INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Data Acquisition and Controlling System Using Cortex M3 Core

Lakshmi Prasanna Boppudi
M. Tech., DRK Institute of Science & Technology, Hyderabad, India
Dr. R. V. Krishnaiah
Principal, DRK Institute of Science and Technology, Hyderabad, India

Abstract:
Data Acquisition and Controlling System is one of the promising trends in the era of computing in today's system automation industry and control. The proposed project is one such attempt of designing online data acquisition and controlling system using CortexM3 core. In this project we have developed Ethernet device drivers for CortexM3 core to transmit the monitored sensor data to the internet. The System can complete the remote monitoring and maintenance operations of equipment through the network using a web browser. By introducing the Internet into control network, it is possible to break through the spatial, temporal restriction of traditional control network and effectively achieve remote sensing, monitoring and real time controlling of equipments. The main essence of this project is to design and implement a Data acquisition and controlling System using ARM CORTEX M3 CORE and TCP/IP Ethernet connection for industrial controlling applications. The real time analog voltages are converted into corresponding digital values using the ADC pins inbuilt in LPC 1768 [6] Cortex M3 and transfer them to the internet through Ethernet. In this proposed project we are monitoring temperature in industry using LM35 temperature sensor and Vibrations of machines using Accelerometer sensor. And we are also controlling the machine depending on the temperature.

Key words: *LPC 1768 Header Board, Sensors –Pressure, Temperature, Humidity, Serial Cable, USB-Power Supply Adapter*

1. Introduction

Computer communication systems and especially the Internet are playing an important role in the daily life. Using this knowledge many applications are imaginable. Home automation, utility meters, security systems can be easily monitored using either special front-end software or a standard internet browser client from anywhere around the world. Web access functionality is embedded in a device to enable low cost, widely accessible and enhance user interface functions for the device. A web server in the device provides access to the user interface functions for the device through a device web page. A web server can be embedded into any appliance and connected to the Internet so the appliance can be monitored through the browser in a desktop. Temperatures, Pressure, displacement, motion are the most often measured quantities. For example, some processes work only within a narrow range of temperatures; Certain chemical reactions, biological processes, and even electronic circuits perform best within limited temperature ranges. So, it is necessary to measure the temperature and control if it exceeds some certain limit to avoid any misbehaviour of the systems. To accurately control process temperature without operator involvement, a temperature control system relies upon a controller, which accepts a temperature sensor.

We have chosen the LPC1768 Header Board for Hardware Development. As most of the peripherals required for the project are on board, there was no need for development of interfacing any external hardware other than sensors for Input Analog Values. The power supply is given using on board USB & adapter. Hence, most of the project is software dependent.

An ARM processor based embedded Ethernet interface system is designed. In the system, the ARM Cortex M3 Core [3] communicates with the Client Device using DP83848 PHY and can transmit data Ethernet interface. An ARM processor based embedded Ethernet interface system is designed. In the system, the ARM Cortex M3 Core communicates with the Client Device using DP83848 PHY and can transmit data Ethernet interface. Here the task of host (LPC1768) is only to complete a single Ethernet communication and its load is lowered. The software part of the project included designing of software codes for ADC Conversion, Ethernet Communication and Switch LED functioning. The Keil IDE is chosen for compiling process. The tasks should be given efficient time slots so that efficient multitasking is achieved. To achieve this we would like to use the Free RTOS Kernel for the efficient scheduling algorithm. The individual tasks are then ported into Cortex M3 with appropriate priorities using free RTOS real time Kernal [5].

Embedded systems [1] have become an integral part of daily life. Be it a cell phone, a smartcard, a music player, a router, or the electronics in an automobile these systems have been touching and changing modern lives like never before. An embedded system is a combination of computer hardware, software, and additional mechanical or other technical components, designed to perform a dedicated function. Most of the embedded systems need to meet real time computing requirements.

