An Interactive Information Management System for Tour Guide and Its Application in Native Education

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Abstract

In this paper, an information management system with interactive environment is introduced. This system provides an efficient way for users to construct location aware information with respect to various subjects. The constructed information can also be transmitted to mobile devices, such as Personal Digital Assistant (PDA), for the purpose of guiding. Furthermore, the developed system provides the interface for mobile devices to upload the information constructed by users during their tour. Thus, the information provided by the users can be regarded as the content of system and can be reused by other users. In the system, the digital map used for guiding can be easily generated and the concept of the map template for each subject to be guided is proposed. In order to overcome the problem of limited storage space on PDA, the wireless communication technique is adopted for users to download the content from the content server dynamically. System administrator, subject administrators, and general users, are the three kinds of users defined in this system with different management authorities. The developed system has been applied as the platform to native education/learning courses in an elementary school. The teacher in the native course plays the role of subject administrator to maintain the content of a specific subject. The experience of applying this system in real learning environment was very interesting and several learning models could be derived through the assistance of this platform. And, currently, we are contacting with the tourist bureau for the application model of integration of native education and local tourism.

Keywords: PDA, GPS, Guide system, Native information, Self-learning

1. Introduction

The main purpose of the proposed system is to create a user-friendly environment for the management of location based information [1, 2]. When the information is associated with the location, several application models can be derived easily, such as the tour guide through GPS. Traditional guide systems always require a very complex process to create its location identification and to provide a binding method to link the information constructed and the associative location. And the location based guide system is not easy to be developed by the users due to the complexity. As the rapid development of the computer technology, a more convenient environment for the design of personal guide system can be easily achieved.

Considering the current information technology, PDA, as the mobile device, it possesses the advantages in its small size and high mobility; however, the memory space and computing ability are not comparable to the Personal Computer (PC). In this paper, we proposed a very convenient approach for users to construct their personal guide system by using the strengths of both PDA and PC. The proposed mechanism consists of an information management system at the PC side and the guide management at PDA. Basically, the information management system is a Web-based system, which supports the management of location-based information. By using this management system, users can create the content and map interactively according to personal preference. The system will store the information including its associated location. The created information then can be applied for virtual guide through Web or downloaded to PDA as a tour guide with the assistance of GPS. One of the typical applications of this system is the platform in native education/learning since the native information can be more meaningful when the information is bound with location. Figure 1 illustrates the basic operation and application of the native information management system.

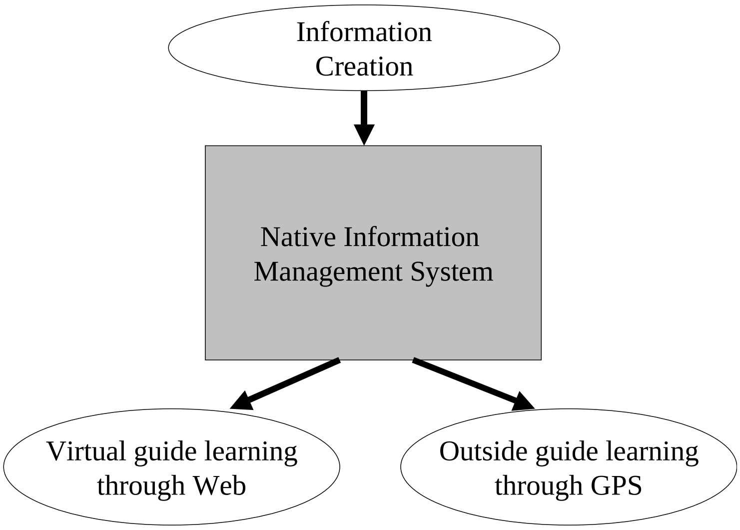

Figure 1 Concept of the Native Information Management and Applications

One of the practical applications of the personalized guide system is the support in native education. The most important concept of this system is that learners can edit native information during the "learning" process with the assistance of teachers. This scenario is different from traditional education [3, 4, 5]. In traditional classes, teachers always prepare the teaching materials before class and then "teach" the students in class.

