Developing a Location Based Tourist Guide Application

Todd Simcock, Stephen Peter Hillenbrand, and Bruce H. Thomas
Wearable Computer Laboratory
School of Computer and Information Science
University of South Australia
Mawson Lakes Boulevard, Mawson Lakes 5095, South Australia
Bruce.Thomas@unisa.edu.au

Abstract

This paper presents the development of the Tourist Guide, a location based tourist guide application for the outdoor environment. Our focus for this project is on software support for location based applications; we are not just interested in the location but also other elements of the user's context, such as buildings in view, attractions and equipment near by, such as public telephones and toilets. In this paper we will describe the Tourist Guide system and discuss the processes involved in the development of this application. More specifically, this paper will look at the design and usability issues.

Keywords: Location Based Systems, Hand Held Devices, User Interfaces

1 Introduction

We have been investigating location based tourist applications targeted at off-the-shelf hand held devices, such as the Compaq Aero. The hand held device is augmented with Global Positioning System (GPS) to provide regular updated information about the user's current location. Such an application enables the user to participate in a travel expo (a self guided tour of a specific area) that will display detailed information about specific features linked to their current position. This will include information about: where they are, attractions nearby, and details about specific buildings.

The Tourist Guide project investigated the use of context-sensitive mobile computing for the use of visitors to both the Mawson Lakes campus of the University of South Australia and the North Terrace precinct in the Adelaide city centre. Rich multimedia support has been incorporated into the system to provide extra features to enhance the tour expo. In this paper we describe the processes involved in designing the Tourist Guide application and in particular we focus on the context sensitive features of the system as well as the reliability of the navigation system. The hand held computing device used in the project is the Compaq Aero colour palm-size PC. This device was connected to a Garmin GPS navigation system that provides the location information required to run the application. Figure 1 depicts the hand held computer and GPS unit used in this investigation. Current hand held devices allow for an integrated computing and GPS system, but at the time the project commenced, there was no integrated solution for the Aero.

Figure 1. Hand held computer and GPS unit

1.1 Aims of the Project

The main aim of this project was to develop a context sensitive travel expo application. The design aims of the project were as follows:

1) Use off-the-shelf hardware and software components.
2) Simple and easy to use interface.
3) Simple and easy to build new expos.
4) The system should operate for one working day (8 hours).

We determined the system was required to complete the following tasks:

1) Display attraction information in the form of Hyper Text Markup Language (HTML) pages relevant to the user's position.
2) Display the user's position graphically on the tour map based on their position from a GPS.
3) Limited screen size requires the user interface to be simple yet effective.
4) Provide functionality for other tours to be created and uploaded onto the system and used.

5) Provide functionality to aid in the tour creation process.

6) Display relevant information to aid in the navigation process.

7) Function adequately in an outdoor environment.

While there have been a number of GPS enhanced travel expo applications (Feiner et al., 1997, Abowd et al., 1997, Cheverst et al., 2000), this project focused on a simple but elegant solution to the creation and maintenance of location based information. None of the above systems enabled such a quick and easy method for developing new location based travel expos.

1.2 Outcomes of the project

The construction of a GPS enhanced hand held travel expo is not new, as shown by the previous referenced applications. The interesting outcomes of this project are as follows:

1) A user interface design that accommodates the input and output features of a hand held computing device. This enables users to obtain relevant location based information quickly and easily. This is achieved by a simple but elegant design of the interface, and adopting a "more is less" approach to quantity of information displayed.

2) Implementation of a tour creation system that is quick and easy to use. The creation tasks are split into major activities, web page creation and defining GPS active areas. Web page creation is achieved through web page templates and off-the-shelf web page creation tools. The definition of GPS active areas is achieved with a software tool on the GPS enabled hand held device itself.

