Customized E-Maps using GPS

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***Abstract*— The location of campus area have been developed in PXA270 XScale processor handheld platform by the customized electronic maps (E-Maps) on the LCD screen through the technology global position system (GPS) and Bluetooth GPS receiver. The friendly navigation interface is designed by using Microsoft Visual Studio 2005 from the feedback GPS data. The formats of receiving GPS data are longitude, latitude and time …etc. The best route (the shortest) algorithm can also be created by the format of dynamic NMEA-0183 protocol GPS data. The goal of this application technology is to develop more economical products in the near future.**

***Keywords*— E-Maps, GPS**

1. INTRODUCTION

Today, most of us are familiar with browsing maps on-line or using them in a navigation device. Electronic maps (E-Maps) are for new travelers in the recreation area to provide a starting point for entry into places of entertainment. GPS (Global Position System) has a variety of applications on land, at sea and in the air. Basically, GPS allows you to determine your location and find other locations on the earth. It helps people navigate to and from those locations [1], [2]. GPS can be used everywhere except where it is impossible to receive a satellite signal such as inside buildings; in caves, parking garages, other subterranean locations; and underwater. The most common airborne applications include navigation by general aviation and commercial aircraft. At sea, a GPS is typically used for navigation by professional mariners, recreational boaters, and fishing enthusiasts [1], [2]. However, most of the commercial GPS navigation developers have to purchase the required geographic information system (GIS) for mapping from the transportation agencies. Unfortunately, the GIS system is not created for all of the places in Taiwan [1]–[3]. It is quite necessary to develop customized E-Maps and give better service in some campus areas for the domestic visitors, students, government officials and international visitors.

SmartDraw software has been used to design the E-maps with JPEG formats for campus areas and use PhotoImpact software to organize the maps and replace the complicated GIS [3], [4]. The handheld platform using PXA270 Xscale processor and the LCDs are connected through multiplexer to the PXA LCD controller.

The program used in this navigating system has been developed by Microsoft Visual Basic 2005 to setup the components through transporting RS-232 interface in the specified defined COMPORT, combining customized campus E-Maps with embedded PXA270 platform and receiving GPS signal to do the campus GPS navigation.

2. BASIC GPS THEORY AND NMEA 0183 PROTOCOL

Global Positioning System (GPS) is a Global Navigation Satellite System (GNSS) developed by the United States Department of Defence. It is the only fully functional GNSS in the world. It uses a constellation of between 24 and 32 Medium Earth Orbit (MEO) satellites that transmit precise microwave signals, which enable GPS receivers to determine their current location, the time, and their velocity. Its official name is NAVSTAR GPS (Navigation Satellite Timing and Ranging Global Position System). Currently, GPS is often used by civilians as a navigation system [1, 2].

A GPS receiver calculates its position by precisely timing the signals sent by the GPS satellites high above the Earth. Each satellite continually transmits messages containing the time the message was sent, precise orbital information, and the general system health and rough orbits of all GPS satellites. The receiver measures the transit time of each message and computes the distance to each satellite. Geometric trilateration is used to combine these distances with the location of the satellites to determine the receiver's location. The position is displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units also show derived information such as direction and speed, calculated from position changes. Usually, three satellites are enough to solve for position, since space has three dimensions. More details about the position calculations are described in reference [1], [2].

Many GPS receivers can relay position data to a PC or other device using the NMEA 0183 (National Marine Electronics Association or NMEA) protocol and this protocol is officially defined by the NMEA references to these protocols have been compiled from public records, allowing open source tools like gpsd to read the protocol without violating intellectual property laws. Receivers can interface with other devices using methods including a serial connection, USB or Bluetooth. Table 1 is the NMEA 0183 output message and Table 2-1 and Table 2-2 are the GGA data format [1], [2].

Table 2 contains the values of the following example $GPGGA, 161229.487, 3723.2475, N, 12158.3416, W, 1, 07, 1.0, 9.0, M, , , ,0000*18.

