# Scan and Tilt – Towards Natural Interaction for Mobile Museum Guides

Jani Mantyjarvi[1], Fabio Paternò, Zigor Salvador, Carmen Santoro
ISTI-CNR
Via G.Moruzzi 1
56126 Pisa, Italy
{jani.mantyjarvi, fabio.paterno, zigor.salvador, carmen.santoro}@isti.cnr.it

## ABSTRACT

This paper presents a new interaction technique –scan and tilt– aiming to enable a more natural interaction with mobile museum guides. Our work combines multiple modalities – gestures, physical selection, location, graphical and voice. In particular, physical selection is obtained by scanning RFID tags associated with the artworks, and tilt gestures are used to control and navigate the user interface and multimedia information. We report on how it has been applied to a mobile museum guide in order to enhance the user experience, providing details on a first user test carried out on our prototype.

## Categories and Subject Descriptors

H5.m. Information interfaces and presentation (e.g., HCI).

## General Terms

Design, Human Factors.

## Keywords

Mobile guides, Gesture interaction, Tilt interfaces, Physical selection, RFID, Museum guides, Multi-modal user interfaces.

## 1. INTRODUCTION

Seamless interoperability of intelligent computing environments and mobile devices is becoming more and more popular in various application domains. A potential application area is the so-called "intelligent guides". Several location-aware, context-aware and multi-modal prototypes have been developed since the beginning of ubiquitous computing in the early 90's [see for example, 2, 3, and 4]. Through the advances in microelectronics – under the impetus of the mobile device industry – novel sensing devices, e.g. accelerometers and RFID-readers have started to be supported in mainstream mobile devices, enabling the implementation of new interaction modalities for mobile devices. In this paper, we present our work on enabling gesture interaction through the scan and tilt paradigm, by extending a previous museum guide [4], which already supported graphical and vocal modalities and location detection through infrared beacons.

To this end, we have designed an interaction technique based on two important concepts:

i) it should not be intrusive on the user experience, by leaving the visual channel open to enjoy the artwork;
ii) it should be able to somehow directly interact with the available physical objects.

The first concept is motivated by previous analysis of museum visitors and how they perceive the support of computer-based devices [4]. The results clearly indicated that the users would not be interested in spending much time understanding how the electronic guide works, especially because they will probably not visit the museum again. On the other hand, the information usually provided by museums regarding artworks is rather limited (e.g.: mainly short textual labels), which raises the need for additional support to be dynamically activated when something interesting is found during the visit. For this purpose, it would be useful for visitors to have the possibility of pointing at the artwork of interest and controlling audio information with small hand gestures.

The organization of the paper is as follows. First, we discuss related work in the area of mobile guides; next, we provide some information on the previous version of our guide. Then, we present the novel interaction paradigm for museum guides, followed by an explanation of how users interact with scan and tilt and a report on an early evaluation. Lastly, some concluding remarks and indications for future work are provided.

## 2. RELATED WORK

The museum domain has raised an increasing interest regarding the support that can be provided to visitors through mobile devices. One of the first works in this area was the Hippie system [9], which located users via an IR system with beacons installed at the entrance of each section and emitters installed on the artworks. The GUIDE project [3] addresses visitors in outdoor environments supported through several WLANs. In our work, we focus on indoor visitors: it requires consideration of different solutions for supporting them. While such works provided a useful contribution in the area, we noticed that in the museum domain innovative interaction techniques were not yet

[1] This work was carried out during the tenure of an ERCIM fellowship


*MobileHCI'06,* September 12–15, 2006, Helsinki, Finland.

investigated. They can be useful to improve user experience by making the interaction more natural.

Research on gesture interaction for mobile devices includes various types of interactions: measure and tilt, discrete gesture interaction and continuous gesture interaction [8]. In [6] a continuous, control theory-based approach for tilt-based interaction for mobile terminals equipped with 6DOF accelerometers is presented. In [5] a study discussing the effects of ergonomics in tilt interaction is presented. An accelerometer-based tilt interaction system for scrolling and determining screen orientation is presented in [7]. Tilt interaction to be utilised in navigating menus and scrolling documents and maps is described in [10]. A distinction from [6] is that we use mobile terminals with 4DOF accelerometers and discrete tilt events instead of continuous control signals. Our study differs from related work since we extend the tilt interaction by associating tilt events with a few easy-to-use interaction commands for the museum guide, and combine such tilt interaction with other modalities, following a consistent interaction logic at different levels of the application.

