International Journal of the Physical Sciences Vol. 7(1), pp. 121 - 131, 2 January, 2012
Available online at http://www.academicjournals.org/IJPS
DOI: 10.5897/IJPS11.1420
ISSN 1992-1950 ©2012 Academic Journals

Full Length Research Paper

Using mobile geographic information system (GIS) techniques to develop a location-based tour guiding system based on user evaluations

Tzu-How Chu[1], Meng-Lung Lin[2], Chia-Hao Chang[3] and Cheng-Wu Chen[4,5]*

[1]Department of Geography and Spatial Information Research Center, National Taiwan University, Taipei City 10617, Taiwan, Republic of China.
[2]Department of Tourism, Aletheia University, Tamsui, New Taipei City, 25103, Taiwan, Republic of China.
[3]Spatial Information Research Center, National Taiwan University, Taipei City 10617, Taiwan, Republic of China.
[4]Institute of Maritime Information and Technology, National Kaohsiung Marine University, Kaohsiung City 80543, Taiwan, Republic of China.
[5]Global Earth Observation and Data Analysis Center, National Cheng Kung University, Tainan, Taiwan 701 R.O.C.

Accepted 15 December, 2011

This study developed a mobile tour guiding system which uses mobile geographic information system (GIS) techniques to provide spatial and guiding information based on user evaluation. The system comprises four main functions, a graphic function, a global positioning system (GPS) function, a route function and a query function. A user evaluation of the system allows the voicing of different opinions and user perceptions about the system. The user evaluation is carried out by asking participants to complete importance-satisfaction questionnaires after using the system. The results of the evaluation provide valuable data to improve the system to meet user demands. It was also found that most participants would recommend the system to friends and agreed that using the system improved their level of satisfaction. Most users also agreed that the system can help the administration to protect the valuable landscape for which the park is famous. Therefore, the mobile tour guiding system is currently being used for guiding services and continues to be improved according to the user evaluations.

Key words: Location-based services, geographic information system, global positioning system, tour guiding system, importance-performance analysis.

INTRODUCTION

Traditional guiding solutions include fixed interpretative signs, multi-media presentations in audio-visual rooms and group guided tours with a knowledgeable guide/ docent. It is now, however, possible to take advantage of mobile geographic information system (GIS) and global positioning system (GPS) techniques to improve the guiding process and offer visual and graphic representation of multi-media information to the user (Cheverst et al., 2000; Zipf, 2002; Frank et al., 2004; Kabassi, 2010). GIS and GPS techniques have already been used to investigate the space-time behavior of individuals in society (Quiroga and Bullock, 1998; Ahas and Mark, 2005; Shoval and Isaacson, 2007; Lin et al., 2009, 2010). GIS can provide comprehensive access to a spatial database, query features, create themes and layouts, and offer reports (Chen, 2007; Ashraf et al., 2011; Lin and Chen, 2011; Lin et al., 2011; Solaimani, 2011). Therefore, mobile GIS, accessed with smart phones and personal digital assistants (PDAs) could make it easier for visitors to find their way around scenic spots at tourist destinations.

In recent years, the rapid increase in the development of GIS technologies has led to the development of a number of integrated GPS/GIS applications, which can be taken advantage of by the tourism industry (Jung et al., 2006; Duncan and Mummery, 2007; Devlin et al., 2008; Duncan et al., 2009). Shoval and Isaacson (2007) for example, have already applied GPS methods to collect

*Corresponding author. E-mail: chengwu@webmail.nkmu.edu.tw.

data on the spatial and temporal activities of tourists.

There has also been rapid technological development of mobile map applications beginning in the mid-1990s (Sarjakoski and Sarjakoski, 2007). With the appearance of mobile computing devices and cheap location sensing systems, location information has become an important resource for both mobile and desktop users (Leonhardt et al., 1996). Mobile GIS is already being applied for the development of location-based services (LBS), where knowledge of the location of an individual is used to personalize the service (Ardagna et al., 2009; Brida et al., 2011). The technological advances that have produced hand-held mobile devices, such as smart phones, PDAs and GPS units have made the development of LBS guiding information services possible. For example, one can look at the successful implementation of the WebPark project (October 2001 to September 2004) which provides information to visitors in natural areas. The platform for this system was developed from a combination of smart phones and GPS (WebPark, 2010).

This work presents a prototype of a mobile tour guiding system which integrates mobile GIS and GPS technologies. The system uses a mobile GIS platform. Its main purpose is to offer tourists timely spatial guiding information for scenic points-of-interest amid natural and cultural landscapes. The tour guiding system offers navigation functions, interpretative information, digital maps and optional guided route selections for tourists. In addition, user assessment and evaluation of the interface is carried out, and the main system functions of the developed mobile tour guiding system described.

MOBILE GUIDES

The largest group of recent LBS applications has been the development of technology for use as mobile guides (Raper et al., 2007). For example, the GUIDE system, which combines mobile technologies with a wireless infrastructure, that was developed to meet the information and navigation needs of city visitors in Lancaster, in the United Kingdom (Cheverst et al., 2000). Tablet PCs are the end-system for use in the GUIDE system. The disadvantage is that they are large and heavy (213 × 153 × 15 mm, weighs 850 g) making them inconvenient for tourists to use. GPS is not used in this system because it is not always possible to receive signals from three satellites at once. The European Union's (EU) Creation of User-friendly Mobile Services Personalized for Tourism (CRUMPET) project is designed to provide a new delivery service for mobile tourism services, utilizing location-based and personalized information (Hwang et al., 2007).

