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Industrial Wireless Monitoring and Control Using Zig-Bee Technology

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Abstract:
The paper work provides real time industrial monitoring and control system using zig-bee wireless technology. The motivation of real time monitoring and control is to monitor the environment parameter like temperature, gas leakage and pressure. The related sensor sense environment parameter and transmit parameter to monitoring room using zig-bee technology. it uses LPC 2148 microcontrollers which based on a 16-bit/32-bit ARM7 CPU that combine microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB.

1. Introduction

The large scale industries monitoring and control system consists of numbers of sensors, controllers and actuators. This system consists of the huge amount of wiring means wired system. This system is growing up to achieve high demands from consumers. So; it is very difficult to change the all system due to the very rigid nature of wired infrastructures. It is the best way to use wireless network [1].

The wireless network platform provides great advantages over traditional wired system. By utilizing WSN technology, sensing and action devices will communicate wirelessly with monitoring room and also with a microcontroller. There are a number of ways of wireless communication in WSN. There are three technologies for wireless communication such as Bluetooth, Wi-Fi and Zig-bee.

Parameter	Bluetooth	Wi-Fi	Zig-Bee
Data rate	1-2 mbps	54 mbps	250 kbps
Numbers of nodes handle	7	34-50	up to 254
Cost	less compared to Wi-Fi	More	less compared to both
Current consumption	65-170 ma	350 ma	30 ma
Battery life	More compared to Wi-Fi	Less	longest

Table 1: Comparison of Bluetooth, WI-FI and Zig-Bee [2]

The basic idea of industrial monitoring and control in WSN is described in figure-1. The industry consists of numbers of sensors and controllers which are monitored by monitor room. The sensors like temperature, humidity, gas leakage, velocity and pressure sense the physical parameter and send it to the controller. There are three sensor used such as LM35 as temperature Sensor and gas leakage sensor MQ-6 detects gas leakage in chamber and SPD015GA as pressure sensor.

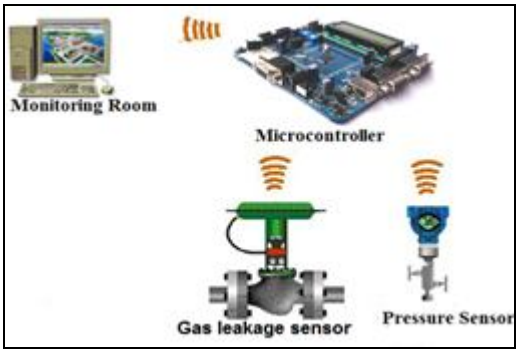

Figure 1: Traditional Industrial System

The microcontroller receives the sensor data output via zig-bee module and send it to monitoring room which also one kind of powerful microcontroller usually LPC2148 through zig-bee module. It belongs to a class of 16/32 bit microcontrollers of RISC architecture & a Program Memory (FLASH) for storing a written program. The communication from microcontroller to sensor or sensor to microcontroller uses wireless media like Zig-bee, Bluetooth and Wi-Fi. Zig-bee provide greater advantages for wireless communication described in table-1

Wireless communication used Bluetooth, Wi-Fi and Zig-Bee technologies for data transfer Zig-Bee provide better node handle capacity and better battery life compared to Bluetooth and Wi-Fi. Zig-bee has advance networking and security. Zig-Bee has AT and API command modes for configuring module parameters. It support Point-to-point, point-to-multipoint and peer-to-peer topologies.

The paper covered in the following sequence. A brief introduction about the work undertaken in this paper and the relevant literatures were presented in the previous paragraphs section 2 represents description about the microcontroller and sensors Section 3 introduction about Zig-bee and configuration for point to point communication. This is followed by the conclusions, followed by the references

2. Description about the Microcontroller and Sensors

This section gives a brief idea about the LPC2148 microcontroller and its features. It also discovered sensor information.

