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Machine Monitoring and Controlling System Using CAN and IOT

K. Vijay Kumar
M.Tech (ES)
Department of ECE
Jogaiah Institute of Technology and Sciences,
Kalagampudi, Palakol - 534 268,
West Godavari Dt., A.P.

Mr. B. Kanna Vijay, M.Tech
Assistant Professor
Department of ECE
Jogaiah Institute of Technology and Sciences,
Kalagampudi, Palakol - 534 268,
West Godavari Dt., A.P.

ABSTRACT

Industrial automation and process control greatly reduces the need for human sensory and mental requirements as well. Most complex industrial automation processes and systems can be automated. A major advantage of industrial automation and process control is the increased emphasis on flexibility and convertibility in the manufacturing process. The main aim of this project is to provide more safety to industry machines by avoiding operating from over temperatures and also provide constant lighting by controlling artificial lights depends upon the ambient light intensity. This will be implemented using advanced CAN protocol and ARM7 based LPC2148 32-bit micro controller.

INTRODUCTION

The CAN bus provides an ideal platform for interconnecting modules and allows each module to communicate with any other module. A networked system which requires fast and robust communication and where data should maintain high integrity CAN protocol can be used. The CAN protocol is robust and uses sophisticated error checking and handling, which allows errors and failures to occur without shutting the entire system down which is useful in the motor control node. Using CAN protocol we can send data from one node to other node.

Here we are having two nodes, each node contains ARM7 based LPC2148 micro controller which is 32-bit controller, MCP2515 (CAN CONTROLLER), MCP2551 (CAN TRANSRECEVER). In first node we are interfacing temperature, voltage and current sensors, in second node contains loads and lights.

OBJECTIVE OF THE PROJECT

In this project we are dealing with protection of the industrial loads and controlling them from a far distance. The sensor parameters are uploaded to the HTML page and the controlling the load from the HTML page itself. To measure the hazardous conditions, we are using the sensors namely LM35 temperature sensor, current sensor and voltage sensor. If the sensor's digital value crosses the set limit the load will OFF automatically. By this way we are protecting the machines from hazardous conditions.

AIM OF THE PROJECT

The main aim of this project is to machines monitoring and controlling in abnormal parameters of the machine. We will monitor voltage, current and temperature of the machine.

We will shutdown the machine having any abnormal values of sensors, we are using CAN network and IOT network for data transfer between network nodes.

EXISTING SYSTEM

In the existing system, we were used Ethernet module only to send the sensor values to the HTML page. But if you want control the machines from anywhere that might not possible. So, every time we should go the control room to operate the machines.

To avoid this situation, we developed new technique to control the machines from the HTML page itself. Existing systems are designed by using RS485 Protocol but our system is designed by CAN Protocol, it is very secured and reliable for transfer data between controllers

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PROPOSED SYSTEM

In the proposed system, we are providing the protection to the machines used in the industry from high voltage, current and high temperature conditions by automatically switch OFF the load. The threshold was fixed to every sensor, if that threshold limit crosses, the BUZZER will give alert sound and load will OFF. And we can control the load from the HTML page. To constitute the communication between the load and the control side, we are using the CAN protocol. LPC2148 do not have internal CAN BUS, so we use CAN controller MCP2515 and CAN transceiver MCP2551.LPC2148 interface with CAN controller using SPI Protocol.

A Controller Area Network (CAN bus) is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other in applications without a host computer. It is a message-based protocol, designed originally for multiplex electrical wiring within automobiles, but is also used in many other contexts.

BLOCK DIAGRAM

Machine Side: This side is consists of three types of sensors such as temperature sensor, LDR sensor, reed switch. These sensors are used to measure the signals from the surrounding of machinery. After measurement these analog signals are converted into digital signals and compared with the actual signals. If any discrepancy occurs between the measured and actual signals, then it is considered as emergency. The ARM LPC 2148 plays an important role in controlling all the devices. It has an inbuilt A/D converter. The ARM7TDMI core is the industry's most widely used 32-bit embedded RISC microprocessor solution.