In 2004, a personalized LBS system was implemented using ESRI's ArcPad, for the city of Münster, Germany (Rinner and Raubal, 2004). This system allows users to pinpoint his/her current position on a city street map without receiving real-time GPS signals. From the determined position, all hotels within a fixed distance (500 m) around this position are selected and highlighted.

The EU has also funded the GiMoDig project (Geospatial info-mobility service by real-time data-integration and generalization), designed to improve the accessibility and interoperability of national topographic databases for mobile devices (Sarjakoski and Sarjakoski, 2007). The GiMoDig project has shown that, for real-time generalization in mobile applications, timely and focused information, customized according to context parameters, user preferences and location is required.

A novel gaze-based guidance system, combined with a 3D photo-logging system, has been developed for tourists to download pictures from an experimental website using a mobile phone (Kadobayashi, 2007). The advantage of this system is that users are able to access guiding information by pointing and clicking their mobile phones. The disadvantage is the need to establish a large collection of photos of scenic spots.

One successful guiding information system has been developed by the WebPark project (Dias et al., 2004). The advantages of this system are that it is web-based, and runs on a smart phone or PDA via wireless internet. The system enables users to request information from databases and then filters the information based on location, time and user profile (WebPark, 2010). Moreover, the system can also operate offline with cached data when an internet connection is unavailable.

The integration of GPS and GIS techniques, including those for navigation, tracking, guiding, gaming, health monitoring and social networking, make it possible to allow maps and information related to a person's current location to be accessed by mobile devices (Raper, 2009). For example, a prototype system, OspreyNav, has been developed to evaluate the theoretical framework of mobile GIS with a Bluetooth enabled GPS (Frank et al., 2004). OspreyNav was tested on the University of Maine Campus. Users could easily determine their location on the map, while moving, the automated selection feature gave feedback on any upcoming objects. Another mobile guide system, designed to support the use of public transport was developed in Melbourne, Australia (Kjeldskov et al., 2005). This system provides route-planning facilities based on the user's current location in a combination of textual instructions and annotated maps.

TOUR GUIDING SYSTEM SCHEME USING MOBILE GIS TECHNIQUES

Main concepts of the tour guiding system

The LBS applications are divided into four main areas: (1) information and navigation services; (2) emergency assistance; (3) tracking services; (4) network related services (Sadoun and Al-Bayari, 2007). The tour guiding system is designed to incorporate these four main LBS applications into a system for the Yehliu GeoPark.

To remedy the lack of real-time tour guiding systems, GIS techniques are applied along with GPS functions to develop a location-based mobile tour guiding system that must be able to represent and offer interpretive information about scenic spots. Both vector and raster data models are used in the location-based tour guiding system to give a complete presentation of location information.

The techniques mentioned earlier are used to develop an LBS mobile tour guiding system for the Yehliu GeoPark. The system uses GIS to integrate electronic and standardized narrative information, GPS positioning, an automatic-narrative function and topical tour routes to provide a mobile guiding service. This service can be accessed using a PDA or smart phone. The system relies on a GIS database and GPS signals to provide attribute, spatial and temporal data to the tourist. All the narrative information, such as spot type, video, audio, pictures and text, are stored in attribute tables. The guiding information (attributes, spatial and temporal data for time and location) changes as the user moves around the park. GPS signals provide real-time continuous location information. It is noted that the set of tourist spots is limited to prevent constant positioning updates. The current location of the moving user is constantly changing, but receives new information only when entering or leaving one of these spots.

The touch-screen interface has become a popular feature of smart phones and PDAs. Thus, the system is designed so that the touch-screen interface can be used to manipulate the functions of the tour guiding system. The information can be displayed on the screen of the mobile device. Mobile GIS techniques are used to integrate the map database and multi-media interpretative information spatially. The location/area of interest changes continuously, and the associated attributes, and spatial and temporal information for each of the interpretative stops (scenic spots) is updated, according to the current location and time of the moving tourist.

System configuration

The SuperGIS Mobile Engine 3.0 software is used to develop the tour guiding system for spatial data display, querying, manipulation and analysis (Chu et al., 2011). The developed system provides a spatial guiding information approach for querying, navigation, route selection, as well as warnings of dangerous areas and route deviations. The system operates in the environment of Windows Mobile 6. The user can download the system to their personal smart phone provided it has a GPS function (built-in GPS module, CF/SD card GPS receiver and blue-tooth GPS receiver). The GPS signals are used to make an electronic compass which directs the user to the “scenic spots” or “points-of-interest” entered into the tour guiding system. The initial system includes the following four functions (Figure 1):

1. Graphic function: runs on the user’s hand-held mobile device and provides the user with a graphic interface to the tour guiding system;
2. GPS function: receives GPS signals and obtains the tourist’s real-time position;
3. Route function provides four guided routes (60, 60 to 90, 90 to 180 min tour, and half day tour) to choose from;
4. Query function: accepts a query and returns scenic spot information in different formats (pictures, text, audio and video) based on the results of the query.

METHODOLOGY

User evaluation

This user evaluation is based on questionnaires designed to obtain explicit opinions about the different functions of the system. Specifically, an importance-satisfaction questionnaire form is adopted, to be filled in by respondents after using the system. The necessity for the two parts arises from our interest in measuring the degree to which the system has fulfilled the initial expectations of each user (Díaz et al., 2008). Importance-Performance analysis (IPA) was used to identify the importance of various items related to user expectations of the system and to determine user satisfaction with these items (Hollenhorst et al., 1992; Lee and Lee, 2009; Wu and Shieh, 2009). A paired sample t-test was conducted to examine the differences in each of the items. The various constructs were measured using scales validated in prior research. The various items were evaluated on the 6-point Likert agreement scale. The list of measurement items was generated from a review of the user evaluation literature (Spink, 2002; Díaz et al., 2008; Nam et al., 2009; Peleg et al., 2009).