1.3 Overview of the Operation of the System

A high level overview of the Tourist Guide is presented as a means of showcasing its main features. When the guide is first turned on, a splash screen is displayed showing a welcome note. The system then lets the user know that the GPS is acquiring a signal from the satellites. After the GPS unit has acquired enough satellite signals to determine the user's position, the user may then walk around operating the system in one of the following three modes: *map mode*, *guide mode*, and *attraction mode*. The user may switch between the three modes selecting a tab on the top of the screen. Figure 2 depicts the map mode and shows the mode selection tabs on the top of the screen.

The map mode provides a map of the site being toured. As the user walks around, a display of the map is present on the screen at all times with a green dot showing where they are on that map. From a drop down menu in this mode, a list of options is available that can be overlayed on the map, for example public phones, cafeterias, bars, and toilets.

When in the guide mode, a trail is marked on the map with an interesting related set of attractions. The attractions are highlighted on the map in red. When the user walks near a highlighted attraction, the system automatically goes into attraction mode. The user may return at anytime to the guide mode by selecting the guide tab at the top of the display.

The attraction mode acts as a digital tourist guide, supplying the user with sound, images, and textual tourism information. The information is provided as short focused episodes. As the user navigates his or her way around the site, the screen is constantly updated providing new information for the different locations or repeated information from locations previously visited.

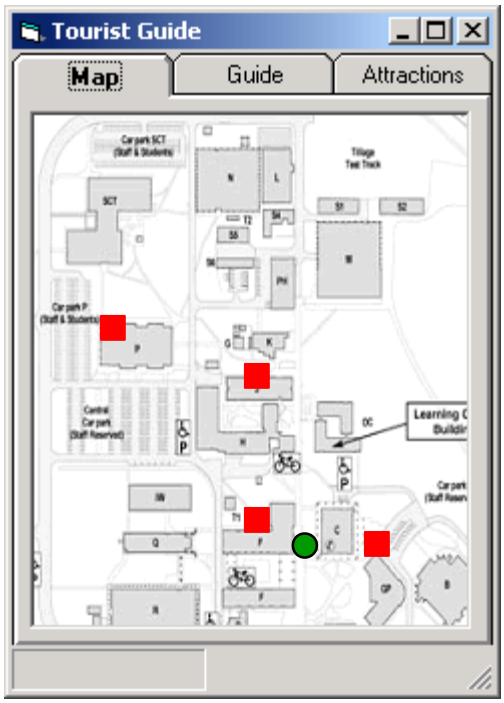

Figure 2. Map Interface

1.4 Progress to Date

The two tours created for the system have been fully developed with a complete selection of the attractions documented into a set of web pages. At this stage there has been two web pages created for each attraction, these pages provide the user a brief understanding of the location, as well as neighbouring attractions. A current open research question is determining the optimal quantity of information to be presented to a user on a small hand held screen.

At present the system has been designed with three separate tour guide modes of operation; these are as follows: map mode, guide mode, and attraction mode. A tour creation system has been developed to support new future tours. A key aspect in the design of the system is that all data required to run the tour be loaded externally from the system, so that any new guide information could be loaded into the tourist application.

2 Background

There have been a number of research efforts into GPS-based hand held tourist applications, and we provide an overview of two of these systems. To achieve the aims of

the project we leverage a number of areas currently being investigated by others, context sensitive computing and mobile computing.

The Distributive Multimedia Research Group at the Lancaster University has an ongoing project GUIDE (Cheverst et al., 2000) to investigate electronic tourist guides in a practical real-world environment. They have been building and testing different versions of electronic tourist guides for the city of Lancaster over the past few years. Their current approach is using wireless communication to a pen based tablet computer.

Compared to our solution, the GUIDE uses a larger device (213mm x 153mm x 15mm in size and 850 grams in weight). This allows for an SVGA resolution display to support a traditional web browser style interface, supplying a rich information service to the user. The wireless communication allows an almost infinite data store for tourism information and services.

Cyberguide (Abowd et al., 1997) is also a hand held electronic tourist guide system that supplies the user with context sensitive information. Initially Cyberguide was developed for indoor tours at the GVU. The system was extended to operate outdoors with GPS. The focus of this system was investigating context sensitive computing, and as such only limited support for tour creation was implemented.

