



An Exhibition Guiding System with Enhanced Interactive Functions

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Review

Purpose—This study developed a highly interactive exhibition guiding system which enables both authors and visitors to interact with each other on an exhibition site. Not only could the system perform the guide tasks well, but it also allowed the users to select interested modules so as to avoid overloading the irrelevant information. Additionally, the visitors could chat with unacquainted visitors who are on site and have the same taste on a specific artwork, and the authors could visualize the visitors' comments, recommendations, and suggestions on their works in a real-time manner.

Design/methodology/approach—This guiding system was designed with a “pull-type” concept in a way that a handheld device must be close to a specific work to “pull” the information out of that work. The highly interactive functions between visitors and authors or among visitors were enabled by the web 2.0. Verification and validation of the system's functions was tested in an art gallery with PDAs utilizing passive RFID readers and tags. Questionnaire survey was conducted to learn of the opinions from authors and visitors after they used the system.

Findings—The verification and validation test showed that all the functions have met the predefined requirements. The results of questionnaire survey also revealed that the majority were satisfied with the interactive guiding system.

Originality value—The proposed system has some innovative features. It enabled the authors to interact with the visitors, to understand the visitor's thoughts and opinions on their works, and to share the ideas of their creativity with the interested visitors on site. On the other hand, this system also enabled the visitors to interact with the authors and other visitors. The visitors can recommend appreciated works to others, provide their comments and suggestions, visualize others' comments and suggestions, and exchange their views with those who are on site and ever recommended the same works.

Keywords: RFID, web 2.0, Interactivity, guiding system

Paper type—Research paper

Introduction

Visiting art galleries or exhibits has long become an important leisure activity for many people, ranging from local residents to foreign tourists from around the world. Such leisure activity not only refreshed one's soul and mind, but also added personal knowledge. In the past, however, when people visited an art exhibit, they rarely had opportunities to interact with the authors or other visitors in a real-time manner. In the era of web 2.0 today, highly interactive guiding systems have become feasible in that the authors (artworks) and the visitors or the visitors and other visitors can have real-time interactivities via the advanced handheld devices on site. Should the guiding systems also provide functions allowing the users to make comments or recommendations, the information would be valuable to the authors and other visitors as well.

A variety of guiding systems have been found in such occasions as museums, art exhibits, and culture heritage sites. The technologies, basically, have been gradually transformed from conventional standalone style to modern electronic devices due to the evolution of information—from unidirectional provision to bidirectional exchange, and from “push-type” to “pull-type” design to largely reduce the amount of information onto the user end. The key to this evolution is interactivity. With interactivity, the boundary between information providers and information users becomes blurring. In the era of web 2.0, information users can become information providers as well. For instance, when a user browses a web page, he/she may respond by making comments or recommendations. This kind of interactivity has provided the users with browsing guidance from which numerous web pages are created daily (Chen, 2009). In fact, the approach providing specific users with recommendation existed long ago. For example, there was a famous program called “American Top 50” (<http://www.americantop50.net/>) which provided the audience to rank the songs from around the United States. From the provider's viewpoint, it indeed served as an effective promotional channel; and from the users' perspective, it also provided valuable information for buying.

In fact, Web 2.0 specially emphasizes on user experience and interactivity, it is easy to find example cases (Harinarayana and Vasantha Raju, 2010). For news related website, many of them provide recommendation and comment functions for every piece of news to enhance the interaction among readers. These functions offered an incredible interactivity manner that any printed type of newspapers has never achieved before. Besides, one may further look into what else also been recommended by a reader. Such a highly interactive function will allow the readers to quickly expand the depth and breadth of related news. Taking Yahoo News—one of the famous portals in Taiwan—as an example, every piece of news is associated with two options: comment and recommendation. For comment, there are a total of eight predefined comments to choose from. Upon choosing the most appropriate one and submitting, the reader will see the statistical results right away as shown in Fig. 1 (top panel). Similarly, for recommendation, upon pressing the recommendation button, the number of readers having recommended this news is instantly displayed in Fig. 1 (bottom panel).



