



# Using RFID guiding systems to enhance user experience

Using RFID  
guiding systems

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319

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## Abstract

**Purpose** – The purpose of this article is to present a guiding system with enhanced functionality based upon radio frequency identification (RFID) technology to promote a user friendly experience.

**Design/methodology/approach** – Based on a user survey, the paper provides a guiding system using RFID with blog platform for further interaction. An example of this technology was built into a gallery at a college in Taiwan.

**Findings** – This guiding system is defined as pull type because users actively pull the relevant information using RFID readers. With such functionalities, users have the opportunity to acquire information, using a mobile device, about a specific object in a context-aware manner. In addition, users can share ideas and comments related to the object on blogs with others who had visited or will visit the object or site. The user survey results showed that visitors seldom met the artists at an exhibition of their works, but desired to discuss and shares comments with them and other visitors. The proposed system addresses this need with a blog, and the user satisfaction survey confirmed that the proposed system met the requirements.

**Originality/value** – The paper provides a guiding system to enhancing user experience by RFID and blog. The system also builds a channel between the creators of the artworks and others.

**Keywords** Radiofrequencies, Portable digital assistants, Social interaction, Customer satisfaction, Communication technologies, Taiwan

**Paper type** Research paper

## Introduction

A guiding system (or touring guide) is a fundamental service provided both by public and private sectors in locations such as museums, art galleries and exhibition halls. The purpose of such a system is to provide comprehensive information to visitors, so that they can find and fully comprehend the exhibited art works or objects. Guiding would be conducted by curators or staff where a trained guide gives information to visitors in a contextual manner, or by multi-lingual recording devices that are carried and operated by visitors themselves. Guiding systems have been deeply influenced by information communication technology (ICT) to provide more comfortable service. One notable ICT technology that affects guiding systems is context-aware ubiquitous technology.



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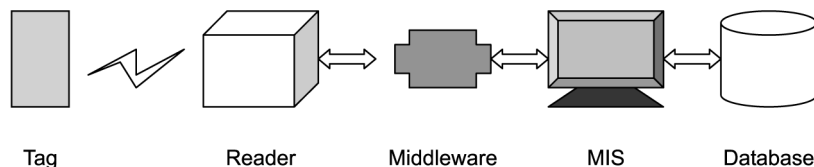
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The concept of ubiquitous computing was initiated by Mark Weiser. In his famous article entitled “The computer for the twenty-first century”, Weiser provided an excellent introduction to the key concepts of ubiquitous computing. Weiser stated “The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it” (Weiser, 1991; Fano *et al.*, 2002). Ubiquitous computing sometimes works in conjunction with context-aware issues. Siewiorek (2005) defined context as any information that can be used to characterize the situation of any entity (person, place, physical or computational object). Similarly, Korkea-aho (2000) stated that context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and the application themselves. Wennlund (2003) defined context or context-aware as almost any information available at the time of an interaction. From a technical point of view, a wearable or portable computing device, some context-aware devices, and a wireless network access facility should be included to realize a ubiquitous context-aware paradigm. A wearable computing device is a computing device that can be worn on the human body – often as part of the clothing. In an ideal case, people who wear a wearable device do not feel its existence. Wearable devices have become a reality today; making ultra-portable computing devices a radical change from traditional mobile technologies and perspectives. Mobile computing devices (such as notebook computers) relieve people from being tied to a fixed location, while wearable or ubiquitous devices free people’s hands and provide a new level of convenience.

Wearable devices must be able to communicate with sensory devices that are located somewhere nearby. There are several ways to realize the sensory implementation. Radio frequency identification (RFID) is one of the most common approaches to implementing a ubiquitous environment (Shien, 2007). The use of RFID in tracking and accessing applications first appeared during the 1980s. RFID quickly gained attention because of its ability to track moving objects and so became interesting for the transportation of goods. An RFID system consists of tags, tag readers, middleware, and application software (Figure 1). An RFID reader detects the existence of, and reads from, an RFID tag within a certain distance using radio frequency signals. The data within a tag may provide identification or location information, or specifics about the tagged product, such as price, color, date of purchase, quality etc. As the technology is refined, more pervasive and wider uses for RFID tags are being developed – for instance, locating tools in the International Space Station.

