PERSONAL NAVIGATION SYSTEM BASED ON GPS

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ABSTRACT

Navigation is the means by which a craft is given guidance from one known location to another. Since the global positioning system (GPS) is very accurate positioning system, a personal navigation system based on GPS is very effective. From the user point of view, the function of this system is to provide real-time positioning and timing data to the user. The system consists of 6-channel GPS oncore receiver, a system controller & processor (SC&P) card, a programmable liquid crystal display (LCD) and a keyboard. The 6-channel GPS OEM card receives GPS signal from six different satellites at a time . After processing the received GPS signal, it gives the result & status message to its output port in a typical data format. The system controller & processor card receives this message from the GPS OEM card and extracts the useful positioning & timing information in binary form. After that it processes the data and displays it on the LCD display. The keyboard has used to select the desired positioning & timing information on the display.

KEYWORDS

GPS OEM card, LCD, System controller & processor (SC&P) card, keyboard

INTRODUCTION

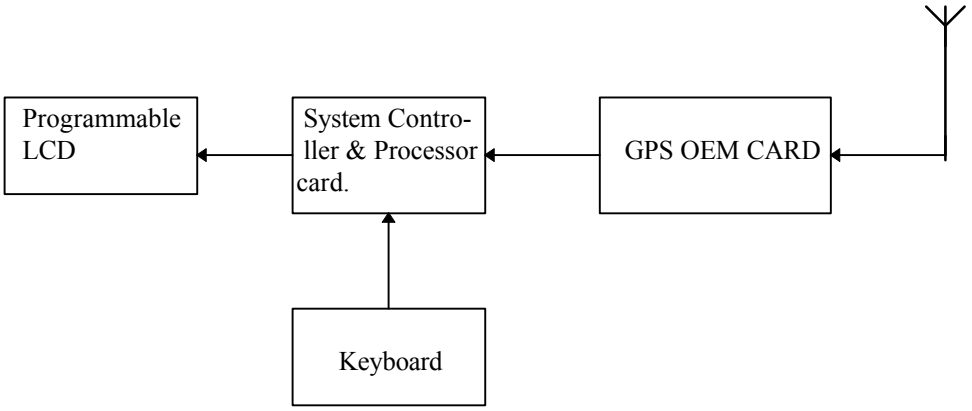
The personal navigation system has designed to get instant positioning & timing information. Considering the simplicity and portability, any body can use the system for his personal use as well. The positioning information contains the Latitude, Longitude, Height (mean sea level) & Height (gps). The timing information contains the date & time. The system is based on GPS and microprocessor technology. Since the whole GPS constellation was built up in 26 June 1993,GPS technology for receiver is growing very fast. There are several types of receiver from different companies are available in the market. Motorola 6-channel GPS oncore receiver has been selected for receiving and processing the GPS signal.

INTEL 8031 single chip microcontroller has been used to receive and analyze the data stream from GPS OEM card and after that it displays the result containing positioning & timing information on the LCD display.

A programmable LCD display has been selected to display the positioning & timing information . To select the desired information on the LCD display, a Dot Matrix type Keyboard has been used in the system.

So, all the system's technical requirements have been satisfied. The system is very attractive to the people due to its simplicity and portability.

SYSTEM STRUCTURE



The L1 band signals transmitted from GPS satellites are collected by a low-profile, microstrip patch antenna, passed through a narrow band bandpass filter, and amplified by a signal preamplifier. These filtered and amplified RF signals are then routed to the RF signal processing section of the OEM card. The RF signal processing section of the GPS OEM card printed circuit board contains the required circuitry for downconverting the GPS signals received from the antenna module. The resulting intermediate frequency (IF) signals are then passed to the 6-channel code and carrier correlator section of the GPS OEM card where a single, high-speed analog-to-digital (A/D) converter converts the IF signal to digital sequence prior to channel separation. These digitized IF signals are then routed to the digital signal processor where the signals are split into six separate channels for code correlation, filtering, carrier tracking, code tracking, and signal detection. The processed signals are then synchronously routed to the microprocessor to process satellite data, pseudorange and delta range measurements for computing position and velocity. The OEM card sends these results to its output port in different forms of messages. The length of the data frame varies according to the type of the message. This system needs only positioning (latitude, longitude, height) & timing (Date & Time) information to display on the LCD. With other information, the Position/ Status/Data Output Message contains these required information. The Position/ Status/ Data Output Message is a 68 byte length message frame. For the communication between GPS OEM card and System Controller & Processor card, Motorola Binary Format protocol has been used .The structure of the Position/Status/ Data message frame is as follows:

