Developing a Tour Guiding Information System for Tourism Service using Mobile GIS and GPS Techniques

Tzu-How Chu, Meng-Lung Lin, Chia-Hao Chang, Cheng-Wu Chen

Department of Geography and Spatial Information Research Center, National Taiwan University, gis127@ntu.edu.tw
Department of Tourism, Aletheia University, mllin1976@mail.au.edu.tw
Spatial Information Research Center, National Taiwan University, windwolf@rskl.geog.ntu.edu.tw
Institute of Maritime Information and Technology, National Kaohsiung Marine University, chengwu@mail.nkmu.edu.tw

doi: 10.4156/aiss.vol3.issue6.6

Abstract

Guiding information services have become more important at popular tourism destinations. Conventional methods seem no longer adequate to provide information to satisfy all tourist needs. A new system for providing such services is described in this paper. Mobile geographic information system (GIS) and global positioning system (GPS) techniques are applied to provide guiding information and manage tourism destinations more effectively. The system includes four main functions, a graphic function, a GPS function, a Route function, and a Query function. In particular, this system combines mobile GIS and GPS techniques with location-based services (LCBS) to provide tourists a better trip experience and deeper understanding of the importance of this valuable landscape. The tour guiding system is currently being used for guiding services in the Yehliu GeoPark.

Keywords: Location-based Services, Geographic Information System, Global Positioning System, Tour Guiding System, GeoPark

1. Introduction

The increasing demand for information at popular tourism destinations has driven tourism specialists to focus on finding better guiding solutions. The traditional guiding solutions are fixed interpretative signs, multi-media interpretation in an audio-visual room, and group guiding with a guide/docent. Visualization and graphic representation of guiding information using geographic information system (GIS) techniques are useful approaches to improve such a guiding process. GIS can provide comprehensive access to a spatial database, query features, create themes and layouts, and offer reports [1-3]. Chen (2007) also notes that GIS can make it easier for visitors to find their way around their destinations. One can take advantage of the widespread use of hand-held mobile phones, which can already precisely track locations of mobile phone users.

There have been recent rapid technological developments of mobile map applications beginning in the mid-1990s [4]. Mobile GIS is already being applied for location-based services. The technological advantages of hand-held mobile devices, such as cell phones, personal digital assistants (PDAs), and GPS units have made the development of commercial information services such as location based services (LBS), possible. In most of the current LBS systems, a hand-held mobile device is used to communicate spatial and geographic information to the users. Mobile network providers have developed a variety of LBS applications, such as friend-finder, point of interest services, emergency rescue and many other safety and security services [5]. In the LBS service, knowledge of the location of an individual is used to personalize the service [5]. The LBS applications are divided into four main areas: (1) Information and navigation services; (2) Emergency assistance; (3) Tracking services; (4) Network related services [6]. The development of LBS relies on advances in computer science and related technologies. With the
appearance of mobile computing devices and cheap location sensing systems, location
ingformation has become an important resource for both mobile and desktop users [7].

Context-Based Services (CBS) also play an important role, similar to location awareness, for
developing tour guiding systems. The aim of a tour guiding system is to connect to location
awareness. CBS is an integral part in the system. The concept can be integrated into Location-
and Context-Based Services (LCBS) as described below. LCBS are a new class of services with
great potential in the near future [8]. In the tourism industry, context and spatial information are
both critical for the tourist to have a satisfying experience. Shi et al. (2009) notes that mobile
GIS information provision is governed by two primary technical objectives: (a) fast response
and (b) accurate information. They also emphasize that mobile GIS should provide users with
precise temporal and attribute information that can be used to procure personal and truly
satisfactory service.

Much tourism information is spatial, with specific coordinates, which lends itself to display
in map form. Individual users of LBS are moving objects, both spatially and temporally. LBS
utilizes the user’s geographic location to provide important information about services or points
of interest. Therefore, we adopt a mobile GIS as a platform for integrating user preferences and
the spatial characteristics of scenic spots to improve guiding services of LCBS.

Information services and guiding information for specific scenic spots at a tourist destination
are a basic service provided by the administration. In this study, we utilize mobile GPS and GIS
techniques to develop a useful tour guiding system designed both to meet tourist demands and
to improve landscape conservation, environmental education and scenic zone management,
specifically in the Yehliu GeoPark. GIS and GPS techniques are integrated using mobile devices
to provide location-based guiding information as needed.