The questions in the questionnaires are grouped under the following headings: interface, user evaluation, main system function and comparison with traditional guiding services. The questionnaires are comprised mostly of closed questions, with answers that are indicated by means of a six level ranking (extremely high, very high, high, low, very low and extremely low).

Sample, data collection and design

All data were collected over a period of one month. 36 respondents who had used the system filled both in the importance and the satisfaction evaluations. 43.2% of these users were tourists, 29.7% were commentators (providing interpretative services at the Yehliu GeoPark), 18.9% were park staff and 8.1% were park managers. This group was judged heterogeneous enough to allow the extraction of significant conclusions on behavior.

Study area

The Yehliu GeoPark is located on a cape along the north coast of Taiwan (Figure 2). The total area of the GeoPark is 457 ha, including 53 ha of land and 404 ha of water. The Yehliu GeoPark is most famous for its unusually shaped sandstone formations, especially one said to look like a queen’s head. Conservation of the sandstone landscape in the GeoPark has recently become an

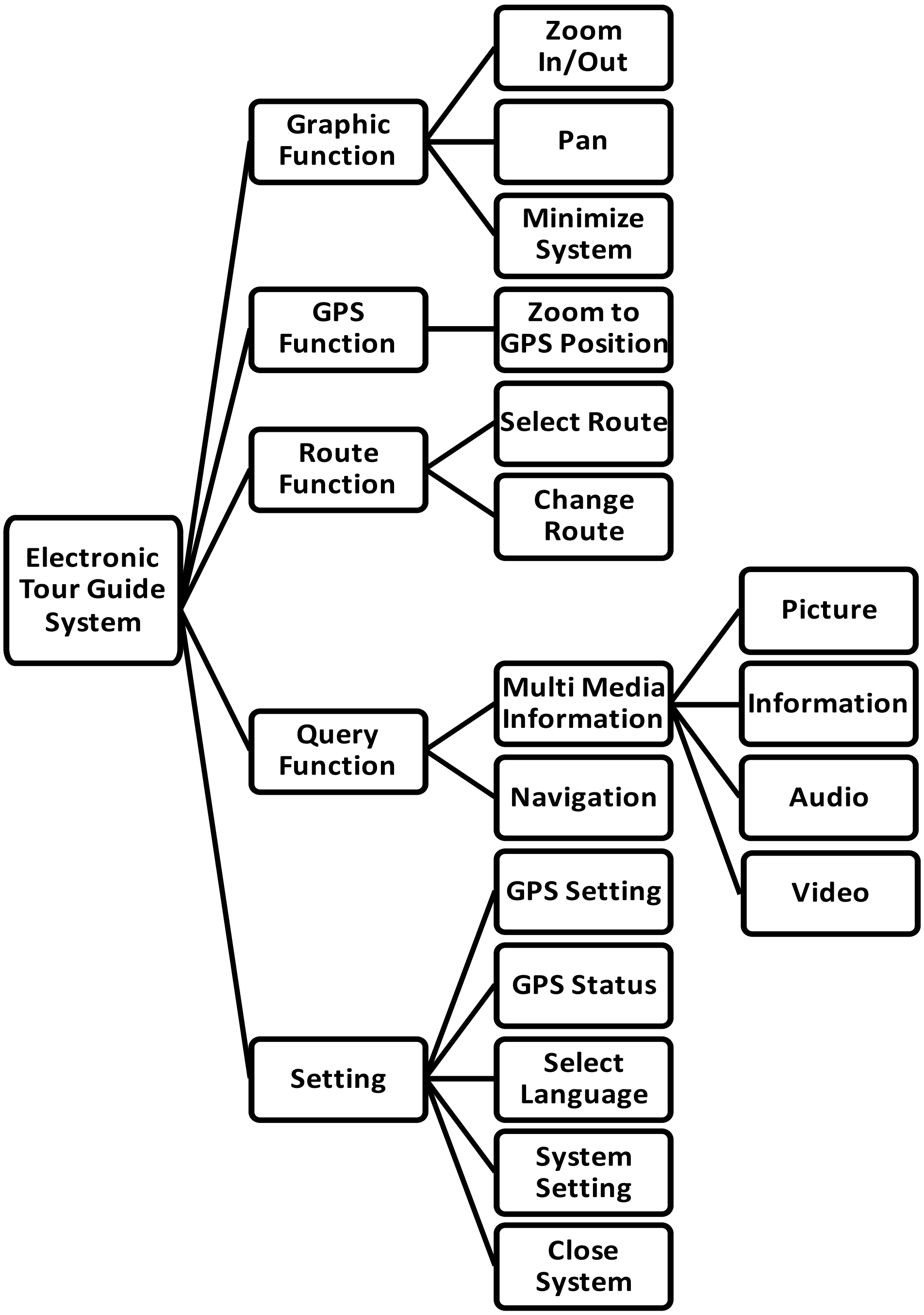

Figure 1. Schematic representation of the functions of the location-based mobile tour guiding system.

important issue. For example, the administration of the GeoPark had to focus on the protection of the queen's head sandstone, applying chemical agents to slow down the rate of weathering. The GeoPark management policy is to carry out minimal construction to protect the vulnerable landscape located in the GeoPark.