@@BamdyyhmsffffaaaaoooohhhhmmmmvvhhddtntimsdimsdimsdimsdimsdimsdsC<CR><LF>

The first two bytes are the head of the message frame and the next two bytes after the message head bytes are message identification bytes. The last two bytes indicate that this is the end of the message frame. The Position / Status / Data message frame contains the following information including positioning & timing data :

Date:

m-month	1.....12
d-day	1..... 31
yy-year	1900..... 2079

Time:

h-hours	0..... 23
m-minutes	0..... 59
s-seconds	0..... 60
ffff-fractional sec	0..... 999,999,999 (0.0 to 0.999999999)

Position:

aaaa-- latitude in msec	-324,000,000 ..... +324,000,000
oooo-- longitude in msec	-648,000,000 .... +648,000,000
hhhh-- height in cm (GPS, ref ellipsoid)	-100000 ..... +1,800,000 (-1000 to +18000 meter)
mmmm-- height in cm (MSL ref)	-100000 ..... +1,800,000 (-1000 to +18000 meter)

Velocity:

vv-- velocity in cm/sec	0.... 51400 (0 to 514.00 m/sec)
hh-- heading (true north. res 0.1deg)	0.... 3599 (0.0 to 359.9 deg)

Geometry:

dd-- current DOP	0.0 .... 999 (0.0 to 99.9 DOP)
t-- DOP type	0-- PDOP (in 3D mode) 1-- HDOP (in 2D mode)

Satellite visibility and tracking status:

n-- num. of visible sat.	0.... 12
t-- num. of sat tracked	0 ... 6

For each of six receiver channels

i-- sat ID	0..... 37
m-- channel tracking mode	0..... 8

Significance of each number:

0-- Code search
1-- Code acquire
2-- AGC set
3-- Freq. acquire
4-- Bit sync detect
5-- Message sync detect
6-- Satellite time avail

7-- Ephemeris acquire
8-- Avail for position

s-- Signal strength 0... 255
(Number proportional to SNR)

d-- Channel status flag (eight bits)

Each bit represents one of the following:
(msb) Bit 7: Using for position fix
Bit 6: Satellite Momentum Alert Flag Set
Bit 5: Satellite Anti_spoof Flag Set
Bit 4: Satellite Reported Unhealthy
Bit 3: Satellite Reported Inaccurate (> 16 meters)
Bit 2: Spare
Bit 1: Spare
(lsb) Bit 0: Parity Error

(End of Channel Dependent Data)

s-- Receiver Status Message (eight bits)
Each bit represents one of the following:
(msb) Bit 7: Position Propagate mode
Bit 6: Poor Geometry (DOP > 20)
Bit 5: 3D fix
Bit 4: Altitude Hold (2D fix)
Bit 3: Acquiring Satellites / Position Hold
Bit 2: Differential
Bit 1: Insufficient Visible Satellites (< 3)
(lsb) Bit 0:Bad Almanac
C -- Checksum (The exclusive-or of all bytes after the @@ and prior to the checksum.)

CR-- Carriage Return.
LF-- Line Feed .

