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Land Area Measurement System Design

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Abstract —*In recent time measuring of land area is usually required in many disciplines like agricultural, construction etc. Many conventional and modern techniques are used for that. Old or conventional methods are time consuming and are not accurate, it contain potential error in measurement. New methods are somehow fast and accurate but most of them are costly and some of them require internet. Thus there is a need of alternative method for land area measurement.*

GPS (Global Position System) have potential for land area measurement. GPS is fast, accurate, easy to use and cost effective solution than other existing solution. Main objective of this study work is to make such battery operated handheld portable GPS device that can measure area of land with high accuracy, with less time, low cost and which can easy to use. For measurement with high position accuracy proposed system use Fastrax UP501B GPS receiver module, having position accuracy <1.8 meter.

Keywords-*NMEA Sequence, Latitude, Longitude, GPS, UART, SPI ,Land*

I. INTRODUCTION

Land area measurement is process of measuring area of land using different method and for various perspective. Land area measurement is part of surveying. People usually need it in many perspective like in agriculture to measure farm size, for construction of building, bridge road etc. Shape of land can be regular or irregular. Measuring area of irregular shape is difficult, and for that there is many different methods are available. Rope and tape measurement (traversing method) are accepted gold standard for land area measurement, butthese are traditional method of area measurement. Traditional method are time consuming and require more human effort. Area measurement using GPS is 3.5 time faster than traversing method[1].80% of GPS sample plots were measured with negligible error when compared with traversing method[2].

There is some modern techniques also available like measurement of area using Google earth, theodolite, total station, sensor technology etc. But among them theodolite and total station instrument are very costly and not easily portable. Google earth provide relatively good platform for land area measurement, also it is cheap and easy method for land area measurement. But position accuracy of Google earth is not fixed and it varies from time to time (This ocur because of process of updating Google Earth by replacing the original images by a better resolution images)[3]. To use Google earth also we require internet connection.

Another side, now a day GPS based applications are becoming very popular. GPS provide easy, accurate, fast and cheap land area measurement. Also GPS are easily portable. Area of any irregular shape land can be measure using GPS. It also reduce the duplication of work.[4].

II. PROPOSED SYSTEM BLOCK DIAGRAM

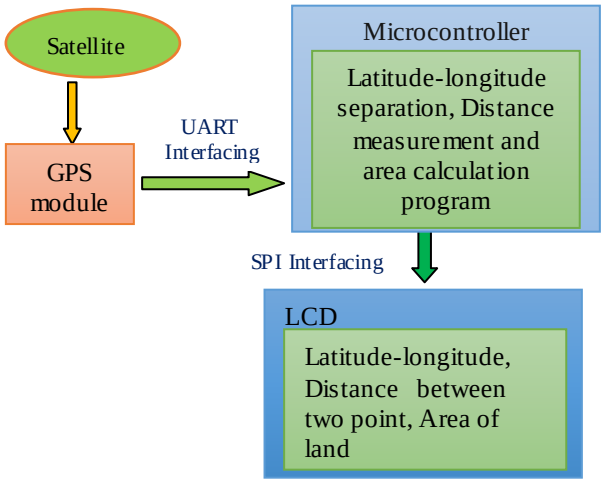


Figure 1. System Block Diagram

Figure 1 shown block diagram of proposed system. First, interface GPS with microcontroller.After interfacing GPS module and microcontroller when we supply it GPS receiver start receiving NMEA sequence continuously. This NMEA sequence then send to microcontroller, here the microcontroller separate latitude and longitude from $GPGGA sequence, this latitude and longitude are in degree minute decimal format (DMD), but we require it in degree decimal format so convert it to decimal degree (DD) format.

GPS receiver send data to microcontroller via UART (Universal asynchronous receiver transmitter) communication. Latitude and longitude of different location are use in equation of distance measurement between two geo graphical point and area measurement equation of irregular shape land.

Latitude, longitude and area of land are display on LCD. Microcontroller send data to LCD via SPI (serial peripheral interface) communication.

III. GPS TECHNOLOGY

GPS stands for Global Positioning System a shorted term for NAVSTAR GPS (NAVigation Satellite Timing and Ranging) a system for locating ourselves on earth. It is a satellite-based system created and controlled by the US Department of Defense, initially for military purposes but extended later for civilian usage. It consists of a constellation of 24 satellites (4 satellites in 6 orbital planes) orbiting at an approximate altitude of 20,200 km every 12 hours.