This paper is organized as follows. In Section 2, the implementation of the proposed system is described; both of the functions at the platform (server) and the PDA (client) sides are stated. Typical application models of this platform in native education and in the integration of education and tourism are given in Section 3; and a practical example adopted in an elementary school in Hwa-Lien is also provided. Finally, the conclusions are provided in the last section.

2. System Design

(A) Design concept

Several useful functions that were not supported in traditional guide system, such as the support of interactive information sharing, generation of digital maps, and the accumulative acquisition of information. These functions are very useful in self-learning environment (which will be described later). The functions provided in this platform can be summarized in the following:

- Information acquisition and location binding;
- Digital map generation/manipulation;
- Information query;
- Information upload/download between server and PDA;
- Location-aware information prompt at PDA;
- Interface for information input at PDA.

It should be noted that a user-friendly digital map construction is adopted in the proposed platform. It is a very convenient tool for users to dynamically adjust or add the reference points on the map. And the mapping between the longitude/latitude and the location on the map is calculated from the reference points. This approach provides the flexibility in creating "templates" of map for various subjects. Detailed procedures of the implementation will be described later.

Native education is a special kind of education because the teaching material is different from city to city and the native information may vary from time to time due to the change of cities or towns. The native information can be classified into several subjects, such as ancient places, environmental protection, progress of hometown, and etc., for the purpose of guide. Therefore, the collected information should also be bound with the correspondent location information, time, and with the specific subject so that the native information can effectively reflect their specific meaning in the hometown. Therefore, the collected native information can be regarded as a 3-dimensional (subject, time, location) database, which is shown in Figure 2.

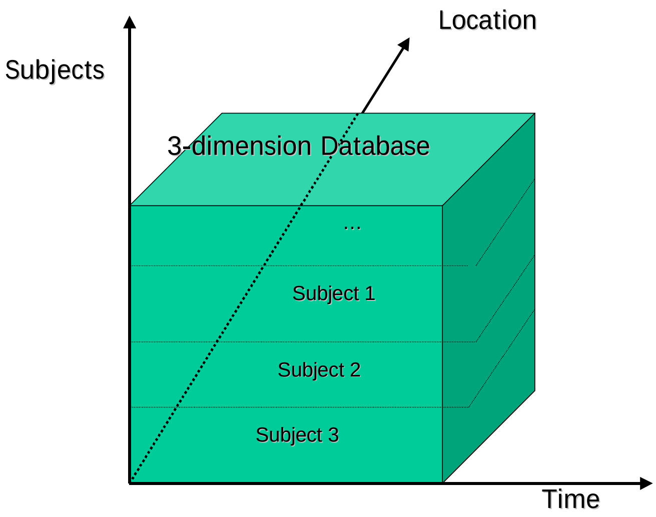

Figure 2 The Information Model

Another important design concept of the platform is to separate the application information and the control program completely such that the location information and the content information can be easily changed. The designed platform can be regarded as a general development platform of personal guide purpose. Thus, the role of server is defined as the development environment and the guide information store because of its high computing ability and large memory space; on the other hand, the PDA is defined as a simple mobile device due to its high mobility, and its function is determined by the program and information downloaded from the server.

(B) Implementation of the server

The main functions of the server are providing the information management for various kinds of users and the communications with PDA. Basically, there are three kinds of users, the system administrator, the subject administrators, and the general users, defined in the proposed system. The system administrator is the user who has the highest authority and can administrate the entire system; the subject administrator is the user who is responsible for a specific subject; and the general user is the user who can only use this system for self-guide with PDA/GPS or Web-based virtual guide. The authorities of these three kinds of users are illustrated in Figure 3.

