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Computer-Aided Mobile GPS Education Set*

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This paper describes the design of a computer-aided educational mobile GPS (Global Positioning System) set. By means of this set, use of a GPS receiver and GPS connectivity with mobile devices can be taught more effectively. In addition, students can develop related GPS applications supported by mobile technologies like GSM, GPRS or Bluetooth. This mobile education set enables students to send location information via SMS or compare GPS receivers' data in different locations via GPRS etc. This set consists of a GPS module, an antenna, an 8051-based microcontroller, a monitor ROM for embedded applications, a portable computer and an application software that communicates with the hardware. Educational materials prepared by Macromedia Flash and Java Programming Language have been added to the GPS education set in order to design an efficient student-oriented system.

Keywords: GPS; mobile technology; computer aided; communication; education set

INTRODUCTION

AS IN OTHER communication systems, the recent developments in communication technology have also affected the navigation systems. The problem of finding position and direction, which has a significant role both in geographical and military systems was solved by means of navigation systems like RDF (Radio Direction Finder) and the hyperbolic positioning system (LoRaN, Decca, Omega). Nowadays, it is possible to make very sensitive measurements with the help of satellite networks.

GPS is the most developed and widely used positioning system. By 2006, GPS users could measure their position with 29 support satellites [1]. Thus, civil and military use of GPS receivers has greatly increased. A study on educating GPS/GIS technicians of the future and improving the functionality and advantages of the GPS system shows that, in the USA alone, an estimated 150,000 GPS/GIS technicians are needed [2], and hence the need for new educational programmes. In addition, this need has been growing continuously because GPS has proven invaluable for a multitude of civilian applications [3].

The aims of this project are:

- to supply students with knowledge about the positioning system;
- to make the students learn the data communication structure of the GPS modules;
- to ensure practical knowledge by developing mobile or non-mobile applications;
- to make connections with other scientific branches like geodesy, construction, telecommunication, logistics;
- to analyze GPS message standard such as NMEA-0183;
- to eliminate educational disadvantages of animations and simulations by supplying real-time applications;
- to apply cooperative and collaborative learning methods;
- to validate through both hardware and software experiments.

HARDWARE DESIGN

This section describes the hardware structure of a computer-aided mobile GPS education set. The hardware consists of a GPS module, an antenna and an 8051-based microcontroller, a monitor ROM for embedded applications and a portable computer. The block diagram of the hardware is depicted in Fig. 1.

A GPS receiver module is built into the hardware. This module is connected to an 8051-based microcontroller and a PC by means of PBX switching IC via a serial interface.

While processing a GPS message, data taken by the GPS module can be switched to the microcontroller or a computer by a PBX switching IC, in this way each part of the system can be used separately. An LCD and a numerical keypad are added. After the GPS are data analyzed, they can be used for other mobile applications. TTL signals from the microcontroller hardware is converted to an RS232-C standard for serial communication. Bluetooth, GSM/GPRS modems can be easily

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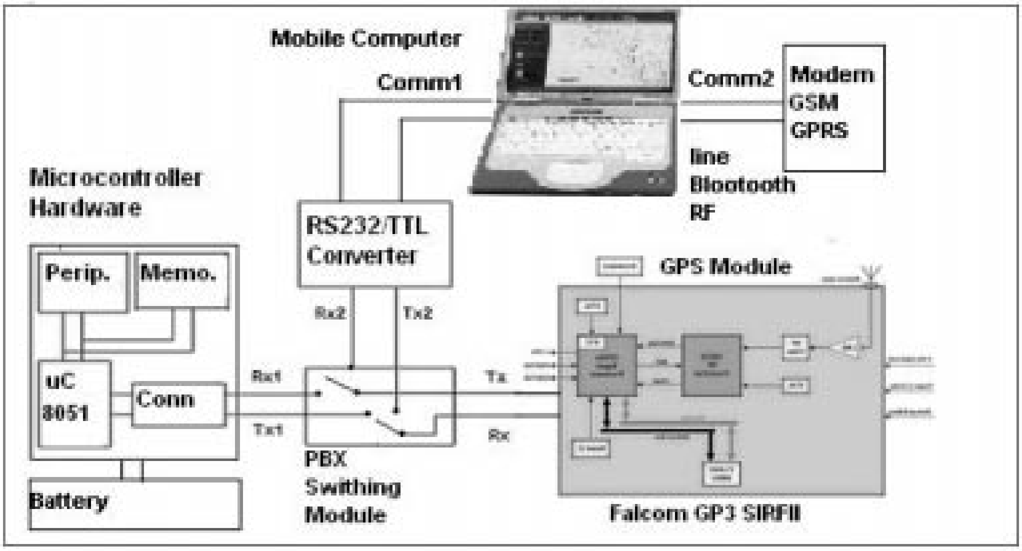

