

Real Time AVR based Monitoring System for Wireless Sensor Network

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Abstract

Wireless Sensor Networks have attracted the attention of many researchers. Such networks are used for various monitoring applications. In this paper a system to monitor analog sensors has been proposed. Variation in sensor data has been displayed on the Web User Interface. This application stores sensor data on the server and has been available to view later. An 8-bit AVR Atmega 64 microcontroller has been selected to interface sensors and C sharp language based web application has been developed. Also Free RTOS operating system is used for the sensor node.

Keywords: AVR, ZigBee, RTOS, GUI, WSN

I. INTRODUCTION

Wireless sensor network recently gained attention from many researchers and developers. Such network is made from small embedded devices, called as sensor nodes. No of sensor nodes are placed over large area to create a network. These sensor nodes are equipped with wireless transceiver and connected with each other through it. Wireless links are used to minimize the ease of wired monitoring system. Basically monitoring systems are used to monitor real world parameters; hence a monitoring system is required to give an actual time response over the variation in those sensed parameters.

The Proposed system consists sensor node hardware based on AVR Atmega 64 microcontroller with FreeRTOS implemented. To enable wireless data transmission to base station ZigBee module is used. To receive transmitted data at base station asp.net based UI is developed, for receiving data another ZigBee module is interfaced with server PC.

II. DESIGN & IMPLEMENTATION

A. Wireless Sensor Node

In this system sensor nodes are designed with ZigBee module, The ZigBee modules are reconfigurable devices which can be configured to operate as router, coordinator or end devices. System block diagram is shown in figure 1. Sensor node consist of FreeRTOS as an operating system. In this system three priority based tasks has been implemented. Sensor task is highest priority task, low priority task is alarm task will continuously checks sensor data and third is lowest priority serial task it transmits data through ZigBee to the main data center. In this system ideal task concept is used to reduce power consumption. All tasks has been suspended after they finished then RTOS kernel will call an idle task to run.

B. Hardware Requirements

Figure 2 shows the block diagram of the sensor node. It consist of a ZigBee transceiver interfaced with Atmega 64 microcontroller with LDR and Temperature sensors.

1) AVR Atmega Microcontroller

In this sensor node is constructed with 8-bit Avr microcontroller. Acronym for AVR is Advance Virtual RISC (Reduced Instruction Set Computing). It is featured by

- Thirty two 8- bit general purpose registers.
- 64k bytes of in-system programmable flash memory, 512 bytes of EEPROM and 1 bytes of internal SRAM.
- 10 bit in -built analog to digital converter (ADC).
- On chip analog comparator.
- Six channel ADC.
- Programmable serial USART.

2) Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling [].

The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^\circ\text{C}$ at room temperature and $\pm 3/4^\circ\text{C}$ over a full -55 to $+150^\circ\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only $60\ \mu\text{A}$ from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to $+150^\circ\text{C}$ temperature range, while the LM35C is rated for a -40° to $+110^\circ\text{C}$ range.

The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package [].

3) *Light Dependent Sensor*

A photo resistor or light dependent resistor (LDR) or photocell is a light controlled variable resistor. Resistance of a photo resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. LDR sensor will be used to detect light level & as LDR return analog value, so through ADC

4) *ZigBee Module*

It is a Technological Standard Created for Control and Sensor Networks, based on the IEEE 802.15.4 Standard. In particular we are using series 2 over series 1. The reason behind this is that we can implement star topology only in series 2, operating at 2.4 GHz and range up to 100 meter. Here using mesh topology. There are two types of communication modes API mode and AT mode. ZigBee router is AT mode and ZigBee coordinator as API mode.

5) *Power Supply*

9 V power supply is required to power on the sensor node.

III. ALGORITHM FOR THE MODEL

A. *Sensor Node Algorithm*

Algorithm of three task implementation of the application as below.

- 1) Initialize sensor node hardware.
- 2) Create a binary semaphore, implemented for synchronization between different tasks.
- 3) Create three tasks.
- 4) Start the scheduler, to run the created task.
- 5) Suspend each task after its execution completes.
- 6) Control automatically transferred to Idle task, after all tasks has been suspended.
- 7) Idle task will resume all other tasks and the program continues.