Physical browsing [1] allows users to select information through physical objects and can be implemented through a variety of tag-based techniques. Even mobile phones that can support it through RFIDs have started to appear on the market. However, we think that it needs to be augmented with other techniques in order to make museum visitors' interaction more complete and natural. To this end, we have selected the use of accelerometers able to detect tilt events, allowing users to easily select specific information regarding the artwork identified through physical pointing with small hand movements, so that the user visual channel can be mainly dedicated to looking at the artworks..

# 3. CICERO

Our interaction technique for museum visitors has been applied to a previously existing application for mobile devices: Cicero [4]. This is an application developed for the Marble Museum located in Carrara, Italy and provides visitors with a rich variety of multimedia (graphical, video, audio, …) information regarding the available artworks and related items. This application is also location-aware. This is implemented through a number of infrared beacons located on the entrance of each museum room. Each of them is composed of several infrared emitters and generates an identifier that can be automatically detected by the application, which thus knows what room the user is entering (see Figure 1) and immediately activates the corresponding map and vocal comments. This level of granularity regarding the location (the current room) was considered more flexible and useful than a finer granularity (artwork), which may raise some issues if it used to drive the automatic generation of the guide comments.

In addition to information regarding artworks, sections and the museum, the application is able to support some services such as showing the itinerary to get to a specific artwork from the current location. Most information is provided mainly vocally in order to allow visitors to freely look around and the visual interface is mainly used to show related videos, maps at different levels (museum, sections, rooms), and specific pieces of information.

**Figure 1. User in the Marble Museum with mobile guide.**

# 4. SCAN & TILT INTERACTION

## 4.1 Design Rationale

Digital metadata on artwork facilitates electronic guides for museums (e.g. it is easier to arrange temporary exhibitions when metadata can be made available to electronic guides). Also, our concept of guide interaction potentially benefits from the fact that artwork metadata can be structured in a nested, tree-type structure. The scan modality operates on a higher level (i.e. it can be used to choose the main element of interest), while the gesture modality enables operations between elements in the metadata structure (i.e. horizontal tilt allows navigating among pieces of information at the same level). These aspects make the interaction more immediate and potentially easier for visitors to orient themselves within the information presented by the device.

## 4.2 User Interaction

A summary of user interactions using multiple modalities with illustrations of the corresponding user interface modifications is presented in Figure 2. When a visitor enters a space, this is detected through the infrareds signals, and a map of the room is provided automatically. A visitor then scans a RFID tag associated with an object by physical selection, and the object is highlighted graphically on the room map. That is, information on a mobile device is associated to an object in the physical environment. In the detailed data-view, navigation among different pieces of information can be done by tilting horizontally. Alternatively, when users enter a room and get information regarding it, they can use the tilt to identify/select different artworks in the room through simple horizontal tilts. Whenever a new artwork is selected, then the corresponding icon in the room map is highlighted and its name is vocally rendered. In order to access the corresponding information, a vertical tilt must then be performed. Note that the current interpretation of the tilt event can also be enabled/disabled through a PDA button. In general, the tilt interface follows a simple to learn pattern: horizontal tilts are used to navigate through different pieces of information at the same level or to start/stop some activity, vertical tilt down events are used to go down in the information hierarchy and access more detailed information, whereas vertical tilt up events are used to get

up in the information hierarchy. Since there are different levels of information supported (the museum, the thematic sections, the artworks, and the information associated to specific artworks and its rendering,.), when a specific artwork is accessed, it is still possible to navigate by horizontal tilting to access voice control (to decrease/increase the volume), control the associated video (start/stop), and access information regarding the author.

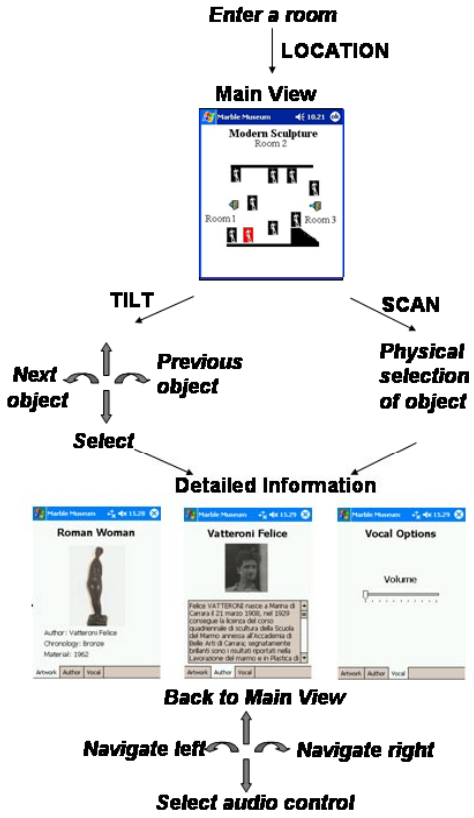


**Figure 2. The use of gesture and physical selection modalities. Information affecting interaction is in CAPITAL LETTERS while interaction actions are written in *italic*.**