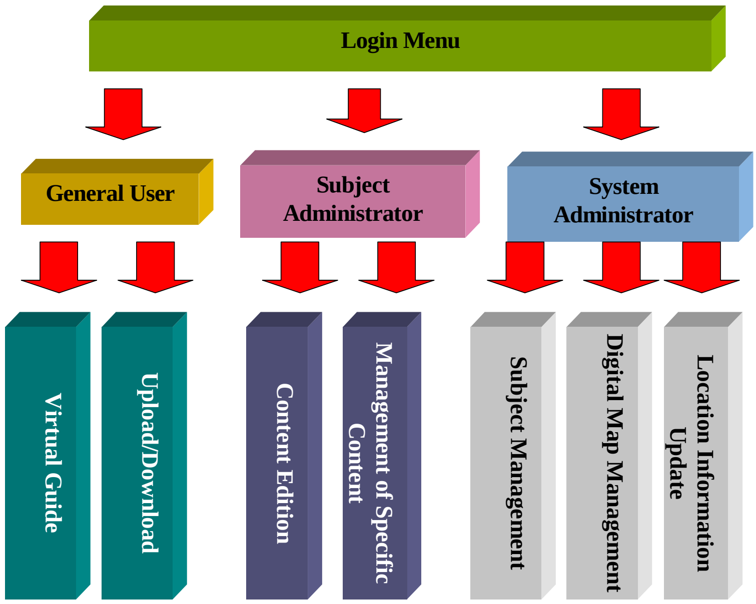

Figure 3 Functions of Users

The flow diagram of information management among these three kinds of users is depicted in Figure 4. It illustrates that two kinds of databases are designed in the system. The digital map information base contains the associations of the longitude/latitude information and the maps that can be easily constructed by users [6]. Although digital map information is very important in guide system, this information can only be modified after the verification of system administrator. And, in Figure 4, it also indicates that the collected information is classified into several logical subject information bases. Basically, each subject information base contains the data of one specific subject and is maintained by a specific subject administrator. General users can submit the information of specific subject to the subject administrator and the submitted information can be downloaded to the subject information base after the examination and manipulation performed by the subject administrator.

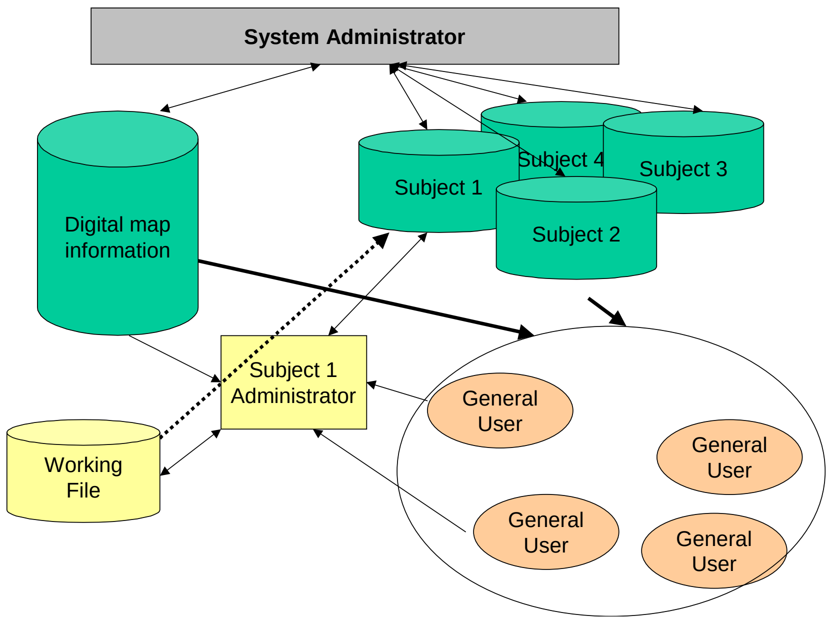

Figure 4 The Information Management Procedures

The operation inside the server is depicted in Figure 5. In Figure 5, it is noted that wireless communication module can provide intelligent download (described in the following) and mutual communication functions