Fig 1. The Yahoo News in Taiwan (accessed date 10/25/2010)

Coming with the innovative progress of information technology and wireless communication, the ubiquitous computing initiated by Weiser (1991) has been adopted onto various domains. In his famous article *The Computer for the Twenty-First Century*, the author provided an excellent introduction to the key concept of ubiquitous computing "...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). The key module to construct a ubiquitous computing is wireless network and sensor module. Among various technologies, RFID is one of the most common approaches to implementing a ubiquitous computing (Domdouzis et al., 2007; Glover and Bhatt, 2006). The related applications of RFID have been found in utilities, transportation, logistics, and medical domains. A system based upon RFID technology basically has a computing device (e.g., a computer) and can be connected to the RFID reader. In a ubiquitous computing environment, the computer is a mobile device, such as PDA, smart phone or dedicated handheld device. The combination methods can vary with different types of device and may have different pros and cons (Lin et al., 2009). PDA generally has more powerful and much richer computing capability, and it is normally connected to RFID reader via CF (Compact Flash) interface. Smart phone usually communicates with the embedded NFC (Near Field Communication) chip, whereas dedicated handheld device is direct integrated with RFID reader (Want, 2006).

A number of relevant studies on advanced guiding functions or computing algorithms can also be found. Hsu and Liao (2010) designed a tour guide system which allows the visitors to select any interested item and instantly share their opinions with others through the Internet. The system is helpful in promoting the exhibition with the broadcasting through micro blogging. Tsai et al. (2010) proposed a location-aware tour guide using simulate-annealing back-propagation network (SABPN) algorithm to locate and monitor the properties of items for customized tour guide. Suh et al. (2009) built a mobile phone-based guiding system with GPS. It tracks users' movement at a cultural heritage site to strengthen spatial awareness, personalization, and social connectedness. Chen et al. (2009) proposed a framework based on RFIDs and WSNs for group tour guiding services. They focused on connecting the members with the leader who guides

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2 the tour. Mobile tour guide systems sometimes provide personalized tour planning services as well. For
3 instance, Souffriau et al. (2008) solved the tourist trip design problem with artificial intelligence and
4 metaheuristic approach. Bellotti et al. (2005) described a palmtop-based tour guide that provides tourists
5 with high-quality multimedia information and services. This tour guide is suitable for different situations
6 including visit in a museum, walk in a city or travel in a car. Gulliver et al. (2007) proposed three usability
7 indexes—efficiency, effectiveness, and satisfaction—to explore the role of context aware feedback on a tour
8 guide. They found that context aware feedback has impact on efficiency and satisfaction, but not on
9 effectiveness. From the survey of previous works, it clearly indicated that ICT-based tour guides have
10 adopted the contactless techniques (such as WiFi, sensor network, RFID, or GPS) to perform location-aware
11 services.
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14 A ‘pull-type’ guiding concept utilizing RFID technology has been found in a recent work (Lin et al.,
15 2009). If the visitors are not interested in an item, they may just walk through and the screen will not display
16 any information of that item. However, if the visitors are interested in an item, they can walk close to it and
17 the RFID reader will actuate the RFID tag so as to pull the information out of that item. Hence, the screen
18 on the handheld device will only display the interested information. This pull-type design concept can avoid
19 information overloading problems occurred in most previous “push-type” guiding systems. Besides, this
20 pull-type system also allows users to enter the blog services in a way that the users can share their opinions
21 by interacting with the author and/or other visitors. Although this system has provided the visitors with
22 better interactive functions than ever before, it still left some room for further improvement. First, the input
23 method may be improved. Should the text be inputted by other means as well, the users may be more
24 willing to provide their opinions. Second, some visitors may lack knowledge on expressing their ideas in a
25 freely-written format; thus, should the screen display a list of predefined comments to allow the users to
26 make appropriate choices, the users may be more willing to reveal their opinions. Third, in some big events
27 where hundreds or even thousands of items may exhibit in the same occasion, it would be convenient for the
28 visitors, especially those who have limited time (say, one hour), to find out and visit only the most popular
29 works recommended by previous visitors (say, top 20). Last but not least, it would be also convenient for
30 the visitors to find out the unacquainted visitors who have the same taste on a specific work (i.e.,
31 recommend the same work) so that the visitors can send message to invite them to meet up somewhere on
32 site to further exchange their ideas face-to-face. All of these require enhanced interactive functions, and this
33 motivates our study.
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37 The present paper aims to develop a highly interactive exhibition guiding system, which enables both
38 authors and visitors to interact with each other at an exhibition venue. To avoid overloading information
39 onto the handheld devices, a pull-type design concept is adopted. The system will enable the visitors to
40 exchange their ideas with others on site who have the same taste on a specific work. It can also collect
41 visitors’ comments, recommendations, and suggestions in a real-time manner to feed back the authors. The
42 subsequent sections are arranged as follows. The design concept and architecture of the proposed guiding
43 system are introduced. The programs and functions at both local and server ends are explained in detail. A
44 demonstration of the system in an art gallery with questionnaire survey is finally presented.
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48 **System Design**