Context sensitive computing (Dey and Abowd, 2000, Herstad et al., 1999, Pascoe, 1998) refers to a program feature that changes depending on environmental conditions of the user during the operation of the application. Context may include: the user's location, people currently interacting with the user, time of day, and current user task. A simple example is of context-sensitive help that provides documentation for the particular feature that a user is in the process of using. Presentation of information and services may be adapted to suit user's changing tasks.

With the advent of mobile phones and hand held computers, mobile computing is fast becoming the norm for personal information spaces (Siewiorek et al., 1998). The use of hand held computing devices communicating via a wireless network has been investigated as a means to facilitate collaboration by Fagrell et al.(Fagrell et al., 2000). Their architecture FieldWise is based on two application domains: first, mobile and distributed service electricians; and second, mobile news journalists. Munger proposes the use of pen-based computing as a means of improving emergency care (Munger, 1999).

3 Design

The Compaq Aero is a pen based mobile computing device; therefore we believe it is relatively simple to operate. We base the user interface on a set of easy to use Windows CE components; this has the advantage of a similar navigation layout to that of other Microsoft Windows applications. The screen size and resolution are the two biggest design issues that we faced during our development. The hand held system has screen dimensions of 240 pixels in width by 280 pixels in height with 16 bit colour. This small screen size therefore limits the number of user interface controls that can be used and displayed. In addition, the size of the fonts, the size of the images, the number of user interface controls all impact the usability of the application.

The limited screen area available constrained our selection of interface controls implemented in the application. As the user interface controls are required to be smaller than normally displayed on a conventional personal computer monitor, it was imperative that the controls be consistent and in predictable positions. Therefore the decision was made to use a traditional menu bar displayed at the top of the screen containing all navigation controls. As screen size and disk space on the hand held is minimal, the content on the attraction web pages is to be kept at a minimum.

As the Tourist Guide is an outdoor application, design issues concerning lighting and ambient street sounds had to be taken into account. Various colours and font representations were informally tested until we and other users were satisfied with the layout and the application's representation in outdoor conditions. By its very nature the system must be sufficiently portable to enable it to be carried and used for extended periods of time. Since the system is designed primarily for use outdoors, the interface must be visible under a range of lighting conditions and viewing angles.

3.1 Designing Web pages for hand held devices

We paid particular attention to the design layout of the attraction web pages; the issues concerning the content, page length, tag support and image support were all addressed during the development. The design goal was to present only the essential information to the user at any given time. As each attraction supported multiple web pages, the most relevant information is displayed on the initial page; this was to ensure each of the pages were not overcrowded or cluttered. We created a template to be used for all web pages that restricted the use to these specific components. We investigated many different designs, but finally settled on an easy to use template. The template has a heading (the title of the tour attraction), a picture (a bitmap image of the attraction), and relevant text of up fifty words maximum. At the bottom of the screen a left and right arrow button gives functionality to the user to choose further information about the surrounding attraction.

4 Operation of the Tourist Guide

We developed a tourist application that made available tours of Mawson Lakes and North Terrace precinct of the city of Adelaide. The tour is loaded via the tour option from the menu bar. All user input is pen based. The different modes are discussed in the following section. From the menu bar within Tourist Guide the user may choose from one of the following options: Load Tour, Exit, Tour Information, Map Information, GPS Information, and Tour Creation. The remainder of this section will discuss the operation of the map mode and tour mode. The tour creation is presented in a later

section. The GPS mode provides a standard GPS visualisation, and as such is not discussed.

4.1 Map Mode

The purpose of this interface is to let the user know where they are in relation to other tour attractions. It displays a dot on the map wherever the user is currently. The map mode involves the creation of a dialog window in which a bitmap image of the required tourist destination is displayed, see Figure 2. The functionality of the Map Information screen is predominately output oriented. The system reads position information from the GPS, calculates the correct pixel position in relation to the map and then paints the dot on a layer above the map. The GPS update is received every second.