RESULTS

In this study, we attempt to incorporate the information technologies of mobile GIS to offer spatial and guiding information related to scenic areas of interest to the moving tourists.

This should help such individuals acquire accurate knowledge about the scenic spot and hopefully prevent inappropriate behaviors that could damage the sensitive formations, such as touching of the thin neck of the queen's-head, or damaging the ginger-shaped and candle-shaped sandstone formations in the GeoPark.

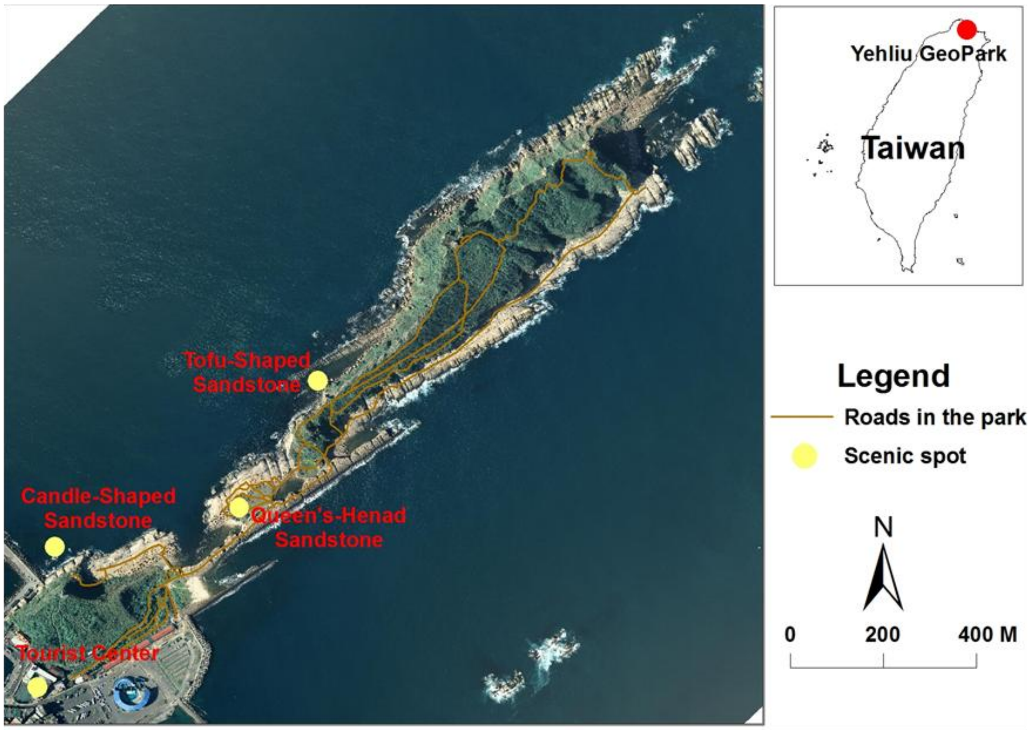

Figure 2. Map of the Yehliu GeoPark.

User evaluation

Here, we present an evaluation of the system, focusing on the quality of the user's experience when using it. Information related to the interface evaluation can be seen in Table 1. In the importance evaluation, the users considered ease-of-use to be most important, followed by friendliness and attractiveness. The results confirm that the focus of system interface design should be on making it easy to use. In the satisfaction evaluation, it was found that users also preferred ease-of-use, followed by friendliness and attractiveness. However, there was a decrease observed for all these items in the interface evaluation. The results of paired sample t-tests indicate that for the items of attractiveness, ease-of-use and friendliness, the importance mean was significantly higher than the satisfaction mean.

The user evaluation (Table 2) shows that the importance items were positive enough. Similar trends were repeated for the four evaluation items, with a significant decrease in the scores for users' opinions about the information quality, information richness, performance response time and smart phone installation. However, a slight decrease was also apparent in the score for providing hand-held mobile devices. It can be concluded from this that the number of hand-held mobile devices was sufficient for use in the park. However, it was shown that the performance response time in the process of selecting attribute information should be improved to preserve the interest of the mobile GIS user (Shi et al., 2009). The results of the usability study show that most users (80.6%) consider performance response time to be important, but only 55.6% of the users expressed satisfaction with this aspect. The process of selecting attribute information should be improved for this item as soon as possible.

With respect to the results for the main system functions (Table 3), it can be concluded that most users consider the main system functions to be important. However, the importance evaluation results showed that users felt the provision of four routes to select from to be less important than other items. Since users consider other items to be more important, the system should focus on these other functions. Slightly lower results are given for item 10, but most results were still positive. The trends for the three evaluation items were similar, with a significant decrease in the scores for items 9, 10 and 12. This suggests that these items need to be improved to increase user satisfaction.

Overall, it is important to note that high importance scores are observed for ease-of-use, friendliness, maps, context, audio and video, and scenic spot location information (Tables 1, 2 and 3). Therefore, paired sample t-testing was carried out to analyze the differences between the importance and satisfaction items. The results for the items of attractiveness, ease-of-use, friendliness, richness of information, time spent, smart phone installation, maps, context, audio and video, scenic spot location information, warning function and providing guiding boards show the importance mean to be

Table 1. Percentage of users and average for each reply to questions about the interface evaluation (N = 36).