49 To enable the authors to interact with the visitors at the exhibition venue, a highly interactive guiding
50 system should at least meet the following requirements, from visitors’ perspective: (i) allowing the visitors
51 to express their comments to further recommend the appreciated works to other people; (ii) allowing the
52 visitors to see others’ opinions; (iii) allowing the visitors with similar taste to exchange their views and
53 thoughts on site. And from authors’ viewpoint: (i) allowing the authors to interact with the visitors real-time;
54 (ii) allowing the authors to visualize the visitors’ opinions; (iii) allowing the authors to find out the
55 interested visitors on site. Based on the above requirements, this study develops a highly interactive guiding
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2 system, using Web 2.0 interaction as kernel and ubiquitous computing as environment, which has the
3 following major features:

- 4 1. The visitors can input text to express their comments on the works.
- 5 2. The visitors can make recommendation to other people on the works they enjoyed or appreciated.
- 6 3. The unacquainted visitors with the same taste (e.g., having recommended the same work) can be
7 directed to a meeting point to exchange their views face-to-face. In addition, the authors can also reveal
8 their locations on site to the visitors so that the interested visitors can have access to them for further
9 discussion.
- 10 4. The authors can make description on their works displaying on the screen to guide the interested
11 visitors.
- 12 5. The authors can visualize any work recommended by the visitors who also made recommendation on
13 other works.
- 14 6. The authors can read the visitors' opinions on their works.

15
16 To facilitate the users, the proposed system lists six predefined options—moving, good creativity,
17 novelty, dull, exaggerated, boring—from which the visitors can make only one choice and will see the
18 statistical results in chart format right away. Besides, the proposed system adopts a pull-type design concept
19 such that the users can actively query the information associated with any specific work. The key advantage
20 of pull-type design, as above mentioned, is to avoid overloaded information when implementing the
21 connection between information contents and the associated objects. If a visitor has some thoughts or
22 opinions on a specific work, he/she can share with other visitors or even with the author through blog.

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24 A more convenient approach commonly used at news websites is adopted in the proposed guiding
25 system to implement the sharing functions. When a visitor has thoughts or comments on a specific work,
26 he/she can express with a blog-like text message or simply select one box from the list of six predefined
27 comments. With this function, the visitors can understand other visitors' comments on any specific work,
28 and more importantly, the authors can realize the visitors' thoughts and comments to stimulate their future
29 creativities. The recommendation function serves two objectives: to provide reference information to those
30 who may have too limited time to visit all items at the exhibit; to provide the information that those who
31 have recommended a specific work also recommended what else. With these blog, comment, and
32 recommendation functions, a visitor in an art exhibit will enjoy more interactivities with the authors and
33 other visitors.

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35 Moreover, the proposed system also has a real-time call out function which provides more useful
36 information regarding who are on site, who made what comments, and who recommended what items.
37 Meanwhile, if other visitors who just recommended the same item (have the same taste), the system will
38 immediately notify this visitor with a message “some visitors who also recommended this item few minutes
39 ago, would you like to talk to them?” If this visitor agrees, then the system can notify them promptly. In
40 sum, the proposed guiding system has advanced the existent counterparts in many aspects including making
41 comments or recommendations, real-time interactions among visitors, and on-line sharing mechanism.