The map's colours and annotations are designed to be easily read while displayed on the Compaq Aero's screen, and high contrasting maps are employed. The map mode can also be run in a non-GPS mode with the use of hotspots on the web page map. When a user taps on an attraction in the map the relative information about that attraction is displayed. Therefore a user does not have to travel to that position to find the relevant information.

4.2 Tour Mode

This mode introduces the context sensitive side of the design into the system. It is the main interface for the system, which provides contextual feedback to the user depending on their location. The tour mode displays text, pictures and other multimedia components in the form of an HTML page. Figure 3 depicts two pages from an example attraction. The functionality of the Tour Information screen is to provide the appropriate HTML page relevant to the most recent longitude and latitude position that the system has read from the GPS device. The left and right arrow keys allow the user to move forward and backwards through the different web pages for the attractions. When the user first selects the tour they wish to load, they are automatically switched into this mode of operation. Similarly when the Tourist Guide is being used in a non-GPS mode this interface is displayed after a selection of a hotspot from the map mode. If there is more than one attraction overlapping the user's current position, multiple thumbnail images appear to allow the user to choose the correct web page, see Figure 4. The images for these thumbnails are taken relative to the overlapping position; thus allowing the user to make a mental match between the image and the physical artifact.

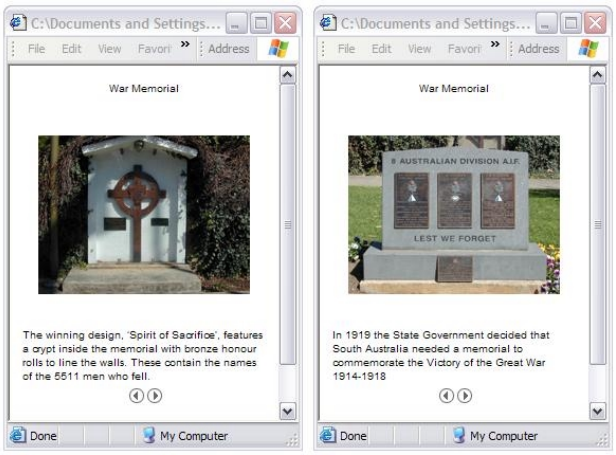

Figure 3. Examples of Attraction Pages

Figure 4. Multiple Attractions

5 Implementation

The implementation of the Tourist Guide as note before was predominately written under Windows CE with Visual C++. This section provides an overview of some of the more interesting aspect of this development. A description of how to create a new travel expo is given, and particulars about the hardware employed in our system are specified.

5.1 Creating Tourist Guides

The process of creating a tourist application and uploading it onto the system was one of the most significant requirements of the system. Throughout the design we emphasised the ability to load all the navigation and tourist information externally. This allows any tourist application to be created and uploaded on additional hand held systems running the tourist application. To be able to create a tour easily, a simple user interface is a key feature of our system. This section describes the process in creating a new tourist expo.

5.1.1 Selection of the Map Image

Creating the map image to be used in the map mode is a central task to the tourist creation process. A few considerations must be taken into account when deciding on the image. The first is the readability of the map once it has been reduced to the correct size. The display on the hand held system is 236 pixels in width by 268 pixels in height. We use the 24 bit BITMAP format, as this is the only image format Windows CE 2.1 will support.

The second consideration is the quantity of information displayed. Small details such as street and building names should be removed, as they are impossible to read once the map has been reduced in size. An image editor may be used to add important features, such as major streets or pathways as needed.

A third factor in deciding what map to be used, is how the image is scaled. If aspects such as buildings and streets have been stretched or skewed their GPS position locations are going to be in error. This can lead to the user being displayed in the incorrect area once the application is running with the GPS system. Selecting a map that is as close to the correct scale as possible will aid in the overall creation process.

5.1.2 Creating the Tourist Guide File

Tourist Guide supports the creation of new tours. The tour file is created using the tour creation wizard incorporated into the Tourist Guide. This wizard (on the Aero hand held device) is initiated by selecting Create menu item then Tour item from the menu bar. Four buttons are implemented, so when a user clicks them the current GPS point is stored to a file. A fifth button has been used to loop through and create more than one attraction point and a final button is used to close the file.