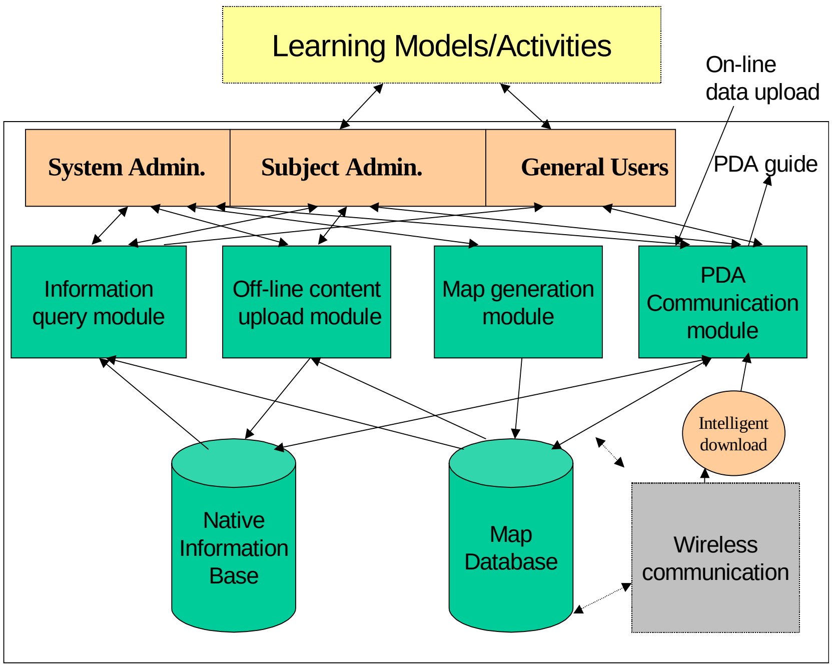

Figure 5 Functional Blocks of the Server

In order to provide the information guide for different subjects, it is better to construct the digital map with respect to the preference locations of a specific subject. Our concept is to design a map template for each specific subject. And the generation of the desired digital map shall be able to be easily constructed by the user so that the personal guide system can be achieved. As the proposed system is subject oriented, the accuracy of the digital map can be designed to be more precise when the points are closer to the target locations of the specific subject. Thus, we can choose the interesting sites, which are related to the subject, as the referenced points to generate the template of the map as shown in Figure 6.

