July 2012

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Recommended Citation

Reddy, Boddu Varun; Vivek, Ch.; Tarigopula, Sanjeev; and Kumaravelu, Vinoth Vinoth (2012) "Wireless Real Time Atmospheric Data Acquisition and Analysis using MATLAB," *Undergraduate Academic Research Journal*: Vol. 1 : Iss. 1 , Article 8.

DOI: 10.47893/UARJ.2012.1007

Available at: <https://www.interscience.in/uarj/vol1/iss1/8>

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Wireless Real Time Atmospheric Data Acquisition and Analysis using MATLAB

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Abstract - Real time wireless atmospheric data acquisition has always been necessary for weather scientists and environmental engineers, especially atmospheric data from 1-50KM above the surface of the earth. The weather balloons with payloads available in the market are expensive and require a lot of effort to launch. We have discussed an affordable and efficient way of doing this with help of MATLAB GUI. The authors have integrated hardware that is the ground station with MATLAB via the RS232 port and analyzed the income data and plotted each of them w.r.t height obtained from the onboard GPS.

Keywords - component; weatherballoon; MATLAB GUI; RS232.

I. INTRODUCTION

There are two parts to this paper, in the first part we discuss the design of the hardware and the second we discuss how we have integrated the hardware to software which is MATLAB and developed a GUI. This system can be used by weather scientists, environmental engineers in colleges to collect atmospheric data like temperature, pressure, humidity, altitude and also the location and use it for their research. MATLAB is a versatile tool for any engineer; one can also communicate with external devices (hardware) with the help of rs232 port of the computer. We have used this to our advantage and received data directly into MATLAB and analyzed it. We have also developed a graphical user interface to help us easily setup the communication system and calibrate the sensors. All in all this complete setup well help gather data from any payload wirelessly and efficiently. We have tested the system for a range of 1-1.5Km in height. We have depended on LOS communication. The range of the system can be improved with properly designed antennas and using a high sensitivity receiver.

II. BASIC BLOCK DIAGRAM

A basic block diagram of operation is given below

III. PAYLOAD DESIGN AND DEVELOPMENT

The payload is basically an embedded system with sensors, GPS, and RF transceiver. The microcontroller we chose for this payload is ATMEGA 8535 it has all the regular ports and communication interface. The advantage is that the interrupts are executed faster in this microcontroller with only 8kbytes of flash available. The sensors integrated to this microcontroller are LM35 for temperature because of its wide range, Freescale absolute pressure sensor MPX6115A and a humidity sensor. We have used a GPS module with a MTK MT3318 chipset which has a sensitivity of -151.6db and 51 channels for more accuracy. The mother board, sensors signal conditioning circuit, the RF board were designed in eagle and fabricated. The RF daughter board contains a CC1100 low power RF IC from Texas Instruments and a power amplifier PA649 which

increases the power output of the RFIC to 1W, which is more than enough for a range upto 1km if we are using the same RFIC at the receivers end. The GPS is connected to the UART port, the RF board to the SPI and sensors to ADC of microcontroller. The software was developed using AVR studio 4. The CC1100 is operated in the slave mode. The register values for the initial configuration were obtained from RF Studio 7. The CC1100 is configured such that it has a data rate of 9600 baud per sec and operates at a frequency of 433MHz with GFSK modulation. The data is arranged in form of data packet which includes the height, date, time, sensor data and then sent to the RFIC. All the electronic components are fixed in a rugged mechanical structure which can withstand heavy vibrations. This payload is launched into the atmosphere using a helium balloon and ascends at a rate of 1m/s. The payload is switched on before it is launched and starts transmitting data continuously.

IV. PAYLOAD BLOCK DIAGRAM

V. GROUND STATION DESIGN

The ground station was developed using the same microcontroller and RFIC that is the ATMEGA 8535 and CC1100. The RFIC is configured with the same settings which were used in the payload design the transmitter and receiver mode are activated in both the cases. The interesting part of the ground station is that it is connected to a PC via the RS232 cable with a max232 level converter. The RS232 port hereon referred to as the com port is accessed through MATLAB. The main idea behind the ground station was to make it as light as possible.

VI. BLOCK DIAGRAM OF GROUND STATION

VII. MATLAB INTERFACE

We have developed a Graphical user interface which allows us to calibrate the sensors to the ground value and also start the communication all the data is received in an array. The data packet received from the microcontroller of the ground station serially has been decoded as follows: Height, date, time, temperature, pressure, humidity. The GUI that has been developed is very user friendly showing the real time plots of the data received. The GUI shows the real-time variation in the graphs accurately. The GUI is developed for simplex communication in case of a packet error a message indicating the error will be displayed on the screen thus avoiding the data loss. The MATLAB GUI makes use of the various radio buttons, push button, axes, edit text and static text in regard to perform various functions in the GUI.

VIII. PLOTS OBTAINED IN MATLAB

Above is the plot of humidity v/s height obtained in MATLAB

Above is the plot of temperature v/s height obtained in MATLAB

IX. CONCLUSION

In this paper we have designed and implemented a wireless data acquisition system exploiting MATLAB's GUI development kit. We have also successfully tested this system for a range of 1 to 1.5Km. Real time plots were obtained and manipulated using the GUI developed.

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