Interactive Traveling Assistant based on Agent Technologies and Mobile Computing

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Abstract—Many people love traveling for entertainment nowadays. In a journey, visitors often produce digital multimedia resources by capturing images, audios and videos. With digital devices like cameras, travel notes are not limited to texts, multimedia resources are also used for decorating records in a journey. In this paper, an interactive traveling assistant application is proposed to save time for creating travel notes. Visitors can use handheld mobile devices like PDA to capture photos or videos and collect related resources from internet by agents. With the GPS functionalities provide by mobile devices, precise location coordinates can be obtained for further analysis and retrieval. Visitors can focus on activities and sightseeing in a journey without dealing with complicated operations of creating travel notes. The interactive traveling assistant application is designed for helping visitors to easily record and share wonderful experience in a journey via internet.

Index Terms—travel notes, mobile devices, agent, multimedia resources

I. INTRODUCTION

In this paper, an intelligent platform for managing travel notes is designed for helping visitors to manage and edit multimedia resources generated from their journeys. Considering the convenience in a journey, using mobile devices is the best selection for users to handle multimedia information. In a tour, visitors always take pictures and capture videos by their cameras or mobile devices. In this case, simple interactions are better than complex ones since visitors don't want to take complicated operations outdoor.

Considering such requirements, we proposed an intelligent platform to help users to easily keep and manage their multimedia resources obtained in a journey. Users just need to take pictures and make simple annotations, the advanced process of editing travel notes can be done after they go back home. Several major components are included in this application: travel note wizard, agent and sever platform.

Travel note wizard is the component which users often touch. In a journey, visitors can carry a PDA to capture images or videos. Like other applications run on PDA, a program we call intelligent travel note wizard will help users to make easy operations to those multimedia resources. Users can use this wizard to process captured images and add some comments if they wish. Combining with the GPS (Global Positioning System) component installed on PDA, the wizard will transfer image or video files, users' comments and coordinates of locations where users locate automatically. So visitors can focus on experiencing wonderful scenes in a journey without worrying the procedures about manage photos and videos. Images, videos and comments will be packaged and transferred to multimedia resources management server automatically. Location information provided by GPS component is also uploaded to the server side. Such resources will be analyzed in advance to help visitors to edit their own travel notes after they finish their journey.

Agent technology plays an important role in the proposed interactive traveling assistant application. Information captured from users is uploaded to the server side. Such information is composed of image, video, audio and textual comments. For ordinary users, if they try to use these resources to make travel notes, it is not easy and convenient since they need to make further operations. The users can edit their travel notes via interactive interfaces provided by the travel note management server. If the authors need more information and materials from internet, they need to browse web pages searched by searching engines. It is not convenient for visitors to collect such information from internet to augment contents of their own travel notes. The intelligent travel note agent will collect information and materials from internet automatically. How do agents

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collect appropriate information to help users to edit their own travel notes? According the location coordinate provided by GPS component in users' PDA, the agent can get information around the location where users are. Further more, the agents can obtain textual data like names of scenes or buildings there and use such data to collect textual and multimedia resources from internet. Such materials collected by agents will be put into a resource pool. Users can edit their own travel note and access these materials after they logged into the travel note management server.

The server platform is designed for storing and analyzing information collected from users. In a journey, visitors capture images and videos and add some annotations. The intelligent travel note wizard will upload these resources automatically to the server side. There are also other resources and materials collected by agents be uploaded to this server. By such materials, users can edit their own travel notes and publish them on internet. The management server not only stores information from the wizard application and agents but also be responsible for presenting travel notes in forms of web pages.

The rest of this paper is organized as follow: related research and proposed systems are mentioned in section II; the architecture of system and detailed functionalities are described in section III; the implementation of components mentioned in section III will be presented in section IV; a brief conclusion about contribution and future works will be discussed in the final section.

II. Related Work

In our previous research [1], a prototype of intelligent travel note management application is proposed. This application provides functions and easy interfaces for users to manage their travel notes. By using programs like agent and travel wizard, users can easily collect and integrate information to help them to build up travel records.

Location-based services have been long envisioned as an important element and applied to various applications. Our system provides a different way for individual users to record their travels and differs significantly from traditional travel applications or mobile tourist guides. [2] in which it is concerned with the traveler rather than the place. An online travel service dedicated on high quality images [3], which helps travelers to plan their trips. Utilizing rich and accurate metadata of pictures from photo forum sites, a virtual tour system can extract geographic location information and assess the quality of them. Its primary purpose is to help travelers to plan their trip. Similarly, a sophisticated map-based user interface is proposed to browse the location tagged photos in [4].