Optimized for cost and power sensitive applications, the ARM7TDM solution provides the low power consumption, small size, and high performance needed in portable, embedded applications. CAN transmitter and receivers connected to ARM these will collect the signals and transfer to the server side.

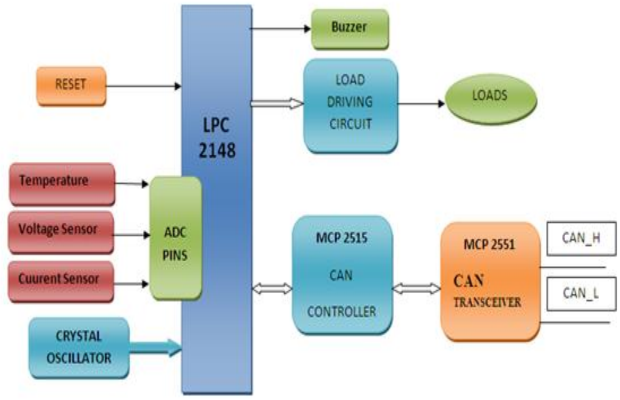

Fig 2.1: Machine Side block diagram of proposed system

Server Side: This side CAN (Controller Area Network) transmitter and receiver that are used to transfer the error to arm to detect the errors and data is transfer to ARM. Those values are displayed on the LCD and those values are compared with the actual values and set correct value.

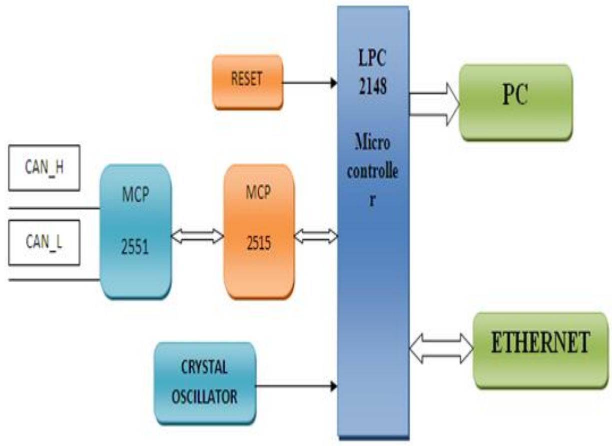

Fig 2.2: Server Side block diagram of proposed system

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 the microcontroller with embedded high-speed flash memory ranging from 32 kb to 512 kb. A128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative

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16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. 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. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kb up to 40 kb, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

ARM7 MICROCONTROLLER

ARM is an acronym for advanced RISC machine and is manufactured by Phillips. ARM7 is based on reduced instruction set computing architecture. ARM7 is most successful and widely used processor family in embedded system applications. The advantage of low power consumption and low cost increases the range of applications from portable devices to almost all embedded electronic market. It is preloaded with many in-built features and peripherals making it more efficient and reliable choice for an high end application developer. It also supports both 32-bit and 16-bit instructions via ARM and THUMB instruction set.

LPC 21XX series of microcontroller are based on ARM 7 TDMI – S architecture.LPC stands for Low Power Consumption, because for the reason it have different voltages for operation and not like other controllers where the entire controller (CPU + peripherals of controller operate at +5V Vcc).

The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro-programmed Complex Instruction Set Computers. This simplicity results in a high instruction throughput and Impressive real-time interrupt response from a small and cost-effective processor core. Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory.

Pin Diagram

ARM7 LPC2148 microcontroller is a 64 pin dual-in package. There are basically 2 ports in LPC2148, Port0 and Port1. Port0 has 32 pins reserved for it. And Port1 has 16 pins. So total it comes to 32+16 = 48 pins. If it were really 2 ports then the number of port pins should have been 32 + 32 = 64 pins.