A blog, consisting of articles that can be organized into different categories, archives, photos, and system settings, is one of the most popular services on the web, especially within Web 2.0. Gordon (2006) described a blog as a mini web site where individuals can record their activities, thoughts, musings, and ramblings for others to



**Figure 1.**  
RFID system

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read and comment on. A blog is also a kind of social computing or social networking. Social computing is defined as any type of computing application that serves as an intermediary or a focus for a social relation (Kwai and Wagner, 2008; Schuler, 1994). On the basis of the above descriptions, people may share their thoughts on the same object (such as an exhibit) with each other asynchronously through the blog. Some may argue that a discussion forum can fulfill such a requirement too, but a blog provides more functions, such as including audio, video, and photo into content, trackback, RSS feed, etc.

In this paper, a guiding system based on ubiquitous context-aware technology with RFID is proposed. This system allows a user to interact contextually with content nearby. An example at an art gallery is introduced. In this example, a visitor who carries a personal digital assistant (PDA) that is equipped with CompactFlash (CF) type RFID reader can retrieve detailed descriptions when approaching an exhibit, and may interact with the creator (artist, author, curator) of that exhibition as well as other visitors to the exhibition on a blog. The remainder of this paper is organized as follows. The next section, related works, introduces some related projects. The section entitled "System design" gives a detail description of the proposed system. The "System implementation" section presents an implementation at a college in Taiwan. The findings and discussion are in the last section.

### **Different RFID approaches**

To improve the interaction between visitors and exhibitions and promote positive visitor experiences, some museums have implemented ubiquitous context-aware environments with ICT and wireless sensory technology. Among these applications, there are some RFID applications. The Tech Museum of Innovation located in San Jose, California implemented a unique TechTag program, which allows visitors to personalize their museum experience during and following their visit. TechTags personalize and extend the museum experience with the usage of a small RFID tag that can be worn around the wrist. When visitors wore and used their tag to activate an exhibit, the TechTag automatically creates a personalized webpage with photographs and activities. The visitors could access the webpage after they left the Museum. As stated in the museum press release, the RFID tags are bringing The Tech closer to realizing its vision of a smart museum, a museum that interacts with its visitors and remembers them after they leave (The Tech, 2007).

The approach proposed in this paper differs from the implementation at The Tech Museum in the way of interaction. TechTag automatically traces a visitor's experience and activity with a wearable RFID tag. The RFID tag is movable and the RFID readers are fixed on certain locations in which any tag can be traced. In the proposed system, the RFID tag is attached to an exhibit and the RFID reader is movable (i.e. carried by visitors). The RFID is used to identify the specific object a visitor is interested in. The visitor can view the messages made by the artist and other visitors, and adds his/her message on site.

The other example of RFID application concerns behavior recording. The Cleveland Museum of Art analyzed the visitors' behavior towards exhibitions during their visits with a recording RFID system. Likewise, in order to increase the value of the visitor experience, the Natural History Museum in Denmark has implemented an interaction scheme with RFID. A number of RFID tags were embedded into certain

specimens. A visitor carries a PDA that is equipped with CF type RFID reader and interacts with these specimens during a visit. A visitor's activity is recorded and can be accessed after he/she has left (Shen, 2006). The approach proposed in this paper is similar to the implementation in Denmark. The difference is that an interactive channel is provided for visitors and authors. The Okayama Digital Museum in Japan has implemented an RFID-based service for visitors. More than 7,000 tags were embedded under the floor of an exhibition room on which a large birds-eye map of the city was printed. Visitors walk around on the floor with an information display device called Korotto, which is equipped with a RFID reader that senses the tag embedded onto the floor and displays historical/ cultural information related to the visitor's current position on the map. In such a setting, the visitor gets location-aware information about the city automatically (Konomi *et al.*, 2007). This is a good ubiquitous context-aware application. By summarizing the above examples, we know that RFID systems are gradually being adopted in public areas to provide better services and enhance users' experiences.