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43 The system architecture is depicted in Fig. 2. In this architecture, the user handheld equipment is an
44 intelligent mobile device equipped with a RFID reader, which reads RFID tags associated with the works
45 and connects to Internet via wireless communication. Mobile device, access to the website via wireless
46 connection, provides information of exhibited items, commentary messages, and recommendations. In
47 addition, the mobile device also connects to a blog system serving as the communication among visitors and
48 authors. Each function is further described as follows:
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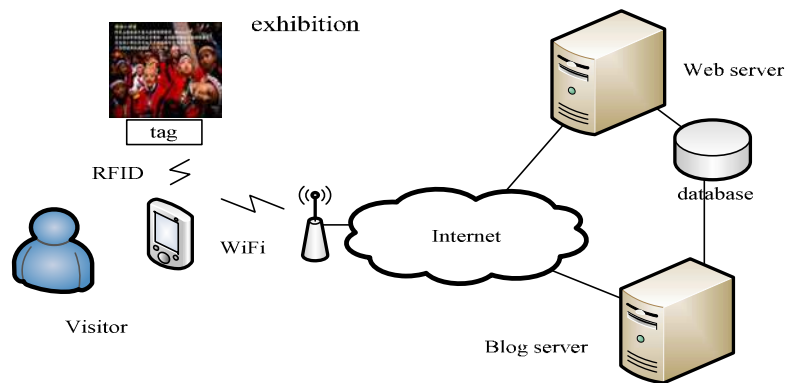


Fig. 2 system architecture

A. Intelligent mobile device unit

The hardware is similar to the pull-type tour guide (Lin et al., 2009) which consists of mobile device with wireless communication and RFID reader. In addition to basic and advanced contents and blog, it also provides the users with functions for commenting and recommending.

B. Web server unit

Web server allows the visitors to connect via Internet, to get basic and advanced contents associated with the ID, and to display on the screen of mobile device. This function is similar to the pull-type tour guide (Lin et al., 2009). If the users wish to make comments or recommendations, this unit can provide the corresponding functions and save the results in the database.

C. Database unit

This unit stores basic and advanced information of exhibited items, users' comments, text messages, and opinions feedback.

System Implementation

The proposed guiding system consists of programs at both local (client) and server ends. Programs at the client end, developed with Visual Studio 2005 C# programming language, is a set of standard windows mobile applications run on a PDA (Fig. 3). The major objectives include reading the RFID tags and taking these tags as references to further read information on the server side and to access the related services. When the system is in active mode, upon reading a RFID tag the PDA will send the tag information to the server side via Internet. As such, a visitor can obtain detailed information about the items and other relevant services by way of web browser. The advantage of such configuration is that RFID subsystem is independent of the system in that not only the guiding system can be implemented by the approaches mentioned above, but it can also be implemented by either combined QR code and smart phone or NFC with smart phone. No matter which approach being adopted, there is no need to make any modification on the server side.