2. Objectives

- Understanding the architecture of ARM Cortex M3 Core.
- Design and develop an ADC conversion driver for an external input signal to ADC Pin using UART. Using on board ISP Switch as a trigger for glowing LED.
- Develop an Ethernet driver for packet transfer.
- Create an HTTP web server using TCP/IP
- Create an HTTP Web server using TCP/IP Protocol
- Porting of Free RTOS Kernel onto the Cortex M3 Core Processor for Multitasking along with Ethernet task& Switch Alarm Task.

3. Project Scope

- Study the architecture, technical specification of embedded Cortex M3 Core based controller LPC 1768.Design the ADC Application Program Interface.
- Study the LPC1768 & HTML [8] programming language environment.
- Study the TCP/IP connection protocol.
- Develop web server program.
- Run the prototype controller in real time and debug.
- Understand Porting Of Free RTOS onto the Cortex M3 Core Processor.

4. Problem Statement

- Controlling a system via PC is very common, but PC is too expensive and cannot work continuously for longer working time.
- A web base controlling system can make us control a system without distance.
- Controlling a webpage use the PLC based controller is very difficult because the programming language too complex.
- Developing a cost effective, programmable and reliable embedded web controller webpage is necessary for the world competition.
- The Cortex M3 Core is chosen because it provides high performance, low power and is highly used in the Embedded Systems domain that can provide a good environment for the webpage controlling system.
- Integrated hardware and software development and build in with TCP/IP capabilities.

5. Architecture

The ARM CortexM3 includes three AHB Lite buses: the system bus, the Icode bus, and the Dcode bus The Icode and Dcode core buses are faster than the system bus and are used similarly to TCM interfaces: one bus dedicated for instruction fetch (Icode) and one bus for data access (Dcode). The use of two core buses allows for simultaneous operations if concurrent operations target different devices. The LPC17xx use a multilayer AHB matrix to connect the ARM CortexM3 buses and other bus masters to peripherals in a flexible manner that optimizes performance by allowing peripherals that are on different slave ports of the matrix to be accessed simultaneously by different bus masters.

6. Functional Block Diagram

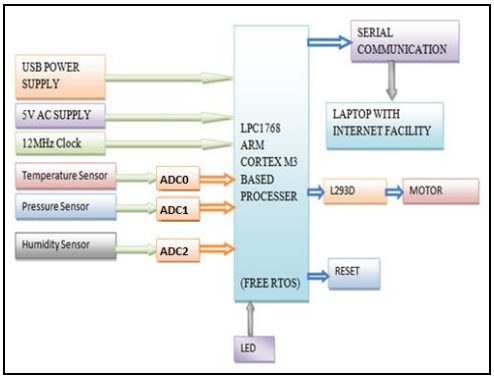

Figure 1

7. Hardware Resources

My main application module regarding our project is to transfer the Digital Values which are obtained from the output of in built ADC (AD 0.5) to a web browser with the help of Ethernet and TCP/IP Protocol and display those values for another person in another location with the help of Wi-Fi..

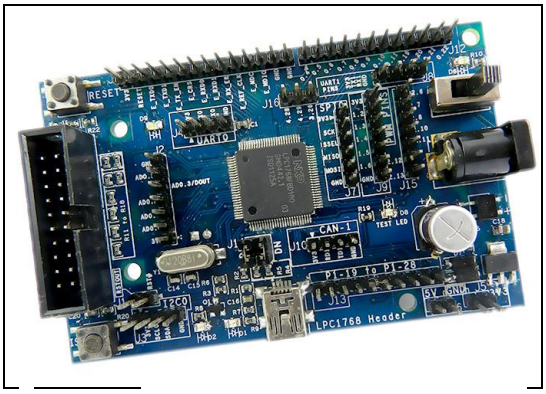

Figure 2: LPC 1768 Header Board Diagram.

In this, I used two protocols: CSMA/CD Protocol for Ethernet Wire Transfer and TCP/IP Protocol for uploading these values to a Webpage and to display those in other PC's. In this report, first I would like to give the readers a brief idea about the Ethernet and its protocol followed by a clear description about how packets can be transferred in Ethernet and how TCP/IP protocol helps our project in data acquisition.