An attraction location is defined by four GPS coordinates that define a polygon around the attraction. To define the polygon, the user walks to the attraction and stands at point 1 of the defining polygon. Once at the point, the user selects the Point 1 button. The user then repeats this process for all 4 points. Figure 5 depicts an example set of points defining an attraction area of interest. Select the next attraction button, the fields will be reset and the user will be able to start on the next attraction. To finish up and save the file select the Finish button.

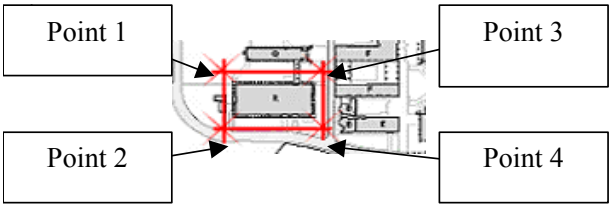

Figure 5. Example set of polygon points

5.1.3 Creating the Hotspot File

A hotspot creation tool has been created to help the user interactively create the hotspot file associated for a particular map that will be used in the map mode of operation. This information is used when the user selects specific buildings about which they require further information. A file needs to be in place so that the position selected can be checked against an array of values containing boundary information for specific attractions. If a match is found the associated web page for this attraction can then be loaded.

To operate the hotspot creation tool, select the Create button then Hotspot button from the menu bar. This tool allows the user to select specific boundaries around attractions. In all cases 4 boundary (x,y) positions are required. This process is similar to the travel expo definition process, as shown in Figure 5. When the user selects Point 1 on the Map an x and y position value will be displayed in the user bar on the screen.

5.2 Creation of online help manual

The online help manual was created using the standard help format and development tools for Windows CE 2.11. The help pages are displayed with the web browser supplied by Windows CE. This provided a stable solution for help within the Tourist Guide. No known knowledge of how to use a hand held device was assumed for this project; therefore online help was essential to make a usable system. The help pages give instruction on how to use the system and also describe what each different menu function entails.

5.3 Hardware Devices

Current mobile computing technologies are resource challenged. They have limited storage of electrical energy, limited computation power and limited memory storage; therefore the appropriate design and choice of hardware was essential in the development of this project. The two mobile devices that we chose to use are as follows: the hand held Garmin 12XL GPS device and the Compaq Aero 2130. The physical specifications of the Aero is 134mm x 85mm x 20mm and a weight of 260 grams. The Garmin GPS device is carried in a small shoulder bag that easily accommodated the size and weight of the device. The reasons for choosing these mobile devices were as follows: the price was relatively inexpensive, provided a sufficient amount CPU, and battery power to suffice for the type of conditions needed for a tour expo.

Factors concerning the availability of GPS reception also needed to be investigated. In both tours building placement and tree coverage posed a serious threat in blocking the reception of the GPS signal. The design had to allow for this, with messages notifying the user of poor GPS signal quality. Other mobile issues such as the battery life of both devices were also areas that required investigation to determine the length of the tours.

5.3.1 GPS vs. DGPS

We investigated the accuracy of the GPS with and without differential correction. The manufacturer's specification for Garmin GPS 12XL stated it has the ability to track a user within a range of 15 metres on average. We found from our investigation that accuracy is much better. In fact we have found that the range is as

little as a radius of ~3.5 meters on average and still closer with the use of a differential system, up to as little as a radius of ~1.5 meters on average.

To determine these results we recorded the readings of our Garmin 12XL GPS device with and without differential correction. For short periods of up to half an hour, twice daily for a week we captured the data. The freeware program called VisualGPS[1] helped us calculate the standard deviation of the longitude and latitude of the current position of the device. It was installed on a laptop computer and a serial connection from the GPS device was use to transmit data to the laptop. Over 20000 samples where read in this time and calculated in separate sessions. The graphs below show the displacement for the DGPS (Figure 6) on average is much smaller than that of the GPS device (Figure 7). The ellipses in the graphs indicate the area formed by one standard deviation around the mean.

