAKE sensors.

Preliminary Evaluation

In order to provide a preliminary validation of the system design, a short observational study was conducted on two groups of three people using the Mementos kiosk interface. 23 tokens were used in this test: five represented prominent tourist sites in the participants' home city while the remaining 18 represented restaurants, payphones, wireless internet, markets, bus stops and taxi ranks. Short paper brochures were provided for each of the tourist sites providing a textual description and indicating opening and closing times and likely visit durations. Participants were required to make a collective plan using the system that visited a preset number of these sites efficiently, took advantage of surrounding amenities (such as restaurants for lunch) and incurred a minimum cost. They were given 30 minutes to plan and 30 Euro of vouchers was offered as a prize to the team that generated the best solution.

Both groups were able to make effective plans. Analyzing video of the sessions and follow-up interviews revealed a range of interesting behaviors. The tokens and UI were general reported as immediately understandable and easy to manipulate. They were also engaging: both groups took the entirety of the allotted time. Frequent collaboration was also in evidence, illustrated by consensual passing of the tokens or, occasionally, one user taking a token from another. These acts were aided by continual use of spatial gestures and body language. The physical environment was also used to simplify the task, for instance by keeping unused tokens in their original placements when not in use,

or assigning users to perform tasks proximate to their location. These acts streamlined the activity and helped manage the space. In summary, although the study was short and exploratory, its results are broadly positive. It validates some of the key concepts in Mementos: the suitability of a tangible interface to tourism and the ability of the system to support collaborative planning tasks.

CONCLUSIONS AND FUTURE WORK

This paper has presented the design, implementation and early evaluation of Mementos, a tangible interface intended to support a range of tourism and travel tasks spanning the full duration of a trip: planning, experience and reflection. The contribution of this work lies in its exploration of the system features, user interactions and enabling technologies that can be used to build tangible interaction suitable for such an everyday, broad and multi-faceted set of tasks and contexts. This is possible due to the design and development of tokens that are not simply linked to a fixed set of digital information, but to a broad concept such as a real-world location. By allowing a token to be used in different contexts and scenarios (e.g. in both planning and remembering) Mementos gains a long-term value, enables users to make the association between token and content more deeply and meets a wide range of user needs.

Opportunities for future work on this topic are wide ranging and include developing the system implementation to a point where the design can be fully studied and validated, particularly in comparison to other interaction styles. We are also considering extensions to the system design including developing the feedback presented by the tokens to more expressively indicate spatial information and supporting richer interaction with the kiosk and home interfaces based on visual marker tracking systems instead of RFID. In the future, Mementos could be applied to other domains, such as in a system that supports cognitively impaired individuals in planning and memory tasks.

In sum, the work presented in this paper represents an early step in the transition of tangible interaction from a promising paradigm in the lab to a realistic approach to the design of interactive systems capable of tackling the everyday problems of everyday users.

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