Question	Importance							Satisfaction							Paired *t*-tests
	Extremely high	Very high	High	Low	Very low	Extremely low	Average	Extremely high	Very high	High	Low	Very low	Extremely low	Average	*t*-value
(1) Attractiveness	13.9	36.1	41.7	5.6	0.0	2.8	4.50	2.8	11.1	44.4	33.3	0.0	8.3	3.58	3.71*
(2) Ease-of-use	36.1	22.2	41.7	0.0	0.0	0.0	4.94	0.0	11.1	58.3	27.8	2.8	0.0	3.78	5.58*
(3) Friendliness	36.1	27.8	22.2	13.9	0.0	0.0	4.86	2.8	8.3	47.2	38.9	2.8	0.0	3.69	5.39*

*P < 0.05.

Table 2. Percentage of users and average for each reply to questions about the user evaluation (N = 36).

Question	Importance							Satisfaction							Paired *t*-tests
	Extremely high	Very high	*high*	Low	Very low	Extremely low	Average	Extremely high	Very high	High	Low	Very low	Extremely low	Average	*t*-value
(4) Information quality	11.1	41.7	36.1	11.1	0.0	0.0	4.53	5.6	16.7	50.0	22.2	2.8	2.8	3.92	2.94
(5) Information richness	13.9	50.0	27.8	8.3	0.0	0.0	4.69	8.3	16.7	50.0	19.4	2.8	2.8	4.00	3.31*
(6) Performance response time	25.0	27.8	27.8	19.4	0.0	0.0	4.58	2.8	5.6	47.2	30.6	8.3	5.6	3.47	4.17*
(7) Providing hand-held mobile devices	11.1	11.1	63.9	13.9	0.0	0.0	4.19	8.3	19.4	52.8	19.4	0.0	0.0	4.17	0.20
(8) Smart phone installation	22.2	22.2	41.7	13.9	0.0	0.0	4.53	2.8	13.9	52.8	19.4	5.6	5.6	3.72	3.43*

*P < 0.05.

Table 3. Percentage of users and average for each reply to questions about the main system functions (N = 36).

Question	Importance							Satisfaction							Paired *t*-tests
	Extremely high	Very high	High	Low	Very low	Extremely low	Average	Extremely high	Very High	High	Low	Very low	Extremely low	Average	*t*-value
(9) Maps, context, audio and video	22.2	36.1	38.9	2.8	0.0	0.0	4.78	11.1	16.7	44.4	25.0	0.0	2.8	4.06	3.39*
(10) Location information for scenic point-of-interest	30.6	30.6	33.3	5.6	0.0	0.0	4.86	5.6	11.1	38.9	27.8	16.7	0.0	3.61	5.07*
(11) Guided routes	16.7	16.7	47.2	16.7	2.8	0.0	4.28	8.3	16.7	55.6	19.4	0.0	0.0	4.14	0.82
(12) Warning function	16.7	52.8	22.2	8.3	0.0	0.0	4.78	2.8	19.4	41.7	25.0	5.6	5.6	3.72	4.55*

*P < 0.05.

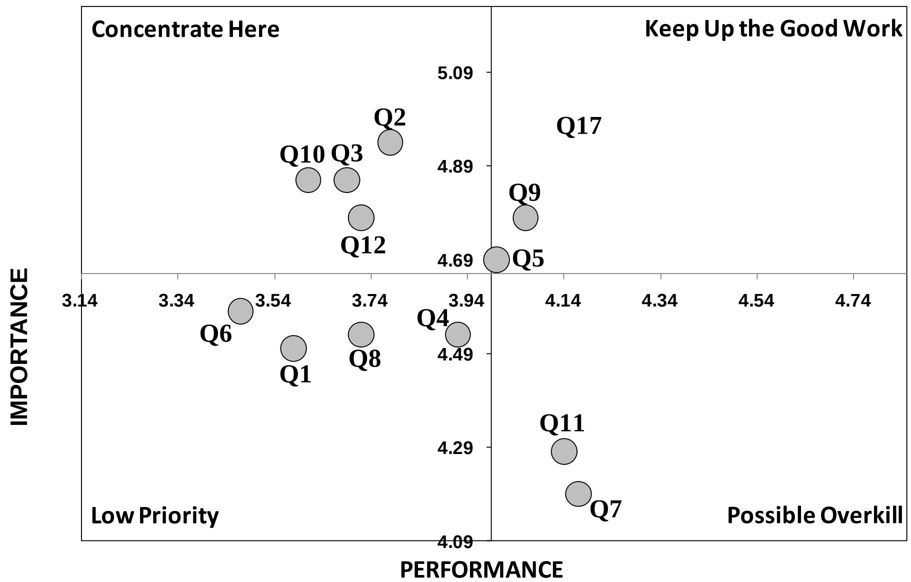

Figure 3. Importance-performance matrix of user evaluations.

significantly higher than the satisfaction mean (Tables 1, 2 and 3). In contrast, for the items of information quality, providing hand-held mobile devices, guiding routes, providing hand-held mobile guiding service, providing guiding services by commentators, providing guiding information and providing guide books differences between importance and satisfaction are insignificant.

These results are due mostly to the fact that users care about the practicality and information provided, but are less satisfied with all items. Thus, although the cumulative percentages of high, very high and extremely high are over 55% for all, satisfaction items, the quality of the guiding system still has to be improved.

Importance-satisfaction evaluation

The IPA method was applied to this set of users in order to acquire more meaningful results. Figure 3 shows the relationship between 12 items in an IPA matrix. Specifically, note items 5, 9 and 17, located in quadrant I, meaning "Keep up the Good Work", whereas items 7 and 11, situated in quadrant IV, indicate "Possible Overkill". In quadrant III, items 1, 4, 6 and 8 belong to "Low Priority", while items 2, 3, 10 and 12 in quadrant II belong to "Concentrate Here", which indicates aspects that need to be improved. The IPA method clearly helps locate items in the four quadrants. The results should help us to improve user evaluated system shortages.