### Guiding system design

In this paper, a guiding system based on context-aware ubiquitous technology is introduced. To distinguish the difference between the proposed system and other systems, a definition is given. According to different types of user interaction, guiding systems can be classified as pull type, voice guide, and push type. These are outlined below:

- *Pull type*: Users purposefully pull information in which they are interested. The system presented in this paper is one of such implementation in which the action of stepping toward an exhibit allows the PDA to detect an approaching RFID tag, and implies the intention of getting further information or learning more.
- *Voice guide*: This is currently the most popular type of tour guide at exhibition halls, art galleries, and museums. This device, which is essentially a media player, contains information about the exhibition in oral form. When visitors come to an art gallery or museum, they may be given such a device to get more information. Visitors may enter the number, which is attached to each exhibit or room, with the keypad or perform a specific action to activate sensors, which are surrounding them. Consequently, visitors hear a voice providing information in a language of their choice associated with this particular exhibit through an ear phone.
- *Push type*: This is one of the most contemporary guiding systems. It is similar to pull type except information is actively pushed to any devices, nearby that are carried by visitors. To implement such an environment, many sensors must be deployed to cover the entire exhibition hall, so that the devices can be detected at any location inside the hall.

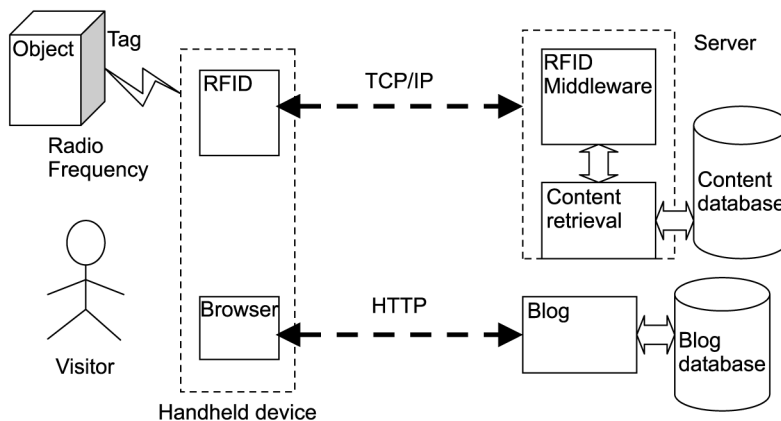
The guiding system presented in this paper is of the pull type and is based on RFID, web, and blog technology. In an ordinary art gallery or museum the creator or curator usually provides a title and a short note for each item in the exhibition. For a visitor who just takes a glance at this exhibition, this brief message is usually sufficient, but it is not enough for those visitors who want to learn more about this particular exhibition. If detailed descriptions of each and every exhibit were provided, it would

be wasteful on space or printed material since not all visitors are fully interested in all the exhibits on display. Therefore, it is better and more efficient to allow visitors get the detailed descriptions or relative information about only those exhibits that especially interest them electronically and automatically. In addition, the actual artist of a piece may not always be at the exhibition hall after the opening day; nor do all visitors have the opportunity to communicate with the artist when he/she is present. If a visitor has some praise or feedback, and wants to share it with the artist or author, it is hard to achieve this in traditional exhibitions. To allow authors and visitors to have a way to interact, a ubiquitous computing environment is one feasible approach.

Bearing the above-mentioned considerations in mind, a framework is thus proposed that allows a visitor to get detailed descriptions and related information, and communicate with authors and other visitors in a ubiquitous and context-aware manner achievable through RFID technology. The proposed ubiquitous environment is shown in Figure 2. This environment consists of three units: the RFID unit, the content unit, and the blog unit. Each of these units is described below.