GPS provides free, twenty-four hour, all weather, and global coverage. The GPS receiver simply calculates the distance to the satellite by measuring the travel time of the signals transmitted from the satellite and multiplying it by the velocity.

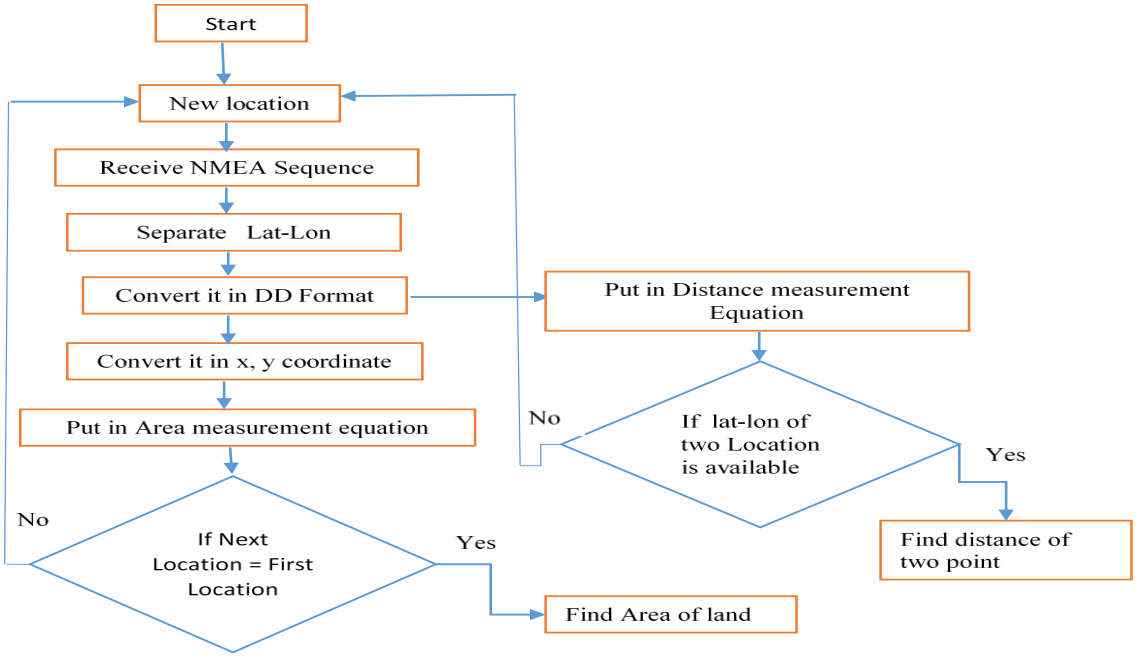
Distance = velocity (speed of light) x Time

The GPS receiver computes its position and time by making simultaneous measurements to the satellites. A signal from three satellites will sort out a 2-dimensional position or horizontal position. In order to get a 3 dimensional position (latitude, longitude and height) at least four satellites are needed within signal range.

IV. NMEA SEQUENCE

NMEA sequence stand for National Marine Electronics Association. When GPS receiver module power on it start continuously receiving NMEA sequence, it contain information of message ID,UTC time, latitude, longitude, date etc. Example of NMEA sequence are $GPGGA, $GPRMC, $GPGSV, $GPGSA etc. Each of sequence have its unique format and GPS receive it in character form. For land area measurement latitude and longitude of particular location are required. Only $GPGGA and $ GPRMC provide information about latitude and longitude. Among them proposed system use $GPGGA sequence. For same location both sequence provide same information about latitude and longitude. From NMEA sequence user can separate physical location (longitude, latitude), speed and other information.

V. FLOWCHART



VI. EQUATION

A. Distance measurement between two geo graphical point

This is added feature of proposed system to fast distance measurement between two geo graphical point. For that as longitude and latitude information from GPS module received of two geographical point, the ground distance between them is to be measured by following Haversine formula:

$$\Delta lon = lon2 - lon1$$
$$\Delta lat = lat2 - lat1$$
$$a = \left[\left(sin\left(\frac{\Delta lat}{2}\right)\right)^2\right] + \left[cos(lat1) * cos(lat2) * \left(\sin\left(\frac{\Delta lon}{2}\right)\right)^2\right] \quad 1)$$
$$c = 2 * atan2(\, sqrt(a), sqrt(1-a)\,)$$
$$d = R * c \,(where\ R\ is\ the\ radius\ of\ the\ Earth)$$