The objective of this study is to provide a solution which integrates GPS and GIS technology
into a tour guiding system for enhanced LCBS for the mobile tour guiding system. The aim is to
provide tourists with real-time temporal and spatial guiding information for scenic spots in
natural and cultural landscapes in the GeoPark. The tour guiding system has navigation
functions, interpretative information, digital maps, and optional guided route selections for
tourists.

2. GIS and Tracking techniques

In recent years, the rapid increase in the development of GIS technologies has led to the
development of integrated global positioning system (GPS)/GIS applications, which can be
taken advantage of by the tourism industry [9-14]. Integrated GPS and GIS techniques including
navigation, tracking, guiding, gaming, health monitoring and social networking, make it
possible to put maps and information, driven by a person’s current location, onto mobile devices
[2, 15].

Temporal change means spatial and attribute changes of geographic objects, over a period of
time and within a certain geographic area [16]. For example, a tourist is located at scenic spot A
at time T1, while there are two scenic spots B and C (with spatial and attribute changes) at time
T2. Mobile devices can be carried by the tourist from one scenic spot to another over a period of
time. In other words, the position of the tourist is always changing. However, GPS-based
methods have been demonstrated to provide reliable multi-day data to record the collection of
one-week travel behavior patterns [13]. The spatial locations and attributes should keep
changing with the tourist’s movements as tracked by a mobile GIS. The guiding information
provided to the tourist by the mobile tour guiding system should also change with time and
location.

The geometric and geographic information obtained from GPS techniques can be used in a
GIS database. The location of the users of mobile device can be shown on pre-produced
thematic maps. For example, GPS time, position and speed data can be usefully employed to
acquire location information from users in traffic studies and for vehicle tracking [17]. The
choice of GPS receiver capability is important for monitoring applications. The GPS receiver
should be designed for mobile use but need not necessarily be the most expensive model available.

The integration of GPS and GIS is critical to carry out the applications of GIS into other disciplines. For example, a system for ambulance management and emergency incident handling has been developed based on the integration of GPS, GIS, and global system for mobile communication (GSM) technologies [18]. GIS, GPS and computer vision systems have been integrated into a system for data collection, flexible data storage, archiving, updating and maintenance priority updating on pavement conditions [19]. Papinski et al. have also presented detailed information on the planned and observed route choices for the home-to work commute. The combination of GPS, GIS provides information for route choice decision-making processes.

New methods for tourists tracking can effectively increase accuracy and reduce the cost of investigation while gathering information on the spatial behavior of tourists. Satellite-based GPS, land-based tracking systems and hybrid solutions are possible choices (assisted GPS is the leading type) [12]. In a related study, GPS routes of timber movement in Ireland were recorded and compared to simulated routes in terms of road classifications, distance, speed and journey time for the route selected [11].

3. Proposed Scheme for a tour guiding system using GPS and GIS techniques

3.1. Conceptual design of the tour guiding system

The basic design principles for a tour guiding system based on a mobile device should include terrain information, thematic information (such as interpretation of scenic spots) overlaid on top of a map. The system utilizes the location information collected by the GPS in a mobile GIS environment.

GIS can be used as a multi-media tool for displaying and guiding spatio-temporal relationships between scenic spots. GPS can be used to locate outdoor locations and provides simple spatial information to individuals. The GPS receivers can be used to collect time, local coordinates and speed at regular sampling periods. Due to the lack of real-time tour guiding systems, we adopt GIS techniques with GPS functions to develop a location-based mobile tour guiding system that must be able to represent and interpret 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. Using the techniques stated above, we develop a Location- and Context-Based mobile tour guiding system for the Yehliu GeoPark. The Location- and Context-Based guiding scheme implements a tour guiding system for mobile GIS applications (Fig.1). This scheme relies on a GIS database and GPS signals to provide attribute, spatial and temporal data to tourists. Although the system proposed in this study provides a generalized solution for all tourists in the GeoPark, the system is particularly suitable for tour groups, since their routes are usually directed by guides or interpreters.
Figure 1. Flow-chart of the Location- and Context-Based mobile tour guiding system

The developed system involves two important parts. The first part is concerned with creating and updating an information database for interpretative stops using GIS techniques. The second part is concerned with delivering guiding information between the mobile tour guiding system and the tourist.