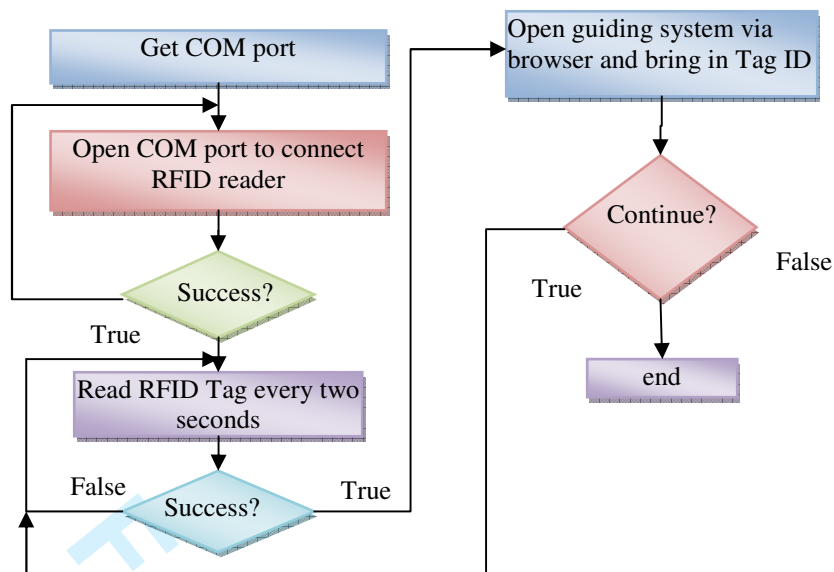


Fig 3. Program flow chart at the client end

In order to achieve the best application and future expansion, the proposed guiding system at the server end is constructed by web-based approach. The implementation at the server end adopts Apache server as the web server, MySQL as the database, and PHP as the programming language. Therefore, the guiding system allows the visitors not only to browse the contents of exhibited items, but also to make comments/recommendations or to input text messages on the items. These functions are user-oriented in such a manner that when visitors make comments or recommendations, the information will be logged onto the database. As such, it can prevent a visitor from making comment or recommendation on the same item more than once. In addition, it can also be used to identify who is on site at that moment. The modules at the web server end are depicted as follows:

A. main page

Main page is used to hand over parameters on URL to other pages. There are three frames on the main page: guide functions, who is on site, and user login.

B. user login module

It allows the user to login into the system. Prior to login, a user can only access to the language module—Chinese or English. This module will write and clear sessions and identify the user as a visitor or an administrator (in the subsequent experiment test, the authors are entitled to act as an administrator). After successful login, all functions become available, but the administrator will have an additional management module, which can revise the contents of the works and modify the wordings for the six predefined comments.

C. basic

When a visitor is interested in a specific work and coming close to it, a highlighted description of that work will promptly be displayed on the PDA screen upon the RFID reader sensing the RFID tag of that work. Of course, the basic description text is provided by the author in advance to let the visitor understand the rationales behind the creation.

D. Advanced

If a visitor wishes to learn more of the advanced information about a specific work, he/she can get it through by using this module. For example, the exhibition demonstrated in this paper was about “tissue tear paint,” an advanced description regarding skills, techniques and etymologies of this art can be found here.

E. comment

This module allows the visitors to comment on any specific works during visiting. To facilitate the visitors to make a choice, a total of six predefined comments are provided, from which any visitor can select

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2 one option for each work at most once. Upon a comment being submitted, the system will update the
3 database with user ID and time stamp. The statistical results shown in bar chart format will help the visitors
4 to grasp an overall picture about that work. Of course, the number and the wordings of predefined
5 comments can easily be modified by the administrators.
6

7 *F. Recommendation*

8 Similar to *comment* function, this module allows the visitors to make recommendation at most once for
9 each work. Upon recommendation, the system will update database with user ID and time stamp.
10 Recommendation will serve as reference for two modules: *ranking* and *who is on site*.

11 *G. Feedback*

12 This module allows the visitors to comment on the items with written-text messages, which are shown
13 in public—not only the author but also the other visitors can view them with the handheld devices. Rather
14 than the simple selection approach used in *comment* module, this module provides the visitors with
15 opportunities to express their comments or suggestions freely by inputting the written texts of their own.
16 Discussion board and blog can be the candidates to construct this module; this paper adopts a simplified
17 blog.
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19 *H. Ranking*

20 This module allows the visitors to view a list of top ranking works (say, top 10). The number of top
21 ranking is adjustable with the setting module. It provides additional services to those who may have too
22 limited time to visit all items but they wish to see the most popular works been recommended by previous
23 visitors so far.
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25 *I. Who is onsite*

26 This module informs a visitor about whoever have the same taste (i.e., also recommended the same
27 work) are still on site. As such, if this visitor wishes to invite them to exchange ideas about that work,
28 he/she can use this module to send a message, and these recommended visitors will receive the message
29 immediately. If they accept the invitation, they can come to that person (assuming he/she is still in front of
30 that work waiting for the responses); otherwise, they just ignore this message. This module updates every 60
31 seconds, it not only displays the number of visitors recommending the same work but also shows the time
32 duration since they made recommendations.
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36 **System Experiment**