Where,
La1 = Latitude of first location,
Lo1=Longitude of first location,
La2 = Latitude of second location,
Lo2 = Longitude of second location,

B. Area measurement equation of irregular shape

Now using latitude and longitude of all location we can measure area of any irregular shape land using following equation.

$$A = \frac{1}{2}\left|\sum_{i=0}^{n-1}(x_i y_{i+1} - x_{i+1} y_i)\right| \quad 2)$$

To use this equation we have to convert latitude and longitude into x and y coordinate. For that first we assume that world equator length is 40075 km and with respect to whole area of world our land for measurement can be assume as flat area instead of circular. Then using following two equation we can convert our latitude and longitude into x and y coordinate

$$X = \frac{40075 * 10^3}{360} * lon * \cos(lat) \quad 3)$$

$$Y = \frac{40075 * 10^3}{360} * lat \quad 4)$$

Using this two equation we have to convert all latitude and longitude to x and y coordinate and put value of this x and y coordinate in equation of area measurement

VII. SYSTEM REQUIREMENT

A. GPS Module:

In proposed system Fastrex UP501B GPS receiver is used .This is well suited for this application, because in this application main aim is to measure area of land, so obviously we require GPS module having high position accuracy. This module provide high position accuracy <1.8 meter

Figure 2.GPS UP501 Receiver

This GPS receiver is having six pin, among pin number two, three and four are configure with microcontroller.

Main feature of Fastrex UP501B GPS receiver is below:

1) Position accuracy < 1.8 meter
2) 22 tracking and 66 searching channel
3) Navigation update rete: 1sec
4) Baud rate: 9600 bps
5) I/O interface: TTL,RS 232
6) NMEA output: GGA,RMC,GSV,GSA
7) Datum:WGS84
8) Power consumption: 7.5 mV

B. Microcontroller:

In this system MSP430F5529 microcontroller is used. This controller is very suitable for this application for many reason. Proposed system is battery operated, so we have to select such component that have less power consumption and MSP430F5529 is ultra-low power consumption microcontroller, it have five power down mode.

Another feature of MSP430F5529 is below:

1) Low supply voltage range: 3.6 V down to 1.8 V
2) 16-Bit RISC Architecture
3) Unified clock system
4) Two universal serial communication interfaces

5) Three channel internal DMA
6) Flexible power management system

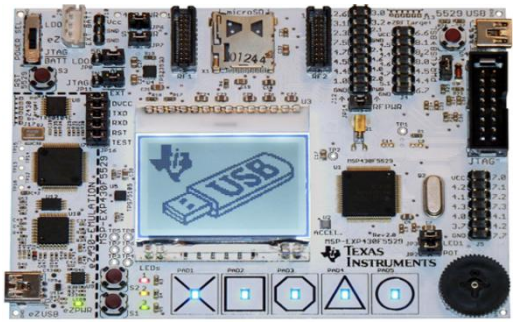


Figure 3.MSP430F5529 Experimental Board[9]

To write code of proposed system algorithm code composer studio (CCS) is used. CCS is more compatible to use with MSP430 Series microcontroller.

Dogs 102x64 dot matrix LCD used to display latitude, longitude and area of land, this is high resolution LCD and this display series was specially developed for low power handheld applications.

Figure 4. Dogs 102x64 Dot matrix LCD [10]

VIII. EXPERIMENTAL RSULTS

Here is shown various result of experimental work done, like of testing of GPS module, interfacing of GPS receiver with microcontroller, receiving NMEA sequence, separating latitude and longitude from $GPGGA sequence and finallyfinding and display area of plot.

A. Testing of GPS receiver module:

It is always better to first test the various component of system requirement. Here below two result show testing of GPS module before use in actual application. In figure no. 5 testing of baud rate of GPS UP501 is shown. This result show that baud rate of this GPS receiver is 9600 bps.Figure no.6 show the result of testing of navigation rate of GPS UP501 GPS receiver and navigation rate of this GPS receiver is 1 sec. This experiment of testing of GPS receiver are done using Digital Oscilloscope (DSO).

