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ARM-7 BASED INDUSTRIAL MONITORING AND CONTROL USING ZIG-BEE TECHNOLOGY

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ABSTRACT

Industries consists of large numbers of sensors, microcontroller and actuators. The communication from sensor to controller or controller to sensor using point to point wired technology in nowadays. Such systems involved a huge amount of wiring. The industries continuously achieve high demand from consumers so, it difficult to modify the systems and versions. The solution is to implement wireless technology instead of wired technology using zig-bee or Wi-Fi.

KEYWORDS: ARM-7, Humidity, Temperature, Flow, Level, Viscosity, ZigBee Technology

I. INTRODUCTION

The monitoring and control system is a combination of architectures, mechanisms, and algorithms used in the factory for monitoring and control the activities of a specific process to achieve the goal. The monitoring and control process data such as pressure, humidity, temperature, flow, level, viscosity, density and vibration intensity measurements can be collected through sensing units and transferred to a control system for operation and management.

The industries consist of large number of sensors, controllers and actuators. The sensors sense the environment parameter and send it to the controller for further process of analysis. The controllers send this data to control room. The communication from sensor to controller or controller to monitoring room is wired in most common industries.

The industries are continuous growing up for achieving high demand so, some modifications are required to change the version and it is difficult to modify the all system with wired environment. The solution is to implement wireless sensor network. There are numbers of ways for wireless communication within industry environment such as Bluetooth, Wi -Fi and zig-bee. [1]

Table 1: Comparison of BLUETOOTH, WI-FI and ZIG-BEE [2]

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

The table shows the comparison of Bluetooth, Wi-Fi and zig-bee. After comparison, zig-bee have good control on numbers node, low current consumption and long battery life ZigBee technology also offers small size, high reliability, automatic or semi-automatic installation and a low system cost.

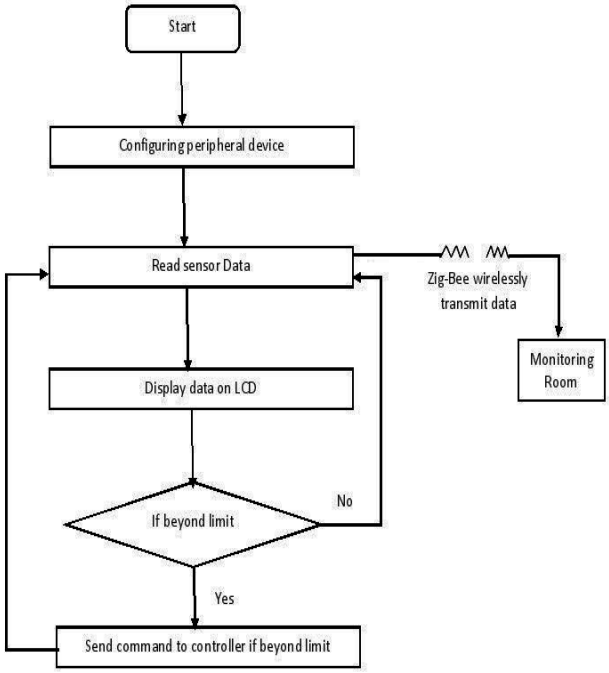

Figure 1: Function Flow Diagram

The sensors integrated with microcontroller sense environment parameter such as temperature, humidity and pressure and send it wirelessly to the microcontroller usually ARM based LPC2148. It belongs to a class of 16/32 bit microcontrollers of RISC architecture & a Program Memory (FLASH) for storing a written program. The sensors information is displayed on 16×2 LCD and controller also send wirelessly to monitoring and control room using zig-bee module. 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 Zigbee and configuration for point to point communication. Section IV covered transmitter and receiver this is followed by the conclusions, followed by the references

II. DESCRIPTION ABOUT THE MICROCONTROLLER AND SENSORS

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

Figure 2: ARM Based LPC2148 Microcontroller

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 project, temperature pressure and gas leakage are used.