LocoBlog [5] is a space-time photo travel blogging service. Unlike traditional travel blogs, the entries are not only displayed linearly, they are also displayed spatially, allowing the viewer to get a greater sense of the journey in addition to place. Another related research [6] has proposed an approach for integrating context-aware computing to a mobile travel assistant. A compact structure called User Task Model providing an explicit record of a user's activities and intentions.

Mark Apperley et al. [7] have demonstrated a graphic visualization of travel itinerary with emphasis on time and time zones. The travel system covers the search aspect by supporting collaborative World Wide Web browsing and document creation by supporting multiple complementary views of the trip and allowing collaborative editing via any of these.

Web Travel Support Engine [8] is introduced to recommend traveling information for users and considering users' interests by applying the reinforcement theory to analyze the user behaviors and studying user interests. The agent technology used for the Personal Travel Market has been also introduced in [9]. Three types of agents, Personal Travel Agent, Travel Broker Agent and Travel Service Agent collaborate to resolve users' travel requirements. Virtual Travel Agent System [10] is built on the technology of multi-agent information system and the use of semantic Web that can effectively organize information and service resources. A research of a mobile game, alien revolt is discussed in [11]. This famous java cell phone game is very popular in Brazil. Users equipped cell phones with location awareness components can play games in cites just like they are in battle fields. In the environment of this game, alien revolt, users can play two kinds of two kinds of roles, alien hacker and human warriors. With cell phones and GPS components, users can enter various gaming stage in different locations.

The authors also pointed out that the level of mobile devices in Brazil is not high enough to give high growth of this game. High price and low accessibility make Brazil not to be a good environment to develop mobile games. If we want mobile games with location awareness mechanism be highly accepted to users, the mobile products distribution on market will be an important part.

An interesting issue of location-based was discussed in [12]. Uncertainty is the major issue in this research. Survival games are very suitable for participants with handheld or wearable sensors and interfaces. Such games are really convenient and exciting. Users do not need to equip real weapons, armors and other devices to play battles in fields. They just only need to carry such mobile devices and can experience battle with less fatigue.

The major uncertainty of this research is about accuracy of GPS. In the experimental results, there are errors from 4 meters to 104 meters; the average is about 12 meters. Obviously the level of errors is too large to be accepted. It also really affects the process of such survival games. The solution in this paper is using better GPS component with antennas. The average of improved errors is about 4.4 meter. The results are much better than original ones. In the proposed learning platform in this dissertation, accuracy is not very important as in mobile games. If higher accuracy is necessary, maybe higher class of GPS component can be installed in our system.

Some research focus on providing services to users by GPS components and electronics map. A project of websigns is published in [13]. The websigns are kind of

hyperlinks to physical locations. Users can access relative information of these physical locations by websigns. The kernel components of websigns are virtual beacons and virtual tags. The beacons are based on IR beacons and the tags are based on RFID tags. With these websigns, users can download and browse information from network. They just need to scan IR beacons or RFID tags, then they can access information on mobile devices.

Another application of electronics maps is published in [14]. Yahoo map is a free service to let users to examine maps on network. By integrating with flickr's services, users can add photos in locations on yahoo map. There are also customized profiles to users to edit their own maps with photos.

III. The System Architecture

As mentioned in the introduction part, the major sub components of the interactive traveling assistant application are wizard, agent and management server. Figure1 shows the flowchart about how users' information will be collected form users or internet and then be transferred to management server. The wizard is a program runs in users' PDA or mobile devices that it can collect information and transfer resources for editing travel notes to management server in the future. Agent is responsible for analyzing the information received from wizard and then collecting related resources from internet. After operations of wizard and agent, the multimedia resources from users and internet will be stored in the server side and users can create their own travel notes using these integrated resources.

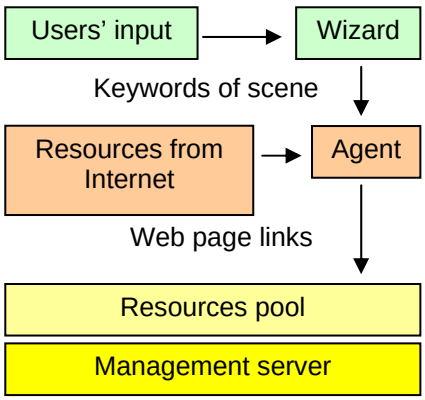

Figure 1. Flowchart of gathering and repackaging information from wizard to server.