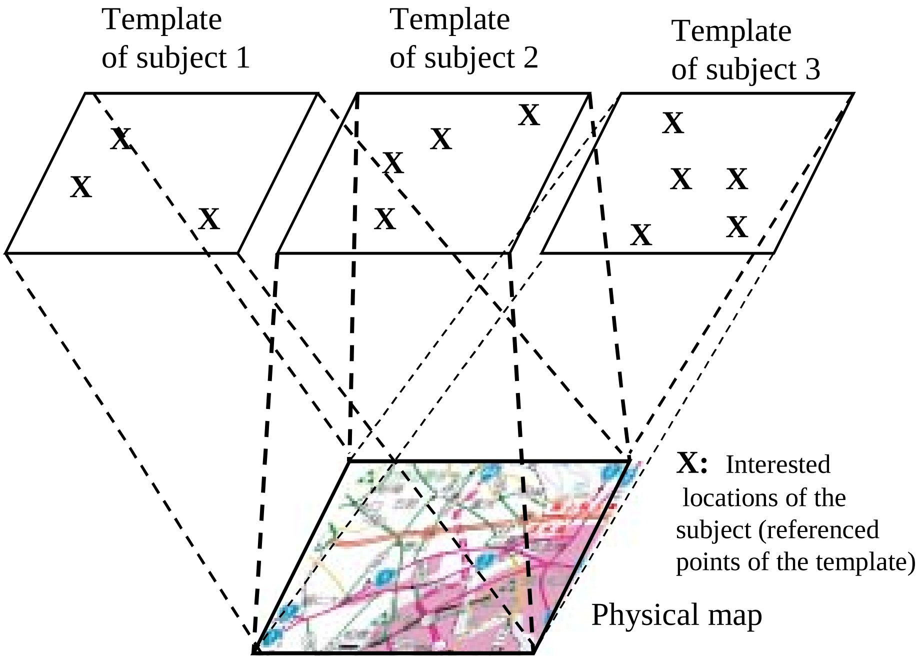

Figure 6 The Templates of the Map

It is noted that the reference points can be dynamically added/modified/deleted by the system administrator. The map generation module provides a very user-friendly interface for users to construct the map template easily. The basic operation procedures and the mapping of the longitude/latitude and the location on the map are as follows:

(i) Scan the required map and save it as the "*.jpg" file;

(ii) Use the digital map generation module to define the referenced points, $n_0, n_1, ..., n_k \ (k \geq 3)$ (associated with the longitude/latitude, (lo_i, la_i) and the location on the map, (x_i, y_i));

(iii) Select the most central referenced point (x_l, y_l) as the relative point to calculate the average change of longitude/latitude for unit length on the map, U, where $U = (u_1, u_2)$, where,

$$u_1 = \frac{\sum_{j \neq l} \frac{|lo_j - lo_l|}{|x_j - x_l|}}{k-1}$$

$$u_2 = \frac{\sum_{j \neq l} \frac{|la_j - la_l|}{|y_j - y_l|}}{k-1}$$

(iv) Then the longitude/latitude of each point on the map can be calculated as the following:

- Select the nearest referenced point as the originating point;
- Calculate its offset and then calculate the longitude/latitude of (x_i, y_i) by using the average change of longitude/latitude per unit length obtained above.

In order to examine the accuracy of the proposed scheme, we select 13 points from an experimental map for comparison. The matching error between the calculated locations and the physical locations are shown in Table 1. The points 1, 7, 8, 11 are selected as the referenced points. And the fixed-point referenced scheme only uses the right-up and left-bottom points as the relative points for the calculation of each point. The experimental results show that the proposed scheme demonstrates a better matching performance than the fixed-point referenced scheme. It is noted that there is no matching error at the reference points for the proposed scheme because the calculated offset will be zero and the location information of the referenced point is directly applied.

Location ID	Fixed point referenced scheme	Proposed scheme
*1	0.16030111399805633	0.0
2	0.5094806302075652	0.2737072832488889
3	0.20164597942362045	0.17229004338626394
4	0.2748688081625816	0.21960982845148466
5	0.3331744101283742	0.3386910654876678
6	0.12159633356049643	0.10309094838457193
*7	0.10377743244390511	0.0
*8	0.17074130047114228	0.0
9	0.4723149565854546	0.07717108371561607
10	0.31317754984780954	0.06603370291618661
*11	0.14231227973266392	0.0
12	0.15406072263948428	0.39843407030439965
13	0.3067513369221418	0.49580699899814523
Average	0.25109252724025327	0.16498730960717115

Table 1 Matching Difference of the Digital Map

(C) Implementation of the mobile device (PDA)

In this paper, WinCE environment is adopted for the development at PDA because WinCE can provide more software utilities and more powerful multimedia functionalities that are helpful during programming. Basically, the modules designed for PDA include the following three notable functions:

- Location based (longitude and latitude) guiding: The mobile device (PDA) accepts the location information from GPS and searches for the information existed in the PDA to prompt the corresponding information on the PDA screen. The information can be text, images, or video files. It is noted that the user can also set a radius value as the coverage for searching regarding to the current location.

- On line information edition: This function provides a menu-driven interface to assist users to record their experience on the PDA during the guiding process. And the recorded information can be uploaded to the native information base at the server.