Suspending and resuming a task will increase runtime of idle task, a power save mode of controller is used to save power consumed by sensor node. In Free RTOS this mode is called as tickless power down mode.

B. *Web application Algorithm*

Algorithm of web application is as below.

- 1) Web page start with asking for the user name and password.
- 2) After successful login, page has been directed to main page.
- 3) At the start of main page, code initializes serial port.
- 4) Data has been received from serial port and stored into a string.
- 5) String data has been split and checked for letters Z, A and B.
- 6) If letter matches to Z then it checked for letter A and if matches store data in sensor text file 1 and display it in textbox1, if no go to step 7.
- 7) Check for letter B, if matches store data in sensor text file 2 and display it in textbox 2.
- 8) If sensor button1 pressed show sensor1 text file content in textbox3.
- 9) If sensor button2 pressed show sensor2 text file content in textbox4.

Timer script is implemented to run the main page code. Timer interval is set to 2 second, hence main code is repeated after every 2 second.

IV. EXPERIMENTAL EVALUATION



Fig. 1: Router Node at Server End



Fig. 2: Sensor Node

Figure 3 shows the Atmega 64 based sensor node. For experimental evaluation purpose temperature and two LDR sensors were interfaces with Atmega 64 development board.

A. Evaluation

After the web application project has been built to a release version of web application and IIS is running on the web server, we can run and test the software. The goal of testing is to ensure that the software meets project requirement. We can go through the web site and see the feature. Login.aspx: It is first page that the client will see. From here user can enter its username and password to login the application as shown in figure 4. After entering correct username and password login.aspx page is automatically directed to main.aspx page. Main page initializes serial port of server pc for 9600 kbps. The application then start receiving serial data, this application continuously monitors sensor data.

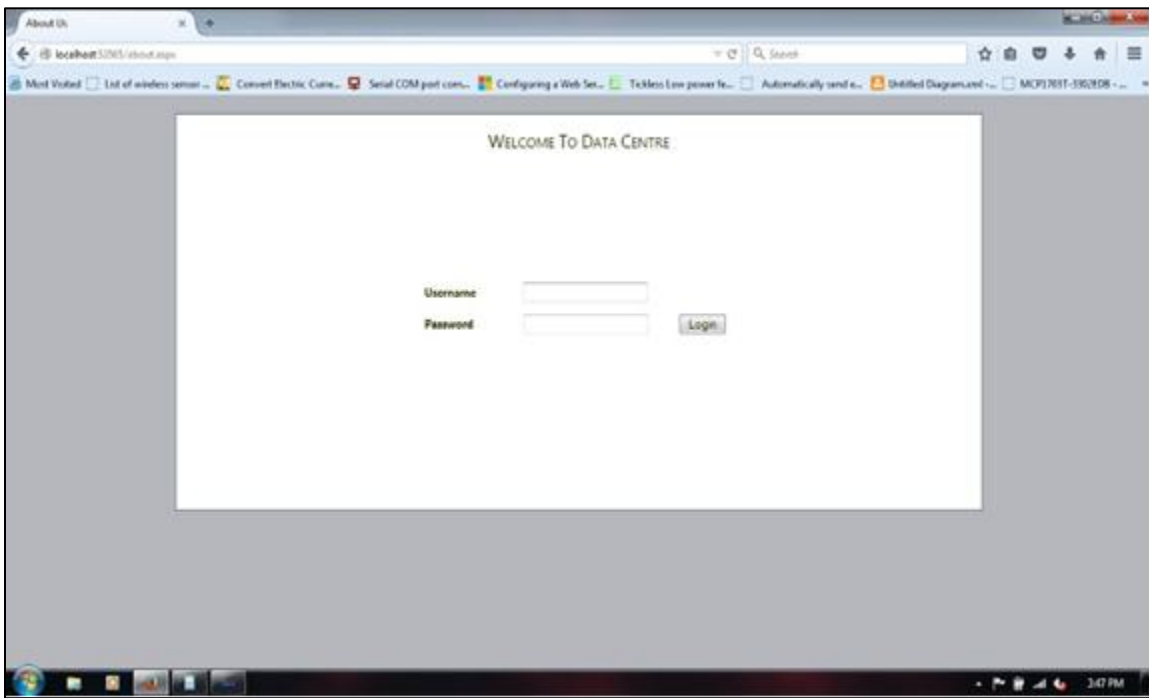


Fig. 3: Login Page

To receive Sensor data a ZigBee is interfaced with the server as shown in figure 2. This stream contains a keyword like ZA and ZB, here Z represents sensor node and A, B represents different sensors. According to these keywords C# application separates received data, displays it in respected columns and stores them in separate text files. GUI (Graphical User Interface) is as shown in figure 5.

