



Arm Based Embedded System for Industrial Application Using TCP/IP

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Abstract: In embedded and real time system it is very essential to design online interactive data acquisition system for monitoring power plant systems. This project provides globally inter connected computer networks to access the power plants at any part of the world by using TCP/IP protocol. In multi tasking embedded C language, Web server application is ported into an ARM processor. In industries, systems are becoming very complex. Industries system needs to test the site equipments and environmental so it can track state of system in real time. This is more reliable in Embedded and real time data acquisition and control system, design and implementation of online embedded web server is challenging part. To interface real time embedded application like data acquisition, automation and control system in industries specially power generation plant. In this system design and development of online Interactive Data Acquisition and Control system (IDACS) using ARM base embedded web server, it can be digital distributed control system. This system uses ARM Processor portability it makes the system more real time and handling various processes based on provides high performance to the system.

Keywords: Interactive data acquisition and control system (IDACS), Control unit, monitoring unit, embedded web server.

I. INTRODUCTION

In industries, systems are becoming very complex. Industries system needs to test the site equipments and environmental so it can track state of system in real time. This system requires design which has to be flexible and adaptable, for that microcontroller based systems can be used. This is more reliable and provides high performance to the system. Microcontroller is very practical and successfully utilized, the conventional 8 and 16-bit Microcontroller has its deficiencies when compared with 32-bit . 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 ARM based embedded system will be more functional, reliable, cost effective, less in size and low power consumption.

Microcontroller has low speed and poor memory, so it can only execute simple control tasks.

RTOS comprises of two components, namely, "Real-Time" and "Operating System". Real-Time indicates an expectant response or reaction to an event on the instant of its evolution. The expectant response depicts the logical correctness of the result produced. The instant of the events evolution depicts deadline for producing the result. Operating System (OS) is a system program that provides an interface between hardware and application programs. OS is commonly equipped with features like: Multitasking, Synchronization, Interrupt and Event Handling, Input/ Output, Inter-task Communication, Timers and Clocks and Memory Management to fulfill its primary role of managing the hardware resources to meet the demands of application programs. RTOS is therefore an operating system that supports real-time applications and embedded systems by providing logically correct result within the deadline required. Such capabilities define its deterministic timing behaviour and limited resource utilization nature.

Real time kernel is simple and stable. RTOS can cut a complex application into several mutually independent tasks based on task priority and it also has its own limitation. RTOS, include the task management, task scheduling, interrupt handling etc. Industrial application requires multiple tasks to be executed. Controlling the industrial system, processing of data, storing of the data and transmission of the data with polling technique.

II. PROPOSED SYSTEM

In this project we are developing the ARM processor based industrial parameter monitoring system. An industrial system require data acquisition for which ADC is required, DAC is required for embedded control and for data backup SDRAM is required which we will contain entire log details. To communicate with desktop computer industries require RS232 protocol so Ethernet control is required. RTC data is written on Lab view for data logging purpose. LABVIEW is used for store and monitor the Parameter values and also control. In temperature and pressure sensor is sensed the industrial machineries temperature and pressure values. All sensor values are analog value and analog values convert into digital values (ADC). Temperature and pressure values are set from Lab view monitoring system via PC. While industrial machineries over exceeding the set values for temperature means automatically switch ON the fan otherwise fan is OFF. As well as pressure sensor also detect the analog values to monitor and control in lab view platform via through serial communication for Ethernet protocol. Ethernet protocol is serial communication for controller and interacts with PC system. Real Time clock using intake data logs updation for every an hour. The Design of ARM based industrial embedded system using RTOS offers necessary mighty functions to developing fast and efficient an application. The system can be used to perform real time controls where there have standard electrical interface. High precision data acquisition can be realized by the embedded system as well. Using the Ethernet port of the embedded system, networked control and acquisitions can be achieved through an industrial Ethernet LAN. The hardware and software provide a platform for diverse control and acquisition applications, including industrial process controls and factory automations.

III. System Overview

A. Architecture

Industrial system require data acquisition for which ADC is required, DAC is required for embedded control and for data backup SDRAM is required which we will contain entire log details. To communicate with desktop computer industries require modbus protocol so Ethernet control is required.

