Implementation of Can and Zigbee Networks Based Industrial Monitoring and Control Applications On Arm 7 Processor

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Abstract

In an industrial plant, physical process systems consist of machines and process equipment. They are individual devices or larger subsystems of their own. Process systems can be in different operational states, such as 'maintenance', 'starting up' or 'operating'. In each state, they provide a set of capabilities that can be combined to perform the various stages of the process. In the course of control system design, control tasks identified in co-operation with users and other engineering disciplines are allocated to the control system and human operators. The automated parts should form a structured set of control activities corresponding to the physical equipment and processing tasks. In this paper we are implementing CAN and ZigBee networks based Industrial monitoring and control applications on ARM. The ARM Microcontroller having two interconnected CAN interfaces with advanced acceptance filters. The system consists of 4 sub systems. The sub systems one and two acts as sensor nodes. These node are acquire the sensor information, process the data and transmitting the through the CAN bus to third Sub system. The third subsystem based the LPC2129 which receives the data from the sensor nodes and processes the data, transmitted this data to central receiver node via wireless ZigBee communication. The Subsystem four is the central receiver systems which can collect the data from the node receiver unit and transmitted this data to data logging sever.

Keywords- ZigBee, CAN(Controller Area Network),ARM7.

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1. INTRODUCTION

Generally in industries there are traditional network communications like RS232, RS485, etc. which are limited for short distances. Data acquisition based on single chip has limited processing capacity and real time reliability. With the development in ARM processor, efficient data acquisition and control in various fields can be achieved. Remote I/O data acquisition system developed in this project measures temperature, humidity, pressure etc.

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. The goal of this project is to produce a network processing node for a rapid, deployable, easily reconfigurable monitoring solution for industries.
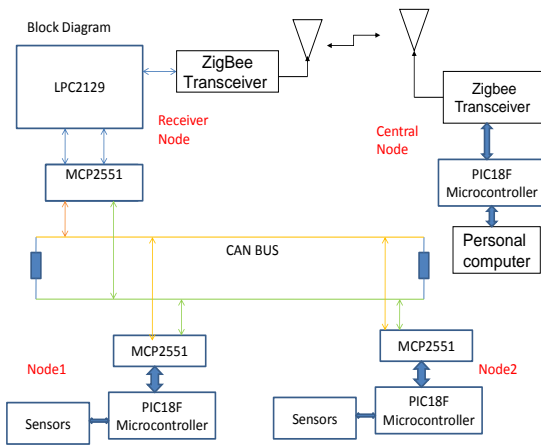
2. BLOCK DIAGRAM & HARDWARE MODULES

Fig1: Block Diagram

2.1 LPC2129 ARM MICROCONTROLLER:

The NXP (founded by Philips) LPC2129 is an ARM7TDMI-S based high-performance 32-bit RISC Microcontroller with Thumb extensions 256KB on-chip Flash ROM with In-System Programming (ISP) and In-Application Programming (IAP) 16KB RAM, Vectored Interrupt Controller, Two UARTs, I2C serial interface, 2 SPI serial interfaces Two timers (7 capture/compare channels), PWM unit with up to 6 PWM outputs, 4-channels 10bit ADC, 2 CAN channels. Real Time Clock, Watchdog Timer, General purpose I/O pins. CPU clock up to 60 MHz, On-chip crystal oscillator and On-chip PLL.
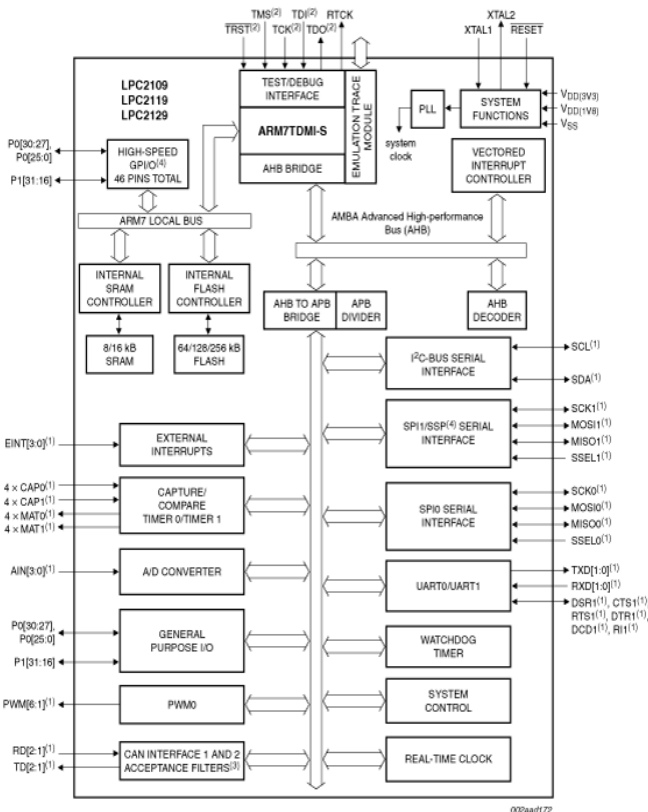

Fig 2 LPC2129 ARM Architecture

2.2 PIC18F458

40-pin Low Power Microcontroller with Flash Program Memory of 32kbytes.EEPROM Data Memory of 256 bytes & SRAM Data Memory of 1536 bytes. I/O Pins are 33,4Timers One 8-bit & Three 16-bit,A/D Converter having 10-bit Eight Channel, PWM: 10-bit with up to 4 Outputs, MSSP: SPI and I²C Master/Slave Support, USART: Addressable Full Duplex Operation, CAN: CAN 2.0B Spec with Transmit and Receive Buffers, External Oscillator: up to 40MHz.