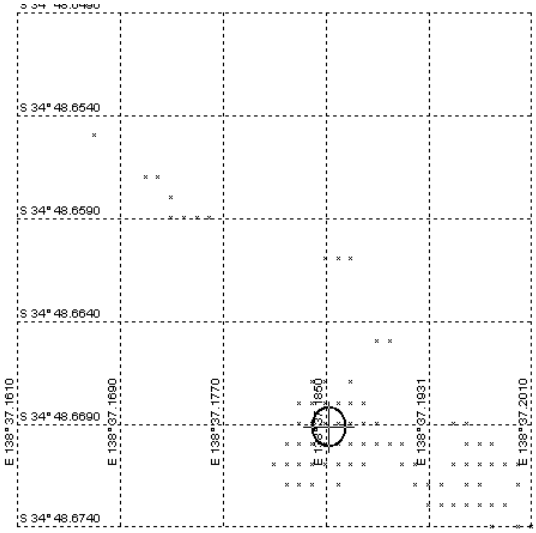

Figure 6. Plot of DGPS positions

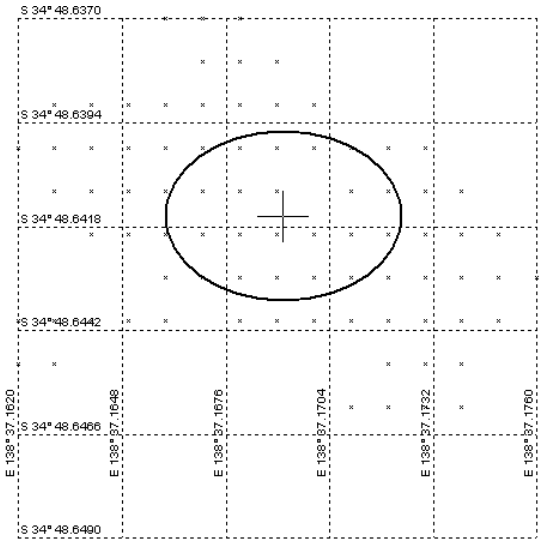

Figure 7. Plot of GPS positions

[1] http://www.visualgps.net/VisualGPS/ last visited Dec. 1st 2002

With relation to our project the accuracy of the GPS was quite sufficient. We did not need to use a DGPS to provide further accuracy. It would have been more accurate but not as practical to use in terms of the costs of the DGPS equipment and the extra weight of the equipment. The standard deviation of the mean values of GPS and DGPS and the difference between the GPS and the DGPS standard deviation are shown in Table 1 in meters. From our investigation, we have found that a DGPS capable device is ~50% more accurate than that of a GPS. If needed in the future, our project has the option of providing a more detailed tour expo giving the user smaller and more defined attractions to view.

	Long	Lat	Elev
GPS	3.18 m	4.23 m	16.73 m
DGPS	1.82 m	1.64 m	3.93 m
Difference	1.36 m	2.59 m	12.80 m
Percentage	43%	32%	77%

Table 1. One standard deviation from the mean of the GPS and DGPS location data, as measured in metres

6 Conclusion

We have designed and implemented a Tourist Guide system that is mobile and also context sensitive. Our system was designed around the user's current location by using the standard GPS infrastructure. A suitably simple but elegant software design produced a powerful but easy to maintain location based travel expo.

We have also researched the strengths and weaknesses of both GPS and DGPS and have found that for our system the accuracy of GPS is sufficient for the needs of our Tourist Guide system. Even though DGPS is 50% more accurate than the standard GPS, DGPS is not required for this type of project.

The final prototype is functioning but not a commercial grade product. There is still more functionality that can be added to this system. Due to limited resources within the Compaq Aero model being used, multimedia design issues such as sound and streaming video are some aspects that could be looked at if a new hand held device with faster processing and storage capability is used. The use of the system over a wireless network is also being investigated. Here the pages would be streamed and loaded as required through the network rather than being stored and loaded internally on the hand held system.

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