ISSN: 2277-9655
Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Weather Parameters Monitoring based on Zigbee and AVR Microcontrollers

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Abstract

This paper focuses on using Atmel AVR series of microcontrollers and TarangZigbee module to monitor the Environmental parameters such as temperature, humidity, CO2, and moisture level of an Environment wirelessly.Nowadays, monitoring climate condition's parameters such as temperature and humidity is a prominent factor to control the changes of the environmental condition of living or working places for the human being. This point can be obtained by using distributed devices in different environments that containing high-resolution sensors and a wireless transmission apparatus for transferring data to remote computers. The Zigbee was chosen as a transmission tool since it is fast and it can work in the absence of the Wi-Fi connection. In this paper, a novel interface by applying a Zigbee-based sensor to sense Temperature and Humidity for monitoring of the environmental conditions using low cost AVR series of microcontrollers is introduced.

Keywords: Temp sensors, humidity sensors, AVR32, Zigbee, weather station.

Introduction

Environmental sensors, such as temperature, humidity, smoke, gases, solar radiation, pressure, and so on, can be placed both in outdoor and indoor sites. There are environmental sensors that monitor some specific elements such as CO2, O2, H2, and so on. In most cases, this kind of sensor network is organized as a short distance transmitter of data. Low power and low cost are the main characteristics of these sensors.

The following parameters will be affected on the sensors structures and subsequently their platforms:

- Deployment (activities)
- Location (indoor / outdoor)
- The application

Data (that should be processing and inferring)

With the continuous development of technology, it gives a new type system of environment monitoring based on Zigbee technology. Using the characteristics of wireless Sensor networks and the mature communication Technologies of Zigbee; it implements real-time Monitoring and intelligent warning for Environment and production parameters. This system is Equipped with a low power AVR processor chip atmega32 as the control of the core and Zigbee as a Communications platform of wireless sensor networks. Through a lot of tests, many valuable data are collected from the actual environment; the result of the experiment confirms the feasibility of the system design and its good stability. Wireless sensor networks are becoming very attractive or monitoring and control applications with smart sensor nodes. We present an implementation of a Zigbee wireless sensor Network compliant with the ieee1451[1] standard to improve the Interoperability.

The Zigbee-based temperature and humidity acquisition system consists of a device comprising a sensor and a microcontroller that wirelessly transmits these climatic parameters to a receiver using the Zigbee communication system. An application called a Zigbee control was developed to acquire data from the Zigbee-based temperature and humidity acquisition system that has described before. The Zigbee control application has two parts. The first part, display, illustrates the temperature and humidity values that are read from the Zigbee-based acquisition system, which is first configured in the second part called setting. The obtained values can be saved in a text file to allow the analysis of the data.

The temperature sensed by the sensor will send the readings to the PC through the Zigbee at transmitting part and at receiving part the Zigbee receives the data and it will send to the PC. Here in this project the various sensors are attachedto the AVR based microcontroller through Analog to Digital Converter.

The monitor system Transmitters are installed in different places. Sometimes it is not easy to install equipment in some areas for many reasons such as lack of access to power or unable to connect to signal wiring. In addition, tools used for measurements are very expensive. To resolve this problem, a wireless sensor network can be implemented tohelp in data communications. The advantages of using a wireless

ISSN: 2277-9655
Impact Factor: 1.852

network are: using less energy, no need for hardwiring, and high transmission distance [2].
In this research, the advantages of a wireless sensor network are taken to benefit weather monitoring stations. Many sensor stations measure and send parameters through a wireless network server.

Block Diagram

- AVR Atmega32 microcontroller
- Zigbee modules
- Max232
- Temperature Sensor
- Humidity Sensor
- LCD Display
- Power Supply.

