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## **Abstract**

Purpose of project PAL: Parking Auto Locator is to address the needs of motorist in a cost effective manner. PAL will provide assistance in locating a person's vehicle no matter its location, but will be especially effective in densely packed automotive areas such as parking garages, large parking lots, and urban streets.

The goal and the main problem to be addressed are the one in the same. The first goal is to easily locate the automobile within a specified region. The idea is for the user of PAL to locate his or her vehicle using a Handspring personal digital assistant (PDA) in conjunction with a global positioning system (GPS). The device will be effective worldwide in a variety of environments anywhere from small parking lots, to large multi level parking garages found in commercial areas such as football stadiums and shopping malls.

Project PAL was meant to conclude with the development of a working hand held prototype with an intuitive interface that met the design specifications, which included the ability to locate an automobile within a certain parking range and to consistently maintain operability of the device using an automobile based recharging base. All of these features were to be found in a user friendly as well as small package device making it a worthwhile yet unobtrusive addition to any individual's electronic portfolio. Although these goals were within easy reach, problems in the developer's software kit prevented the upload of the PAL software onto the Handspring PDA.

## **Introduction**

The original concept behind the Parking Auto Locator (PAL) was to build a device that would have enabled an individual to quickly and simply locate his or her vehicle anywhere within a radius of approximately one-quarter to two miles. The PAL would have employed two transceivers, one located on a base station mounted in user's automobile and another located on a small, portable handheld device, which would have been carried by the user. These transceivers would have communicated with one another to display the location of the automobile on the handheld's LCD screen.

This design was based on the simple fact that very few designs for a device of this type have been developed and that the United States Patent Office has issued no patents for a commercial automobile location-finding system. Based on market research, demand clearly existed for such a product, especially in areas of high population density with endless parking lots and city streets packed bumper-to-bumper with automobiles. Pursuing the original PAL concept seemed prudent.

The challenges the PAL system had to overcome however were many. In areas of high population density such as cities, signals are limited in how far they will travel before a building, a highway overpass, or other type of obstruction blocks them. Consequently, the team felt that if an appropriate frequency band and power rating was selected, multipath problems could be overcome. After continued research, the problems of overcoming multipath interference mounted until the project was no longer convenient or cost-effective. Estimates placed the final cost of the design well above \$1000 for an incomplete product. In the end, no consumer would purchase this device, no matter how convenient. As a result of the design team's continuing research, the

original design had proven unfeasible due to a restricted knowledge base and an inadequate monetary supply.

The team then decided to review its initial requirements. Originally, a decision was made to avoid the use of GPS because of its high cost. After weighing the \$1000 cost of the original design and looking further into GPS systems, it was decided to reconsider that decision. GPS devices can be found on the market for a little as \$120, are compact and portable, and can operate worldwide in any outdoor condition and many enclosed areas with line-of-sight to the open sky.

That being the case, GPS was a valuable tool to allow not only one's parking location but also route tracking. The team's only concern was the addition of another electronic device to the modern individual's already extensive portfolio, which normally consists of a cellular telephone, a PDA, and sometimes a third device. Faced with carrying a fourth electronic device, the team was sure no one would be willing to carry such a product, regardless of its added benefits. The search was on to find a solution to this dilemma.

## Prototype Specification

The answer to the dilemma of carrying numerous electronic devices was found in the Handspring series of personal digital assistants (PDAs), which have a port for additional modules, including GPS units. One such module, purchased by the team for testing, is the HandGPS Pro with Rand McNally's StreetFinder. Used in conjunction, the Parking Auto Locator was meant to operate in the following manner:

The user was required to own or purchase one of the many available Handspring Visor units. He or she would then have to purchase a compatible GPS module. The aim of the PAL is to allow the user to record the traveling and resting position of his or her vehicle. This was to be done when the user set the Handspring unit in a cradle inside the car which would have also acted as a recharging base. When the ignition was turned on, a signal would have been sent to the Handspring to begin tracking the user's location. This signal could have been sent either via the physical port at the bottom of the Handspring or via the infrared port. Visual Basic programming would have allowed the Handspring to interpret these signals. When the engine was turned off (ignition to the accessory position), a signal would have been sent to the Handspring to stop recording and note the user's final position.

The PAL was to be a "set it and forget it" device. The user would not have had to intervene with the operation of the Handspring/GPS during the drive. The purpose of continual recording was to prevent the user from becoming totally lost in the event that he or she enters a covered area, such as a parking garage, where the GPS signal will cannot be received. Once parked, the user was to remove the Handspring from the cradle and go about his or her business. When the user desired to return to his or her automobile, the Handspring unit would have direct the user resting position of the car using simple directions such as "turn left" or "turn right."

Since GPS also records altitude, it will be possible for the GPS unit to direct the user to different levels of a parking garage.

Unfortunately, the goal of having a PDA-based automobile locator was never realized. The un-realization of fully developed PAL software was mainly due to a bug found within the developer software that was being used, Falch.net.

The developer studio provided by Falch.net, a Norwegian based software provider for the PalmOS operating system. The software was an all in one developer's package for PalmOS. The software was GUI based, as you would create the program based on a style format. Many of the items required for the software menus were drop and drag items found within the software itself. The object of the group as described before was to develop a parking auto locator based on off the shelf items. Initially described PAL was to be a hardware-based solution, but as the project progressed it become more evident that PAL would be a software solution. Realizing the software solution and using the idea of off the shelf we decided to create a niche function for the already existing GPS device found for the Handspring Edge. Palm and Handspring provided several avenues of software development support including resources for development and samples. From here we found Falch.net where we downloaded their developer studio under a 30-day trial period. The developer studio required downloading Palm's Software Development Kit (SDK) 4.0 file to let us build and download our programs on to the PDA. However, following the given directions, as well as help files we were unable to solve the problem of PalmOS68.h file missing from our SDK package. The absence of this file caused the inability to further test our actual program in the actual PDA environment.