Intelligent information download: It will be more convenient if the content of PDA can be updated according to some heuristics at any time. However, PDA still has limitation on space capacity in today's technology. Therefore, the PDA is designed to actively ask the server (e.g. a notebook PC) for information download according to the location it is going to travel. And the space containing the information that has been traveled can then be overwritten by the required information. Thus, the PDA can keep interaction with the server during guiding. The operation flow of PDA is illustrated in Figure 7.

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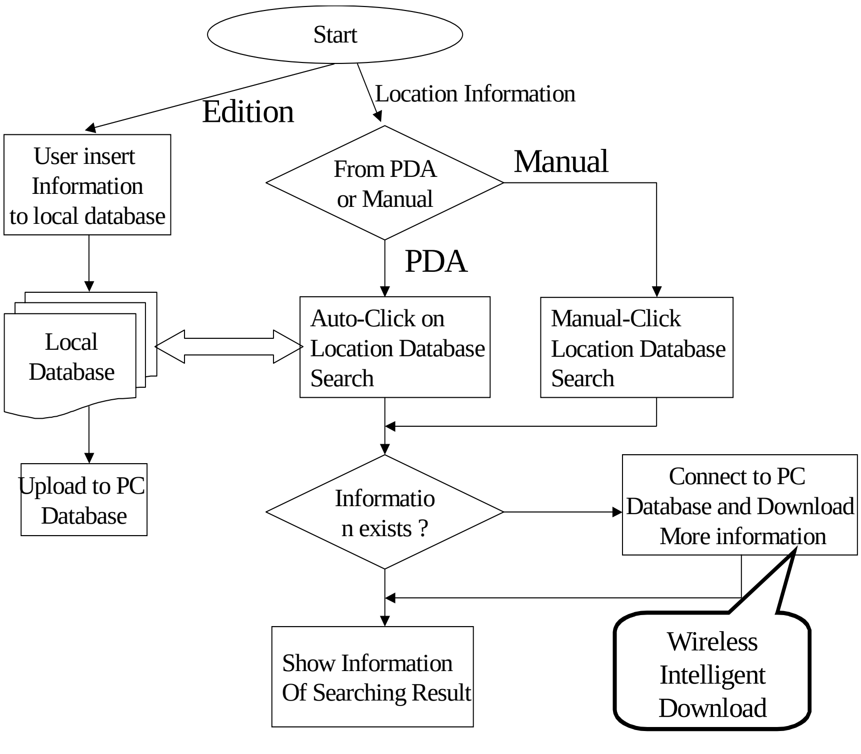

Figure 7 The Basic Operational Flow of PDA

It is noted that, in addition to providing the intelligent download, wireless communication function can also support mutual communication among mobile devices for the interaction among users.

3. Application Models and Practical Example

(1) Application Model

Native education is a special kind of education because the teaching material is different from city to city and the native information may vary from time to time due to the change in the cities or towns. Therefore, it would be more meaningful if students can observe their living environment, the history, or the interesting place of their own hometown and keep records of them with teachers' assistance [3, 5, 6]. In this case, the students can learn more from native courses and the information can be collected continuously. The collected information should provide the correspondent location information with the subject so that it can effectively reflect the specific location of hometown. The information will be stored in a 3-dimensional phenomenon. The 3-dimensional information that has been collected and classified can be reused for other purposes, such as the derivation of other learning models and local tourism.

As the native information is bound with the location information, the execution of the native courses can be run in two different ways: Firstly, students can download the information related to a specific native subject into PDA for self-guiding outside; and the other one is that the collected information can be virtual guide through Web with the digital map. For outside learning, the location indicated in this paper is the longitude and the latitude received from the GPS. And the wireless local communication enables the mutual discussion among students and teachers. As for the Web-based virtual guide, students can reach the Web site for self-learning and the teacher can teach the students in the classroom before outdoor activity. Several interesting learning/education models can be derived from the above environment.

