Environment Aware GPS

Group 2
October 14, 2003

Faculty Technical Advisor:
Prof. Bruce McNair

Group Members:
Christopher Dong
Allan Flores
Omar McGann
Vikram Soni
Nicole Taylor

Stevens Pledge
“We pledge our honor that we have abided by the Stevens Honor System."

Table of Contents

I. Abstract

The Global Positioning System (GPS) is one of the hottest technologies to permeate the consumer market from its military origins. GPS receivers are excellent at providing precise positional data on the globe, yet a vast potential for greater utilization of GPS technology as an interactive informational delivery aid remains to be tapped.

A large realm where this potential could be unleashed is in the travel and tourism industry. Current GPS systems for the consumer market make minimal use of the information provided by the technology. Our project intends to add environmental awareness, which the group defines as the ability to provide detailed information on what is situated at and around a particular location, and what is interesting or important about it, to portable GPS devices. By simply walking around and exploring, a user can get a full and insightful account of a locale, including information such as the history of a statue or building, or perhaps that a restaurant near a particular location is highly regarded and is a "must-stop" eatery.

The group's approach to technically creating the described system involves the amalgamation of several existing technologies. The platform for this system will be a Personal Digital Assistant (PDA) attached with a compatible GPS receiver module. The group will also develop a native application and database for this platform capable of providing the described usage.

Upon completion of this project, it is expected that the group will be able to produce a working prototype as proof-of-concept for this technology, by

demonstrating its effectiveness in and around the group's home base, the Stevens Institute of Technology campus.

II. Project Proposal Plan

II-1. Introduction

The application of GPS technology for the consumer market can still be considered in its infancy. The systems currently available can provide the location of a user on the globe, the location of a desired destination, and instructions on how to navigate to a set of coordinates. Products from companies such as DeLorme (www.DeLorme.com) even provide the ability to locate a particular restaurant, address, or shop, which is useful if a user knows of their existence. Yet, there is a deficiency among these applications – all they do is tell the user where something is. Compelling reasons why a user should care about what they have located using GPS do not exist, and the overall experience of simply finding places can seem empty and incomplete. To enhance the experience of using GPS devices for travelers, tourists, and explorers, the group's project is to create and environmentally aware GPS. As the group envisions it, an environmentally aware GPS not only fills in this knowledge gap by displaying the existence of these places, it also provides the benefit of describing the human experience of these points of interest. This idea is not unprecedented; a company such as Zagat collects reviews of restaurants, bars, and nightclubs from the many patrons of these establishments, and a service such as Citysearch.com offers a compilation of human experience for these types of establishments and many others. By bringing this level of human detail into a GPS device, the entire

market for these devices can extend past a niche and into the enormous population of world travelers.

II-2. Design Requirements

In order for the group's project to be practical, several requirements must be satisfied, the first of which being that the device must be mobile. A user must be able to easily carry the "environmentally aware" system through and around a locale for the desired functionality to be realized. This requirement places a restriction on the physical size and weight of the system. It also introduces a strong need for portable power; as the envisioned device is a mobile one, and it should be battery powered with a life of no less than 5-7 hours. This should provide ample time to allow a full day's use of the product without interruption. The catalog of suitable existing technologies the group can use to realize the system is narrowed significantly by this preliminary requirement.

The other crucial requirement for the system to operate properly is the ability to maintain a semi-constant stream of positional data from the GPS satellites. With the focus on providing environmental awareness in urban areas, the particular receiver should be able to operate sufficiently in "urban canyons", and have an ability to maintain tracking in weak signal situations. Hand in hand with this is the need to have enough positioning accuracy to detect a defined area around a human being. The estimated range of the GPS receiver that will be needed is approximately 10m, based upon the size of a human being, and the abilities of existing receiving modules. This combination of these design requirements on the GPS receiving component is most important to realize the system as described.