TABLE 1
NMEA 0183 OUTPUT MESSAGE

NMEA Record	Description
GGA	Global positioning system fixed data
GLL	Geographic position, latitude / longitude
GSA	GNSS DOP and active satellites
GSV	GNSS Satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed

TABLE 2-1
GGA DATA FORMAT

Name	Example	Units	Description
Message ID	$GPGGA		Global Positioning System Fix Data
UTC Position	161229.487		hhmmss.sss
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=North or S=South
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=East or W=West
Position Fix Indicator	1		See Table 2-2
Satellite Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	meters	-34.0 meters
Units	M	meters	No last update
Geoid Separation		meters	
Units	M	meters	
Age of Diff. Corr		Sec.	Null field when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*18		
CR LF			End of message termination

TABLE 2-2
POSITION FIX INDICATOR

Value	Description
0	Fix not available or invalid
1	GPS SPS mode, fix valid
2	Differential GPS, SPS mode, fix valid
3	GPS, PPS mode, fix valid

3. PXA270 XSCALE PROCESSOR

The Intel® PXA270 XScale processor is designed to meet the growing demands of a new generation of leading-edge embedded products [5]. Featuring advanced technologies that offer high performance, flexibility and robust functionality, the Intel PXA270 processor is packaged specifically for the embedded market and is ideal for the low-power framework of battery-powered devices (see Fig. 1).

The followings are a summary of the PXA270 handheld platform key features and specs:

- Maximum 1 GB Mobile SDRAM.
- Memory sticks (supporting MS card).
- MMC/SD/SDIO (supporting MMC and SD card).
- LCD controller (maximum 800×600 pixels and touch screen).
- USIM interface (SIM card interface and be connected GSM or 3G).
- Cam recorder interface (200×200 pixels CMOS recorder.
- Full function serial port (921,600 bps), standard serial port, Bluetooth controller.
- Mobile scalable link (MSL) interface (professional handheld platform).
- Baseband interface
- Three sets SSP controllers.
- USB client1.1 /USBhost1.1 /USBOTG1.1
- AC' 97 controller.
- I2S digital audio controller.
- I2C controller.
- 32 high speed DMA data channels.
- 4 sets PWM controllers (easily control LCD contrast, brightness ...etc.).
- 8×8 keyboard interface.
- GPIO controller (120 I/O interrupt).
- Instant clock to be a timer or to interrupt period.

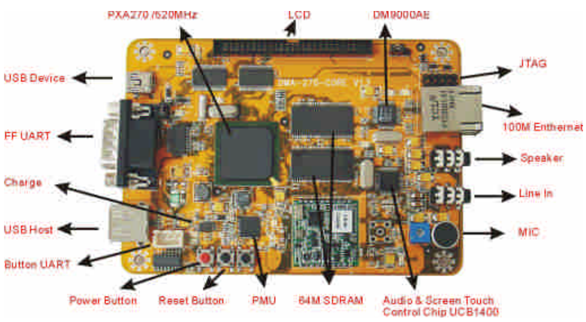

Fig. 1 PXA270 handheld platform.

4. Results and Discussion

We are showing an example of navigation with E-Maps in Tung Fang Institute of Technology and this work was designed and used in the format of $GPGGA. The output message in the format of $GPGGA is shown in Table 3.

TABLE 3
THE OUTPUT MESSAGE WITH THE FORMAT OF $GPGGA

Message	Units
16	hours
12	minutes
29.487	seconds
N	Longitude
121	Degrees
23.2475	seconds
W	Latitude
12	Degrees
58.3416	seconds

Fig. 2 is message of latitude, longitude, time and satellite number and is developed by Visual Basic 2005. Furthermore, Fig. 3 is also the result of guiding route organization.

The length of receiving format is fixed, therefore the guiding program will detect the first series letter of buffer area is $GGA or not. If the receiving message is $GGA format, the guiding program will show the time of Greenwich, the latitude and longitude of PXA270 platform, GPS message and number of satellite. Since the format is fixed length, it will be ok to show the bit number of buffer. Moreover, the local time of Taiwan is 8 hours later than Greenwich, the time will have to add 8 hours to catch the Greenwich Time and it is also shown in Fig. 2.

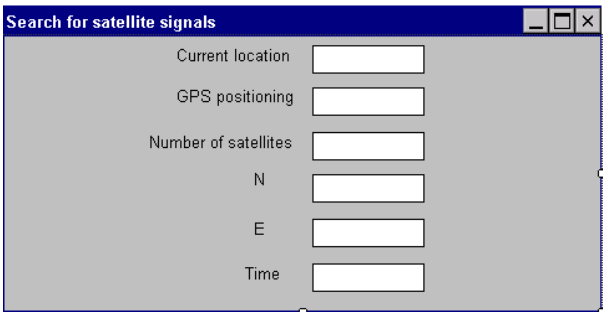

Fig. 2 Message of position, latitude, longitude, time and satellite number and are developed by Visual Basic 2005.