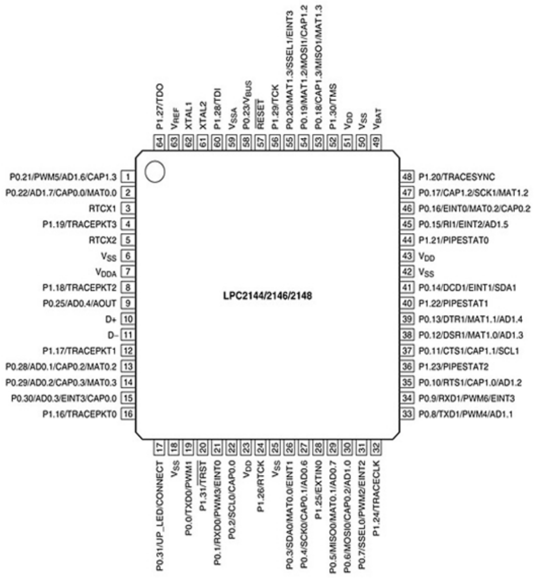

Fig 2.7: Pin Diagram of LPC2148

Architectural Overview

The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro

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programmed Complex Instruction Set Computers (CISC).

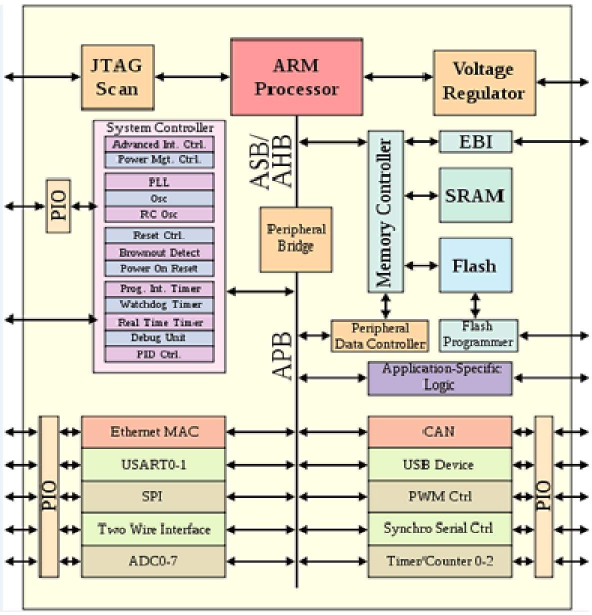

Fig 2.8: Architecture of ARM7 LPC2148

This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core. Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory. The ARM7TDMI-S processor also employs a unique architectural strategy known as Thumb, which makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue. The key idea behind Thumb is that of a super-reduced instruction set.

Essentially, the ARM7TDMI-S processor has two instruction sets:

- The standard 32-bit ARM set.
- A 16-bit Thumb set.

The Thumb set's 16-bit instruction length allows it to approach twice the density of standard ARM code while retaining most of the ARM's performance advantage over a traditional 16-bit processor using 16-bit registers. This is possible because Thumb code operates on the same 32-bit register set as ARM code.

Thumb code is able to provide up to 65 % of the code size of ARM, and 160 % of the performance of an equivalent ARM processor connected to a 16-bit memory system. The particular flash implementation in the LPC2148 allows for full speed execution also in ARM mode. It is recommended to program performance critical and short code sections (such as interrupt service routines and DSP algorithms) in ARM mode. The impact on the overall code size will be minimal but the speed can be increased by 30% over Thumb mode.

Operating modes in ARM7

The ARM processor has several Operating Modes which are described in bellow

- ARM supports 7 modes of operation.
- ARM core modes of operation:
- User (usr): Normal program execution state
- FIQ (fiq): Data transfer state (fast irq, DMA-type transfer)
- IRQ (iqr): Used for general interrupt services
- Supervisor (svc): Protected mode for operating system support
- Abort mode (abt): Selected when data or instruction fetch is aborted
- System (sys): Operating system 'privilege'-mode for user
- Undefined (und): Selected when undefined instruction is fetched

The User Mode has limited access to the hardware (non-privileged) whereas all other modes have full access (privileged) to the CPU resources.

