Global Journal of Computer Science and Technology
Network, Web & Security
Volume 13 Issue 17 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Wireless Transmission of GPS Values for UAV's Navigation using 802.15.4b Lan Standard Protocol (Zigbee)

By Mannika Garg, Abdul Wahid Ansari, Sushabhan Choudhury, Rajesh Singh & Ruchin Garg

Univeristy of Petroleum and Energy Studies, India

Abstract- In the last few years UAVs systems have become relevant for many military applications including non military security work such as surveillance of pipelines. An autonomous UAVis often preferred for those missions that are dull, dirty or dangerous for manned aircraft. It has the ability to hover and it has free band GPS direction and tilt sensors for smooth navigation. There is no person on board to control the aircraft. Due to the advancement in satellite receiver tracking systems, an integrated system employing latest tracking techniques using satellite Receiver in the form of GPS is integrated with this vehicle. The data of GPS is transferred to the vehicle wirelessly with the help of Zigbee transceiver module. The GPS has made navigation systems practical for a number of land-vehicle navigation applications. In this paper we have devised an algorithm and hardware implementation scheme to transfer the GPS values from the PAV to the ground station wirelessly to control its aerial navigation.

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GJCST-E Classification : *C.2.1*

Strictly as per the compliance and regulations of:

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Nomenclature

GPS- Global Positioning Satellite
UAV- Unmanned Aerial Vehicle
USART- Universal Synchronous Asynchronous Receiver Transmitter
ISM- Industrial, Scientific and Medical
EEPROM- Electrically Erasable Programmable Read Only Memory

I. Introduction

An UAV is an aerial aircraft with no onboard pilot. It can be RC (Remote Controlled) or can be controlled autonomously whether using pre-programmed plans or dynamically complex control systems [1]. As UAVs are free from the burden of physiological limitations caused by human pilots, they can be designed for maximum on-station times.

Author α: Student, University of petroleum and Energy studies, Dehradun. e-mail: mannika91.garg@gmail.com
Author σ: Student, University of petroleum and Energy studies, Dehradun. e-mail: awahidansari.re@gmail.com
Author ρ: Head of Department, University of petroleum and Energy studies, Dehradun. e-mail: schoudhury@ddn.upes.ac.in
Author ω: Assistant Professor, University of petroleum and Energy studies, Dehradun. e-mail: rsingh@ddn.upes.ac.in
Author ¥: Student, Graphic Era University, Dehradun. e-mail:ruching6@gmail.com

They are mainly used for surveillance, reconnaissance[10] and penetration of hostile territory without the deployment of human beings in areas of high risk. Now-a-days, motorvehicles, farming and mining equipment, and many varieties of land-based vehicles are equipped with GPS based navigation system[8].As per recent technologies used a vehicle tracking system was designed for making a smart farm in the framework of precision agriculture by employing the GPS and Zigbee wireless network including software for acquiring data from the vehicle, storing and displaying it in real time on a web site. [2]. System was employed as tractor tracking system based on mesh topology to cover the large area and data is collected from the tractor [3]. Using 32 bits LPC2220 microprocessor of ARM7, and muC/OS-II real-time embedded operating system, GPS with Zigbee a record system is designed that can provide precise synchronization among instruments and also position the fault, and also allow communication among instruments[4]. The DDAU (Distributed Data Acquisition Unit) used in three-dimensional electromagnetic exploration targeted for oil and gas (hydrocarbon) detection, is composed of data acquisition and DSP module, embedded control module, GPS sync and timing module, and power supply module. The embedded control module includes ZigBee OEM board, temperature sensor, Ethernet, 4 UARTs, 4 SPIs, 2 SSCs, 8 GB NAND flash and 8 MB NOR flashes, is based on AT91RM9200 and Linux 2.6 [5]. With the advancement in technology an enhancement scheme for GPSsignals received on an unmanned aerial-vehicle helicopter system is introduced where using Kalman filter the smooth and accurate signals are generated for automatic flight control systems [6]. A Real-time Aerial Monitoring System performing the rapid mapping in an emergency situation using the position/attitude information obtained from GPS/IMU is used to perform the aerial triangulation without GCPs. The positions and attitudes of GPS/INS integration with the solution from AT in regular intervals are updated. The GPS/IMU/Image data for an UAV-based aerial monitoring system is simulated and compared with the result of GPS/INS/AT with and without updates from AT [7].