- **Temperature Sensor (LM-35) [4]**
  - It is gives directly in Celsius (centigrade)
  - Resolution is + 10.0 m V / ◦C scale factor
  - It gives 0.5◦C accuracy
  - Range of Measurement is -55◦C to +150◦ C range
  - Operating Voltage range from 4 to 30 volts
  - It is gives low impedance output at 0.1 Ω for 1 mA load condition
- **Gas Leakage Sensor (MQ-6) [5]**
  - It detect Butane, Propane and LPG
  - The concentration is between 300 to 1000 PPM for Butane, Propane and LPG
  - It has circuit loop voltage(V_L) ≤ 24V DC
  - It has circuit heater voltage(V_H) 5.0V±0.2V AC or DC
- **Pressure Sensor (SPD015GA) [6]**
  - The sensor is available in the range from 5 to 100 psi.
  - Available in Gauge and Absolute type.
  - The output is radiometric to the power supply voltage 5 V
  - Output voltage span is 0.5 to 4.5 V.
  - Maximum Pressure for SPD015GA is 15 PSI.

III. BASICS OF ZIG-BEE AND CONFIGURATION

Zig-Bee provides 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. Zigbee module is an embedded solutions providing wireless end-point connectivity to devices. These modules use a simple proprietary networking protocol for fast point-to-multipoint or peer-to-peer networking.

Zigbee Configuration

Two different zig-bees are used for point to point communication. One zig-bee S2 configure as coordinator and another zig-bee S2 configure as router. Procedure is as follows

Coordinator

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

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

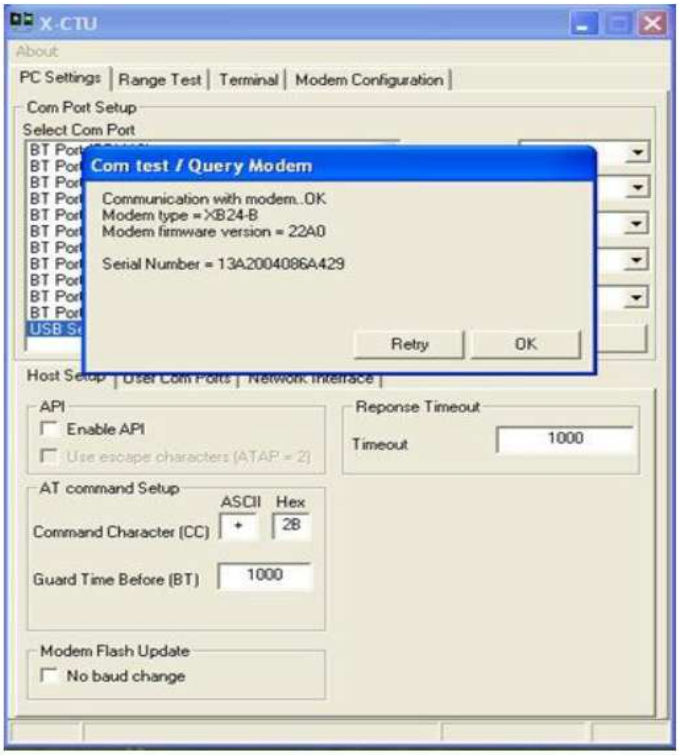

Figure 3: X-CTU TEST/QUERY for Zig-Bee Module

Step 2: Update the Firmware

- Go to modem configuration and click on read
- Select x-bee modem type (XB24-ZB) and zig-bee function type (zig-bee coordinator AT)
- Give PAN ID, destination high (DH), destination low (DL)

