Designing and Implementing GPS based Navigation System for Location based Services

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ABSTRACT
This paper proposes designing of the Global Positioning System (GPS) in a very simple and efficient way for navigation, positioning and tracking. This system is designed to provide information about location based services along with the emergency services. The presented GPS based hand held terminal is designed using hardware components like Microcontroller 89C52 and GM 48 GPS Receiver. We can carry this handy device anywhere there is no need to connect it to PC all the time for tracking. The main feature of this Navigation System is its ease of use along with the compact size and visual display of results using PC and LCD display. Subsequently a small computer interface can be added to the system to provide download of location details and superimposing the results on to a GIS mapping system to provide On-Line tracking.

General Terms
Global position system, Navigation and Tracking.

Keywords
Context-aware services, Emergency based services, Location based services.

1. INTRODUCTION
The GPS is a constellation of 24 satellites that continuously transmit coded information, which is received by GPS receiver to precisely identify location on earth by measuring distance from the satellites [1]. Our main aim is to design the GPS in an effective way that allows navigating, positioning and tracking and provide location based emergency services information. The system proposed in this paper utilizes the GPGGA string format captured by the GPS receiver for providing exact location.

Basic principle of GPS consisting of three segments has been introduced in section 1.1. Section 2 provides details of related work. System design is discussed in section 3 and section 4 shows the different modes of operation used for navigation. System execution methodology is described in section 5 and section 6 explains the data format used in this system design. Section 7 summarizes empirical results and analyses.

1.1 GPS OVERVIEW
There are three segments of GPS. The Navigation Satellite Timing and Ranging (NAVSTAR) system for GPS consists of the space segment, the control segment, and the user segment.

Figure 1 illustrates the three Segments of GPS.

- The Space Segment

It consists of at least 24 satellites, and is the heart of the system. The satellites are in the high orbit about 12000 nautical miles from the Earth's surface. The satellites are arranged in their orbits so a GPS receiver on earth can always receive from at least 4 of them at any given time. The navigation message contains the satellite orbital and clock information and general system status messages and an ionosphere delay model. The satellite signals are timed using highly accurate atomic clocks.

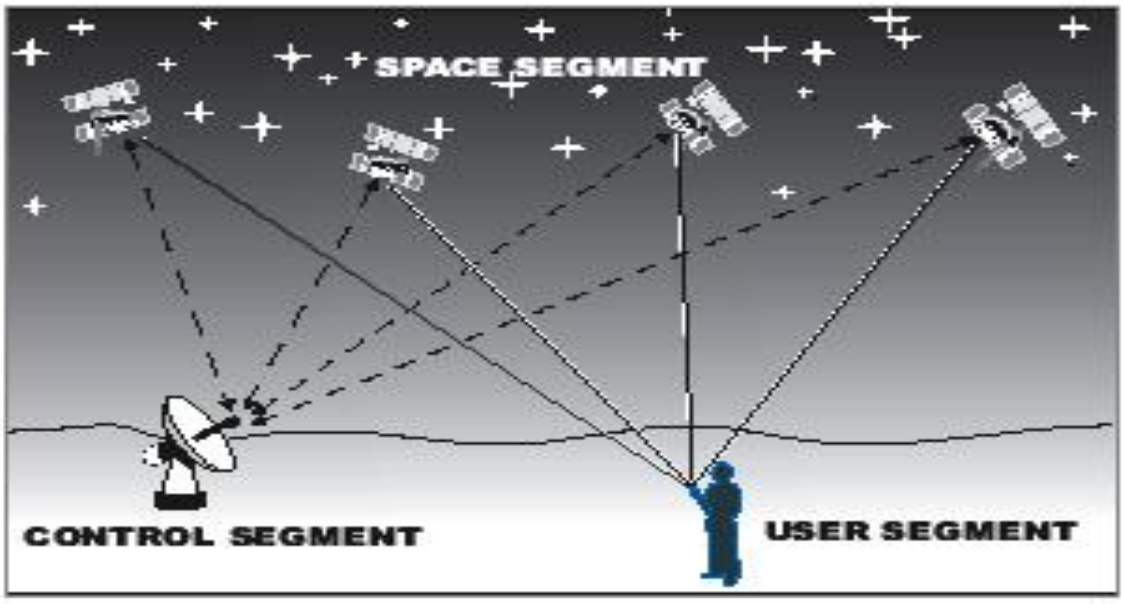

Figure 1. Three segments of GPS

It controls the satellites by tracking them and then providing them with corrected orbital and clock information. There are five control stations around the world- 4 unmanned monitoring stations and 1 "master control station". The 4 unmanned receiving stations constantly receive data from the satellites and then send that information to the master control station, which corrects the satellite data and together with two other antenna sites, sends the information to the GPS satellites.