# 5. THE INTERACTIVE SYSTEM

The scan modality is used to orient users in a physical environment and to select data on a higher level. After summary information is provided on the mobile device, gesture modality is used to navigate between various views/levels of detail by tilting. Figure 3 shows the architecture of our interactive system: when users receive scan data through the RFID manager, it is communicated to the museum application, and when the device is tilted, the tilt manager feeds the tilt data to the application accordingly.

## 5.1 Tilt - Modality

The gesture modality in our approach utilizes 2D acceleration sensor hardware from Ecertech. The sensor hardware is attached to an iPAQ PDA with Pocket PC operating system and can be used also in other Pocket PC PDAs and SmartPhones. The sensor produces signals that are interpreted as events (TiltLeft, TiltRight, TiltBackward, TiltForward) by the tilt manager-data processing module of the mobile device. User-generated tilt-based events can then be used to execute interactions (selection, navigation or activation) according to the user interface at hand.

## 5.2 Scan - Modality

The scan modality employs RFID technology by Socket Communications. The RFID reader (ISO 15693) is connected to the Compact Flash socket of a PDA. Artworks in the museum environment are equipped with RFID-tags containing identifiers of the given artwork. A user can obtain information related to a work of art by placing the device near the tag and having the data associated with the tag code passed to the guide application through the RFID reader hardware.

## 5.3 The Algorithm

The first release of the software prototype uses a simple tilt monitoring algorithm based on static angle thresholds and taking into account the initial tilt angle of the device when the application starts. The tilt of both horizontal and vertical axes is measured every 1/10 second. These values are then compared to the original tilt measurement performed at application start-up time, and if a 15 degree threshold is exceeded for over 500ms in one of the axes, this is interpreted as the appropriate tilt gesture for that axis: 'forward', 'backward', 'left' or 'right'. Although the algorithm might be deemed as a simple solution, its usage has allowed us to obtain valuable preliminary user feedback.

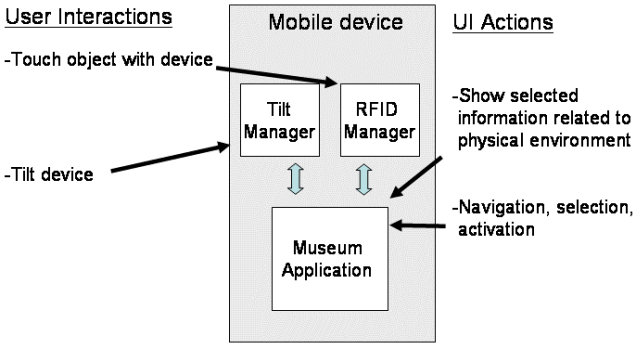


**Figure 3. The Architecture of our interactive system.**

# 6. THE FIRST EVALUATION

We have performed a first evaluation of our prototype to assess the ideas associated to this novel interaction technique. The test involved 12 people (10 men, 2 women), ages ranging between 24 and 50 years old, recruited in the institute community: 3 had secondary school education level, while the others had university degrees or higher levels of education.

Before starting the exercise, users were instructed to read a short text in which the different movements that have to be done in order to activate the scan and the tilt procedure were explained. Then, a short description about the task that they were expected to carry out was provided: users were asked to scroll a number of artworks belonging to a specific section (main window); then, they were expected to select one artwork (secondary window) and navigate through the different pieces of information available (e.g.: author, description, image, ...), to finally get back to the

initial window in order to finish the exercise. After carrying out the exercise, users were asked to fill in a questionnaire, which was divided into two parts. In the first part some general information was requested by the user (age, education level, level of expertise on using desktop/PDA systems, etc.). The second part was devoted to questions more specifically related to the exercise.

People involved in the tests reported to be, on average, quite expert in using desktop systems, but not particularly expert in using PDAs. Roughly half of them had already used a PDA before the exercise (7/12), only a few reported to have ever heard about scan and tilt interaction. On average they judged scan and tilt useful, with interesting potentialities.

