International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 1 Issue 5, July - 2012

IMPLEMENTATION OF CAN AND ZIGBEE NETWORKS BASED INDUSTRIAL MONITORING AND CONTROL APPLICATIONS

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ABSTRACT

Generally in industries there is a traditional network communications like RS 232, RS 485 etc. are limited for short distances. But the use of intelligient protocol converter provides the long distance communication .The goal of this work is to produce a network processing node for a rapidly, deployable, easily reconfigurable monitoring and controlling solutions for Industries.

This work addresses the integration of CAN bus and ZigBee network. In this a couple of sensors located at the industries acquire the information, process the data and transmitting through the CAN bus to the ARM& processor .This processor receives the data from the sensor nodes and transmitted to central receiver via ZigBee Communication. The central receiver systems which can collect the data from the node receiver unit and transmitted this data to data logging sever, and if there is any over threshold sensor readings according to that it loads the data with corresponding control signal information along their ids and send it through zigbee

Key words—Wireless Sensor Networks, Zigbee, CAN, Industrial Communications

I.INTRODUCTION.

In general the traditional communication networks like RS 232 etc are used but they are limited for short distance communication. The integration of CAN bus and wireless sensing systems is used to solve problems in Industrial Automation. The Controller Area Network (CAN) is an International Standardization Organization (ISO) defined serial, asynchronous, multi-master communications bus originally developed for the automotive industry to replace the complex wiring harness with a two-wire bus. The specification calls for high immunity to electrical interference and the ability to self-diagnose and repair data errors. CAN was designed for automotive and industrial applications needing high levels of data integrity and data rates of up to 1 Mbit/s. Today the CAN bus is also used as a field bus in general automation environments; primarily due to the low cost of some CAN Controllers and processors. CAN bus will be increasingly used in wide range of applications for its superiority. Wireless remote monitoring systems are very much essential in industrial environment where manual movement is not possible. Today several wireless technologies are used for building wireless sensor networks. Among them the 2.4GHz wireless network is most widely deployed and used. The wide usage of 2.4GHz wireless communication indicates that this infrastructure can give near real time responses and makes suitable for crucial industrial monitoring systems. In our specific case, of applications in Heavy Process Industries, namely Oil and Gas, Energy, Pulp & Paper and Chemical, we have realized that the new Wireless Sensing approaches must coexist with Wired Smart Sensors which rely in field bus protocols. We consider that this coexistence is the best available solution at the moment, since a truly wireless Automation System can only exists when Energy Harvesting Technologies reach a higher development stage which, hopefully, will allow wireless sensors to maintain performance concerning data rate comparable to mains powered devices. Wireless Sensors are already very good solutions for applications in which there is not a close mains power source, where data transmission rate can be lower, and therefore there is no need of cable installation, or where cable installation is a problem, e.g., in rotating and, in general, moving parts, or for portable and temporary installations.

II BASIC PRINCIPLE.

In this work we are Implementing CAN and ZigBee networks based Industrial monitoring and control applications on ARM 7 and PIC Microcontroller. This work allows the transparent flow of data sense by the couple of sensors located at the industries. This data is transmitted through CAN bus through a receiver module. This module processes the data and sent to a central receiver through Zigbee module. The central receiver monitors and controls the respective sensor device.

III SYSTEM HARDWARE DESIGN.

The ARM 7 Microcontroller is having two interconnected CAN interfaces with advanced acceptance filters. This system consists of 4 sub systems. The sub systems one and two acts as sensor nodes.