37 To test the functionalities of the proposed guiding system, a field experiment was demonstrated at an
38 art gallery in Taiwan. The exhibition period lasted from May through July 2010, during which the “Tissue
39 Tear Paint” artworks created by nine authors were jointly exhibited. The principal author, Yijun Lu, is
40 currently a teacher at Green Lake Elementary School in Hsinchu County. She has been teaching arts and
41 crafts at school for years, and has been instructing the community residents about the tissue tear paint after
42 school. The principal author together with her students has jointly exhibited their works several times at
43 different cultural centers in Taiwan.
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45 Tissue tear paint is a way of painting by tearing and pressing the papers (Fig. 4). Skilled artists can
46 create Yunlong paper which has long fiber, Danji paper which is as thin as cicada’s wings, and Ho paper
47 which has elegant textures. These papers have different textures and colors. The use of tear and pinch sway,
48 instead of pen, can draw out a variety of artworks, such as sky and white clouds, roadside new-born flowers,
49 sunset dusk, and sunrise dawn. The performance of tissue tear paint is so close to the reality that it can well
50 present the effects of natural biological realism. However, tissue tear paint is not as popular as other kinds of
51 arts (e.g., oil paint) in Taiwan. Many visitors may have no ideas at all about this art; therefore, it was
52 thought as a suitable candidate for testing the functionalities of the proposed guiding system.
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Fig. 4 An example of tissue tear paint

Four sets of handheld devices—PDAs were available in this experiment. Each visitor may borrow a PDA (Fig. 5) from the counter. To collect the user opinions after using this guiding system, visitors and authors who checked out the PDAs were requested to fill up a questionnaire. A total of 54 questionnaires were returned (9 authors and 45 visitors), but only 50 (9 authors and 41 visitors) are valid for further analyses.

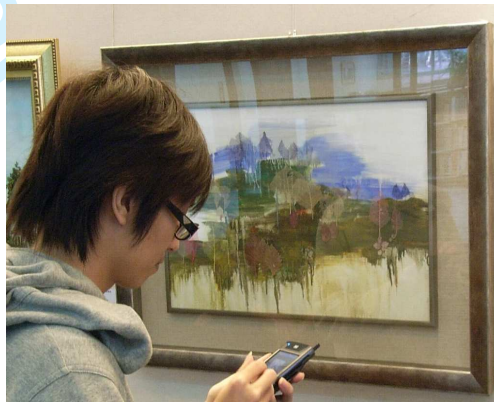
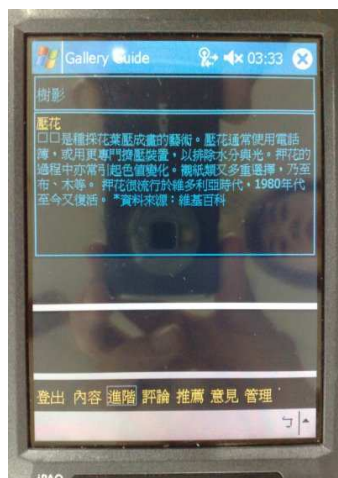


Fig 5. Functionality test experimented at an art gallery

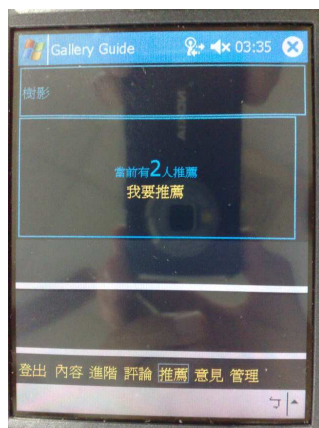
The actual clips of the PDA display are shown in Fig. 6, on which the characters can either be Chinese or English.