To provide the environmental information to the device, the group will use the coordinates given from the GPS receiver as query data for a robust database. The particular data stored on the device will be divided into different regions of coverage, and thus should be placed on a form of high capacity removable memory due to the projected volume. Because all regions are not identical in both size and content, there will be customization for particular locations. For example, an area such as New York City is so large and detailed that it would be isolated onto its own flash card. Conversely, an area such as the Midwest could incorporate multiple cities into a single storage media.

In order to convey the sense of environmental awareness, the full-color display of the device will be required to change passively as the user changes his or her location. It will highlight places of interest near the user's current position, providing not only directions, but also historical information, anecdotes, and possibly feedback from previous visitors. There is also the potential for the use of satellite imagery - the group would use these pictures to associate a visual element with the various sites incorporated into database.

The entirety of these design requirements will allow the group to engineer a system that makes interesting use of GPS technology for the wide consumer market. In all the research conducted by the group, there seems to be no severe technological impediment to fully achieve the "environmental aware" GPS system described in this proposal.

II-3. Design Approaches

II-3.1 - Hardware

There are a variety of options for the group to assess when it comes to choosing the hardware for our project. The basic setup will require a portable device and a GPS receiver, but there are a multitude of options that satisfy this projected arrangement

For the portable device, it has been decided that an electronic handheld information device (PDA – Personal Digital Assistant) with the ability to connect a GPS receiver is the most practical approach to more quickly develop this project. This PDA needs to have sufficient processing power to run the software that will be developed by the group, which will be discussed in more detail below. Typical technical specifications sufficient of PDA's that support GPS receivers are as follows: a 400 Mhz main processor, 64 MB or more of RAM, 32 MB or more of ROM, and a 16-bit TFT active matrix screen. As for the operating system, a Windows Pocket PC based PDA or a Palm OS based are the two possible approaches, with the rationale elaborated upon in the software approaches below.

One major additional requirement of the PDA is that it will need to have available both USB and compact flash ports. The primary rationale for this constraint is that many of the "off-the-shelf" GPS receivers targeted for use, and elaborated upon below, are plug-and–play devices that interface via the flash port or the USB port. However, the flash port will be needed to accept Compact Flash cards storing the significant quantity of information about different urban environments, and there will be the need to exchange different flash memory cards for different cities. One would

think that a GPS receiver that plugs into the UBS port must be required; thereby ensuring the flash port is free for memory. However, as it turns out, there exist GPS units that attach via a PDA's native connector, and provide a free slot for a Compact Flash card anyway. Thus, many different hardware approaches are possible with regards to selecting a PDA for use.

The GPS receiver that will serve as the other major hardware component of this project will need to be small and portable so it is convenient to carry around with a handheld, and models of suitable receivers such as the DeLorme Earthmate weigh in at only .4lbs. It will also be required to have a sufficiently high range of accuracy since the function is to find points of interest surrounding a human user. Another aspect that the receiver must fulfill to practically serve this project is the direct ability to connect to a handheld PDA, and the most convenient interface that most GPS receivers have is USB connectivity. It is possible to either connect directly to the USB port of a handheld directly, or in most cases, buy a cord that connects to the handheld on one end through its proprietary interface and via USB port to the GPS receiver. While working on programming the details of the environment aware application, it will be useful to use software that can emulate a PDA on the laptop. Using the emulation software will necessitate having the GPS receiver work with a laptop, and using a USB connected receiver will ensure this, thus creating the necessity to strongly consider using only a USB capable unit instead of one specific to a particular model of PDA.

The final hardware component to complete the overall system functionality would be a compact flash card. The reasoning behind the flash card is that information for

specific areas will be stored on individual cards. As a user travels from one location to another, as in going from one city to another, the user would be able to switch flash cards and have all the data on hand for the new city. Depending on the size of the city there will be a greater need for the flash card to have a higher capacity memory, with a minimum set at 256MB. This estimate is garnered from the high level of detail and multimedia the group expects to incorporate into the "environmentally aware" information presented to the user, as well as the wide area the group expects the project will be able to cover.

In summary, the particular hardware requirements and possible models for this project are shown below in Table 2.3.1.