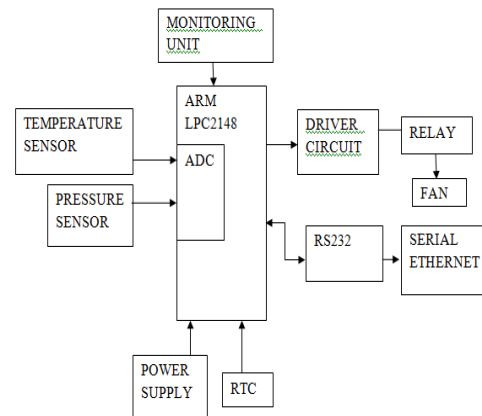


Fig.1 Block diagram of Proposed Architecture

The proposed embedded system uses FLASH and MMC memories for program running and data storage. The BIOS codes, user's codes and the useful data are stored in FLASH memories. RTC data is written on MMC for data logging purpose. As far as the control and acquisition system concerned, the Analog to Digital Converter (ADC) is essential components. The ADCs are applied for data acquisition.

B. RS-485

Serial port is backed up for more widely applications. The LCD controller can be programmed to support different requirements on the screen. LCD is connected to the General Purpose Input/output ports (GPIO) of the microprocessor. The IP address of the system is burned in a serial EEPROM. The Ethernet controller will read the IP address when reset. Ethernet is interfaced to serial peripheral interface of controller.

C. Rs232 to Ethernet bridge

A serial to Ethernet converter is sometimes referred to as a serial device server, a terminal server or a serial over TCP/IP server, however all these names are simply different names for the same type of device which basically

converts serial RS232, RS485 or RS422 data To Ethernet packets and Ethernet packets to serial RS232, RS485 or RS422 data (it is bi-directional). The serial Ethernet converter has it's own IP address which is why it sometimes is referred to as a server.

a. 1-Port Models

The most common and widely used Serial to Ethernet converter is the 1-port serial RS232 to Ethernet converter. This type of converter converts one serial RS232 port to Ethernet packets and Ethernet packets to serial RS232 data. An upgrade from the 1-port RS232 to Ethernet converter is a converter which also can convert RS485 and/or RS422 data in addition to RS232, either simultaneously or one type of data at a time.

b. 2-Port Models

Another often used type of Serial to Ethernet converter is the 2-port model. It is similar to the 1-port model with the main difference that it can convert two serial RS232, RS485 or RS422 ports to Ethernet in both directions, with simultaneously or one port at a time.

c. Multi-Port Models

Serial to Ethernet converters usually comes in 1, 2, 4, 8, 16, 24 or 48-port versions, however port number can change from manufacturer to manufacturer. 1 to 8 port models are usually referred to as multi-port models and converters with more ports are sometimes referred to as high-port Serial to Ethernet converters/servers or terminal servers. Multi-port models can have RS232, RS485 and/or RS422 capabilities and each port usually can convert data individually without initializing the remaining ports.

d. High-port models

High-port serial to Ethernet converter units with more than 8 serial ports are sometimes called high-port serial to Ethernet converter servers or terminal servers. These usually come in 16, 24, 48 or 64-port models but models with up to 100 ports exist. This type of converter is often made as a rack-mountable unit so it can easily be installed in a rack cabinet along with other data equipment such as routers and other network equipment.

e. Industrial Models

Serial to Ethernet converters are mad specifically for use in industrial environments such as factories, laboratories or commercial buildings. These converters usually has an extra hard and improved enclosure, higher temperature

specifications, more advanced software features and are generally of a higher quality due to its demanding uses. Industrial Serial to Ethernet converters often has a built-in or attachable DIN rain mount so it can be mounted on a standard DIN rail, convenient if the converter needs to be installed in an electrical cabinet or power panel. Some serial to Ethernet converter servers has a security feature encrypting the data which is being sent/ received over the LAN network.

f. Wireless models

A serial to Ethernet converter can even be wireless, meaning the Ethernet part is wireless and can connect to any local Wi-Fi network. This is very convenient at locations where cabling is not an option. Wireless serial to Ethernet converter servers are often quite higher priced than wired serial to Ethernet converter units.