(a) Advanced



(b) Comment



(c) Recommendation



(d) Who is onsite

Fig. 6. The PDA displays

Results and Discussions

Table 1 presents the results of questionnaire survey from 41 visitors, in which a five-point scale (5: strongly agree; 4: agree, 3: neutral; 2: disagree; 1: strongly disagree) was used. The results showed that the majority of the visitors have never used this kind of service before. About 82% of the visitors (strongly agree plus agree) agreed that it is an interesting experience to give comments to exhibited works via PDAs. About 84% of the visitors liked the approach expressing their comments by the predefined options, implying that provision of convenient means to make comments is supported. About 78% of the visitors would like to know other's comments on the same works. The proposed system has provided such function to fulfill their expectation. About 84% of the visitors were willing to recommend their favorite works to others. Besides, they would pay more attention to the works been recommended by others. About 74% of the visitors wished to interact with people who have the same taste. Most visitors wish to learn of others' comments, but only a few had chances to learn so before, indicating the contribution of the proposed guiding system.

Table 1 The results of questionnaire survey from visitors

Content	5	4	3	2	1
a. Giving comments to the authors is a very interesting experience	0.18	0.64	0.18	0.00	0.00
b. I like to use the selection approach to express my views on the work	0.26	0.58	0.12	0.02	0.02
c. I like to know other visitors' views on the works at the exhibition site	0.18	0.60	0.18	0.02	0.02
d. I will not hesitate to recommend good works to other people	0.34	0.50	0.14	0.02	0.00
e. I will pay more attention to the works been recommended by other visitors	0.28	0.56	0.16	0.00	0.00
f. I did not know the visitors who had the same preference as me before	0.20	0.54	0.26	0.00	0.00
g. I like the opportunity to chat with the visitors who have the same taste as me	0.20	0.52	0.28	0.00	0.00

Note: 5: strongly agree; 4: agree, 3: neutral; 2: disagree; 1: strongly disagree

Table 2 presents the results of questionnaire survey from all of the nine authors. About 55% of them rarely had opportunities to interact with the visitors before; they rarely had opportunities to express their creative process to the visitors but they would like to do so. About 78% of the authors agreed that the

proposed guiding system is of great help in displaying their works. They were eager to know the visitors' feedback on their works and happy to learn of their works being recommended, but only 55% of them agreed that the visitors' feedback can stimulate their future creativities.

Table 2 The results of questionnaire survey from authors

Content	5	4	3	2	1
a. I rarely had the opportunity to interact with visitors at previous exhibitions	0.11	0.44	0.22	0.22	0.00
b. I like to share the creative ideas of each work with the visitors	0.22	0.33	0.44	0.00	0.00
c. I rarely had the opportunity to express my creative process to the visitors	0.11	0.44	0.33	0.11	0.00
d. The guiding system provides great help for displaying my work	0.22	0.56	0.22	0.00	0.00
e. I am eager to know the evaluation of my works made by visitors.	0.33	0.44	0.22	0.00	0.00
f. I am very happy to know that my works have been recommended	0.33	0.44	0.22	0.00	0.00
g. Knowing the evaluation from the visitors can help my future creation	0.22	0.33	0.44	0.00	0.00

Note: 5: strongly agree; 4: agree, 3: neutral; 2: disagree; 1: strongly disagree

Conclusions and Future Research

The functionalities of the proposed guiding system has been successfully verified and validated via a demonstration experiment at an art gallery in Taiwan proving that all system features were valid. The majority of authors and visitors, after using the system, have agreed this guiding system convenient, interesting and helpful. Compared with conventional push-type guide systems or early version of pull-type systems, the proposed system not only can avoid overloading the information onto the client end but also possess more interactivities between authors and visitors or among visitors. Moreover, it allows a visitor to give recommendation and comment to a specific work, in particular, to invite unacquainted visitors still on site who recommended the same work in a way that they may meet together and further exchange the views with each other.

In the future study, conducting a larger-scale test and users' satisfaction survey at different exhibit occasions with the proposed guiding system is suggested. The PDAs and CF-type interface may soon become obsolete and will be replaced by the smart phones. It is almost inevitable to integrate the smart phones, instead of PDAs, with RFID readers using Bluetooth or other innovative WSNs, thus the proposed guiding system should be further modified with such configurations in the near future.

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