#### *The RFID unit*

The purpose of this unit is to build a context-aware environment; it consists of an RFID reader, an RFID tag and RFID middleware. An RFID reader can be a dedicated RFID reader or a portable type such as the CF type and integrated with a handheld device such as a PDA. An RFID reader senses any tag within its sensing range. An RFID tag consists of electrical circuitry and a microchip; it can be active, with power supply, or passive, without power supply. In this framework, a passive type tag is used. A tag is attached to every item in an exhibition such as a painting or porcelain vase. When a visitor is interested in one of the works of art, he/she may step towards it thus bringing the RFID reader within range of the tag. Once the reader senses this tag, the RFID middleware will take this information and send it to the server side to get detailed information about the object in question.



**Figure 2.**  
System framework

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*The content unit*

The purpose of this unit is to store and retrieve the detailed descriptions and relative information; it consists of a content database, a data input routine, and a content retrieval and dispatch routine. When the RFID unit sends tag data to it, the content retrieval and dispatch routine queries the content database and sends the information back to the visitor's handheld device (e.g. PDA). The content database has three parts:

- (1) *Detailed description*: The detailed description of each object (exhibit). This is created by the originator of the art work with a web-based interface on a desktop computer. The originator may describe anything about this piece that he/she wants to share with visitors.
- (2) *Relative information*: The originator (or curator) of an art work (or exhibition) may select this function if necessary. For example, if the work is an oil painting, and a visitor wants to learn more about the actual techniques and materials used in oil painting then he/she can get information from here. Basically, most of the fundamental knowledge with regards to artistic creation is in the database already; therefore artists need just select a suitable article instead of inputting all the possibly relevant information themselves. This feature provides art work originators with a very convenient approach.
- (3) *Blog id*: each exhibit has a blog accompanying it, which is maintained by the blog unit. To make this association, the permanent URL link of an allocated blog is set to the blog id.

*The blog unit*

The blog unit is a modification of a normal blog system. The purpose of this unit is to set up a communication channel between artists and visitors. The content of a blog is usually initiated by a visitor, and afterwards the artist and other visitors may reply. The basic functions of this unit are as follows:

- *To give feedback*: this unit provides a forum to let visitors conduct a dialogue with artists about their works. Since artists will not be in the exhibition hall or gallery all the time, this function provides a convenient communication channel. This is an advantage of a ubiquitous environment over a traditional one. Visitors may input their comments in the form of text, voice, or even video, if the handheld devices provide such a function. Audio and video capturing capabilities are a common function on a PDA, therefore this option is easy to realize. This provides an alternative to compensate for the inconvenience of a text input approach (typing with stylus).
- *To view other visitors' feedback*: visitors can view feedback or dialogue submitted by other visitors to the art gallery or museum.
- *To reply to feedback*: the artist can view the visitors' feedback and give responses to them.

Because the blog unit is an adoption of normal blog systems, visitors and artists can access it with desktop computers outside of the exhibition hall or gallery.

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### System implementation

An implementation based on the proposed framework was built into an art gallery at a college in Taiwan that can accommodate about six exhibitions per year. At this college, since there is campus-wide wireless access available, it is easy to construct such an environment. The specifications of hardware, software, and blog concerning this implementation are as follows:

- RFID reader: The RFID reader has CF Type I Interface, a half wave Hertz Antenna, and the frequency range is between 2.4 and 2.4835 GHz (Sunlit Corp., 2007).
- RFID tag: The inlet of the RFID tag is Hitachi  $\mu$ -Chip (TCP Type), the frequency is 2.45 GHz, and the memory size is 128 Bits ROM.
- Handheld device: The HP iPAQ hx4700 PDA has a CF slot, WiFi wireless LAN, bluetooth, and an audio recording unit. The operating system is Microsoft Windows Mobile 2003. The RFID reader is plugged into the CF slot.
- Programs for client and server were programmed with Microsoft visual C# language. The database used is Microsoft Access.
- The blog was built on the Lifetype platform (Lifetype, 2007). Visitor may access this blog by using web browsers (such as Microsoft Internet Explorer or Firefox) on desktop computers outside of the gallery or an handheld devices provided by gallery personnel. A category is assigned to each exhibit, and visitors inside the gallery may make an entry (article) on this category or comment on an entry made by another visitor. The system presumes that visitors who borrow a handheld device from gallery personnel get permission to make an entry; therefore they can make the entry without authentication. But, when accessing later from outside of the gallery, visitors must be granted the permission before making an entry.