The system controller & processor card consists of INTEL 8031 single chip microcontroller, 8 Kbytes EPROM, 8 Kbytes static RAM, RS-232 to TTL conversion circuit, CPU reset circuit, keyboard interrupt generator circuit. All ONCORE GPS receivers available in the market do not provide TTL serial data port only. Some of them also provide RS-232 serial data port for data communication. But the serial port of INTEL 8031 microprocessor is TTL. Considering this problem during design, a provision has been provided in the SC&P card to select the RS-232 to TTL conversion circuit when it is necessary, so that the SC&P card can be used with any type of serial data port provided by ONCORE GPS receiver.

The Oncore GPS OEM card works in two different modes. The Position Fix mode and Idle mode. The Position Fix mode is the normal operating mode of the OEM card. In this mode, the OEM card tracks the satellites' signal and performs the navigation solution. After performing navigation solution, it gives the result data to its serial data outport. The Idle mode is the reduced power mode. In this mode, it does not track the satellites' signal. So to get the positioning and timing data, we must set the OEM card in Position Fix mode

and thus we have to send the input command to the OEM card in the following format that initialize it in Position Fix mode.

@@Cg1C<CR><LF>

@-> Hex value for @
C -> Hex value for capital C
g -> Hex value for small g
1 -> Decimal value
C -> Exclusive OR of C,g & 1.
CR , LF -> Hex value of Carriage Return and Line Feed respectively.

This input command is sent to the GPS OEM card during the initialization algorithm of the system software.

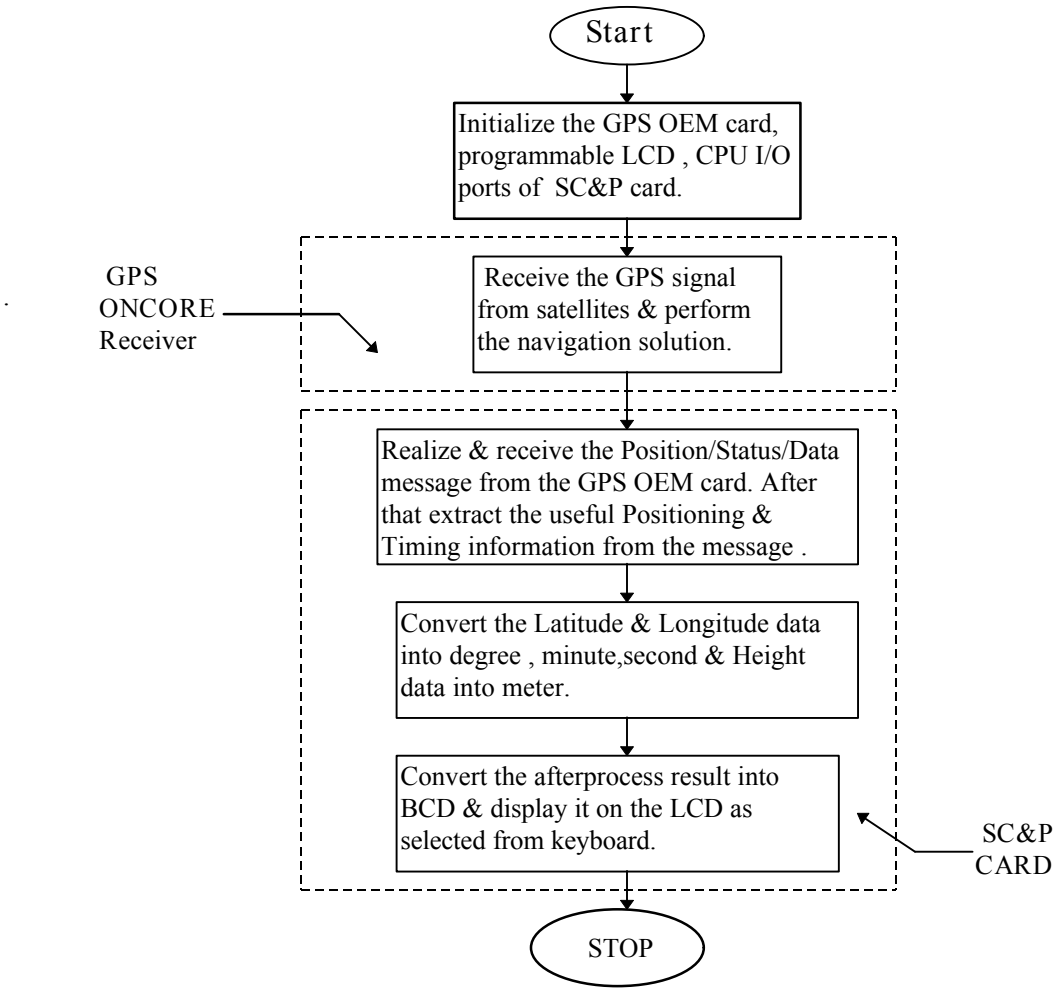
After receiving the above input command, the GPS OEM card tracks the satellites' signal and performs the navigation solution. After that, it sends the output message to its serial out port that contains much information including useful positioning & timing information. As we have mentioned earlier, the Position / Status / Data message carries much information including Positioning & Timing information that is required for our system. The main task of the System Controller & Processor card is to receive the Position / Status / Data message, then extract the Positioning & Timing information and finally display those information on the LCD as selected by the user. To perform these tasks, The System Controller & Processor card first establishes serial port data communication with GPS OEM card during the initialization algorithm. Then it judges whether the head of the Position / Status / Data message frame has received or not. When the SC&P card finds that the message head has received, then it continues to receive the message bytes . With the receive of each byte, it also makes a count of the byte. When the received bytes equal to the message length, then it compares the received last two bytes with the message end flags. Carriage Return & Line Feed are the message end flags. If it finds that the received last two bytes are the message end flags, then it copies the whole message frame from its internal memory to its external memory for further data processing.