Querying functions and multi-media guiding methods

The advantage of the developed system is that it uses multi-media methods to provide educational information that will enrich the visitor's understanding and prevent the destruction of the landscape by the tourist. Maps are basic tools used to present information regarding the spatial location of points-of-interest. The tourist can use the querying function to select the scenic spot of interest spatially (Figure 4). The screen shows the four types of multi-media guiding methods (pictures, audio, information and video) for him to choose from. They use the arrow to click on the selected scenic spot on the screen of the tour guiding system, then click on the tab for pictures, audio, information or video to access detailed interpretative contents about the selected spot.

Navigation and guiding information using GPS techniques

Individual users are in actuality objects moving in space and time. The GPS receiver accurately positions a specific individual using satellite signals. The GPS signals furnish the tourist using the system with spatial and temporal location information. The location information, obtained from the GPS signals, is displayed on a map. Guiding information is spatial, with specific coordinates, which lends itself to be displayed on a map.

With respect to the navigation and guiding information (Table 4), users (over 60%) consider that the information (maps, instant positioning and guiding information) provided from the system most fit the tourist's needs. The interpretative information delivers an educational message to users of the system. Most respondents (over 80%) considered the information provided helpful to appreciate the valuable landscape in the Yehliu GeoPark and its conservation concepts. More and more tourism activities are being planned at many scenic spots to allow

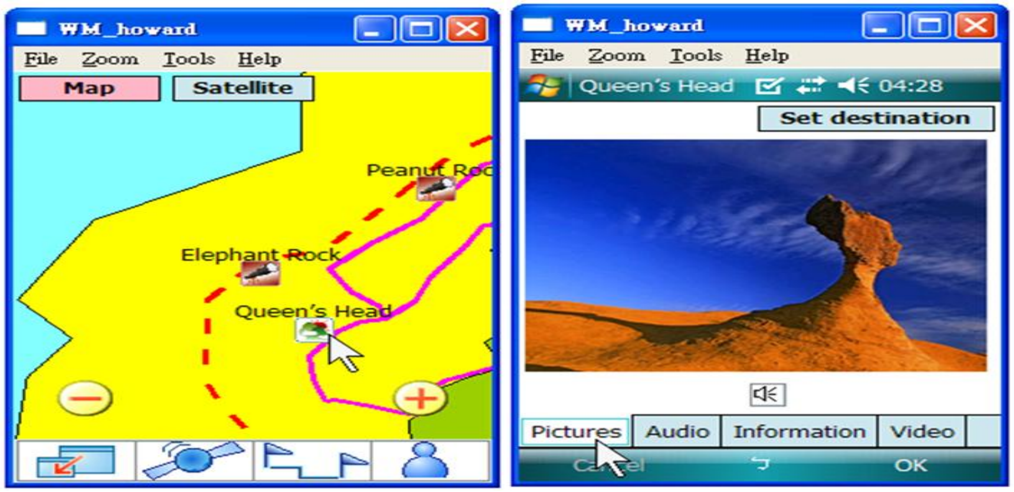

Figure 4. Querying functions for scenic spots.

Table 4. Percentage of users and average for each reply to questions about the navigation and guiding information (N = 36).

Question	Agreement						
	Extremely high	Very high	High	Low	Very low	Extremely low	Average
(13) Providing maps, instant locations and guiding information to meet tourist needs at Yehliu GeoPark	2.8	19.4	38.9	30.6	8.3	0.0	3.78
(14) Recognizing valuable landscapes and conservation concepts for Yehliu GeoPark	5.6	25.0	52.8	11.1	2.8	2.8	4.11
(15) System can reduce the tourist demand for commentators	5.6	16.7	50.0	19.4	8.3	0.0	3.92
(16) System can help the administration of Yehliu GeoPark to protect the valuable points of interest located in the park landscape	0.0	8.3	63.9	25.0	2.8	0.0	3.78

visitors to enjoy and appreciate valuable natural and cultural resources, including natural and cultural heritage sites, protected natural areas and unusual geographic formations. The results demonstrate that the information provided helps tourists to better understand the meaning and value of the natural and cultural points-of-interest in the GeoPark. This also reduces temptation to touch and damage the surface of the sandstone formations thereby reducing weathering rates in the valuable and unusual geological landscape. The guiding system developed for the Yehliu GeoPark has similar advantages to environmental education and park information as provided by the WebPark guiding system (WebPark, 2010). GIS and GPS techniques are integrated using personalized mobile devices to provide location-based guiding information which helps to improve

Table 5. Percentage of users and average for each reply to a question about the guiding route selections (N = 36).

Question	Agreement						
	Extremely high	Very high	High	Low	Very low	Extremely low	Average
(17) Four guided tours provided (60 minutes, 60 to 90 minutes, 90 to 180 minutes and half day) for tourists to select from in order to most effectively match the travel time	2.8	25.0	47.2	19.4	5.6	0.0	4.00

Table 6. Percentage of users and average for each reply to a question about the warning function (N=36).

Question	Agreement						
	Extremely high	Very high	High	Low	Very low	Extremely low	Average
(18) Provide an audible warning to help tourists to feel safer when the system is approaching warning lines	13.9	19.4	41.7	19.4	5.6	0.0	4.17

landscape conservation and environmental education.