In this paper we are representing an aerial system which can fly in the air based on the decisions

and directions decided by the person sitting on the ground to make it move on a concerned path to fulfill the target. Here we are focusing on the wireless navigation system which can control the system during its flight. First we are preparing a database which contains the GPS values of different locations which are traversed frequently. This database is included in the program code. Whenever change in the position of the vehicle is required a command is send from the control room and then vehicle will continuously check the GPS value of that particular location where it has to reach. When the value matches with the stored GPS value that becomes its destination.Here we have designed a network with its hardware design.

II. Hardware Development

Hardware of this system basically consists of two parts: Transmitting node and Receiving node.

a) Transmitter Node

The components of this section are explained below:

i. *Power Supply Module*

This module is designed using center tapped 9-0-9 transformer [9] to step down the AC voltage, 1000uf/35V electrolytic capacitor which is used as a filter circuit, IN4007 diodes used to form a bridge rectifier to convert AC to DC, 7805 regulated IC to obtain a 5V at the output of the regulator, 330Ω resistor and a LED as an indicator. These components are mounted to obtain 5V, 500mA of power supply to drive our whole protocol.

ii. *Embedded Microcontroller*

There is a whole wide range of controllers available in the market. But this particular project is developed using AVR series of microcontroller (ATMEGA16) because of its inbuilt USART and its variable frequency. ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture [11]. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz, allowing the system designed to optimize power consumption versus processing speed. Further it also minimizes the cost of this personal area network.

iii. *Transmitting module*

It is a low power, low cost 2.4 GHz transceiver designed for wireless applications. The ZigBee is designed for the 2400- 2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. This is the radio frequency receiver module, through which OEM designers can design the remote control applications in the fastest way. The circuit is designed with SMD components and the module size is small enough that can be used for all types of applications. The modules are using IC CC2500 made by Texas Instrument.

iv. *GPS (Navigation module)*

The GPS is actually a constellation of 27 Earth-orbiting satellites (24 in operation and three extras in case one fails). GPS is widely characterized as satellite navigation or a satellite positioning system, providing signals for geo location and for safe and efficient movement, measure, and chase of individuals, vehicles, and different objects anyplace from the earth's surface to celestial orbit in house.

v. *USART*

The USART is additionally called a Serial Communications Interface or SCI. The USART are often configured as a full duplex asynchronous system that may communicate with peripheral devices like CRT(Cathode Ray Tube) terminals and private computers, or it are often configured as a half -duplex synchronous system that may communicate with peripheral devices like A/D or D/A integrated circuits and Serial EEPROMs etc.

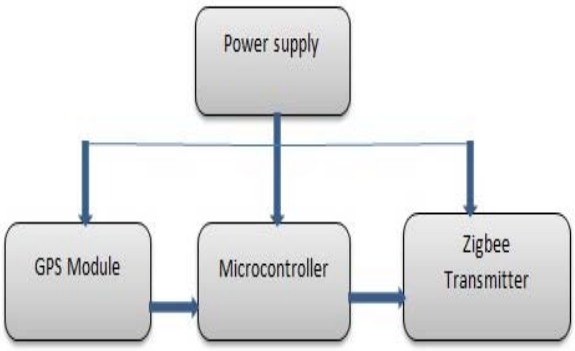

Figure 1 : Block Diagram of Transmitting Node

b) Receiving Node

The components used under this section are described below:

i. *Power Supply Unit:* It is same as described above.

ii. *Zig Bee Module:* It is same as explained above in transmitting section

iii. *Display Module*

The LCD LM016L (16x2) is interfaced with AVR microcontroller to display the data information. The data pins of LCD i.e., 11,12,13,14 are connected to port C (PC0 through PC3) of the AVR microcontroller. The control pins of LCD 4, 5, 6 i.e., Register-select (RS), Read/write(R/W) and enable respectively, are interfaced with PD6, PD5 and PD7 of the AVR microcontroller, severally. R/W pin is keep for good low to place the digital display into writing mode. This unit receives character codes (8 bits per character) from a chip or PC, latches the codes to its show knowledge RAM (80-byte) Doctor of Divinity RAM for storing eighty characters,

transforms every character code into a 5*7 dot-matrix character pattern, and displays the characters on its digital display screen.