The contents of the guiding information (attributes, spatial and temporal data for time and location) change as the tourists moves. GPS signals provide real-time continuous location information. GIS techniques are used to integrate the map database and multi-media interpretative information spatially. The touch-screen interface has become popular for use with PDAs and cell phones. Tourists can use the touch-screen interface to manipulate the functions of the tour guiding system. The information can be displayed on the screen of the tourist’s mobile device. The location of interest area changes continuously, and the associated attributes, and spatial and temporal information for each of the interpretative stops (scenic spots) is updated constantly, according to the current location and time of the moving tourist.

3.2. System configuration

Super GIS software is used to develop the system for spatial data display, querying, manipulation and analysis [20]. The developed system provides a better guiding information approach for querying, navigation, route selection, as well as warnings of dangerous areas and route deviations. The software architecture and the interface of the location-based mobile tour guiding system are described, and a conceptual process model proposed. The system operates in the environment of Windows Mobile 6. Tourists can also download the system to personal cell phones with a GPS function (built-in GPS module, CF/SD card GPS receiver, blue-tooth GPS receiver). The initial system includes the following four functions (Fig. 2):

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 minute tour, 60-90 minute tour, 90-180 minute 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 result of the query.
4. Implementation of the tour guiding system

The Yehliu GeoPark is located on a cape along the north coast of Taiwan. The total area of the GeoPark is 457 hectares, including 53 hectares of land and 404 hectares of water. The Yehliu GeoPark is 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 important issue. For example, the administration of the Yehliu GeoPark has had to
Developing a Tour Guiding Information System for Tourism Service using Mobile GIS and GPS Techniques
Tzu-How Chu, Meng-Lung Lin, Chia-Hao Chang, Cheng-Wu Chen
Advances in Information Sciences and Service Sciences, Volume 3, Number 6, July 2011

focus on the protection of the queen’s head sandstone, applying chemical agents to slow down the rate of weathering. The management policy of the GeoPark is to carry out minimal construction in order to protect the landscape.

In this study, we attempt to incorporate guiding services with the new information techniques of mobile GIS and GPS to offer instant scenic spot information to the moving tourist. This should help such individuals acquire accurate knowledge about scenic spots and hopefully prevent inappropriate behaviors that could damage the sensitive formations, such as banning the touching of the thin neck of the Queen’s-head, or damaging the ginger-shaped and candle-shaped sandstone.

4.1. Querying functions and multi-media guiding methods

The GeoPark administration regularly arranges guided tour services for tourists with a guide. If a tourist desires to join a tour, he can arrive at the GeoPark, but might miss the scheduled time for the tour. In the above case, the tour guiding system (with GPS and GIS techniques) would provide that individual with another choice to enjoy their stay. They would be supplied with useful guiding information about specific locations distributed throughout the area of the park which, for example, are sensitive to environmental disturbances, such as heavy rains, tsunamis, even touching by human hands. The advantage of the developed system is that it can provide educational information with multi-media guiding methods to educate and to prevent the destruction of the landscape by the tourist.

Maps are basic tools used to present information regarding the spatial distribution of scenic spots. The tourist can use the querying function to select the scenic spot of interest (Fig. 3). The screen shows the four types of multi-media guiding methods for him to choose from (Fig. 3). The 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 acquire detailed interpretative contents on the selected scenic spot.

![Figure 3. Querying functions for scenic spots. The scenic spot shown on the screen of mobile device is the GeoPark’s landmark “Queen’s Head”](image)

The following four types of multi-media guiding methods are designed for better providing guiding information to meet tourist demand: (a) pictures offers photos about the queried scenic spot; (b) audio plays a pre-recorded sound introducing the scenic spot; (c) information gives an organized article containing educational knowledge about the scenic spot; (d) video gives a pre-recorded short film of the scenic spot.

4.2. Navigation using GPS and GIS techniques

The GPS receiver acquires the accurate positioning of a specific tourist using satellite signals. The hand-held mobile device on which the tour guiding system is to be installed must be
equipped with a GPS receiver. The GPS signals furnish the tourist using the system with spatial and temporal location information (Fig. 4). The GIS database of the Yehliu GeoPark supplies geographic information to the tourist about specific scenic spots. The location information the system obtains from the GPS signals is displayed on a map. Moreover, the GPS signals are used to make an electronic compass showing the direction which directs the tourists to the scenic spots using the tour guiding system.

