A Global Positioning System Course for Non Electronics Majors

Terrence Kelly, John Cremin

Parks College of Engineering and Aviation
Saint Louis University

Abstract

The Avionics Program in the Aerospace Technology Department of Parks College of Engineering and Aviation of Saint Louis University offers a course, GPS: Applications, for non-avionics and avionics majors. The course has no prerequisites and operates as a semi-independent study course. The class meets together during the first half of the semester to cover the basic operation and interfacing of Global Positioning Systems (GPS). In the second half of the semester students concentrate on developing entrepreneurial GPS applications. Applications documented thus far include:

- Low cost systems to assist the Botswana Army locate Park Rangers who become engaged with poachers in the jungles and forests of Botswana.
- A low cost timekeeper for a PC using QBASIC and a hiking class GPS receiver.

During the Fall 2001 semester, investigations included projects on:

- The use of GPS in identifying and mediating traffic backups in the St. Louis area[1].
- Application of GPS techniques to a robotics navigation and communication subsystem[2].
- The use of GPS and "Geocaching" for recreation/entertainment while providing environmental preservation.

This paper will outline the learning objectives and examine the criteria and process used by students in the selection of an entrepreneurial application of GPS technology by students who are not electronics or avionics majors.

Introduction

The GPS Applications course began as an independent study course for avionics majors. The course attracted students in other majors and a separate technical elective course on GPS Theory and Applications was developed for avionics majors. The newer GPS theory and applications course for avionics majors provides greater detail on signal processing and interfacing while the

original GPS Applications course provides the theory at a level sufficient to release the entrepreneurial appetites of non-avionics majors. The course continues to attract avionics majors with an entrepreneurial bent and an interest in global positioning systems.

Student learning objectives include:

1. Understanding the U.S. NAVSTAR system in terms of the system elements including satellite, ground control, and user segments.
2. Understanding the role of time in determining position.
3. Understanding the role of atomic clocks in GPS satellites.
4. The purpose of coding in GPS.
5. The ability to develop an entrepreneurial application of GPS to a field of interest and write a paper on the application.

Objectives 1 to 4 are evaluated by quizzes based on student reading and class discussions about the material in three tutorials available on the Internet[8, 9, 10]. Students are also evaluated based on assigned Internet search topics and subsequent class discussion. Topics such as Differential GPS, Geographic Information Science, Remote Sensing, Attenuation of GPS Signals in Buildings[11], and Pseudolites[12] are examples of assigned topics. Students post the links they find most appropriate and understandable on WebCT[13], an Internet tool used at Saint Louis University. WebCT has a Bulletin Board feature that allows the instructor to track student activity in an independent study format.

Fifty percent of the student grade is based on the accuracy of the content and the potential of the project for developing a proposal for funding or a potential product. Students are required to develop an oral/electronic presentation for the class, instructor and interested faculty members at the end of the course. The Notes section of the electronic presentation contains the written, narrative portion of the presentation and is posted on the WebCT Course Bulletin Board.

The following sections of this paper will focus on describing the non-avionics major's applications.

An Information Technology Support (ITS) staff member developed an application involving GPS as an element in detecting and avoiding traffic jams[2].

GPS and Traffic Jams

The ITS staff member started with the idea of finding a way to use GPS to avoid traffic jams on his commute to the university. From class discussions involving applications, the traffic jam avoidance project developed in to a system involving a central computer data base, low cost GPS receivers with an NMEA interface to a cell phone, and a number of different methods for distributing information about traffic problems and alternate routes to clients. An avionics student worked on a companion project developing a low cost interface from the GPS receiver to a cell phone[3].

GPS and Geocaching

Geocaching[4, 5] describe a sport/hobby that has emerged over the past few years. The term geocaching is the synthesis of the term geo for geography and caching from the term cache.

Geocaching utilizes GPS equipment in the search for cache items. The Geocacher is able to obtain the coordinates of a cache site from the internet[7], program those coordinates into the GPS unit and then navigate to the aforementioned site. The cache itself normally contains token prizes and a log book to record the find.

The intent of the course is to appeal to non-avionics related majors, the practical use of Geocaching as a relatively low cost aid in navigation will ideally appeal to those students who have a fascination with the practical applications of technology but have not formally studied electronics and/or navigation.