Due to the recursive process of information self-construction, the native education course can become more meaningful for students. Furthermore, the information base can be used as tour guide for local tourism. Thus, native education can be tightly integrated with the local tourism (as shown in Figure 8). In this model, teachers and students can support the tour guide information for their hometown, and the visitor can use a PDA to download the information for her/his tour guide. We believe that it will be a great encouragement for the local native education.

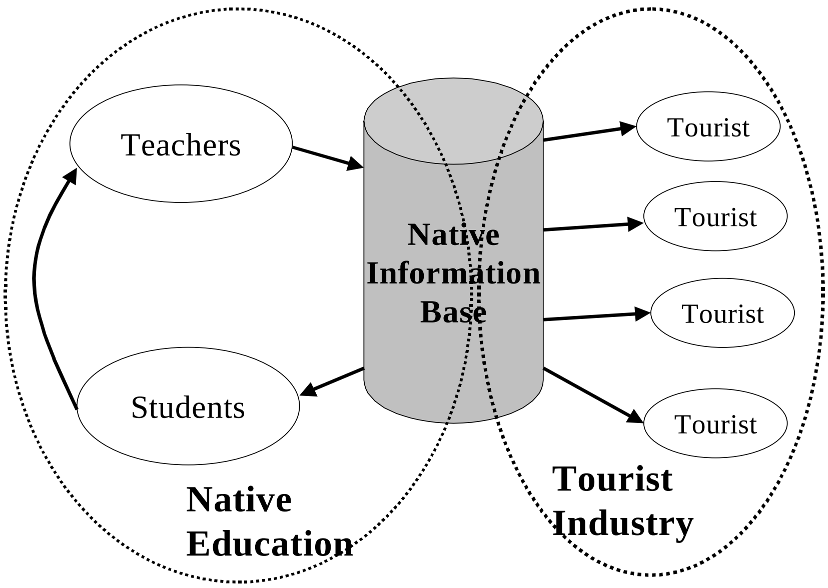

Figure 8 The Application Model

(2) Practical Example

We have selected an elementary school in Hwa-Lien city of Taiwan as the first education trial for practical application. The reason of choosing the school at Hwa-Lien city is that Hwa-Lien is a very famous place for visiting in Taiwan and has the potential to implement the model of integrating native education and tourism described above. The main purpose of the initial activity was to find out whether this tool and the learning model is suitable for the students or not. We established the preliminary native information of Hwa-Lien city (one of the operation menu is shown in Figure 9) and taught the students how to use the system firstly. Since the system is menu driven and very easy to use, each student easily becomes familiar with the system (mainly the PDA/GPS device) after a short training. During the activity, students could move along to observe interesting places and record what they found during the learning guide. Some photos taken during the learning activity are illustrated in Figure 10. After this activity, all of the students felt very excited about the outdoor course because it is quite different from the traditional course. The teacher also collected the information edited by students and saved it in the information base as reference for assessment and future course design.

Figure 9 Information Creation at the Platform

↑ **Practice Before Guide**

↑ **Connect the GPS with PDA**

↑ **PDA Guide**

↑ **PDA Guide**

↑ **Observation**

↑ **Record the report on the PDA**

Figure 10 Photos from the Practical Education Activities

4. Conclusions

In this paper, we proposed a self-guide development system for the native information management and education. Three kinds of users are provided in this system. In this system, teachers and students can effectively act as the subject administrators and general users, respectively. The iterative information construction can motive users (students) to construct the information they are interested in and this function is very helpful in native education. As the collected information is accumulative and reusable, we think it is a good idea to integrate the native education with local tourist industry because it is a win-win policy for both of them. And we also believe it is applicable. The future works, in addition to promoting the application in native education and tourist industry, include specifying a unified application program interface (API) for the need in developing different kinds of application/learning models and the adoption of the cellular communication techniques, such as GPRS/3G, to our systems so that the applications can be more versatile.

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