■ Intelligent Travel Note Wizard

The intelligent travel note wizard is designed for collecting user data and providing adequate resources to agent. The wizard is a program runs on users' PDA or other mobile devices and it can access hardware resources of these mobile devices. By using adequate program libraries provided by operation system runs on PDA, the developer of wizard can easily get information and multimedia resources from PDA. There are several kinds of user data collected by this wizard: images, audios, videos, spatial and temporal information.

Images, audios and videos are common multimedia resources generated by users. Visitors may capture such multimedia resources using their PDA during their journeys. Such resources can be used for editing travel notes of visitors in the future. Handling such resources is the first task of the wizard. The wizard will upload these resources to the server automatically without troubling users. These multimedia resources are basic units of packages which will be uploaded to the resource pool at the management server. Most of these multimedia resources will not be processed with additional procedures; users can access theses resources in the resources pool as the same as they captured in PDA.

Another kind of information collected from users is spatial information. This kind of information is more important than other ones. The wizard gets the spatial information by accessing GPS component in the PDA. With GPS, the wizard can get coordinates like latitude, longitude and etc. The information captured from GPS is not the final form which will be transferred to agent for further usage; the wizard need to some procedures to transform such information to useful data.

One objective of the wizard is to locate where visitors are. By using GPS component in PDA, the wizard can get simple coordinates of the location where users are. For further analysis for agent, the wizard need to transfer simple coordinates to string of landmarks. With the advanced functions provided by GPS, the wizard will get a different kind of information in forms of string. The final task of the wizard is to find landmarks around users and transfer them to agents for advanced reference web pages searching.

Landmark is the basic unit we used for gathering related information. The wizard needs to find all possible landmarks around users first. It can be easily achieved by GPS component. Landmarks, buildings and other meaningful objects will be shown to users if an adequate range is assigned. With the coordinates and radius, several objects around visitors will be stored in caches of PDA for the moment. The landmarks will be used as keywords for agent to gather reference web pages from internet. Not all landmarks are useful for users to create their travel notes. A landmarks selection engine is used for filtering unnecessary objects. By processing strings of landmarks and users' comments, some landmarks will be ignored if the relevance is too low. The remained objects will be sent to agent for collecting information.

The concept of landmarks selection engine is very simple. The input source of the selection engine is a set of strings generated by GPS in PDA. The selection engine will find the maximum similar sub string in all input landmark strings. There may be several similar names of landmarks in the same region which visitors are. We choose some terms appeared in those strings of landmarks as keywords for further searching in the agent phase. The approximate procedures are listed as follows:

1. Storing all landmarks around visitors for selecting representative keywords.

2. Comparing all input landmark strings and users' comments for generating keywords.
3. Handing in those selected keywords to agent for searching related web pages on internet.

The information collected by the wizard also provides another type of records to users. The wizard can obtain geographic data from GPS and transfer these data to landmark selection engine and agent. When visitors are in their journeys, the information provided by GPS will be uploaded as time goes by. The precise position of visitors may changes frequently in a journey. A route of visitors' journey is obtained by connecting every landmark which users passed. It is also meaningful information for users to edit their travel Blogs.

■ INTELLIGENT TRAVEL NOTE AGENT

The agent is designed for help visitors to collect related information from internet. It is a program stored in the management server. After the wizard transmitted keywords generated by selection engine, these keyword will be transferred to servers. These keywords are most important information for agent to search resources.

The searching procedures are similar with ordinary search on searching engine. Taking the famous searching engine Google as an example, users just need to feed keywords and set some additional properties and then searching results will be listed in a web page. Integrating such function to the agent is not a hard task; we can use hyperlinks compliant with http protocol to replace searching behavior by a simple procedure in the agent. For example, if users want to search information of TamKang University, they will key in the keywords in the searching area.

Searching information of Tamkang University can be represented with a hyperlink "http://www.google.com/search?hl=en&q=TamKang+University", the wizard just needs to follow the form and change keywords, a searching request will be made to the searching engine. The searching results are also compliant with http protocol, the wizard just need to parser the result web pages and discover http address of these web pages to get reference links.

There are many web page links in searching result window. By filtering those unrelated resources, some keywords are used to ignore web pages like names of searching engine since there are advertisements or services provided by searching engines. By parsing and filtering pages retuned by searching engines, hyperlinks and comments will be gathered and transferred to the management server.