The wireless serial to Ethernet converter works the same way as a wired converter except that it transmits the data wireless. Usually this type of converter only has 1 - 4 serial RS232, RS485 or RS422 ports so these are rather limited in number of ports compared to wired units.

Serial to Ethernet converters are also offered as PCB solutions, consisting of only the bare PCB with components, without any enclosure or other accessories. This is convenient if the user with to build-in a serial to ethernet conversion feature as part of another device or equipment. Some PCB models even allows the user to program and change the parameters of the processor chip and software.



Fig. 2 Serial to Ethernet bridge

IV. IMPLEMENTATION

The heart of the system is a real-time kernel that uses preemptive scheduling to achieve multitasking on hardware platform. The previous sections dealt with μ COS_II porting to the application desired. This section deals with the implementation of hardware and software. Depending on the required application the number

of tasks may vary. Porting of $\mu\text{C}/\text{OS-II}$ we can perform simple tasks like Temperature sensor (i.e., ADC), 16x2 LCD, Ethernet (i.e. to communicate with desktop PC) MMC (i.e., memory card for data backup).

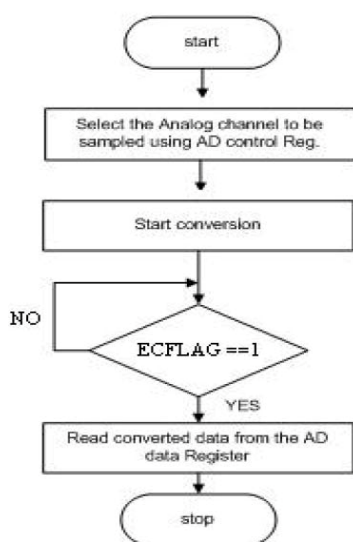


Fig. 3 Flowchart for analog to digital conversion

V. SOFTWARE USED

Keil IDE is used for implementation. Keil IDE is a windows operating system software program that runs on a PC to develop applications for ARM microcontroller and digital signal controller. It is also called Integrated Development Environment or IDE because it provides a single integrated environment to develop code for embedded microcontroller. Keil $\mu\text{Vision4}$ IDE (Integrated Development Environment) is a Windows based front end for the C Compiler and assembler. Keil $\mu\text{Vision4}$ is used for writing embedded C programs. Embedded C is a high level language, which includes many aspects of the ANSI (American National Standard Institute) C programming language. Standard libraries are altered or enhanced to address the peculiarities of an embedded target processor. Simulation output is done by using proteus 7.6 version.

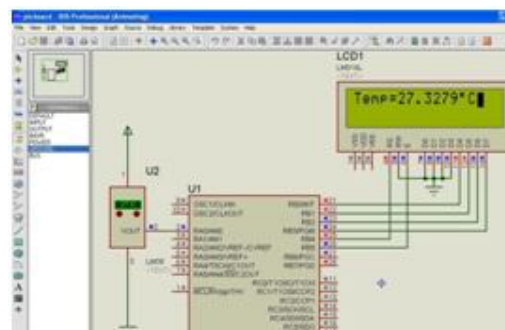


Fig.4 Output for temperature sensor using ARM

VI. CONCLUSION

The Design of ARM based industrial Embedded system using RTOS offers necessary mighty functions to developing fast and efficient an application. The system can be used to perform real-time controls where there have standard electrical interface. High precision data acquisition can be realized by the embedded system as well. Using the Ethernet port of the embedded system, networked control and acquisitions can be achieved through an industrial Ethernet LAN. The hardware and software provide a platform for diverse control and acquisition applications, including industrial process controls and factory automations. Since the embedded system is able to deal with Multi-Tasks and can run operation systems, field operations, supervisions and managements can be done by the lower embedded devices, hence the upper PC or workstation in the industrial LAN will do fewer works, which lowers the concentration degree of the whole system. This enhances the reliability of the control and acquisition system and reduces the risks Thus the embedded system is compact system that is useful for industrial applications.

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