There were about 20 pieces of shell boule creations displayed at an exhibition that opened in April 2007 for a period of two months. The author of this exhibition, Mr Chen, a native Taiwanese artist, input the detailed descriptions about his creations into the database, and selected suitable knowledge about shell boule as related information. In this implementation, each individual exhibit was attached an RFID tag. When visitors, most of them students, came into this gallery, they could borrow a PDA in which a CF type RFID reader was attached before they started the tour. Each exhibit was associated with a small note (see Figure 3) to allow a visitor to get a basic idea of the art work. When visitors were especially interested in a work, they might step towards it. When their RFID readers detected the tag, the basic information was acquired from the server and displayed on the PDA (see Figure 4). In this way, visitors did not need to get information manually. The exhibition was aware of the visitor's presence and pushed information to the visitor's handheld device in this ubiquitous context-aware environment.

### System evaluation

Two approaches were adopted to evaluate the performance of this system. One is a comparison between different types of guiding systems, and the other one is a questionnaire analysis about user satisfaction. In order to make comparison, four

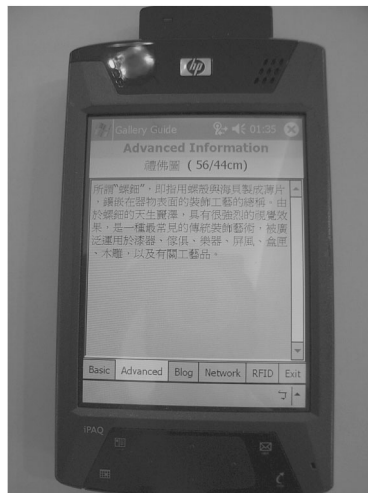
**Figure 3.**  
An example exhibition

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**Figure 4.**  
A snapshot of the  
handheld device

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criteria are used: cost, information overload, comfortable, and storage location. The result is shown in Table I. It is noted that pull type guiding has a reasonable cost, does not cause information overload, and provides comfortable service. We thus conclude that the pull type system is a good guiding system implementation.

#### *Other solutions to guiding systems*

It is worth mentioning, however, that RFID is not the only solution to implement pull type guiding systems. There are other possibilities, for instance barcodes. People sometimes claim that RFID is merely a replacement for the barcode because of the similarity of operation and system configuration. On one hand, because RFID can completely constitute the functions of barcodes, this claim is true; but on the other



hand, the capabilities of RFID far surpass those of barcodes. In the circumstance described in this paper, a barcode system could possibly replace RFID and its functions properly provided – but with several exceptions as follows. First, the sensing range and orientation of a barcode is far more limited than RFID. It means that an RFID reader can receive information from a tag over a greater distance and with less severe orientation requirements. Second, a barcode is printed onto an object on a piece of paper with a readable format. Therefore it carries the risk of becoming too difficult (contaminated, damaged, effaced) to read and decode. In a summary, RFID is superior to barcodes in such implementations. Another possibility is Zigbee – a wireless control counterpart to RFID in many application scenarios, especially when compared with active type RFID systems. In the guiding system presented in this paper, Zigbee and active type RFIDs can be classified as push-type guiding systems. Therefore, they are in a different application category

*User experience survey*

To have a general picture about people’s experience at an art gallery or similar exhibition, a survey was conducted with 515 students, of which 358 were male and aged from 18-22. The summary is shown in Table II. About three quarters of the students had been to an art gallery or similar exhibition before. Most of them did not use a guiding system, or meet and talk to the artists. Some students (32 per cent) wanted to discuss things with artists, and over 58 per cent desired to know other people’s comments and discuss the works with them. Therefore, a convenient tool to

	Pull type	Push type	Voice guide
Cost	Fair	Most expensive	Fair
Information overload	No	Maybe	No
Comfortable	Yes	Yes	Yes
Information stored at	Central database	Central database	User device