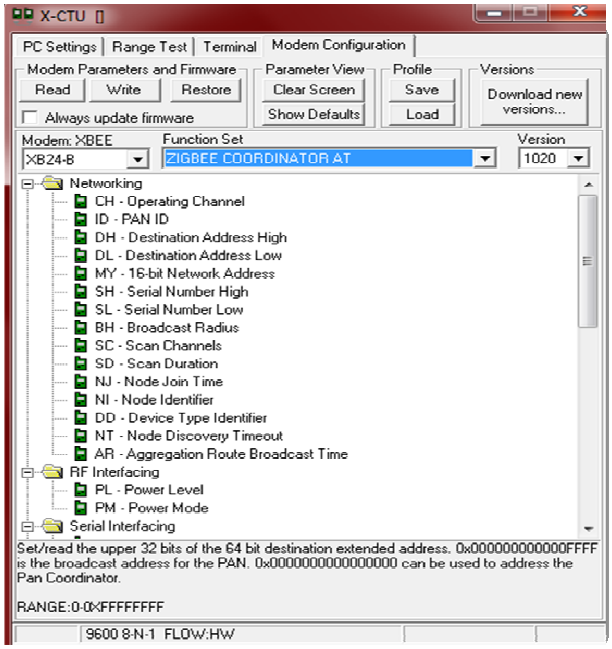

Figure 4: Screenshot of X-CTU Modem Configuration

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

Router

Same procedure step as previously done in zig-bee as coordinator expect step-2 here select function type (ZIG-BEE ROUTER AT) and give destination high(DH) and destination

Low (DL) of zig-bee coordinator.

IV. TRAMSMITTER AND RECEIVER

The sensor integrated microcontroller which transmitted data to microcontroller LPC2148 using zig-bee. The zig-bee module is mounted on ARM based LPC2148 microcontroller as well as with sensor circuit. The zig-bee with sensor circuit transmitted data to the microcontroller LPC2148. The zig-bee mounted on ARM tool kit receives data from sensors one by one. The ARM based LPC2148 also displayed data on 16×2 LCD which also mounted on ARM tool kit. Zig-bee with LPC2148 microcontroller act as broadcast receiver. The sensor data continuously received LPC2148 microcontroller using zig-bee. Zig-bee with ARM tool kit also wirelessly transmitted data to the monitoring room. so, sensors are send data to controller and from there it transmitted to monitoring room. Here, sensor with zig-bee act as transmitter and LPC2148 microcontroller tool kit as transceiver and monitoring room usually computer/laptop displayed data on X-CTU TERMINAL it act as receiver. Zig-bee also connected to the computer/laptop using MAX 3232. The data communication path is from sensor to microcontroller and from microcontroller to monitoring room.

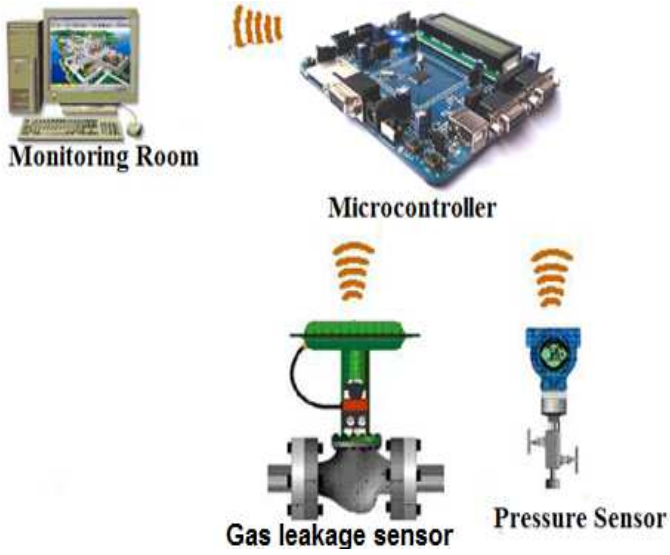

Figure 5: Traditional Industrial System

Figure 6: Receiving End at Monitoring Room

Zig-bee with sensor has a destination address of zig-bee mounted on LPC 2148 microcontroller so, LPC2148 microcontroller receive data continuously and delay is inserted between two different sensor data. The figure shows traditional view of industry and also show data receive at monitoring room through RS-232.

CONCLUSIONS

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.

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