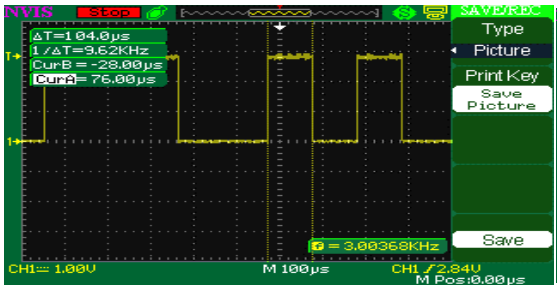


Figure 5. Testing of Baud Rate

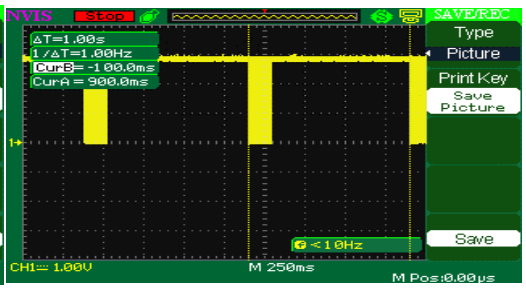


Figure 6.Testing of Navigation rate

B. **Interfacing of GPS receiver module and Microcontroller:**

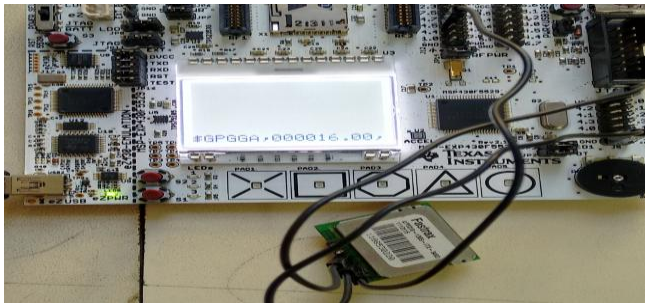


Figure 7.Interfacing of GPS UP501 and MSP430F5529 Microcontroller

Pin no.2 (TxD) of GPS UP501 receiver is connect with pin no.52 (RxD-P4.5) of MSP430F5529.

C. **Display NMEA sequence on LCD:**

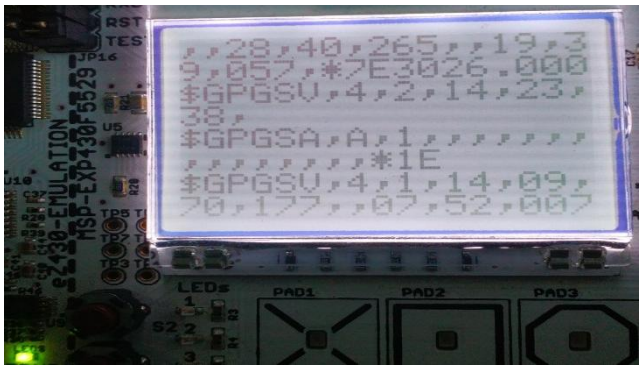


Figure 8. NMEA sequence

D. **Display Latitude and Longitude**

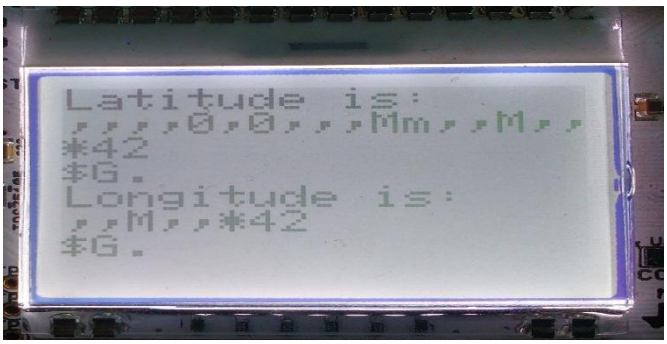


Figure 9. Latitude and Longitude

Here proper or complete NMEA sequence and longitude and latitude is not displayed means in actual format ,because of this result was taken in project lab,this ocure due to of building obstecale.But when we go in open ground to measure its area ,it will work properly.

E. **Display area of land:**

Figure 10. Area of plot

For initial stage we manually take latitude and longitude and put in equation and manually find area, figure no. 10 result for the same. Still real time experiment are going on.

IX. CONCLUSION

Land area measurement is very essential task in agriculture and for construction of building, road bridge etc. point of view. Proposed system provide fast, easy and cheap land area measurement. To design handheld, battery operated GPS device combination of Fastrex UP501 GPS receiver with MSP430F5529 microcontroller is well suited. There is certain limitation of using GPS receiver is also, like it work well only under open sky, if we try to use it in our close house it cannot give better result .As future scope we can also make provision to measure volume.

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