- User Segment

The user segment simply consists of you and GPS receiver. The GPS receiver you can hold in your hand or mount on your vehicle. The GPS receiver measures the time it takes for the signal from four separate satellites to get to the receiver for computing precise latitude, longitude and altitude.

2. RELATED WORKS

Many researchers have recognized the use of GPS for navigation and tracking applications. The effectiveness of Global Positioning System electronic navigation has been proposed in [2, 5, 12]. A localization System based on Enhanced Software GPS receiver has been introduced in [3]. The Enhanced Software GPS receiver is making use of hardware for RF Front End and Analog to Digital Converter, and Software approach for acquisition, tracking and navigation solution calculation [4, 5, 6]. An Automobile localization system has also been designed using GSM services for transmitting the position and localization of automobile to the owner on his mobile phone as a short message (SMS) at his request [7,8, 9]. This system can be interconnected with the car alarm system and alert the owner on his mobile phone about the events that occur with his car when it is parked. A simple expandable GSM and GPS systems simulator allows user to learn advantages of modern wireless technology and use it in many complicated solutions [10, 11]. Navigation and positioning system based on GPS and Code division multiple access (CDMA) has been proposed in [13]. In this paper, the data format of short message data in CDMA and the data format about GPS data stream are introduced, and then a GPS and CDMA application system based on embedded Linux operating system is researched in position navigation, remote control, data transmission and personal communication[14].

3. SYSTEM DESIGN

Following Figure 2 shows the hardware module of GPS Based Hand Held Navigator System. The system is composed of hardware as well as software modules.

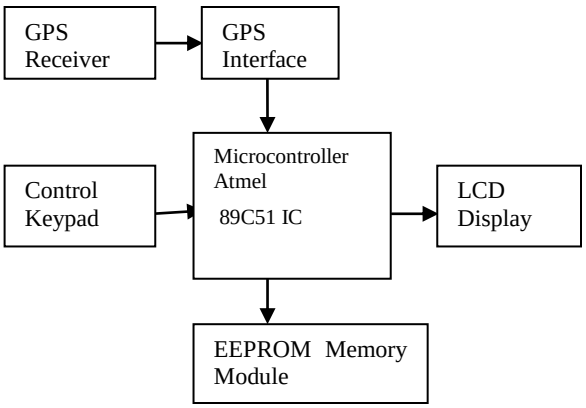

Figure 2 GPS Receiver block diagram

3.1 Hardware Modules

The hardware part is designed using following modules as described below

Microcontroller: All ports are used for the interfacing devices like GPS receiver, Data bus, keypad and latches. Port 3 lines RXD and TXD have been used to interface to GPS Receiver through RS232C compatible serial port that is implemented through MAX232 driver chip. Balance bits of port 3 have been used to select Latches.

Port 2 has been used to interface to Bi-directional Data bus connections of the 28C64 Memory chip.

Port 1 has been used to interface to Local Keypad used to control the system and navigate through the system.

Port 0 has been used to drive set of latches that interface to address lines of 28C64 memory IC, data and control ports of LCD Display and control lines required for the Memory.

EPROM Memory Module: The memory module is used for the purpose of sorting location data along-with its positioning information such as Longitudes, Latitude and optionally the Altitude.

LCD display and Keypad: The LCD module is used for the purpose of showing the results as well as the display of menu screen to navigate through the system. For operator's control 8 direct interfaces, decoded keys have been used.