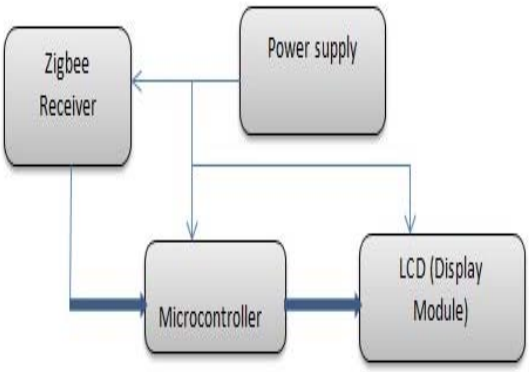

Figure 2 : Block Diagram of Receiving Node

III. Software Development

The software development of designed system is used to get integration and functionality. Here, 'C' language is used to develop the program to drive the system designed and AVR studio4 is used as compiler (WINAVR is running in backend). AVR studio4 software is free firmware for Windows and Linux operating systems.

To get the result of wireless personal area network application, the microcontroller has been programmed, which involved the following steps.

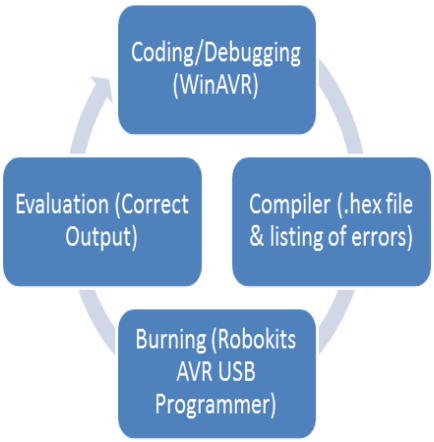

Figure 3 : Steps for Software Development

a) Coding / Debugging

Coding or debugging is one in a high-level language (such as C or java). Compiler for a high level language helps to reduce production time. To program the microcontrollers Win AVR was used using C language. The source code has been commented to facilitate any occasional future improvement and maintenance. Win AVR is a suite of executable, open source software development tools for the Atmel AVR series of RISC microprocessors hosted on the Windows platform. It includes the GNU GCC compiler for C and C++.

b) Compiling

After collecting the program, it's regenerate to machine level language within the sort of 0's ans1's.This file is named because the Hex file and is saved with the extension (.hex). The compiler additionally generates errors within the program that ought to be removed for correct execution of the program.

The Program is compiled after removing all the errors generated.

c) Burning

Burning the machine language (hex) file into the microcontroller's program memory is achieved with a fervent engineer, thatis attached to a PC's peripheral. PC's port has been used for the aim.

d) Evaluation

The system performs as desired by the user and performs all the tasks expeditiously and effectively the code development section is over and therefore the project is prepared to be put in in any of the economic sites as a private space network. If not, the whole method is perennial once more to rectify the errors.

In the programming of the proposed system is used the following .c and .h file.

A.lcd.c -This c file contains the code for control of functionality of the attached LCD module. The code controls the initialization of the LCD, data writing on the LCD. This file contain InitLCD ( ), LCDClear ( ), LCDWriteString ( ) and LCDWriteInit ( ).

i. *To initialize the LCD*

Void Initlcd( )
{
//This function Initializes the lcd module
must be called before calling lcd related functions
Arguments:
style = LS_BLINK,LS_ULINE(can be "OR"ed for combination)
LS_BLINK :The cursor is blinking type
LS_ULINE : Cursor is "underline" type else "block" type
}

ii. *To display strings to LCD*

Void display (const char *data)
{
//This function writes a given string to lcd at the current cursor location.
Arguments:msg: a null terminated string to print
}

B.lcd.h- This header file contains all the constant variable values and names of the subroutines used by various files used in the software. It clearly indicates which variable can be used as a global

variable and which of the subroutines can be used across the software files.

C.usart_lib.c-This library can be used to transmit and receive data through the built in USART. An interrupt is generated when the USART has finished transmitting or receiving a byte. This contain three major functions USART In it ( ), USART Read ( ) and USART Write ( ).

Initialization of USART:

This function will initialize the USART.

voidUSARTInit(uint16_t ubrr_value)

{

UBRR= ubrr_value; //Set Baud rate

UCSRC= (1<<URSEL)|(3<<UCSZ0);// Set Frame Format

UCSRB= (1<<RXEN)|(1<<TXEN);// //Enable The receiver and transmitter

}

Reading From TheUSART:

This function will read data from the USART.

```
char USARTRC()
{
        while(!(UCSRA & (1<<RXC))) //Wait until a data is available
{
//Do nothing
}
        return UDR;   //Now USART has got data from hostand is available is buffer
}
```

Writing to USART:

```
void USARTWC(char data)
{
        while(!(UCSRA & (1<<UDRE)))     //Wait until the transmitter is ready
  {
    //Do nothing
  }
        UDR=data;     //Now write the data to USART buffer
```