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-SCPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. Due to their tiny size and low power consumption, LPC2141/42/44/46/48 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. [3]

- **SENSORS**
  A sensor is a device that measures a physical quantity and converts it into an equivalent digital signal. The basic parameters which are measured in the climate monitoring are temperature, pressure, velocity, humidity and gas leakage. For this, temperature pressure and gas leakage are used.

2.1. Temperature Sensor [4]

LM35 IC gives output voltage linearly proportional to centigrade temperature. The LM35 is rated to operate over a −55°C to +150°C temperature range. The temperature sensor has three terminals as shown in Fig.2. The data pin is connected to the chanel-3 of the inbuilt ADC using port pin P0.30. The general equation used to convert output voltage to temperature is T (oC) =Vout*(100o C/Vcc)

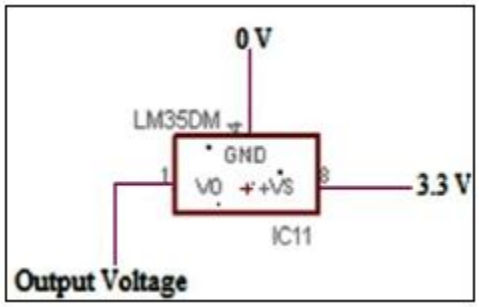

Figure 2: LM-35 Temperature sensors

2.2. Gas Leakage Sensor [5]

MQ-6 as gas sensor which detect gas leakage in industries and it suitable for detecting of LPG, iso-butane and propane it also detect cooking fumes and cigarette smoke. MQ-6 has six pin, four of them are used to fetch signals and other 2 are used for providing heating current.

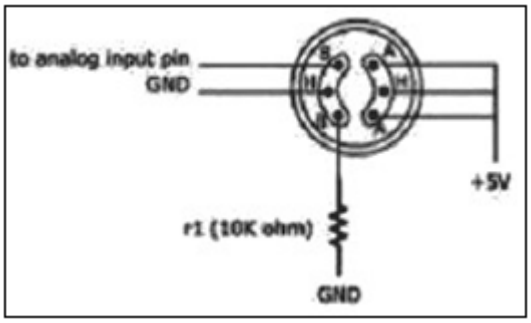

Figure 3: MQ-6 Gas Sensor

2.3. Pressure Sensor [6]

The pressure sensor is SPD015GA it gives output proposal to voltage with respect to applied pressure. SPD015GA, G is indicate Gauge and A for Absolute. The sensor is available range from 5 to 100 psi for measuring pressure. It give atmosphere pressure when do not applied pressure on sensor. And depending on pressure it gives different kind of output voltage.

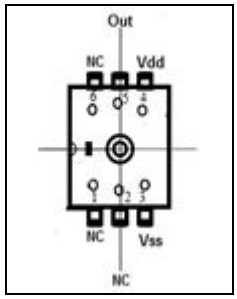

Figure 4: SPD015GA Pressure Sensor

3. Basics of Zig-Bee and Configuration

Zig-bee is supports wireless network protocol specifically designed for wireless transmission as shown in Fig. 5. Zig-bee is a consortium of software, hardware and services companies that have developed a common standard for wireless, networking of sensors and controllers. While other wireless standards are concerned with exchanging large amounts of data, Zig-bee is for devices that have smaller throughout needs. The other driving factors are low cost, high reliability, high security, low battery usage, simplicity and interoperability with other Zig-bee devices.

Zig-bee hardware typically consists of an eight bit microcontroller combined with a miniature transceiver a small amount (example 32 KB) of flash memory and RAM. Most of the Zigbee stack is provided in ASIC.