The Position / Status / Data message contains more information than it is required for this system. These information are in the binary form. The SC&P card extracts the Positioning & Timing data from this message frame. The Position data contains Latitude, Longitude in msec & height in cm. It contains two types of height data. One type of height data is calculated with respect to mean sea level and another type of height data is calculated with respect to ellipsoid. The Timing data contains current date in year, month & day and time in hour, minute & sec. After extracting the useful Positioning & Timing data from Position/ Status / Data message, the SC&P card converts the Latitude & Longitude data into degree, minute & second and height data into meter. To display these

real-time data on programmable LCD, the SC&P also converts these extracted data into BCD form.

After performing above real-time data processing, the external RAM stores the results. The Programmable LCD display is two lines & 16 characters per line type display. So, only two types of data can be displayed at a time. The total data to be displayed have divided into three screens. The first screen will display the current date & time, the second screen will display the Latitude & Longitude of current position in Degree, Minutes & sec. and the third screen will display the height with respect to ellipsoid & height with respect to mean sea level in meter. The keyboard has given to the user to select the screen. The keyboard has connected to the port-1 of 8031. The initialization algorithm of the system software initializes the port-1 to a particular preset binary value. If any user press one key, then the Keyboard interrupt generator circuit of SC&P card generates an interrupt to CPU. When CPU acknowledges the interrupt, it reads the binary value from port-1 and compares it with the preset value. If the binary value in port-1 does match with any one of preset values, the CPU will display that screen on the LCD according to the preset binary value.

SYSTEM REALIZATION ALGORITHM



CONCLUSION

The Personal Navigation System Based On GPS is one of the most simple and effective application of GPS in day to day life. The system although have some limitations, it can measure height within the range -1000 meters to +18000 meters. If it is used above this limit, the height output will be clamped to the maximum value. In addition, the Latitude & Longitude data will be incorrect. The positioning accuracy of this system is less than 25 meters, SEP without any selective availability (S/A) and with selective availability degraded up to 100 meters. The Timing accuracy is 130 nanosec. observed with S/A on. At present, the whole system is in use in the laboratory in a single compact unit. This system may be integrated with the electronic map technology to build a personal automobile tracking system. This system may also be used for geological survey and archeological expedition.

REFERENCE

Motorola ONCORE GPS Receiver User's Guide