Fig. 1. Block diagram of education set.

connected to the set over this serial port. This feature makes the set mobile and functional simultaneously. Therefore, students that use this set can carry out their experiments effectively and connect their hardware to the software platform more flexibly. With the support of the computer, cooperative and collaborative learning is possible [4]. Figure 2 shows the hardware and GPS module.

SOFTWARE DESIGN

Application software is developed in an .NET platform. The user interface is designed to attract the students' attention and it is arranged so as to use the communication ports effectively [5]. The application software works in a Microsoft Windows XP environment and it needs .NET

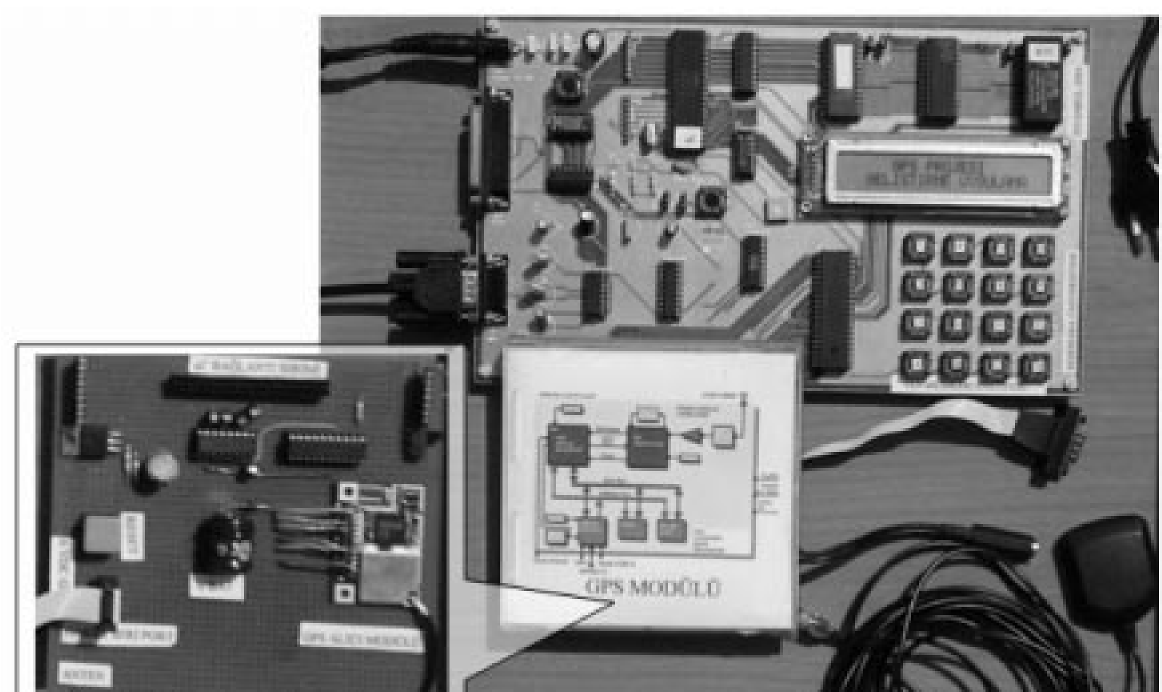

Fig. 2. The hardware.