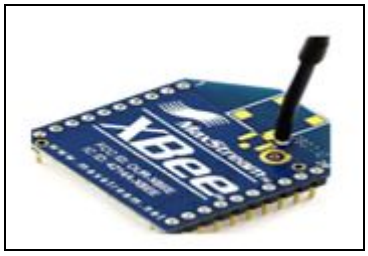

Figure 5: Zig-Bee chip

Zig-bee operates with ISM 2.4 GHz frequency band. There are three radio frequencies used for Zigbee radio frequency communications 2.4 GHz with 16 channels and a data rate of 250 kbps for worldwide coverage, 868 MHz with a single channel and a data rate of 20 kbps in Europe and 915 MHz with 10 channels and a data rate of 40 kbps in America. For comparison even at 250 kbps the data throughput is only about one tenth that of blue tooth.. Broadcast range for Zigbee is approximately 70 meters. Theoretically Zig-bee networks can contain up to 64 k (65,536) network nodes.

Configuration of x-bee module using X-CTU software

Step:-1 Run X-CTU and connect to the x-bee

- Open X-CTU software
- Connect zig-bee module with laptop
- Click on test/query button
- It shows modem serial number and firmware version

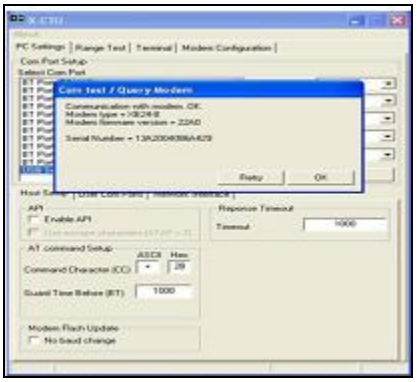

Figure 6: X-CTU Test/Query for Module-A

Step:-2 update the firmware

- Go to modem configuration and click on read
- Select x-bee modem type and zig-bee function type i.e. zig-bee coordinator AT
- Give PAN ID, destination high (DH), destination low (DL)
- Check out source high (SH) and source low (SL)

Figure 7: X-CTU Software for Module-A

Step:-3 Modem configuration

- Click on analog update firmware and click on write
- Check write completed and close the X-CTU
- Again click on test/query and check updated version
- Give PAN id 1234 default in both zig-bees

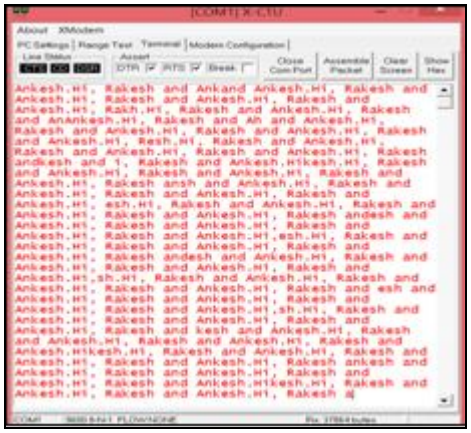

Figure 8: X-CTU terminal for module-A

This all procedure step shows configuration of zig-bee module-A and same procedure is repeated for module-B as zig-bee router after completing procedure in both zig-bee communicate to each other the figure shows module-A send the data from terminal of X-CTU

which is continuously received by module-B. now, all sensor send data to monitoring room via zig-bee module it uses point to point communication for sending data also we set the delay for receiving sensor data output among all three sensor using ARM-7 microcontroller LPC2148.The TERMINAL of zig-bee shows continuously receive the output of all three sensors simultaneously.

4. Conclusion

The wireless industrial monitoring and control project is based on microcontroller as well as zig-bee. The industry consists of large numbers of sensors, microcontroller and actuators. Sensor and microcontroller communicate with each other. This system consists of large amount of wire for communication in present day.

The industries is growing up to achieve high demands so, we need to modify the all current system and different version.it is better way to used wireless system by means of zig-bee.it is easy to modify and maintain.

The ARM-7 based industrial monitoring and control using zig-bee provide better environment for industries communication and data transfer. By implementing wireless system in industry environment there is no need of wires. It is easy to find out faulted module.

In future, the industries wired network is replaced by wireless network by means of zig-bee or other wireless technologies.

5. Acknowledgement

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