Parts List	Possible models
Handheld	any handheld with USB port and flash card port – Dell Axim, Compaq iPaq, Palm m500,
GPS receiver	Navman GPS 3450,
	Magellan GPS Companion
	DeLorme Earthmate GPS for Handhelds
Compact Flash Card	Lexar Media Professional 2GB CompactFlash 40X w/ Image Rescue, Type 1
	Lexar Media Professional 512MB CompactFlash 40X USB
	San Disk 256MB CompactFlash Memory Type I

Table 2.3.1 - Projected Hardware

II-3.2 - Software

Throughout the development of the product, various application development approaches will have to be considered. The first consideration is whether to develop for the Palm OS environment or the Windows Pocket PC environment. The team has researched the different types of tools that are available, and with the existence of Microsoft eMbedded Visual Tools it seems the task to develop for the Windows platform will have a shorter cycle.

The tools that were initially researched included Microsoft eMbedded Visual Basic, but after some reading, the team has decided to move away from using eMbedded Visual Basic because Microsoft, along with many other developers, have decided to phase out this language and replace it with a more powerful Visual Basic .NET language. Since eMbedded Visual Basic is a scripting language as opposed to a full language, there are many drawbacks to using the eMbedded Visual Basic as opposed to the other Visual Tools. Foremost among these issues is that eMbedded Visual Basic uses the Visual Basic language and enables the applications. Yet, since the resulting code is interpreted at run time, performance will suffer and it will not be a good choice to use this programming language. Depending on the hardware the group will acquire, it also may not be feasible to use the eMbedded Visual Basic to program the device because certain handheld devices do not have the runtimes to support the language.

The Visual C++ language is a separate development environment and can be used independently. The Visual C++ provided by Microsoft offers a native code compiler that can be used with the product that is being developed by the team. Visual C++ code can be executed on any Pocket PC, any application that can run natively on the device, and applications that use high-speed graphics can be created using it. Depending on the language selected to code the project on the Windows-based mobile device (i.e. Pocket PC), it will be necessary for the team to acquire the required platform Software Development Kit (SDK), and is provided as a free download from Microsoft's website, further supporting the use of a Windows based PDA device.

The Smart Device Programmability (SDP) features of Visual Studio .NET also provides many advantages to assist the development of a fully functioning "environment aware" system. One such advantage is the extensive class library available through the .NET Compact Framework which allows applications to be written much faster than with traditional tools. Another advantage is that the same development tools can be used for desktop, server, and device programming, and provide portability for different devices.

ASP.NET Mobile Controls is an extension to the .NET and Visual Studio .NET framework, which can be used to build mobile Web applications by enabling ASP.NET. With this technology the group will be able to develop a single mobile Web application that will adapt the information for use in the PDA/Pocket PC. It enables developers to integrate information into Visual Studio .NET by allowing the "dragging and dropping" of various controls on a mobile web form. Another advantage of ASP .NET is that it does not require the downloading of any components onto a device because it uses server-side logic and generates a wireless markup, HTML, and compact HTML. Using this Mobile control also allows developers to change devices that the program is targeting very easily.

Finally, the data that will be used in this project will need to be stored in database, and for practicality the group has decided to have a local database on the handheld device so that information can be retrieved easily. The group will research Microsoft SQL Server 2000 Windows CE Edition heavily because it is used for data management in mobile devices. SQL Server CE also allows remote data access and merge replication that ensures reliable data is delivered. The data that is delivered

can be manipulated offline and then synchronized to the server at a later time. The availability of a version of SQL specific to the Pocket PC OS further enhances the groups lean toward following the Windows software development approach.

II-4. Financial Budget

This budget would be dedicated to acquiring the hardware and software necessary for our project. The core of our item's list is a GPS module, a current PDA, and software for programming. In each category, we have options depending on the approach or constraints of the project. In terms of quantity, our minimum requirement is 1 of each item for the prototype. Ideally, the right sponsors would offset the cost of materials (i.e. PDA on loan).

Currently, this project is controlled by students in a senior design. Any consideration of personal/employee wages would be reviewed in a proposal revision when the project is ready to be marketed.