72.3% of users consider the system to have the ability to reduce demand for human commentators. This positive evaluation indicates that developing a mobile tour guiding system is a valid approach for providing information without consuming huge amounts of human resources to establish a well-organized commentator team. Most users also agree that the system can help the administration of Yehliu GeoPark to protect the valuable landscape of the park.

Guiding route selection for tourists

The combination of GPS and GIS provides spatial information for route choice decision-making processes. The system incorporates several interpretative routes of different lengths designed to meet tourist demands. There are four different guided tours (60, 60 to 90, 90 to 180 min tour, and half day tour). Users select a route according to their preferences and stay time in the park.

With respect to the guiding route selections (Table 5), most users (75%) agree that the provision of four different guided tours to select from can help them to spend their time in the park effectively. The results demonstrate that such preplanned guiding routes are needed for tourists.

Dangerous areas and route deviation warnings

Reminding travelers when they enter dangerous areas along the rocky coastline is an important way for the GeoPark administration to improve tourist safety.

The real-time location of visitors can be tracked using the GPS capacity of the tour guiding system. The system warns users when they approach within 3 m of the red warning boundary indicating dangerous areas.

Furthermore, after the tourist chooses a planned guiding route, the system tells the user whether they are on the right route or not. The system offers an immediate warning when they deviate from the scheduled route. The great majority of users agree that the system provides a safer experience (Table 6).

DISCUSSION

A mobile tour guiding system, taking advantage of mobile GIS technologies, was developed to meet tourist demand for guiding information and to improve landscape conservation, environmental education and scenic zone management at the Yehliu GeoPark. The system can also help park administrators to overcome the difficulties of protecting, conserving and effectively managing valuable points-of-interest. Detailed guiding information about scenic spots can be helpful to educate visitors and protect the valuable and unusual geological landscape of the Yehliu GeoPark. The GeoPark administrators can use the tour guiding system to minimize the need to expand human resources on commentators.

A usability study is conducted to obtain user evaluations of this developed system. The results show that most users are satisfied with the system although a few users are still dissatisfied with some items. Therefore, the results are plotted on an IPA matrix to provide useful information for us to improve the system.

Conclusion

In this study, mobile GIS techniques are utilized to develop a tour guiding system designed to provide LBS information to visitors at a popular tourist destination. It has low cost, since other guiding facilities are not needed. In the near future, everyone will have their own smart phones with GPS functions which would make the system available to most tourists. Finally, guiding information can be improved and modified by field surveys and environmental research funded by the Yehliu GeoPark. It is necessary to devise more useful functions for the system according to the user evaluations.

ACKNOWLEDGEMENTS

The authors would like to thank the National Science Council of the Republic of China, Taiwan, for financial support of this research under contract nos. NSC99-2410-H-156-020 and NSC98-2410-H-156-015. The authors are also most grateful for the kind assistance of Prof. Huisheng Peng and Prof. Sanjay Misra, editor of the journal, International Journal of the Physical Sciences, and the constructive suggestions of the anonymous reviewers, all of which has led to the making of several corrections and modifications that have greatly aided us in improving the presentation of this paper.

REFERENCES

Ahas R, Mark Ü (2005). Location based services--new challenges for planning and public administration? Fur., 37(6): 547-561.

Ardagna CA, Cremonini M, Gianini G (2009). Landscape-aware location-privacy protection in location-based services. J. Syst. Archit., 55(4): 243-254.

Ashraf S, Afshari H, Ebadi AG (2011). Application of GIS for determination of groundwater quality suitable in crops influenced by irrigation water in the Damghan region of Iran. Int. J. Phy. Sci., 6(4): 843-854.

Brida P, Machaj J, Benikovsky J (2011). A study on the accuracy of AGA positioning algorithm in multipath environment. Int. J. Phy. Sci., 6(14): 3409-3418.

Chen RJC (2007). Geographic information systems (GIS) applications in retail tourism and teaching curriculum. J. Retail. Consum. Serv., 14(4): 289-295.

Cheverst K, Davies N, Mitchell K, Friday A, Efstratiou C (2000). Developing a Context-Aware Electronic Tourist Guide: some issues and experiences. In: T. Turner, G. Szwillus, M. Czerwinski and F. Paterno (eds) Proceedings of the CHI2000: Conference on Human Factors in Computing Systems, New York, pp 17-24.

Chu TH, Lin ML, Chang CH, Chen CW (2011). Developing a Tour Guiding Information System for Tourism Service using Mobile GIS and GPS Techniques. Adv. Inform. Sci. Serv. Sci., 3(6): 49-58.

Díaz A, García A, Gervás P (2008). User-centred versus system-centred evaluation of a personalization system. Inform. Proces. Manage., 44(3): 1293-1307.

Devlin GJ, McDonnell K, Ward S (2008). Timber haulage routing in Ireland: an analysis using GIS and GPS. J. Transport Geogr., 16(1): 63-72.

Dias E, Rhin C, Haller R, Scholten H (2004). Adding value and improving processes using location-based services in protected areas. In: P. Prastacos and M. Murillo (eds) Research on computing science, Centre for Computing Research, IPN. Mexico City, pp 291-302.

Duncan MJ, Badland HM Mummery WK (2009). Applying GPS to enhance understanding of transport-related physical activity. J. Sci. Med. Sport, 12(5): 549-556.

Duncan MJ, Mummery WK (2007). GIS or GPS? A Comparison of Two Methods For Assessing Route Taken During Active Transport. Am. J. Prev. Med., 33(1): 51-53.

Frank C, Caduff D, Wuersch M (2004). From GIS to LBS, An Intelligent Mobile GIS. In: M. Raubal, A. Sliwinski and W. Kuhn (eds) Proceedings of GIS Days 2004, Münster: IfGI prints, pp 277-287.