The majority of them (8/12) reported some difficulties in performing the exercise. Only 2 reported no difficulty, while other 2 reported many difficulties. People that experienced difficulties, generally self-explained this fact saying that it could have been motivated by the novelty of the technique and their complete lack of experience with such an interaction technique. As for the kind of difficulties encountered, there were aspects connected to the initial difficulty in using the technique and understand the tilt thresholds expected for activating the tilt event, but most of these problems diminished after the initial interaction phases. Vertical tilt was found to be the most difficult interaction, while horizontal tilt was found the easiest one for the majority of users. Almost all the users judged the application user interface to be clear (in a 1-5 scale, only one reported a value of 2, whereas the others reported 4 or 5). Users judged scan and tilt interaction fairly easy to use (on average, the mean value was 3 in a 1-5 scale) and in fact several of them pointed out that it is just a matter of time to get used to it. They judged that scan and tilt makes interaction slightly easier with respect to traditional graphical interfaces, even if they conceded that it would be quite difficult to use it without looking at the PDA. All in all the feedback was positive, even if we are aware that more empirical test is needed in order to draw definite conclusions.

# 7. CONCLUSIONS and FUTURE WORK

We have proposed a new interaction paradigm – scan and tilt – for mobile museum guides aiming at enabling more effective interactions through the combination of multiple modalities – gesture, physical selection, location, graphical and voice - reporting how it has been applied in a mobile museum guide. A preliminary user test was carried out, which provided encouraging feedback and indications for further refinements: further user studies are planned in the near future aiming also to understand the most effective parameters for the tilt monitoring algorithm.

Our solution for a mobile museum guide considerably extends interaction towards more natural ways of interacting with the environment. Related approaches which focus on scan modality, such as [11], exploit similar ideas, but our solution offers a greater degree of freedom for users to move around and more control in obtaining information only when they want and without overloading the visual channel by having to graphically browse the application. Some future work is also planned for the algorithm that manages tilt events, in order to support dynamic angle thresholds to allow for a more natural interaction with the device. The use of combined axis movement (i.e. 'up' and 'right' at the same time) also opens up new interaction possibilities which could further improve the interaction richness between the user and the application. The complexity of such an algorithm is however not to be underestimated, therefore requiring a thorough analysis.

# 8. REFERENCES


[1] Ailisto, H., Plomp, J., Pohjanheimo, L., Strömmer E.: A Physical Selection Paradigm for Ubiquitous Computing. Proceedings EUSAI 2003: 372-383.

[2] Burigat S., Chittaro L. (2005). Location-aware Visualization of VRML Models in GPS-based Mobile Guides, Proc. of Web3D 2005, ACM Press, pp. 57-64.

[3] Cheverst K, Davies N, Mitchell K, Friday A, Efstratiou C (2000) Developing a context - aware electronic tourist guide: some issues and experiences. In: Proceedings of CHI 2000, ACM Press, The Hague, The Netherlands, pp 17–24.

[4] Ciavarella, C., Paterno F., The design of a handheld, location-aware guide for indoor environments Personal Ubiquitous Computing (2004) 8: 82–91.

[5] Crossan, A., Murray-Smith, R., Variability in Wrist-Tilt Accelerometer-based Gesture Interfaces, Proc. of MobileHCI'04, Glasgow, September 13-16, 2004. LNCS 3160, Springer-Verlag, pp. 144-155, 2004.

[6] Eslambolchilar, P., Murray-Smith, R., Tilt-based Automatic Zooming and Scaling in Mobile Devices - a state-space implementation, Proc. of MobileHCI'04, Glasgow, September 13-16, 2004. LNCS 3160, Springer-Verlag, p120-131, 2004.

[7] Hinckley, K., Pierce, J., Sinclair, M., Horvitz, E., Sensing Techniques for Mobile Interaction, ACM UIST 2000 CHI Letters 2 (2), pp. 91-100.

[8] Mäntyjärvi, J., Kallio, S., Korpipää, P., Kela, J., Plomp, J., Gesture interaction for small handheld devices to support multimedia applications, In Journal of Mobile Multimedia, Rinton Press, Vol.1(2), pp. 92 – 112, 2005.

[9] Oppermann R, Specht M (2000) A context-sensitive nomadic exhibition guide. In: The proceedings of symposium on handheld and ubiquitous computing, LNCS 1927, Springer, pp 127–142.

[10] Rekimoto J., Tilting operations for small screen interfaces, ACM UIST 1996, 1996., pp. 167-168.

[11] Valkkynen P., Korhonen I., Plomp J., Tuomisto T., Cluitmans L., Ailisto H., Seppa H., A User Interaction Paradigm for Physical Browsing and Near-object Control Based on Tags, Physical Interaction '03 – Workshop on Real World User Interfaces, in conjunction with Mobile HCI'03.