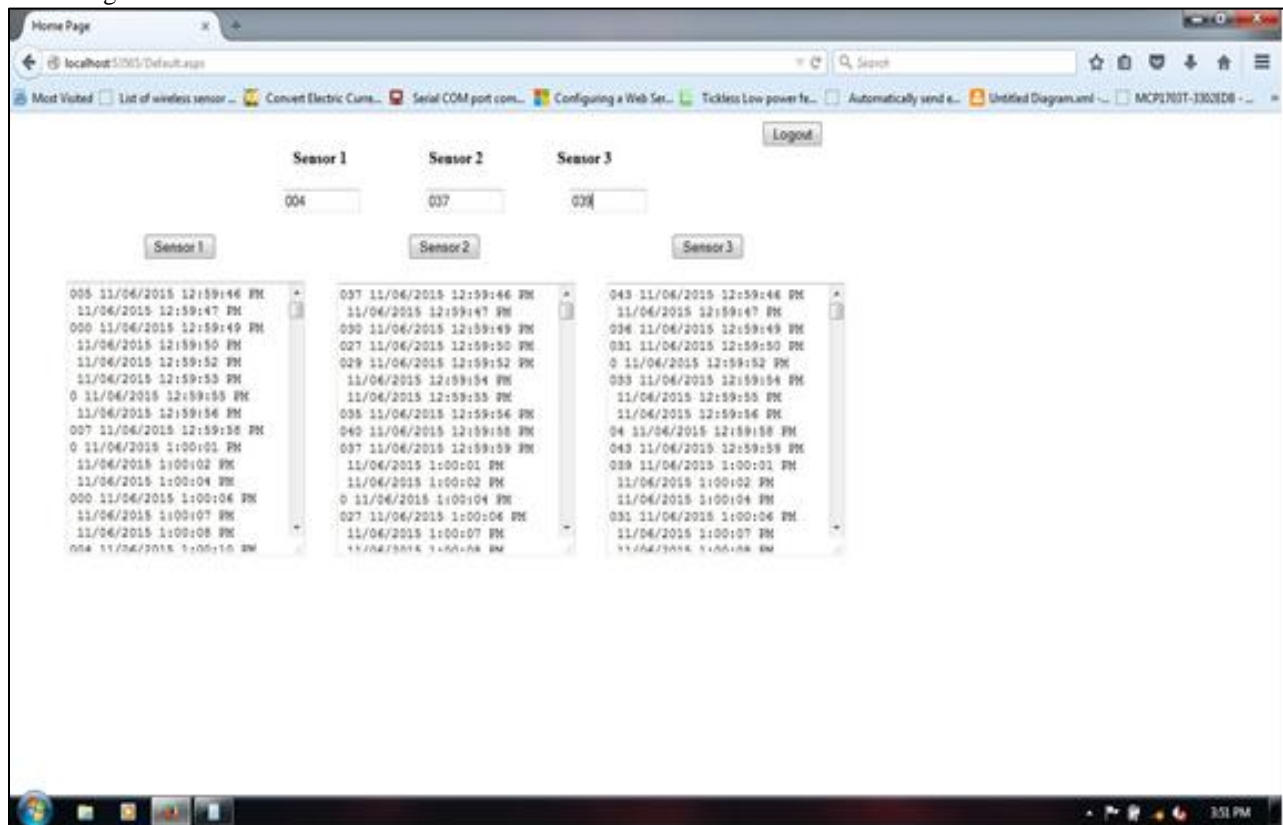


Fig. 4: Main Page

V. CONCLUSION

The proposed work shows a monitoring application based on the Atmega 64 microcontroller using FreeRTOS operating system which continuously monitors variations in output of various analog sensors. The system consist of router node interfaced with server pc to receive sensor data from the coordinator. The proposed work also shows that various sensor data can be collected and transmitted synchronously with real time constraint over wireless media.

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