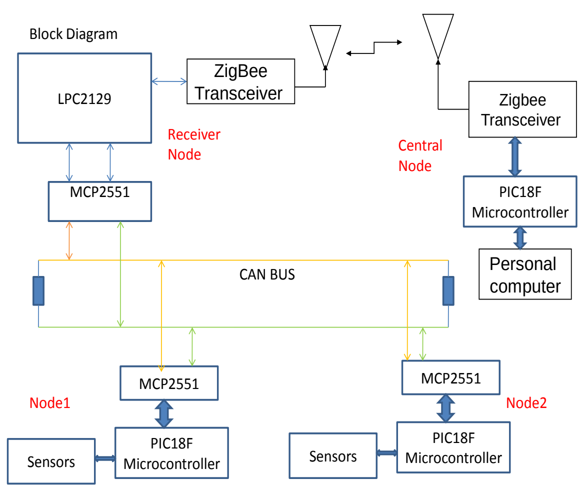


Figure 1 :Block diagram for controlling & Monitoring

As shown in the figure1 the three individual PIC nodes are interfaced with Temparature, Humidity, and Gas sensors Respectively and used to acquire the information, process the data and transmitting the processed data through the CAN bus with respective enode ID's to third Sub system LPC2129 microcontroller A CAN transceiver MCP2551 which is a high-speed fault-tolerant device serves as the interface between a CAN protocol controller and the physical bus. The third subsystem based the LPC2129 using acceptance filter. Built around an ARM7 (LPC2129) microcontroller with two interconnected CAN interfaces and advanced acceptance filters. The LPC2129 microcontroller receives the data from the CAN bus, converts the data to a serial format, arranges according to the ID's and transfers the data to the PIC central receiver through Zigbee module. The PIC central receiver collect the data from the node receiver unit and transmitted this data to data logging sever,and if there is any over threshold sensor readings according to that it loads the data with corresponding control signal information along their ids and send it through zigbee as shown figure 1.The LPC2129 receives the data from zigbee and rearranges it according to CAN data and places in CAN bus with their respective ID's. Then the 3 individual PIC nodes continuously monitors the CAN bus, whenever its respective id appears in CAN bus it will accepted by the CAN ACCEPTANCE Filter and stored in Receive Buffers available. Reads the data from CAN receive buffers according to the data present which indicates control signal whether to control the respective sensor devices or not.

A.LPC2129 ARM 7 Processor.

The LPC2119/LPC2129 are based on a 16/32 bit ARM7TDMI-S"CPU with real-time emulation and embedded trace support, together with 128/256 kilobytes (kB) of embedded high speed flash memory. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at maximum clock rate. For critical code size applications, the alternative 16-bit Thumb¤ Mode reduces code by more than 30 % with minimal performance penalty. With their compact 64 pin package, low power consumption, various 32-bit timers, 4-channel 10-bit ADC, 2 advanced CAN channels, PWM channels and 46 GPIO lines with up to 9 external interrupt pins these microcontrollers are particularly suitable for automotive and industrial control applications as well as medical systems and fault-tolerant maintenance buses. With a wide range of additional serial communications interfaces, they are also suited for communication gateways and protocol converters as well as many other general-purpose applications.

B.PIC 18F Microcontroller.

PIC 18F is a 16 bit micro controller which contains a program memory of 32KB, data memory of 4kB. PIC microcontroller is with Harvard architecture ,RISC processor. It has inbuilt ADC and should operate less than 5v

C.CAN NETWORK.

Controller Area Network (CAN) is an asynchronous serial communication protocol which follows ISO 11898 standards and is widely accepted in automobiles due to its real time performance, reliability and compatibility with wide range of devices. CAN is a two wire differential bus with data rates up to 1Mbps and offers a very high level of security. Its robust, low cost and versatile technology made CAN applicable in other areas of applications where inter processor communication or elimination of excessive wiring is needed. Some of the areas it is widely used are industrial machinery, avionics, medical equipments and home automation etc. The data can be transmitted through data frame as shown in figure 2.

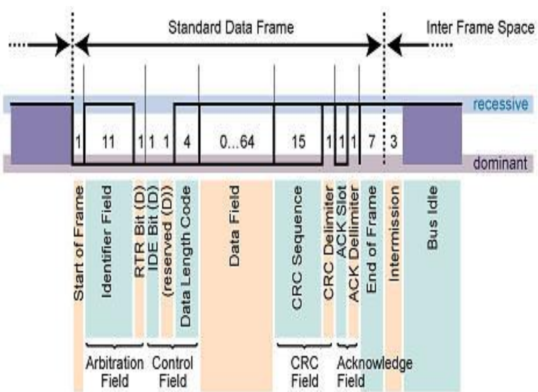


Figure 2:DATA FRAME

The Start of Frame bit is followed by the Arbitration Field consisting of 12 bits: The 11-bit Identifier, which reflects the contents and priority of the message, and the **Remote Transmission Request** bit. The Remote transmission request bit is used to distinguish a Data Frame) from a Remote Frame .The next field is the Control Field, consisting of 6 bits. The first bit of this field is called the IDE bit (**Identifier Extension**) and is at **dominant state to specify** that the frame is **a Standard Frame**. The following bit is **reserved** and defined as a dominant bit. The remaining 4 bits of the Control Field are the **Data Length Code** (DLC) and specify the number of bytes of data contained in the message (0 - 8 bytes).The data being sent follows in the Data Field which is of the length defined by the DLC above (0, 8, 16, ..., 56 or 64 bits).The Cyclic Redundancy Field (CRC field) follows and is used to detect possible transmission errors. The next field is the Acknowledge Field. Any node that has received an error free frame acknowledges the correct reception of the frame by sending back a dominant bit (regardless of whether the node is configured to accept that specific message or not). From this it can be seen that CAN belongs to the "in-bit-response" group of protocols.

D.SENSORS:

Here we use the various sensors usually designed by eletronics components for sensing the industrial parameters like temperature, pressure, fire or smoke , intensity levels, hummidity, etc.