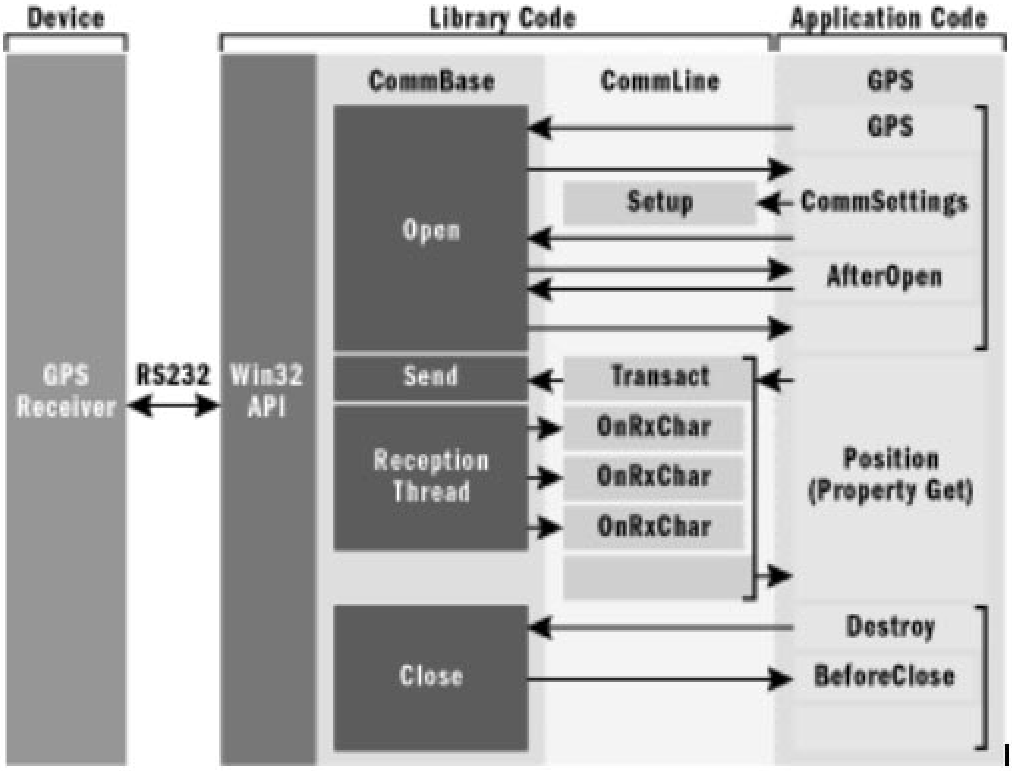

Fig. 3. Flow Control for application software [6].

framework components. Operating system sources and library codes are used to adjust communication ports for devices such as Bluetooth, GPRS/GSM and a V.90 modem. Figure 3 shows the flow control between the device and application code in the operating system.

This flow control chart can be used not only for GPS receivers but also for devices that have an RS232-C standard communication interface.

The user interface consists of several windows such as system clock, speed counter, satellite clock, etc. As seen on Fig. 4, clearly recognized icons and

Fig. 4. User interface of software.