CAN CONTROLLER

CAN is a computer network protocol and bus standard designed to allow microcontrollers and devices to communicate with each other without a host computer CAN is a multi-master, asynchronous serial bus system. This CAN protocol developed by ROBERT BOSCH GmbH in 1986.

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It was originally developed for automotive applications in Germany in the early 1980's.The CAN protocol was internationally standardized in 1993 as ISO 11898-1 and comprises the data link layer of the seven layer ISO/OSI reference model. Good error handling mechanism and reliability it's data.CAN is one of the most dominating bus protocols. This protocol has found wide acceptance in automotive in-vehicle applications as well as many non-automotive due to its low cost, high performance.

Description

Microchip Technology's MCP2515 is a stand-alone Controller Area Network (CAN) controller that implements the CAN specification, version 2.0B. It is capable of transmitting and receiving both standard and extended data and remote frames. The MCP2515 has two acceptance masks and six acceptance filters that are used to filter out unwanted messages, thereby reducing the host MCUs overhead. The MCP2515 interfaces with microcontrollers (MCUs) via an industry standard Serial Peripheral Interface (SPI).

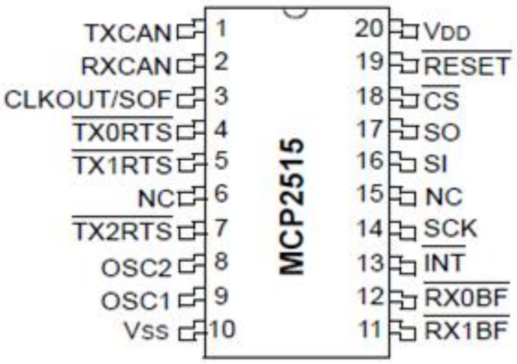

Fig 3.1: MCP2515 pin diagram

Features

1. Implements CAN V2.0B at 1 Mb/s:
    a. 0 – 8 byte length in the data field
    b. Standard and extended data and remote frames
2. Receive buffers, masks and filters:
    a. Two receive buffers with prioritized message storage
    b. Six 29-bit filters
    c. Two 29-bit masks
3. Data byte filtering on the first two data bytes (applies to standard data frames)
4. Three transmit buffers with prioritization and abort features
5. High-speed SPI Interface (10 MHz):
    a. SPI modes 0,0 and 1,1
6. One-shot mode ensures message transmission is attempted only one time
7. Clock out pin with programmable presale:
    a. Can be used as a clock source for other device(s)
8. Start-of-Frame (SOF) signal is available for monitoring the SOF signal:
    a. Can be used for time-slot-based protocols and/or bus diagnostics to detect early bus degradation
9. Interrupt output pin with selectable enables
10. Buffer Full output pins configurable as:
    a. Interrupt output for each receive buffer
    b. General purpose output
11. Request-to-Send (RTS) input pins individually configurable as:
    a. Control pins to request transmission for each transmit buffer
    b. General purpose inputs
12. Low-power CMOS technology:
    a. Operates from 2.7V – 5.5V
    b. 5 mA active current (typical)
    c. 1 µA standby current (typical) (Sleep mode)
13. Temperature ranges supported:
    a. Industrial (I): -40°C to +85°C
    b. Extended (E): -40°C to +125°C

ADVANTAGES

- Low cost
- High Speed
- Reliable because of its error checking mechanism.
- Provides more safety

APPLICATIONS

- Industry automation.

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- Security and safety systems.

RESULTS

The implementation and realization of "Machine Monitoring & control using CAN & IOT" is done successfully. The communication is properly done without any interference between different modules in the design. Design is done to meet all the specifications and requirements.

PROPOSED SYSTEM RESULTS

IP address to connect to the server is: http://192.168.1.25/. No external device is needed to get the sensor data.

In this we can observe the monitoring data in a webpage which was created for this application. It's very flexible to monitor the data using Ethernet module. Easy to operate the application and get the entire data up to date.