2.3 MCP2551:

Supports 1 Mb/s operation. Low current standby operation. Protection against damage due to short-circuit conditions (positive or negative battery voltage. Protection against high-voltage transient. Automatic thermal shutdown protection Up to 112 nodes can be connected. High noise immunity due to differential bus implementation.

2.4 PIC18F452:

It is a 'C' compiler optimized instruction set architecture. It can operate up to 10 MIPS. Power consumed is 40 MHz osc/clock input and 4 MHz - 10 MHz osc/clock input with PLL active. It is of 16-bit instructions, 8-bit wide data path. Three external interrupt pins.

2.5 ZIGBEE:

ZigBee is an open technology developed by the ZigBee Alliance to overcome the limitations of BLUETOOTH and. ZigBee is an IEEE 802.15.4 standard for data communications with business and consumer devices. It is designed around low power consumption allowing batteries to essentially last forever. BLUETOOTH as we know was developed to replace wires and Wi-Fi to achieve higher data transfer rate, as such till now nothing has been developed for sensor networking and control machines which require longer battery life and continuous working without human intervention.

2.6 Temperature Sensor(LM35):

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the 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 Centi-grade scaling.

Fig 3 diagram of LM35

2.7 LPG Gas Sensor:

This LPG Gas Sensor (MQ6), ideal sensor for use to detect the presence of a dangerous LPG leak in your Home, car or in a service station, storage tank environment. This unit can be easily incorporated into an alarm unit, to sound an alarm or give a visual indication of the Combustible Gas / LPG concentration. The sensor has excellent sensitivity combined with a quick response time. The sensor can also sense iso-butane, propane, LNG and cigarette smoke. This LPG Gas Sensor can be used to make wireless Gas leak detector in home security system.

3. IMPLEMENTATION:

The temperature sensor Vout pin is connected to the RA0/AN0 pin of the PIC. LPG gas sensor Vout is connected to the RA1/AN1.TWO LED's LED1,LED2 are connected to RC0,RC1 of PIC controller respectively. Sensors output is analog signal which is processed through analog channels of the controller and this analog data converted to digital and this can be received by the UART0 within PIC.   Every sensor has three terminals Vcc,Vout,GND.Vout of every sensor connected to analog channels of the PIC18F458.PIC has total 8 analog channels so at a time we can use 8 sensors. PIC has internal ADC so this analog input will be given to the AD0,AD1 channels of ADC.It is also having 8channels(AD0,AD1,AD2,AD3,AD4,AD5,AD6,AD7).To convert analog to digital signal "Successive Aproximation" method can be used. The way successive approximation works is thru constantly comparing the input voltage to a known reference voltage until the best approximation is achieved. At each step in this process, a binary value of the approximation is stored in a successive approximation register (SAR). In this mainly used sampling and quantization.PIC controller gives 10 bit output,this output will be compared to binary value in the coding.   After converting this data from digital to analog by multiplying digital data with step size. One wireless module Zigbee is connected to PIC. This information will be transmitted from UART0 of the controller. Zigbee received the information and transmit to another zigbee which is connected to ARM7.
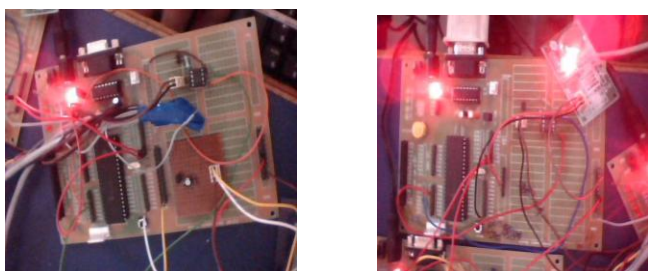

Fig 4 Result of Sensors unit

The information transmitted to Zigbee from ARM7 using CANBus. CAN Zigbee receiver is connected to LPC2129

Board . In this CAN bus will receive the information from temperature sensor & gas sensor. Temperature sensor & Gas sensor have unique id's variations from each sensor will sent through CAN Bus & what ever the information will send through LPC2129. Zigbee output pin is connected to transmitter & input is connected to receiver. 2nd pin is output pin connected to RC7 & 3rd pin is input connected to receiver. What ever the information received from CAN will sent through Zigbee Transmitter. Zigbee transmitter will receive information & communicate with Zigbee receiver & send this to the central node.

Fig 5 Result of CAN ZIGBEE Receiver Node

The information from zigbee transmitter received to zigbee receiver in central node. By using serial port this data can be transmitted to PC. The values can be displayed in PC through terminal software.
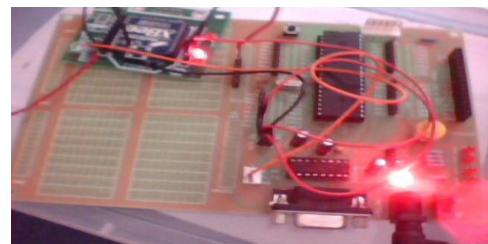

Fig 6 Central Node Output

4. CONCLUSION:

Connection between Zigbee and CAN has been successful for a significant period of time, being important to the capability of 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 CAN bus proprietary protocol to the CAN open standard. In this new framework, Zigbee Application Layer features are to be used, therefore providing full compatibility in Industrial Monitoring & Controlling.

5. FUTURE SCOPE:

Combination of this CAN and other wireless devices would dominate in the near future. Many "works are in progress" that will surely develop into more usable devices in the future.

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