Hollenhorst S, Olson D, Fortney R (1992). Use of importance-performance analysis to evaluate state park cabins: The case of the West Virginia state park system. J. Par. Rec. Admin., 10(1): 1-11.

Hwang H, Shin S, Kim C (2007). A User-Oriented GIS Search Service Using Ontology in Location-Based Services. In: M. S. Szczuka, T.-H. Kim, I.-S. Koet al (eds) Advances in Hybrid Information Technology: First International Conference, ICHIT 2006, Jeju Island, Korea, pp. 209-218.

Jung H, Lee K, Chun W (2006). Integration of GIS, GPS, and optimization technologies for the effective control of parcel delivery service. Comput. Ind. Eng., 51(1): 154-162.

Kabassi K (2010). Personalizing recommendations for tourists. Telematics Inform., 27(1): 51-66.

Kadobayashi R (2007). A Gaze-based Guidance System based on a Real-world 3D Photo Logging System. In: G. Broll, A. D. Luca, E. Rukzioet al (eds) Proceedings of the joint workshop in conjunction with the 9th International Conference on Human Computer Interaction with Mobile Devices and Services (MobileHCI) Singapore, pp. 37-40.

Kjeldskov J, Graham C, Pedell S, Vetere F, Howard, S, Balbo S, Davies J (2005). Evaluating the Usability of a Mobile Guide: the Influence of Location, Participants and Resources. Beh. Inform. Technol., pp. 2451-2465.

Lee G, Lee CK (2009). Cross-cultural comparison of the image of Guam perceived by Korean and Japanese leisure travelers: Importance-performance analysis. Tourism Manag., 30(6): 922-931.

Leonhardt U, Magee J, Dias P (1996). Location service in mobile computing environments. Comput. Graphic., 20(5): 627-632.

Lin ML, Chen CC, Perng CH, Tsai CH (2010). Spatial cluster analysis of the cyclist source area and assessment of the cycling environment. Environ. W., pp. 2235-2254.

Lin ML, Chen CW (2011). Using GIS-based spatial geocomputation from remotely sensed data for drought risk-sensitive filtering. Int. J. Inno. Comp. Info. Cont., 7(2): 657-668.

Lin ML, Chu CM, Tsai BW (2011). Integrating gis-based spatial autocorrelation analysis with MODIS imagery for drought risk assessment in Western Inner-Mongolia. Int. J. Environ. Res., 5(1): 139-148.

Lin ML, Chu CM, Tsai CH, Chen CC, Chen CY (2009). Geovisualization of Tourist Activity-Travel Patterns Using 3D GIS: An empirical study in Tamsui, Taiwan. 60: 454-458.

Nam CS, Johnson S, Li Y, Seong Y (2009). Evaluation of human-agent user interfaces in multi-agent systems. Int. J. Ind. Ergon., 39192-39201.

Peleg M, Shachak A, Wang D, Karnieli E (2009). Using multi-perspective methodologies to study users' interactions with the prototype front end of a guideline-based decision support system for

diabetic foot care. Int. J. Med. Inform., pp. 78482-78493.
Quiroga CA, Bullock D (1998). Travel time studies with global positioning and geographic information systems: an integrated methodology. Transport. Res. PT. C-Emerg. Technol., 6(1-2): 101-127.
Raper J (2009). GIS, Mobile and Locational Based Services. In: K. Rob and T. Nigel (eds) International Encyclopedia of Human Geography, Elsevier, Oxford, pp. 513-519.
Raper J, Gartner G, Karimi H, Rizo C (2007). Applications of location-based services: a selected review. J. Locat. Based Sev., 1(2): 89-111.
Rinner C, Raubal M (2004). Personalized Multi-Criteria Decision Strategies In Location-Based Decision Support. J. Geogr. Inform. Sci., 10(2): 149-156.
Sadoun B, Al-Bayari O (2007). Location based services using geographical information systems. Comput. Commun., 30(16): 3154-3160.
Sarjakoski T, Sarjakoski LT (2007). A Real-Time Generalisation and Map Adaptation Approach for Location-Based Services. In: A. M. William, R. Anne and L. T. Sarjakoski (eds) Generalisation of Geographic Information, Elsevier Science B.V., Amsterdam, pp 137-159.
Shi W, Kwan K, Shea G, Cao J (2009). A dynamic data model for mobile GIS. Comput. Geosci., 35(11): 2210-2221.
Shoval N, Isaacson M (2007). Tracking tourists in the digital age. Ann. Tourism. Res., 34(1): 141-159.
Solaimani K (2011). GIS-based multidate flood forecasting using hydraulic model. Int. J. Phy. Sci., 6(3): 577-582.
Spink A (2002). A user-centered approach to evaluating human interaction with Web search engines: an exploratory study. Inform. Proces. Manage., 38(3): 401-426.
WebPark (2010). Overview. Available online at http://www.webparkservices.info/overview.html [accessed 28 October 2010].
Wu HH, Shieh JI (2009). The development of a confidence interval-based importance-performance analysis by considering variability in analyzing service quality. Expert Syst. Appl., 36(3, Part 2): 7040-7044.
Zipf A (2002). User-Adaptive Maps for Location-Based Services (LBS) for Tourism. In: K. Wöber, A. Frew and M. Hitz (eds) Proceedings of the 9th International Conference for Information and Communication Technologies in Tourism, Innsbruck, Austria: Springer, Heidelberg, Berlin, pp. 329-338.