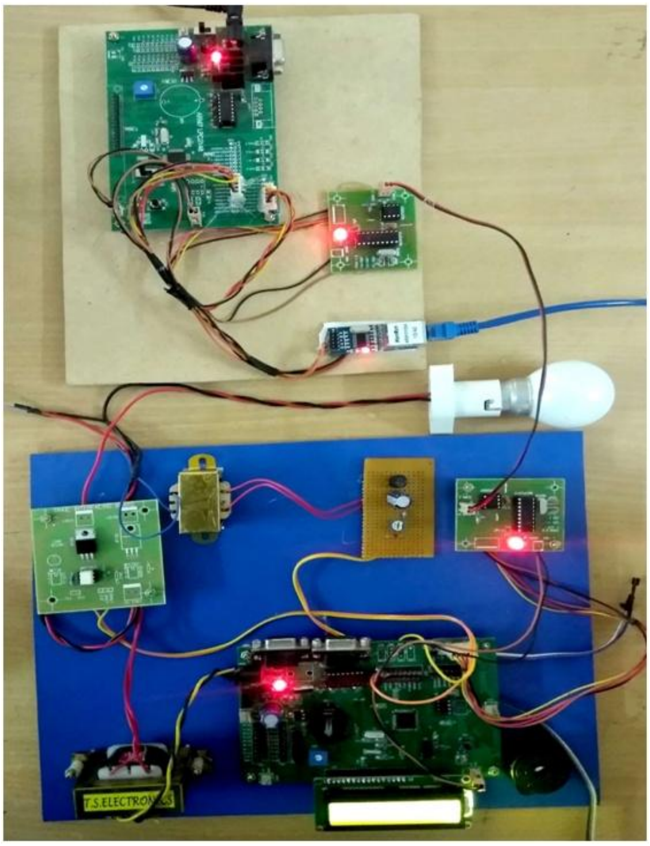

Fig 5.1: Machine and Server part of the proposed system

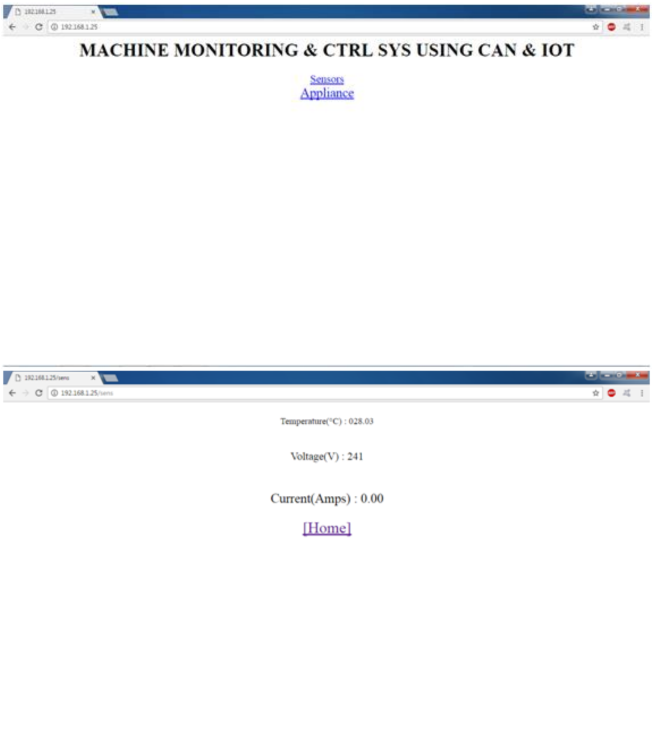

Fig 5.2: Monitoring data in a Webpage

CONCLUSION

From the above project we came to conclude that in all the industries there are lot of issues we can rectify the error with some sensors and ARM 7. ARM has lot of advantages and even work for all types of industries with less cost and more accuracy.

FUTURE SCOPE

In future, we can use Raspberry Pi 3 as a core, which has in built Wi-Fi module. Due to this we can reduce the hardware by avoiding the Ethernet module. By using Ethernet module we should use LAN cable and the parameters upload to HTML page. But if you use Wi-Fi module, there is no need of LAN cable and the sensor values will upload to web server like things peak.

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