GPS receiver and Interface: The GPS receiver module generates information strings [12]. The GM-48 GPS Receiver module generates information strings in the NMEA Protocol format. The strings are available at RS232C compatible serial interface as ASCII character sequences. The system interfaces to GPS receiver with the help of MAX232A Line driver/converters that connect to microcontroller UART through P3.0 and P3.1 pins. The GM- 48 Mobile Locator provides real time GPS position, speed, distance travel and heading information in the NMEA-0183 format such as GPRMC (Global positioning recommended Minimum specific GPS/Transit data), GPGGA (Global positioning Global Positioning system Fixed data), GPGSV (Global positioning GPS Satellite in View), GPGLL (Geographic Position in Geographic position, Latitude/Longitude) and GPGSA (Global positioning GPS DOP and Active Satellites') to our portable System.

Front Panel key interface: Total 32 Key are connected to the microcontroller. The key returns Logic 1 (+5V) level when in un-pressed condition while it returns Logic 0 (Ground) level in the key pressed condition.

LCD Panel interface: The LCD panel is connected to the Microcontroller through Latch 3 operating as LCD control port and Latch 4 operating as LCD Data port.

3.2 Software module

The development of embedded software required for implementing the required functionality is carried out in Embedded C and Assembly language of MC89C52 family.

4. MODES OF OPERATION

The system has following modes of operation:

GPS Sense Mode- A Default Mode: GPS receiver captures NMEA Strings carrying position information. User can switch between following types as tabulated in Table 1.

Table 1. Types used in GPS Sense Mode.

Key No.	Type Name	Type Name used
0	Deleted Entry	DEL
1	Police Station	PST
2	Hospital	HSP
3	Bus Station	BUS
4	Railway Station	RLY
5	Fueling Station	FST
6	Extra landmark1	Ext1
7	Extra landmark2	Ext2

Calibration Mode: The system records the location with its position co-ordinates. Figure 3 illustrates the program flow of GPS operations.

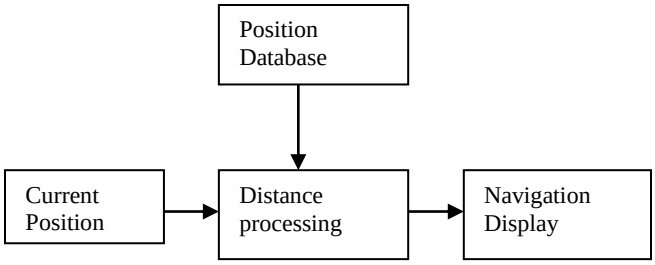

Figure 3 GPS operational flow

5. SYSTEM EXECUTION METHODOLOGY

The Software main flow chart is shown in Figure 4. Figure 5, 6 and 7 illustrates the Pseudo Code for Test Entry, Calibration Mode and Run Mode.