Temperature sensors:

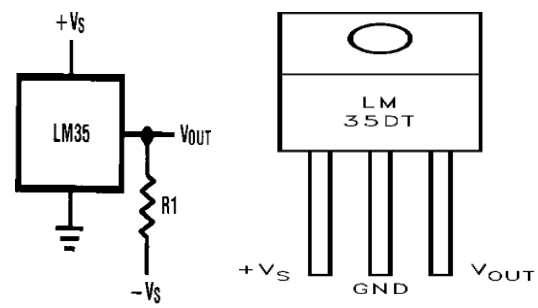


Figure 3: Temparature sensor and logic symbol

Calibrated directly in ° Celsius (Centigrade) Linear variation of +10.0 mV/°C This 0.5°C accuracy guaranteed (at +25°C) Rated for full −55° to +150°C range Low cost Operates from 4 to 30 volts

Gas sensors

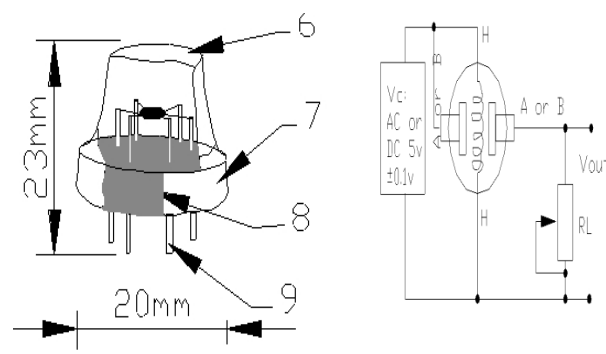


Figure 4:Gas sensor and circuit diagram

Gas sensors are High sensitivity to LPG, iso butane, propane and less sensitivity to alcohol, smoke. They are used in gas leakage detecting equipments in family and industry, are suitable for detecting of LPG, iso-butane.

Humidity sensor

The Humidity sensor converts output to analog voltage. The accuracy is up to ±5%.The operating current for humidity sensor is maximum of 2ma.

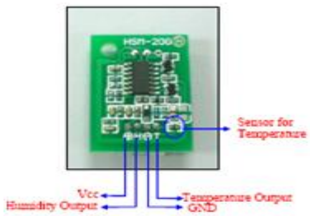


Figure 5:Humidity Sensor

IV. RESULTS.

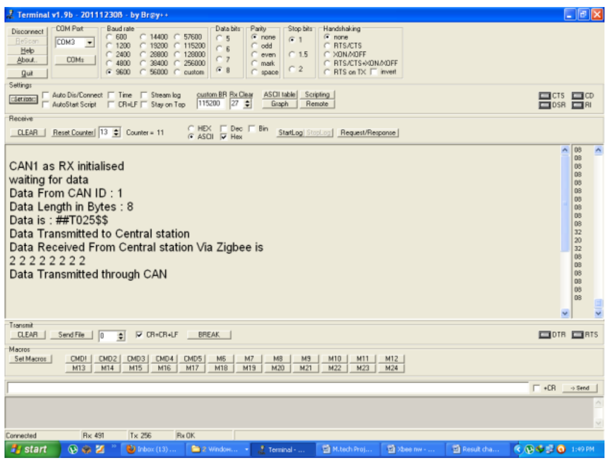
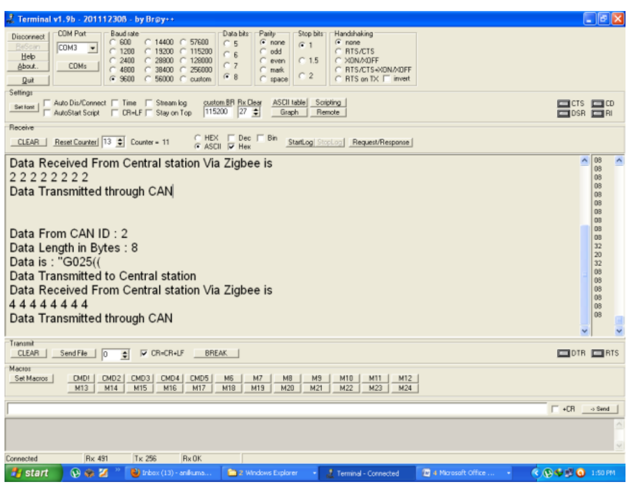


Figure 6: Temperature received at central node



V.CONCLUSION.

Connection between Zigbee and CAN has been successful for a significant period of time, being important to the capability of Zigbee module to integrate its product range into a mesh network. Also, in order to make those products compatible with equipments from other sources, we plan to migrate from the present CANbus proprietary protocol to the CANopen standard. In this new framework, Zigbee Application Layer features are to be used, therefore providing full compatibility in international markets.

Figure 7: Gas information received from node 2

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