The basic idea of the program was to create an interface between the user and the GPS device/software that was easier to understand and focused on a certain task rather than just a

general interface. The basic idea was for our device to give you limited buttons hence not to confuse the user and yet enough to do the task at hand. The program using the GPS libraries and calling on the GPS unit itself would help store the car's current location and then locate the car when the user wanted to go back. The program then activated would generate a simplistic general bitmap with a line to your car with direction and distance. The unit would continually refresh the bitmap every few seconds to give you an updated view till you found your car. This method was referred to as point-to-point because it would give you a direct line using two compounding methods of Pythagorean theorem and the Dijkstra's algorithm for the shortest path from point-to-point by using the fact the GPS unit creates points for each step. With this all in hand we developed the program in Falch.net and making any specific changes using our knowledge of C++, but upon the building of the program we encountered the SDK problem. Since we did not actually purchase the developer studio we were not provided with adequate support while Palm and Handspring only provided libraries after we registered as developers.

Realizing this problem we began to scramble on how we could show our goal with the limited time, MS Visual Basic (VB). Using VB we created a simulation of PAL that brought the point across of what was the actual goal of our group. The simulation showed how an user would interact with the device and what ease it would provide for the user in locating his or her automobile.

The program based solution also provided a better entry market solution. Based on our survey results the effectiveness of selling a total new device would have proven more difficult than just having a piece of software you could download from the sites granted you have said device. Making PAL easier to integrate into society and in time more fashionable to be purchased as stand alone device or a software package provided by the GPS unit designers.

Based upon these ideas we developed our current PAL status and software based solution with more time can be refined and greater enhanced for more desirability based on people's needs.

Finally, simple time constraints prevented the construction of an automobile-based recharging cradle. Also the idea of the device automatically saving the current car location is another enhancement based on the cradle because as it is removed from the cradle the device would save the location. The idea of not forgetting to remove the device would be based on an alert when the car doors are opened and shut. These are some future additions that can be put into the hardware side and further developed because the background knowledge provided by the PAL team.

### **Prototype Performance and Evaluation**

As the actual PAL software was never uploaded on to the Handspring PDA, a test of our software's technical function was impossible. However, it was possible to test both the effectiveness of the Global Positioning System and the practicality of our software design.

The GPS system employed allowed the user to set a beginning location and track the path taken. The test involved three individual users marking the location of an automobile in a densely populated environment, the City of Hoboken, New Jersey. The users then allowed the GPS system to track their path as they walked a distance away from the vehicles until they were out of sight. The test concluded successfully when all three users were able to navigate back to the automobile using the admittedly complex GPS tracking map. (The PAL system would have provided a simple and direct return path to the automobile.)

A test of the software design was equally successful. The test was conducted by having non-technically-minded individuals use our simulation software at a recent Senior Design exposition. In each case, the individuals were able to set the starting location of their vehicles with a simple touch. All persons understood they were then permitted to walk anywhere, and, in order to find their automobiles, were required to touch one button. All users then stated that they understood how to navigate back to their automobile's location using the on-screen map. This positive response was deemed a successful test of the PAL software.

### **Financial Budget**

The majority of the financial costs incurred to the group came in the cost of the PDA unit and GPS unit. The cost of the Handspring Visor unit was \$195.69. The GPS unit was slightly more expensive, at \$247.99. Finally, a total of \$10.29 Was spent on presentation costs, specifically for the poster board used to create the poster for senior design day. The total cost to the group members for all project related purchases was \$453.97. Of this, \$250 should be reimbursed to the group by the Electrical and Computer Engineering department's senior design budget.

To keep costs low, free student evaluation version software was used to develop all code created. While this meant that the group didn't need to pay for the Falch.net developer's studio software, it also meant that the software created had to be shared with other users of the software package in an online forum. The members of the group did not see this as a negative point, however, as it affords the project opportunity for future development by design groups, within Stevens Institute of Technology or otherwise. Also to keep costs low, the group members used materials already in their possession for presentations. For example, the laptop owned by one group member was used for demonstration of a simulation during senior design day, and various office supplies were used for the poster.



## Conclusion

The Parking Auto Locator, although not developed into a successful prototype, proved a successful design. If not for a glitch in the developer's kit, the PAL would have proven an absolute success, allowing individuals to locate their automobiles with a simple touch of a button on their Handspring personal digital assistant.

The major benefit of the PAL Parking Auto Locator is its simplicity of operation. A user would simply have to press one button to save the location of his or her automobile. That user would then be free to complete a day's activities without the hassle of remembering the exact location in which he or she parked. When the day finished, the user would then press another button and would be provided with a simple and direct return path to his or her automobile, accurate to within 30 feet.

The outlook for future development of the PAL is bright. Recommendations for improving the Parking Auto Locator include purchasing the full version of the developer's software in order to receive full technical support, allowing the PAL software to be uploaded onto the Handspring PDA. The location software could be improved to include a street map of the areas in which a user most commonly parks, allowing that user to be comforted by familiar reference points and to avoid navigating around objects such as city blocks which are not presently account for in the first phase of the PAL software. The incorporation of new software technologies such as Pseudo-Lite could allow for continuous operation of the PAL, even in enclosed environments where the GPS signal would fail. This would ensure that a user to locate his or her automobile not matter how enclosed its location. Finally, helpful features such as the inclusion of waypoints—the location of gas stations, rest stops, lodging facilities and

convenience stores—could be added to the software to make the PAL user-friendlier. These additions would make the PAL an indispensable companion for any road traveler.