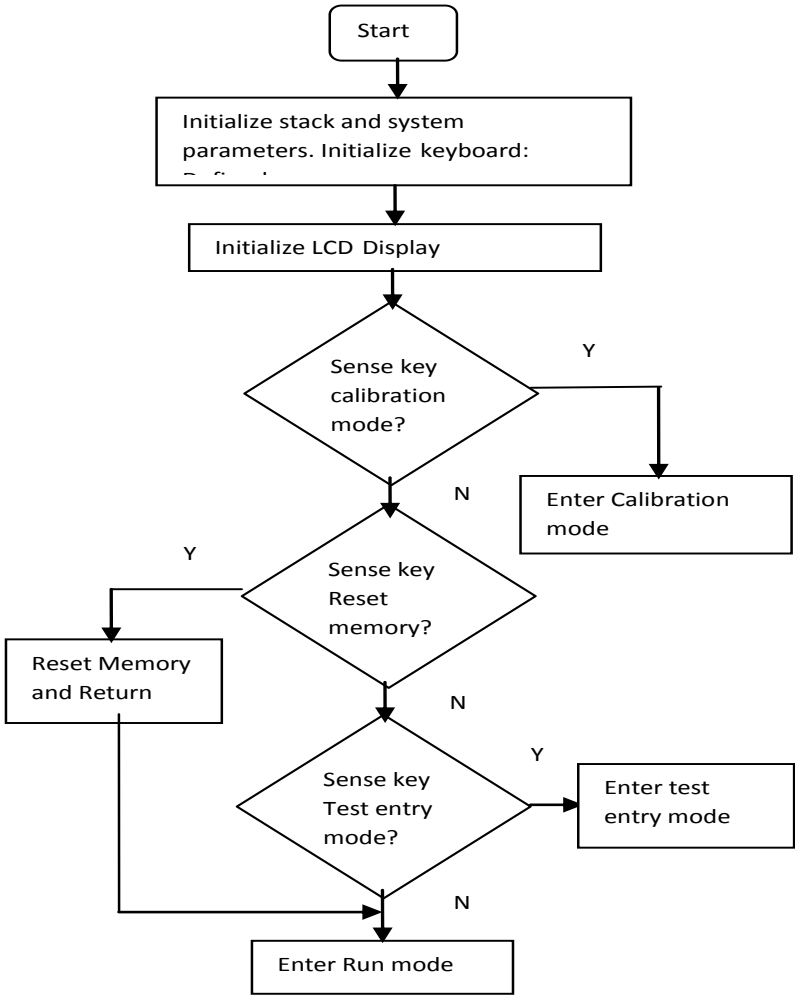

Figure 4 System execution flow sequence

The Pseudo Code for Test Entry Mode is as follows:

```
Initialize Variables for Test Entry Mode
Insert 16 Test Entries in the Database
End Test Entry Mode
```

Figure 5 The Pseudo code for Text entry mode

The Pseudo Code for Calibration Mode is as follows:

```
Initialize Calibration parameters,
Display Calibration mode input screen
Accept Point Details: Type
Accept Point Latitude/Direction
Accept Point Longitude/Direction
Accept Point Details: Name
Check for One More Entry?
Initialize Screen for next entry OR  Exit Calibration
Mode
```

Figure 6 The Pseudo Code for Calibration Mode

Pseudo Code for Run Mode is as follows:

```
Initialize Parameters for Run Mode Display
Capture GPGGA String from GPS Receiver
Process the GPS String
Compare it with Memory Database Display
information of the Point
Check for, Add this Point as Entry
Store the Point as New Entry and Continue
Capturing GPGGA String from GPS Receiver OR
Continue Run Mode
Check for Continue Run Mode
Continue Capturing GPGGA String from GPS
Receiver OR End Run Mode :Shutdown
```

Figure 7 The Pseudo Code for Run Mode

6. DATA FORMAT

The system makes use of National Marine Electronics Association (NMEA) strings taken by GPS receiver. NMEA defines a RS-232 communication standard for devices that include GPS receivers. The GPS receivers can output geospatial location, time, headings and navigation-relevant information in the form of ASCII comma-delimited message strings.

Out of these the following GPGGA string format is used in this system.

*$GPGGA,060003,3348.794,N,11754.064,W,1,07,1.0,66.2,M,-31.9,M,,*45*

GPGGA format of the NMEA string contains the required Geographical Positioning information and the time frame reference.

7. EMPIRICAL RESULTS AND ANALYSES

To evaluate the performance of the proposed handheld device, the real time results were taken by GPS based Hand Held Navigator System. The tested results are tabulated in Table 2. The locations tabulated in fourth column of table are real time locations but for brevity they are written in symbolic form.

This system can be used for geographical surveys for generating the Longitude, Latitude and Altitude information for the required locations. This system can be used for In-Motion Tracking system. With a front end application build on this, it can serve as Fleet Management system to manage large fleets of vehicles and keep a central control for tracking and guiding the vehicles across the country or anywhere in the world.

Table 2. Main performance index of GPS based Handheld Terminal

Sr. No.	Latitude North (N)	Longitude East (E)	Actual Point/ Location Name
1	21.091340	79.049504	A
2	21.110528	79.035799	B
3	21.152307	79.088947	C
4	21.157246	79.076565	D
5	21.121616	79.030762	E
6	21.113660	79.005641	F
7	21.139253	79.082424	G
8	21.122557	79.048824	H
9	21.124709	79.042980	I
10	21.130927	79.067218	J
11	21. 135854	79.060714	K
12	21.164073	79.074367	L
13	21.152977	79.090641	M
14	21.152591	79.044544	N
15	21.129892	79.095884	O
16	21.151855	79.025004	P

8. ACKNOWLEDGEMENTS

I offer my thanks to all who have supported me by giving helpful insights and suggestions in any respect during the completion of this paper.

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