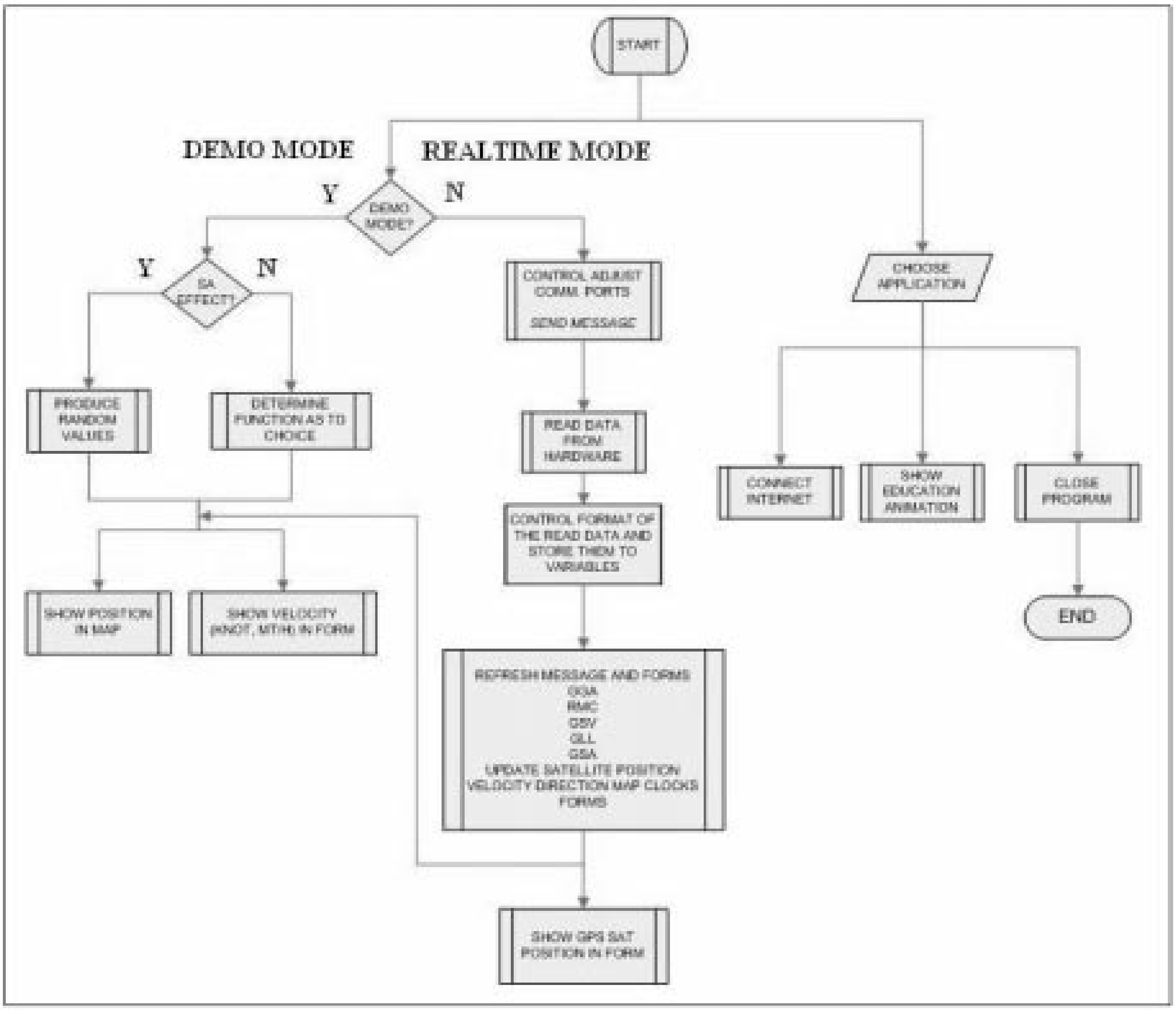

Fig. 5. Software flowchart.

animated forms are used for student attention when they work on the set.

The application software enables users to analyze a GPS message and send it to another communication device. It is possible to see the analyzed message in a form window and send it to another device by choosing the appropriate communication port number. The software supports both real-time and demonstration applications. In addition, many educational animation links clarify the complex subjects in GPS theory. This is shown in Fig. 5 presented as a software flow chart.

EDUCATION APPROACH

We create an appropriate use by providing education animations and simulations as shown in Fig. 6. The animations also help students understand more complex and critical information related to GPS and satellite communication. For example, students can see the differences between geostationary satellites and GPS satellite routes while moving on their orbits by using education animations. In addition, it is possible to make evaluations and see results for distance calculations between two points in a 3D space by using a Java Applet application.