![Image](image.png)

**Figure 4.** A tourist sets Science Hall to be a “land mark”. The system adapts and delivers real-time maps, directions and distances to him

### 4.3. Guiding route selections for tourists

The system incorporates several interpretative routes designed to meet tourist demands. The interpretation routes contain four different guided tours (60 minute tour, 60-90 minute tour, 90-180 minute tour, and half day tour) (Fig. 5). Users (tourists) may select one tour route according to their preferences and stay time in the park. The route function automatically provides guiding information in audio and text forms for spots close to the selected route. Through assistance of GPS and the multimedia presentation of the mobile devices, tourists can navigate towards the scenic spots along the selected interpretative route.

The route function of the system provides recommends routes for different tourist demands and leads visitors through the GeoPark along the recommended routes. This reduces opportunities to touch and damage the surface of the sandstone formations thereby reducing weathering rates of the valuable and unusual geological landscape.

### 4.4. Dangerous areas and route deviation warnings

Reminding tourists when they are about to enter dangerous areas along rocky coasts is an important way for the GeoPark administration to improve safety. Real-time locations of tourists can be tracked using the GPS techniques of the tour guiding system (Fig. 6). The system will remind tourists when they approach within 3 meters of the red warning boundary for dangerous areas an effective way or minimizing accidents. Furthermore, after a tourist chooses a planned guiding route, the system judge whether the tourist is on the right route or not. The system offers an immediate warning when tourists deviate from the scheduled route.
Developing a Tour Guiding Information System for Tourism Service using Mobile GIS and GPS Techniques
Tzu-How Chu, Meng-Lung Lin, Chia-Hao Chang, Cheng-Wu Chen
Advances in Information Sciences and Service Sciences, Volume3, Number6, July 2011

Figure 5. Four planned interpretative routes depending on specific demand

Figure 6. Four planned interpretative routes depending on specific demand
5. Conclusion

This paper describes a tour guiding system for a mobile GIS. The system offers contents that change with the location of the moving tourist spatially and temporally. The system is implemented by integrating GPS and GIS techniques using hand-held mobile devices. The aim is to improve guide services in an outdoor environment. The system is described in detail and its main functions explained. After being tested outdoors, tourists can use the system in the Yehliu GeoPark.

The tour guiding system developed in this study integrates GPS and mobile GIS techniques to provide tourists with information about scenic spots. Information is provided with multi-media methods for navigation, guided route selections and warnings about dangerous areas and route deviation. The advantages of this tour guiding system which is used with the tourist’s own mobile devices are its low cost and that extra guiding facilities are not needed. Moreover, the detailed information about scenic spots can be helpful to educate visitors and protect the valuable and scarce geological landscape of the Yehliu GeoPark.

The functions displayed in this system confirm the importance of the role played by the integration of GPS and mobile GIS to describe the spatial attributes of scenic spots and create a link between interpretative information and tourist demand. More and more tourism activities are emerging at many valuable scenic spots of natural and cultural landscapes, including natural and cultural heritage, natural protected areas, and GeoParks. The interpretative information delivers an educational message to tourists using the tour guiding system. The message can help tourists to better understand the meaning and value of the natural and cultural landscapes in the GeoPark. Our system is designed to help the park administration overcome the difficulties of protecting, conserving, and effectively managing valuable scenic spots. Furthermore, the multi-functions of the tour guiding system help meet tourist demand and increase visitor satisfaction. The GeoPark administrations can minimize using human resources as guides.

The system developed in this study integrates the GPS and GIS techniques to provide LCBS guiding information for tourists in a popular tourist destination. Our system can be upgraded continuously to improve guiding services, LCBS, and GPS accuracy on mobile devices. Information can be corrected by field survey and environmental research (Fig. 1). It is necessary to devise more useful functions for LCBS services to utilize the system effectively. Those functions could use information on tourist positions obtained from GPS signals to meet tourist demand.

6. Acknowledgement

The authors would like to thank the National Science Council of the Republic of China, Taiwan, for financial support of this research under contract no. NSC99-2410-H-156-020 and thank the Aletheia University for financial support of this research under contract no. AR990020. The authors are also most grateful for the kind assistance of Dr. Ko Chi Chung and Dr. Yunji Na, Editor-in-Chief of the Advances in Information Sciences and Service Sciences, and the constructive suggestions of the anonymous reviewers, all of which has led to the making of several corrections and suggestions that have greatly aided us in improving the presentation of this paper.

7. References

Developing a Tour Guiding Information System for Tourism Service using Mobile GIS and GPS Techniques
Tzu-How Chu, Meng-Lung Lin, Chia-Hao Chang, Cheng-Wu Chen
Advances in Information Sciences and Service Sciences, Volume 3, Number 6, July 2011