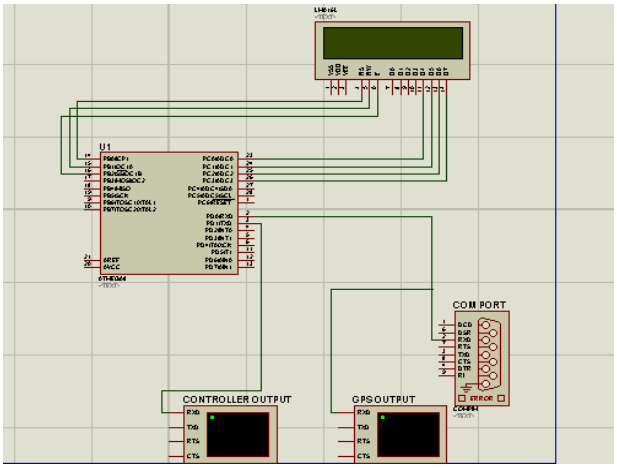

Figure 4 : Simulation Model on Proteus

This is the basic simulation model we have done on Proteus software and the required connections to extract GPS data are also figured.

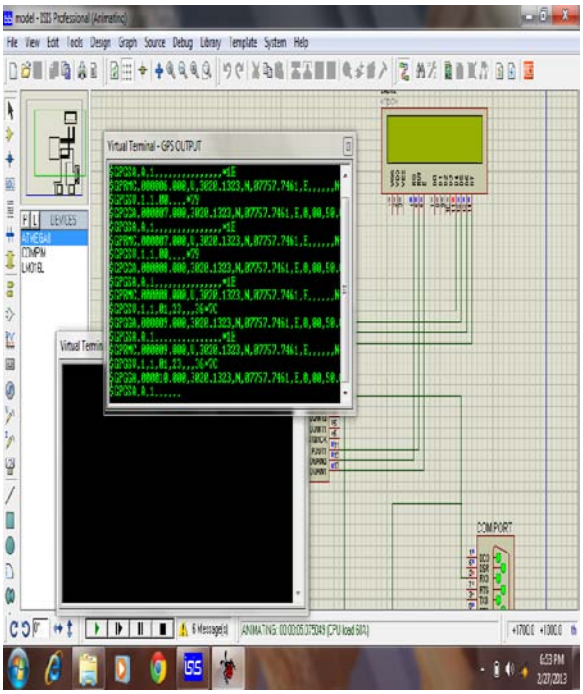

Figure 5 : Extracted values of GPS through Proteus Model

This figure is showing all the values of GPS displaying on virtual terminal through Proteus model. The GPS values are simply transferred through USART using microcontroller and through COM port displayed on virtual terminal.

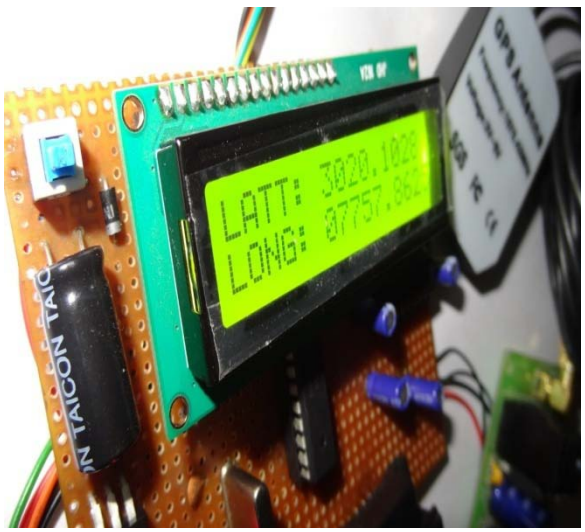

Figure 6 : Hardware view of GPS extracted values

This figure is representing the GPGGA values extracted out of 18 values of GPS on lcd. For our system we only require values of latitude, longitude and altitude. Here only values of latitude and longitude are shown.

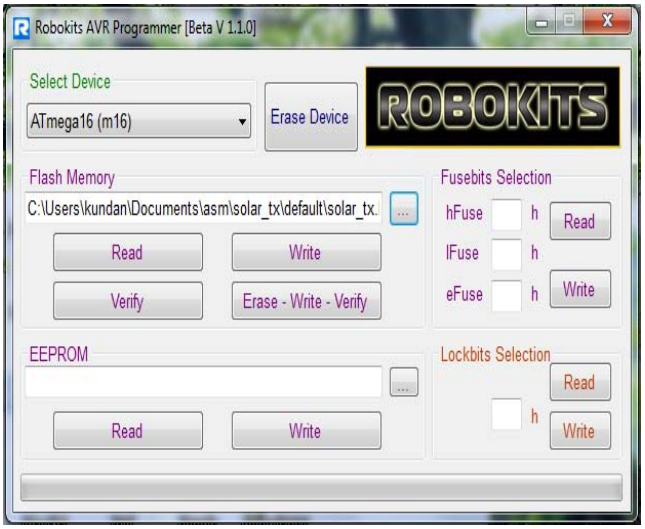

Figure 7 : View of hardware AVR programmer (ISP) by Robokits

IV. Conclusion & Future Scope

Both the hardware and software system was tested with real time data and accurate values of the positions were recorded.