Besides web pages of searching results using keywords from landmark selection engine, there are also other kinds of related resources distributed on internet. Visitors can capture image and add comments using mobile devices when they are in journey; the keyword can also be used for searching non-textual resources. Users may be interested other photos took in the scene they are and use these photos to make comparisons with their own ones in travel notes. Searching related pictures on internet is very similar with web pages. Some searching engines provide interfaces to find pictures with keywords. What agent needs to do is just feeding keywords to searching engine and parses result web pages to download image files. In this paper, complex methods and technologies for retrieving image files is not discussed. The objective of agent is just send keywords to searching engine without touching which searching algorithms they use.

■ INTELLIGENT TRAVEL NOTE MANAGEMENT SERVER

The intelligent travel note management server is the final part of the proposed application. Multimedia materials captured by user are first transferred to the management server. Such materials are generated by visitors and don't need to process in advance. They are stored in the resource pool and users can access them directly while establishing a travel note. Another kind of materials is collected from agents. Before users begin to create travel notes, they can not access such multimedia resources.

The management server provides an easy interface to users to access related resources collected from internet. After users ended a journey and want to begin creating travel notes, they need to login to the server first. There are not only multimedia resources but also usage history of users in the server. In the process of creating travel notes, users can easily download related resources from the server and rearrangement them in travel notes.

Some multimedia resources and information collected from users stored in the intelligent travel note management server. For advanced query for users, a simple data structure for these multimedia resources is adopted. Some represented tags are listed follow:

- Resource Name
- Longitude
- Latitude
- Time
- Date
- Media type
- Descriptions

The first tag, resource name, is a basic item for the management server to handle them. Users can package a multimedia resource and upload it to server with a specified name. This name is only used for users to easily manage their contents. On the server side, a unique ID will be generated automatically.

Longitude and latitude attributes are collected from GPS module of users' mobile devices. These two attributes are most important tags in the multimedia resource information structure. After users produced a multimedia resource, the value of longitude and latitude will be record automatically. Other users can find these resources in the database of management server according to their locations. If users want to access multimedia contents related to the location they are, the travel note wizard mentioned in the previous section can also present image, audio or video to users immediately.

Longitude and latitude attributes provides an easy way to retrieve multimedia objects in specified locations. Users can make simple query directly to management server without relying agents to collect information from the huge network. Although the coverage of retrieval can be only limited in the management server; users can get precise query results quickly. Another tag will be used in the retrieval process of multimedia objects. Before users start to make query to find simple resources at their current location, they need to input a parameter, radius. Meter is adopted as distance unit of radius. Since latitude and longitude are hard to use for users, a transferring procedure is necessary to solve this problem. After users input the value of radius, the wizard will transfer the input to management and complete the retrieval process with longitude and latitude attributes. The follow algorithm shows a simple verification of target multimedia resources retrieved from management server:
R: Radius input by users.

C: A set of information of users' current location

n: numbers of multimedia objects in the management server

M: A set of information of multimedia objects stored in the management server

dist( ): To get distance of two input value

e: A coefficient to transfer meters to value of latitude and longitude

Q: A list to store the query results.

Selecting target resource with radius(R, C)
Loop l : i ← 1~n
If dist(M[i].latitude, C.longitude)< R*e and
dist(M[i].latitude, C.longetude)< R*e
Q[j] ←M[i]
j ←j+1
Repeat l
Output Q
End

Time and date tags represent temporal information of multimedia objects. Such information can be also used for users to choice resource they want. For an example, if a tourist visits a place at morning, he or she may want to access photos or video captured at evening. Since tourists can not stay a location all the day, the time attribute of multimedia resources can help users to have a look of scenes in different hour. Figure2 shows an example of displaying multimedia resources in different time. The date is also used for the same purpose. If users at a specified location in spring; they may want view photos of the same scene in winter. Retrieving resources according to time and date tags can fulfill such requirements.

The tags of media type include several items like audio, image and video. The management server can use this tag to classify multimedia objects into three categories. For every type of objects, the client application needs to have adequate means to present them to users. The final part is description of objects. Using descriptions for retrieving resources is another way for users to make advanced queries. There is a little difference from tags mentioned above. Since descriptions are totally generated by users' input, some casual descriptions may lead to bad query results.