Hardware: GPS module choices

- DeLorme Earthmate GPS for Handhelds	$240	
- Magellan GPS Companion		$100
- Navman GPS 3450		$280
- TF30-CF Card GPS (Compact flash card format)	$135	

Hardware: PDA

- Any handheld with USB and flash card port (examples listed)	$180-$700
Dell Axim X5	$300
Toshiba Pocket PC e350	$249
HP iPaq H2215	$399
Palm m500	$180
Compaq iPAQ H5455	$500
Compaq iPAQ H3835	$250

Hardware: Database Storage size options

- SanDisk 256 MB CompactFlash Card Flash Memory		$70
- Lexar Media Professional 2GB CompactFlash 40X	$700	
- Lexar Media Professional 512MB CompactFlash 40X USB	$200	
- Lexar Media JumpDrive 128MB USB Flash Drive (PC/Mac)	$40	

Software choices (for programming)

- Microsoft eMbedded Visual C++ 4.0 SP2	Free	
- Microsoft eMbedded Visual Basic 3.0		Free
- Microsoft.NET Compact Framework		Free
- Microsoft SQL Server 2000 Windows CE Edition Version 2.0		Free
- MS Visual Studio .NET Professional 2003 – license (eng-acad)		$70
- MS Visual Studio .NET Professional 2003 – full product		$640

Miscellaneous

- Laptop (backup PDA emulator / mock database server)		$2000
- Appropriate Programming Books	$400	
- Office supplies (printing paper, printer ink, cd-r)	$100	
- (Optional) Programming advisor fees / Database research	$200	

Total Financial Budget (high estimate): $5,020

Total Financial Budget (low estimate): $640

High estimate is based on picking the most expensive options (retail prices) and including miscellaneous category. Low estimate is from assuming that miscellaneous category is covered by personal property, free/licensed software option, and competitively priced hardware options.

II-5. Project Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Fall Semester Work**	**136 days?**	**Mon 10/13/03**	**Mon 4/19/04**	
2	**Economic Analysis**	**135 days?**	**Mon 10/13/03**	**Fri 4/16/04**	
3	Business Model	2 wks	Mon 10/13/03	Fri 12/12/03	
4	Volume Estimation	2 wks	Mon 4/5/04	Fri 4/16/04	
5	Capital Estimation	4 wks	Mon 10/13/03	Fri 11/7/03	
6	Product Cost	4 wks	Mon 10/13/03	Fri 11/7/03	
7	Price Estimation	4 wks?	Wed 1/14/04	Tue 2/24/04	
8	Labor Cost Est	4 wks?	Mon 10/20/03	Fri 11/14/03	
9	Sales, R&D Costs	3 wks?	Mon 2/16/04	Fri 3/5/04	
10	Depreciation	3 wks?	Wed 12/24/03	Tue 1/13/04	
11	After Tax	9.2 wks?	Mon 11/3/03	Fri 1/16/04	
12	Financial Leveraging	4.69 wks	Wed 12/17/03	Thu 1/29/04	
13	Break-even Analysis	3 wks?	Thu 11/13/03	Fri 12/19/03	
14	Sensitivity Analysis	4 wks?	Mon 11/17/03	Fri 3/26/04	
15	Patent Analysis	4 wks?	Mon 1/19/04	Fri 2/13/04	
16	**Software Development**	**123 days**	**Wed 10/15/03**	**Fri 4/2/04**	
17	Feature-Function Requirement Definition	8.2 wks	Wed 10/15/03	Fri 12/26/03	
18	Use Case Definition	3 wks	Mon 10/20/03	Fri 11/21/03	
19	Interface Conceptual Layout	3.4 wks	Mon 11/24/03	Fri 4/2/04	18
20	Satellite Imagery Integration Planning	3 wks	Tue 11/25/03	Fri 1/16/04	19SS+1 day
21	Hardware Communication Planning	2 wks	Mon 1/19/04	Fri 1/30/04	20
22	UML Diagramming	5 wks	Mon 2/2/04	Fri 3/5/04	21
23	Database Planning	4 wks	Mon 3/8/04	Fri 4/2/04	22
24	**Hardware Development**	**12.5 days?**	**Mon 11/17/03**	**Wed 12/3/03**	
25	Analyze hardware	5 days?	Mon 11/17/03	Fri 11/21/03	
26	Produce instruction set	1.5 wks?	Mon 11/24/03	Wed 12/3/03	25
27	**Project Material Procurement**	**30 days?**	**Mon 10/13/03**	**Fri 11/21/03**	
28	Contact Companies	6 wks?	Mon 10/13/03	Fri 11/21/03	
29	Senior Design Presentation	1 wk?	Tue 11/18/03	Mon 11/24/03	
30	Economic Analysis Presentation Development	1 wk?	Tue 11/18/03	Mon 11/24/03	
31	Website	5 wks?	Mon 10/13/03	Fri 11/14/03	
32					