**Table I.**  
Comparison between the  
different systems

Item	Yes (%)	No (%)
Have you ever been at art gallery or similar exhibition?	75	25
Have you ever used voice-guiding system at art gallery or similar exhibition?	21	79
Have you ever met author of works at art gallery or similar exhibition?	9	91
Have you ever talked with author of work at art gallery or similar exhibition?	6	94
Have you ever had intention to discuss with author of work at art gallery or similar exhibition?	32	68
Have you ever desired to know others’ comment about works at art gallery or similar exhibition?	58	42
Have you ever had intention to discuss about arts with other visitors at art gallery or similar exhibition?	58	42

**Table II.**  
User’s experience survey

allow visitors to share and discuss ideas and opinions at an art gallery or similar exhibition is deemed highly necessary.

User satisfaction about this system is summarized in Table III. A total of 107 students who also participated in the user survey stated above, visited an art gallery and were asked to complete the user satisfaction survey. By viewing the result of survey, it is clear that most users (visitors) were satisfied with the functions and services provided by this guiding system.

The students who completed the user satisfaction survey were also asked to give comments on additional functions. Generally speaking, they thought this system was easy to use. The text inputting approach (with stylus) was not inconvenient, but they appreciated the audio and/or video approach. Voice and/or video recording has been a common feature on PDAs, therefore, it should not cause too much trouble to include these functions (Table IV).

Items	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
It is easier to understand the insight of works with guiding system at an art gallery or similar exhibition	0	1	12	48	39
The quality of visiting is improved with a guiding system at an art gallery or similar exhibition	0	1	8	42	49
It lets me have an opportunity to discuss with authors by using this guiding system at an art gallery or similar exhibition	3	6	30	43	18
It benefits me to access the advanced information in the guiding system at an art gallery or similar exhibition	0	1	18	47	34
It lets me have an opportunity to share ideas with authors on a blog	0	0	17	45	38
I like to browse others' comment on a blog	1	2	24	39	34
I like to share my view with other visitors on a blog	2	4	31	41	23
I like to share my view with authors on a blog too	2	5	38	35	21

**Table III.**  
User satisfaction survey

**Notes:** 1= Strongly disagree; 2= Disagree; 3= Fair; 4= Agree; 5= Strongly agree

Items	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
I feel this guiding system is easy to use	1	2	14	43	40
It is a little inconvenient from a sharing viewpoint to comment on a blog with text input approaches on a PDA	9	21	36	25	9
I think if can share opinions with audio or video clips, it will be better	1	9	21	32	37
I think the arrangement of guiding system is succinct and convenient for viewing information	1	2	14	34	49
I think that carrying a guiding system won't bother me while visiting an art gallery or similar exhibition	2	2	15	36	45

**Table IV.**  
Comments on functions of system

**Notes:** 1= Strongly disagree; 2= Disagree; 3= Fair; 4= Agree; 5= Strongly agree

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## Conclusions

Enhancing user experience with ICT is a current trend. Blog applications have become popular social computing software, and RFID has gained a positive reputation and shown its capabilities. In this paper, a ubiquitous context-aware environment built on RFID technology was proposed. The specific kind of implantation was defined as pull type in contrast to push type guiding system which is usually based on Zigbee technology. This implementation has been built and deployed in an art gallery and it allowed visitors to automatically get the information about the exhibits they were interested in, and communicate with artists and other visitors about the relevant pieces. By comparing with other types of guiding systems, the pull type one is superior to others in categories such as information overloading, cost, and comfort. The survey of 515 students showed that students seldom met artists at the art gallery, but had the intention to share their ideas and comments with the artists and their companions. The proposed system addresses their needs. The user satisfaction result showed that the proposed system is easy to use, provides extremely relevant contextual information and gives opportunities to share ideas and comments with others, especially those who are not present at the same time. Although the stylus may be slightly inconvenient for inputting comments or ideas on the blog, most of the students did not have such feelings, but they especially appreciate the prospect of communication in ways such as audio and/or video recording. These functions will be included in the future.

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