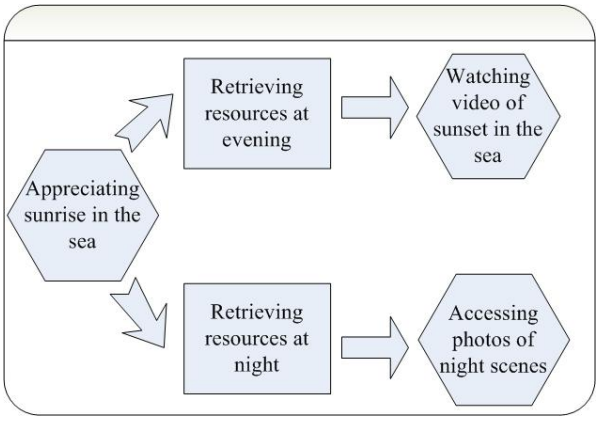

Figure 2. Retrieving multimedia resources in different hour.

Such tags can be used for helping users to quickly find resources they want. There is little difference from information collected from agents and these resources mentioned above. Information collected from agents presented to users with a more complete form. They are presented mainly in web pages. These pages may be captured from web pages of other tourists. These multimedia resources can be considered as minimal unit for help users to augment contents of their travel records.

Information of users' history usage is also stored and analyzed in the management server. Data and records collected from users can help tourists to make schedule for their next journey. Besides information presented in users' personal profiles, they can access other traveling records provided by other users. By referencing these data, tourists can find suitable locations for their next journey by comparing data records of other users. In the management server, every procedure of uploading multimedia resources will be considered as a basic record. By analyzing these records, locations visited by users can be stored. A simple approach is adopted for computing the similarity of two users' traveling record in the server:
U: Visited locations by users

n: numbers of visited locations of user1

n: numbers of visited locations of user2

S: Grade of similarity of the two users

Getting similarity of two users' record (U_1, U_2)
Loop l_1 : i ← 1~n
Loop l_2: j ← 1~m
If $U_1[i] = U_2[j]$
S←S+1
Break
Repeat l_2
Repeat l_1

Output S/n and S/m

End

By adopting this approach, users can find the traveling similarity with other tourists in the management server. The procedure of finding the most similar users is a little inefficient since every record of users needs to be compared once. The numbers of repeated location of two users can not indicate the traveling similarity of them because the total visited locations should be also considered in the similarity evaluation. The numbers of repeated scenes will be divided by number of total scenes visited by tourists. The final results will present the degree of the similarity between users' travel records. With adequate presentations like ranks, users will find similar tourists and can access locations they visited.

IV. Implementation

The proposed system utilized Microsoft .NET compact framework to implement the client program on Pocket PC with the Operating System – Windows Mobile 5.0. The test Pocket PC, Dopod 9100, integrates the wireless internet access, camera and GPS functions. In our scenario, the user brings the Pocket PC when he is traveling. GPS traces the user's geographic location and updates the information periodically to the server so that the user's route of the trip is able to be constructed and stored in server at the same time. The user can also take a picture with the device while on vacation, attach relevant audio information as well as captions and time stamps then upload them to the server for further processing.

The pictures taken by the user are temporarily stored in the Pocket PC according to the date during the trip. Figure3 shows the pictures taken for the first day of the trip. The pictures that belong to each day are also categorized by location. The user may visit several places within a day and add additional information to describe the pictures.

Figure4 illustrates that the user is selecting a picture to display its detail in a larger window adding text notes and audio description is also available in this mode. Comments or other information represented in text will be important clues for discovering related information from internet.

Figure 3. Snapshot of the interface of wizard runs on mobile devices.

Figure 4. Adding user comments to captured images.

V. Conclusion and Future Works

An interactive traveling assistant application integrating with agent and web technologies is proposed in this paper. The wizard runs on users' mobile devices collects and filters information from visitors' photos and comments. Geographical information gathered from GPS component in mobile devices also provides means to get precise landmarks in visitors' journeys. The strings of landmarks generated by a selection engine will be inputs to an agent, and then these related materials on internet will be collected for references in the phase of travel notes editing. Visitors can easily create Blogs included the multimedia resources collected in their journey. Other reference web pages and images are also available in the resource pool. By this management application, creating travel notes becomes an easy task even an entertainment for visitors.

The methodologies used for retrieving related materials in this paper are simple. In order to get better searching results or performance, other novel approaches of image or video retrieval may be adopted. Such multimedia retrieval techniques would be useful for collecting non-text resources.

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