The features of geocaching that involve navigation concepts using GPS include the concepts of:

- Waypoints
  The ability to input cache location coordinates
- Bearing/Heading
  The ability to know the direction of travel and/or direction to cache location
- Distance
  Distance to cache location
- Backtrack feature
  The ability to trace a route back to its original starting point

One feature not found on all hand held GPS units is mapping. The mapping feature allows the GPS to display land, water or topographical information. While not required, this feature is extremely helpful in navigating roadways or ascertaining terrain conditions for a given cache location.

One core concept behind Geocaching is the cache-in/trash-out philosophy. The Geocacher is encouraged and expected to collect any trash in the Geocaching area for proper disposal. While concerns exist over the use of public land for Geocaching, entrepreneurial efforts facilitated by government resources (local, state, federal) may act to promote/provide improvements in parks and recreational environs by coordinating clean-up, conservation and appropriate use policies.

Future Directions

The course is not required, nor does it satisfy any requirement for non-avionics/electronics majors beyond the open elective. The course will only attract non-majors by recommendations from students who have taken the course or those with an innate fascination with navigation technology. One area of student population that seems promising is a Geographic Information System program in the School for Public Policy. An additional student segment of non-

electronics majors is the marketing program in the College of Business and Administration. The appeal to marketing majors is the very wide range of applications of GPS in the consumer product area. The entrepreneurial focus of the course has appealed to avionics majors and non-student staff members.

Conclusions

The semi-independent study feature, where the class meets and discusses the assigned material in the tutorials from the internet[8, 9, 10], promotes active learning among the students and provides the instructor feedback on student progress. Additionally, class discussions provide individual students peer critiques on their project ideas in the formative stage.

Evaluation of the first four student learning objectives was based on self-test quizzes of the tutorial material from the Internet. Student understanding of the GPS segments (Satellite, Ground Control, and User) and the role of time in determining GPS receiver position posed no problem for non-avionics majors. The effect of atomic clock accuracy on lowering the cost of GPS receivers as well as position accuracy appeared to be a new awareness but calculation of range error as a function of time error seemed to work. Some simple auto correlation and cross correlation of 7 bit code examples are used to describe the more complex Gold codes used in GPS[16]. The instructor, in class discussions following each of the tutorials, evaluates the level of student understanding.

In the GPS traffic jam avoidance application, there was significant interaction between the three students in the class as they developed their applications.

One lesson learned from the last course offered in the Fall, 2001 semester is to emphasize that the GPS receiver has no uplink communication to the GPS satellite. A possible source of confusion was identified. The applications of GPS in tracking packages and moving vans gave the impression that the GPS information was relayed to a central tracking system via a GPS satellite.

A demonstration of a simple GPS to Personal Computer (PC) Com port interface provides an example of an electronic interface at a level of detail useful to non-majors.

A Garmin GPS100 receiver[14] with an NMEA 0183 serial output is used in conjunction with a laptop PC. A simple OpAmp circuit converts the voltage levels of the NMEA circuit from the 0.25-volt, 5volt levels to +/- 9 volts. A small QBASIC program in the laptop displays the raw NMEA sentence data on the screen. The NMEA data is easy to interpret since it is in ASCII format and the sentences end with Carriage Return and Line Feed.

More detailed information about the demonstration using Magellan MAP 7000 and Magellan Trailblazer III XL are available in a previous ASEE paper[15]. The paper includes examples of NMEA data recorded on a laptop.

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TERRENCE KELLY

Terrence Kelly is a Professor, Aircraft Maintenance Engineering, at Parks College of Engineering and Aviation. He teaches Aircraft systems, Aerodynamics, Airframe Analysis and a departmental Capstone course. His technical interests include all aspects of safety, quality, aging aircraft and aircraft maintenance management.

JOHN D. CREMIN

John Cremin is an Associate Professor, Avionics, at Saint Louis University, Parks College of Engineering and Aviation. He teaches Electronic Communications, GPS Theory and Applications and Avionics. His technical interest is in the areas of applications of electronic communications and avionics to communication disorders and also to novel applications of Global Positioning Systems (GPS).