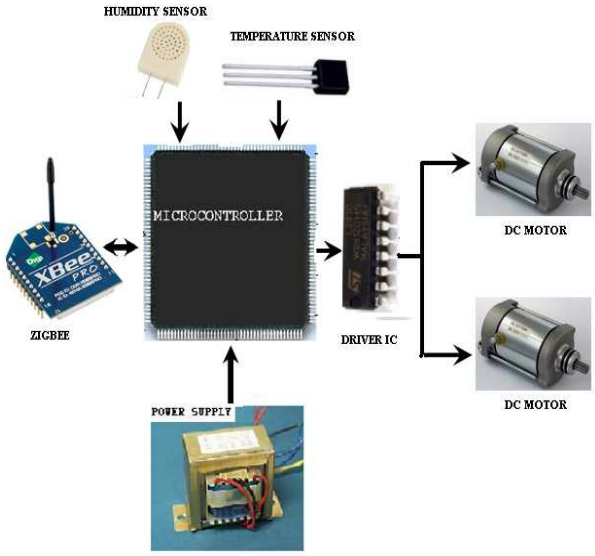

Figure 2.1 Transmitter

Figure2.2 Receiver

Introduction to AVR Atmega32 [3]

The Atmega32 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the Atmega32 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.
The Atmega32 provides the following features: 8K bytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 1024 bytes EEPROM, 2K byte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the USART, Two-wire interface, A/D Converter, SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next External Interrupt or Hardware Reset. In Power-save mode, the Asynchronous Timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except Asynchronous Timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator and the Asynchronous Timer continue to run.

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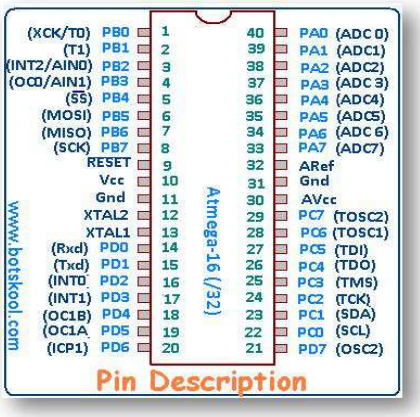

Fig. 3.1AVR Atmega32 pin description

Zigbee Operation

The Zigbee boards [5] use a V2 XBEE module to interface to the Zigbee network. These modules are compliant with the 2007 Zigbee Pro / ZNET standard. The V2 XBEE modules come in two varieties. One is configured to be the Zigbee network coordinator (EB051C) and the other is configured to be either a router node or an end device node (EB051R). The variety of the module is marked at the top right hand side of the Zigbee board. Coordinator nodes are responsible for creating the Zigbee network and allowing other Zigbee nodes to join. Only one coordinator node can exist on any single network. Router nodes are responsible for routing signals to other routers or to end nodes. End device nodes are responsible for collecting or depositing real world data to and from the Zigbee network. The Coordinator node and Router nodes are capable of handling up to eight children devices. The children devices can consist of either other Router nodes or End device nodes. If an End device node is configured to sleep then the parent device associated for that node will be responsible for buffering any incoming data. Therefore if you are using sleeping End devices you must make sure to poll the parent for data every time the device comes out of sleep mode.The board is compatible with 3.3V and 5V systems.

Communications

The XBEE modules [4] are configured by means of using a TTL level RS232 bus to send and receive AT commands. This protocol requires a start bit, eight data bits and a stop bit.The baud rate for the XBEE modules is set to 9600, with no parity and flow control lines RTS and CTS that can be used. AT commands are strings of ASCII data that are sent over the RS232 bus. For more information on the AT commands used by the XBEE module please refer to the V2 XBEE datasheet. Example AT command ATID 234 - Assigns a personal area network identifier of 0x234 or 564 in decimal. *6. V2 XBEE Module.*

Zigbee is a wireless network protocol specifically designed for low rate sensor and control networks. Compared to other wireless protocols, the Zigbee wireless protocol offers

- low complexity,
- reduced resource requirements
- And most importantly, a standard set of specifications.
- It also offers three frequency bands of operation along with a number of network configurations
- And optional security capability.

Interface and Operation [9]

The Tarang modules interface to a host device through a logic-level asynchronous serial port. Through its serial port, the module can communicate with any logic and voltage compatible UART or through a level translator to any serial device (For example: RS-232 or USB interface board).