It will go to the navigation selection, when the GPS is ready. If the first series letter of buffer is not $GGA, the guiding program won't work at all.

The guiding route organization can help user using the shortest route algorithm to find the best route as soon as the user select the location. The results of guiding route organization will tell user which way is the best and lets the user go to the location quickly (see Fig. 3).

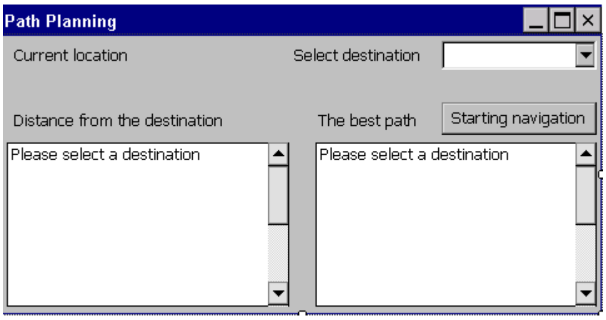

Fig. 3 The results of guiding route organization.

The guiding program will go to the starting screen when the location has been selected and is shown in Fig. 4. The GIS used in our PXA270 platform is different comparing with commercial navigation software and is developed by SmartDraw software with JPEG formats. Therefore, it is free without paying any copyright fees. Fig. 5 is displayed the location screen of PXA270 handheld platform. The Bluetooth GPS receiver gets the position of latitude and longitude according to each E-Map in navigation system and is shown in Table 4. The E-Map will be switched to another one following the next position.

TABLE 4
THE BLUETOOTH GPS RECEIVER GETS THE POSITION OF LATITUDE AND LONGITUDE

Position	Latitude	Longitude
School door	N22 52 47.4	W120 14 49.2
Family market	N22 52 53.3	W120 14 43.2
Library	N22 52 49.0	W120 14 46.7
EE building	N22 52 52.4	W120 14 43.4

The screen capture software of SnagIt 8 is used to develop the E-Map of JPEG formats to replace the complicated GIS [6]. Fig. 6 is showing the overview different locations of image developed by SmartDraw software.

Fig. 4 The starting screen of guiding program.


Fig. 5 The location screen of PXA270 handheld platform.

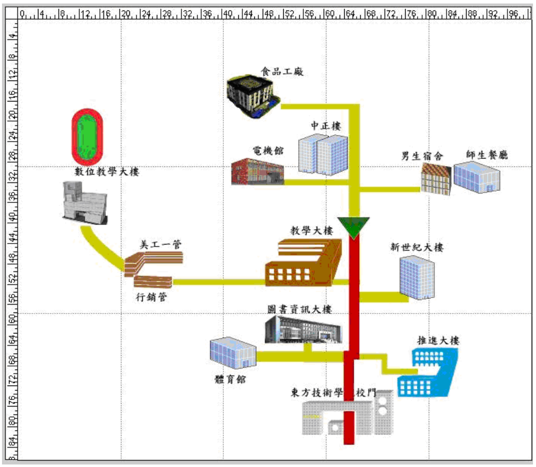
Fig. 6 The overview different locations of image developed by SmartDraw software.

The memory used in this navigation is around 130 KB for main program and is about 20 MB after including images and voices. The occupied memory is around 1.5 MB for customized navigation software. Comparing to commercial navigation software, it is around 3 MB for ASUS GO and 6 MB for MIO. Table 5 is the occupied memory size comparison.

TABLE 5
OCCUPIED MEMORY SIZE COMPARISON

Type	Memory size
Customized electronic maps	1.5 MB
ASUS GO	3 MB
MIO	6 MB

4. CONCLUSIONS

Satellite navigation application has been used more and more according to the advanced technology of information and commercial GPS. The higher demand is reaching the advantage of lower monthly fee, installation fee and setup fee. The integrated service from GPS technology is getting more in our daily life; therefore it is quite important to develop friendly customized E-Maps to let users find an easy way wherever they like to go.

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