Furthermore, while carrying out a mobile experiment such as speed measurement, comparing positions, tracking on the map etc. students create their own maps and calibrate them with respect to picture resolution to see their location in a field.

A sample experiment

It is possible to make numerous experiments with this education set. For instance, coordinates of a local area can be sent in a message. For this experiment, users need a GSM modem or cellular phone to supply distance communication, besides the education set. Before the sending process, a connection between the GPS hardware and the GSM modem/phone must be make via separate communication ports. Figure 7 shows the user interface of the experiment. In this experiment, connection between the computer and the GSM/GPRS modem is supplied by a Bluetooth Dial-up

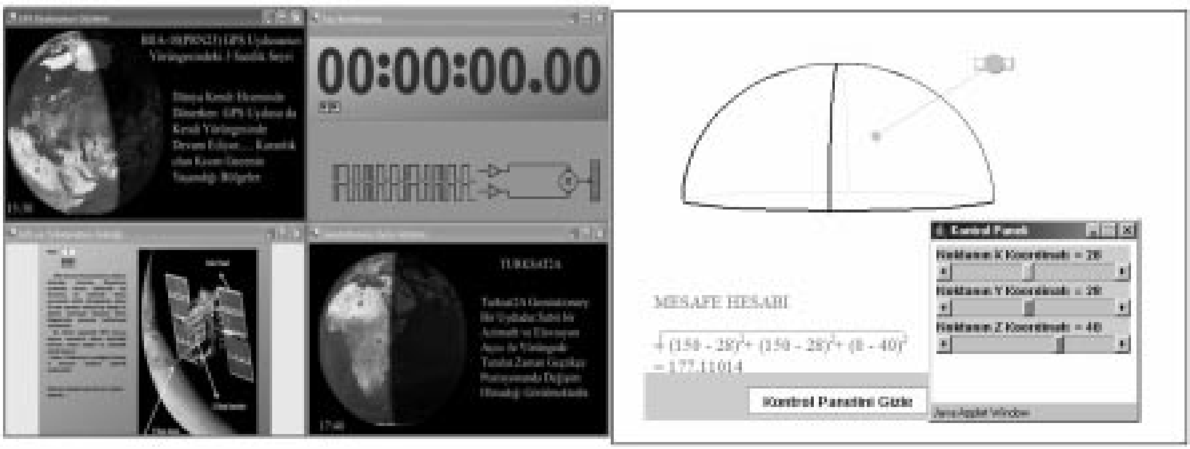

Fig. 6. Education material pictures view.