Serial Interface

Tarang can be interfaced with a micro controller or a PC using serial port with the help of

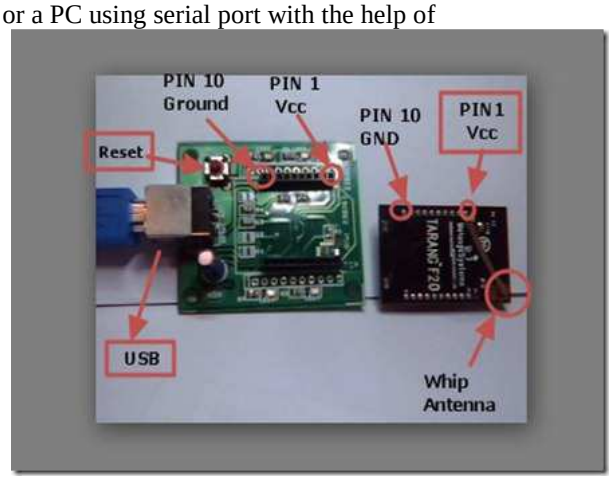

Fig. 4.3.1Serial Interface

CTS and RTS are optional. (Refer pin configuration for pin details) Tarang supports serial data with,

• Flow Control: Hardware, None
• Parity: None
•BaudRates:
1200,2400,4800,9600,19200,38400,57600,115200
• Data Bits: 8

To establish a successful serial communication with the module, serial parameters need to be configured properly in the module and host side. Both the module and PC settings can be Viewed and set using AT command set through popular terminal applications like 'HyperTerminal'.

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5. Combustible Smoke Sensors

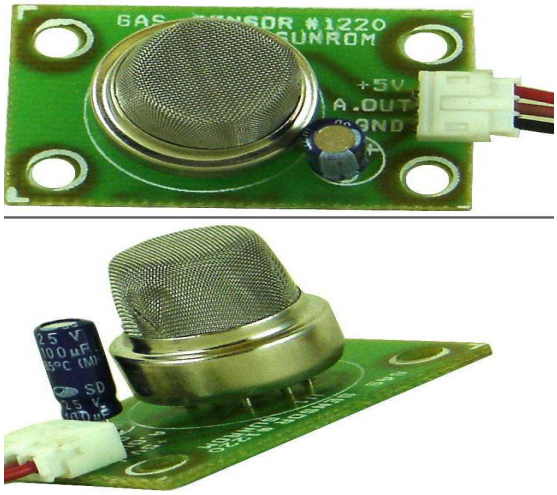

Fig. 5combustible smoke sensors

These Sensors are used in gas leakage detecting equipment for detecting ofLPG, iso-butane, propane, LNG combustible gases. The sensor[8] does not get trigger with the noise of alcohol,cooking fumes and cigarette smoke. They are used in

- Gas leak detection system
- Fire/Safety detection system
- Gas leak alarm / Gas detector

Features

- Simple analog output
- High sensitivity to LPG, iso-butane, propane
- Small sensitivity to alcohol, smoke
- Fast response
- Wide detection range
- Stable performance and long life

Results and Discussion

This paper investigates a novel approach to acquire temperature, Smoke and humidity signals using relative low cost and low power components and the Zigbee communication system for the transmission of the acquired data to an central monitoring base station. An application for the acquisition and storage of temperature and humidity values was created for the central data collection station. The performance of the entire system was tested by laboratory tests using a climate chamber in order to modify the environmental conditions. Results shown that the presented device correctly follows the environmental condition which created by the climatic chamber and the application for the base station properly acquired and stored the data by the apparatus using the Zigbee connection as a transceiver. This approach is useful to monitor climate condition for small environments, such as a laboratories, home rooms, medical spaces, etc., and turn on alarms when the condition changes or overlaps some fixed thresholds. Another possible application of the presented system is the detection of fire in small environments.

Future Scope

- Data can be collected on smart phone along with the base stations.
- Various other industrial sensors can be used for industrial parameter monitoring [6].
- This project can find application in domestic agricultural field. In civilian domain, future work can be used to ensure faithful irrigation of farm field, since we have the option of finding out moisture level of soil in a particular area. [7].

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ISSN: 2277-9655
Impact Factor: 1.852

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