ID		Task Name	Duration	Start	Finish	Predecessors
1		**Spring Semester Work**	**70 days?**	**Tue 1/13/04**	**Mon 4/19/04**	
2		**Software Development**	**70 days?**	**Tue 1/13/04**	**Mon 4/19/04**	
3		**Interface**	**25 days?**	**Tue 1/13/04**	**Mon 2/16/04**	
4		User input	5 wks?	Tue 1/13/04	Mon 2/16/04	
5		Asthetic design	4 wks?	Tue 1/13/04	Mon 2/9/04	
6		Hardware communications	3 wks	Tue 1/13/04	Mon 2/2/04	
7		**Database**	**35 days?**	**Tue 1/13/04**	**Mon 3/1/04**	
8		Information Research	6 wks?	Tue 1/13/04	Mon 2/23/04	
9		Programming	7 wks?	Tue 1/13/04	Mon 3/1/04	8SS
10		Satellite Imagery Integration Planning	5 wks	Tue 1/13/04	Mon 2/16/04	
11		Operating System Integration	4 wks	Tue 1/13/04	Mon 2/9/04	
12		Main Application	14 wks	Tue 1/13/04	Mon 4/19/04	
13		Final Presentation	2 wks?	Tue 4/20/04	Mon 5/3/04	2
14		Final Economic Tally	1 wk?	Tue 4/20/04	Mon 4/26/04	13SS
15						
16						
17						
18						
19						

The project schedule presented here shows the projected work for both the fall and spring semesters. The fall semester schedule includes work associated with the complete economic analysis of the project. The project entails a major software engineering effort, which is broken down into its composite parts.

III. Conclusion

The potential for growth in the commercial applications of GPS technology remains vast. The group's project intends to tap into this promise by creating an information delivery system attractive for a broad user base in travel and tourism. The level of detail and human feedback provided to a user by the "environmentally aware" mobile device the group will engineer are features of a "killer application" for the consumer market that will promote the widespread sales growth of GPS hardware products.

It is expected that the group will be able to fully demonstrate the functionality of this "environmentally aware" device with a working prototype. This archetype will be able to receive GPS signals and passively display information specific to the surrounding area onto a screen. As a user makes his way in and around a setting, the information will change and update based upon the changing environment.

This proof-of-concept model that will be engineered as described in the group's design approaches will combine existing technologies in GPS receivers and handheld electronics with a robust application to intuitively deliver information to a user. It is expected that this prototype will be completely usable upon conclusion of the program for a predefined area because the approaches described tap into the heap of available technologies. What the group will do is synergistically combine them to demonstrate the wide ranging possibilities of the GPS system.

IV. References

Deighton, N., N. Jones. "Location-Based Services and Telematics." Gartner Research.

"Global Positioning System." IEEE Virtual Museum. http://www.ieee-virtual-museum.org/collection/tech.php?taid=&id=2345902&lid=1

"Introduction to Development Tools for Windows Mobile-based Pocket PCs and Smartphones." Microsoft.com http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dnppcgen/html/devtoolsmobileapps.asp

Wood, Ben. "Wireless Location Services for Telematics Have Yet to Thrive." Gartner Research.