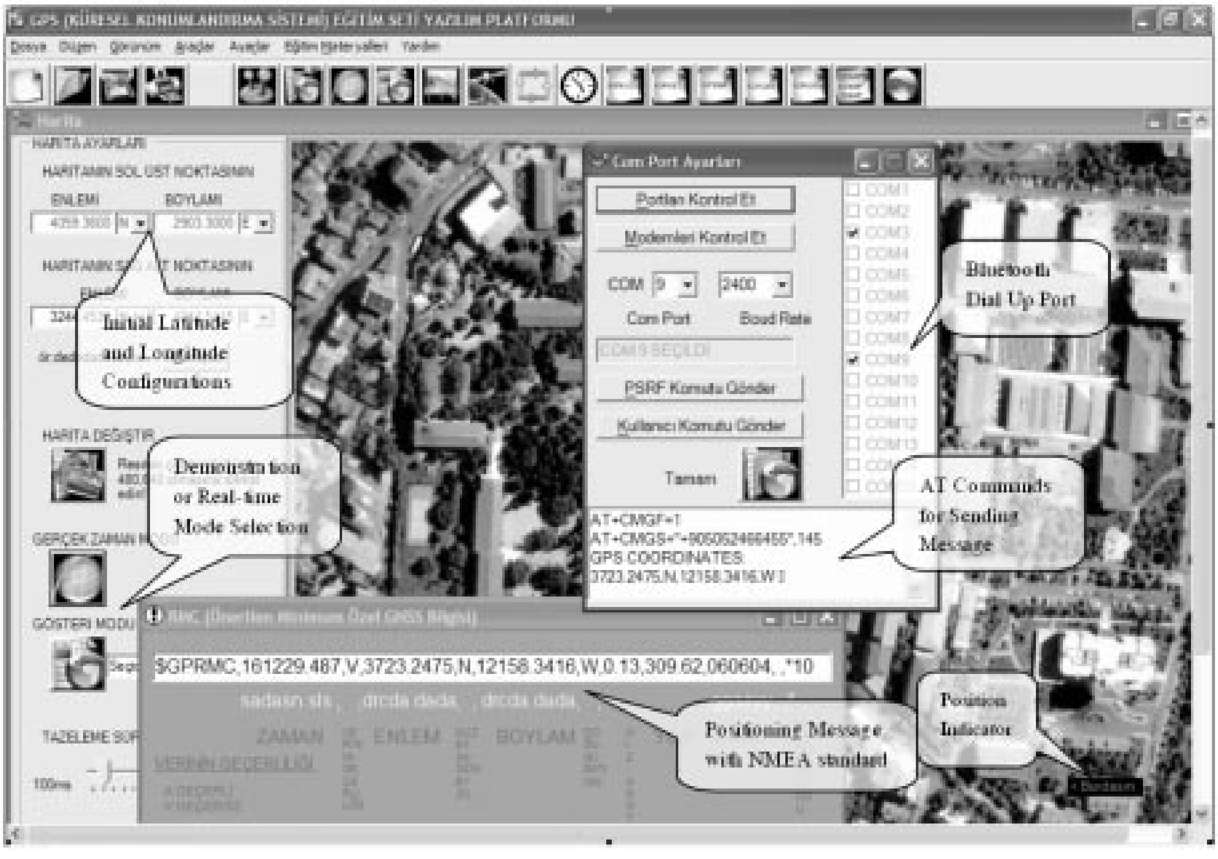

Fig. 7. Experiment user interface view.

connection. The GPS hardware sends positioning messages via the COM3 port. Then the students analyze this using the software and send it via the COM9 port by using the related form window.

Table 1 shows AT commands, which send messages from the GSM modem. First, the modem is set up in Text Mode, then messages are sent with the destination telephone number.

In this mobile application experiment, students see the relationship between the GPS module, the communication devices and the computer software. Thus, this set makes students aware of positive responses and encourages them to adapt to a more experimental and mobile approach to learning.

Table 1. AT command set for sending message

1st AT+CMGF=1
2nd AT+CMGS="Telephone Number",145
Your Message(ctrl-z)

CONCLUSION

A new computer-aided mobile GPS education set was presented in this paper. As a result, students learn the fundamentals of a positioning system and how to make mobile GPS applications. The students learn mobile concepts by using both the hardware and software of this set and by using external communication devices or transceivers. At the Marmara University Institute for Graduate Studies in Pure and Applied Sciences, this educational set has been used in the course called 'Global Positioning System—Kuresel Konumlandirma Sistemi' for the Master's degree program since the Fall 2005 semester [7]. In this course, both theoretical knowledge and practical applications are learned with the set. In addition, this education set was designed for use in multipurpose courses, such as Traffic Control Systems, Satellite Communication, Industrial Measurement, Navigation Instrumentation and Data Communication. The Marmara University Electronics and Computer Education Department is a member of the MVET (Modernization of Vocational Education & Training in Turkey) project, which is supported by the EU. In this project, a modular education program is employed for undergraduate studies It is planned that the 'Global Positioning System' course content be appended to the Bachelor's degree program. Finally, it was seen that a significant development to learn GPS applications could be achieved while still maintaining a strong emphasis on mobile applications. In the future, effective problem solutions will be developed for positioning systems (GPS, Galileo etc.).

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