This system as compared with other traditional manual inspection is more accurate since it increasesthe accuracy of data acquisition by using non-licensed Zigbee protocolwhich also supports real-time transmission. Also, its operation is flexible since its flight can be controlled from ground station by the designed hardware platform. Themeasurement is accurate (accuracy in position-5 meters, accuracy in velocity-.1m/s,accuracy in time: 0.1 s). The operation is simple and power consumption is also low (12V/750mA)and it iscost effective also because of using non licensed band.Being wireless it also reduces the complex wiring system. Here, a personal area wireless network is designed and implemented. This can be used for surveying at emergency situations like pipeline damages etc. Further if system is carrying payload then in that case it can be used for transferring the load as per the changes in plans.

V. Appendix

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VI. Acknowledgement

The authors are thankful to the administration of the UPES, Dehradun for their support in implementation of the work.

References Références Referencias

1. Abdul Qayyum, Moona Mazher "Autonomous Navigated Global Positioning System Based Surveillance Unmanned Aerial Vehicle", ITEE Journal" Vol.I, Issue 1.
2. Angel, G. ; Brindha, A. "Real-time monitoring of GPS-tracking multifunctional vehicle path control and data acquisition based on Zigbee multi-hop mesh network" International Conference on Recent Advancements in Electrical, Electronics and Control Engineering (ICONRAEeCE), 2011, pp.398 – 400.
3. Watthanawisuth, N.; Tongrod, N.; Kerdcharoen, T.;Tuantranont, A. "Real-time monitoring of GPS-tracking tractor based on Zig Bee multi-hop mesh network" International Conference on Electrical Engineering/Electronics Computer Telecommu-nications and Information Technology (ECTI-CON), 2010, pp. 580 – 583.
4. HualiChen; Zhifan Feng "Design of Data Acquisition and Record System Based on Zig Bee and GPS" Workshop on Computational Intelligence and Industrial Application, 2008. PACIIA '08. Pacific-Asia, pp. 682 – 686.
5. Rujun Chen ; He Zhangxiang ; QiuJieting ; He Lanfang ;CaiZixing "Distributed data acquisition unit based on GPS and Zig Bee for electromagnetic exploration" Instrumentation and Measurement Technology Conference (I2MTC), 2010 IEEE, pp. 981– 985.
6. Ben Yun; Kemao Peng ; Chen, B.M., "Enhancement of GPS Signals for Automatic Control of a UAV Helicopter System" International Conference on Control and Automation, 2007. ICCA 2007. IEEE, pp. 1185 – 1189.
7. Joong-hee Han ; Kwon, J.H. ; Impyeong Lee ; Kyoungah Choi "Position and Attitude Determination for UAV-Based GPS, IMU and AT without GCPs" International Workshop on Multi-Platform/Multi-Sensor Remote Sensing and Mapping (M2RSM), 2011, pp. 1 - 5 .
8. Eric Abbott, David Powell "Land vehicle navigation using GPS" for Heat Detection by Infrared thermography & Alkali metal detector and their alloys in fast reactors Using ZIGBEE Transceiver module based Personal Area Network" UIT Journal
9. Rajesh Singh, Akanksha, Shashank Mishra, Ankit Joshi "Wireless Personal Area Network Node Design And Simulaton Of Alcohol Sensor Using Zigbee Transceiver Module" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 3, May-Jun 2012, pp.133-138.
10. Jinling Wang, Matthew Garratt, Andrew Lambert, Jack Jianguo Wang, Songlai Han, David Sinclair, "Integration of GPS/INS/Vision sensors to navigate unmanned aerial vehicles" Commission I, ICWG I/V.

11. Rajesh Singh, Siddharth Sobti, Naman Bhandula, Shashank Agarwal, Laxman Poonia "Wireless Micro Power Meter System up to 100 W Load Simulation and Design using 2.4 GHz Transceiver Module" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 4, July-August 2012, pp.051-055.