8. Flow Chart of the Project

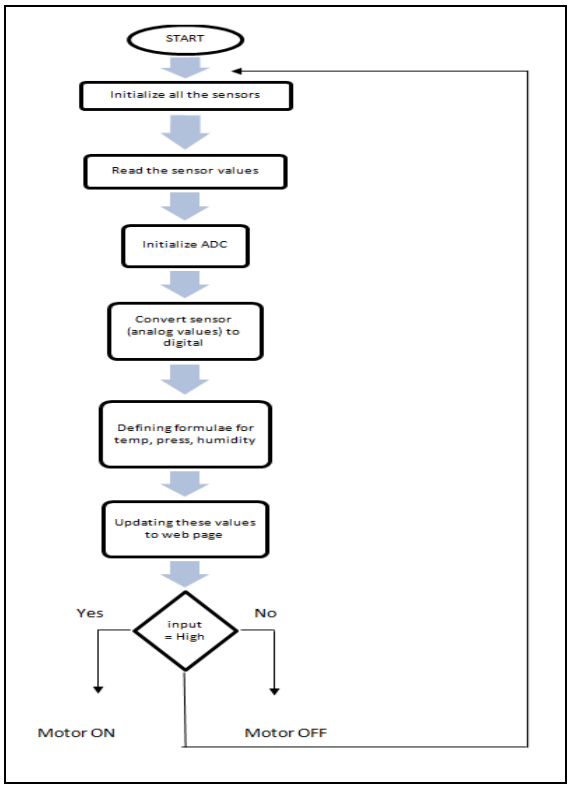

Figure 3

9. Results and Discussion

For monitoring the sensors

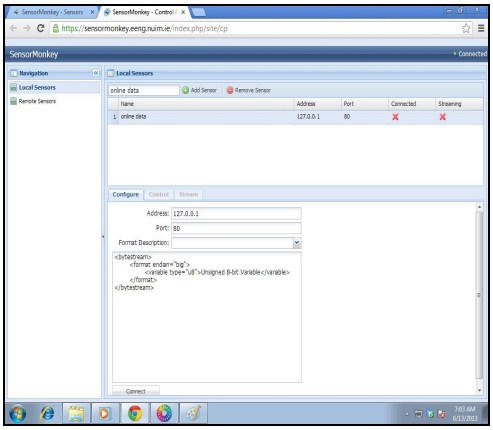

Figure 4

Whenever the motor is ready to burn then we will stop the motor by passing the command 1 then that will shows the below result

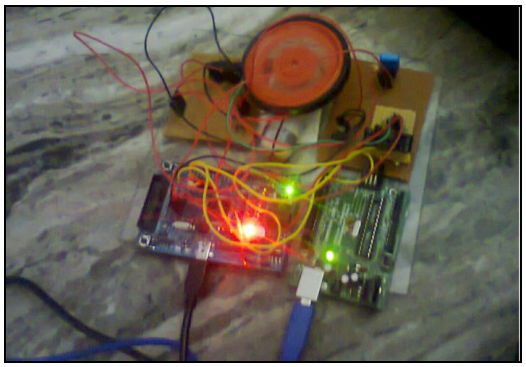

Figure 5

10. Discussion

We have understood the key areas associated with a simple embedded Web server design and implementation, such as typical microcontroller hardware and its constraints, the network protocols needed for a Web server and the implementation RTOS techniques to minimize resource usage. The presented results have sufficient resources to support the creation of useful Web pages, including dynamic data. The real challenge in designing a workable and extensible embedded Web-based server is in the data layer.

We have observed the real time changes in the input analog voltage applied to the onboard ADC pin P1 through the web page and monitored them an Voltage Scale on an Web Page. However, rapid changes input values cannot be strictly updated to the web Page. There exists a time delay of 1-2 seconds. We think that these time delays are due to anomalies in designing of Scale conversion programmer inbuilt in Web Page Coding.

The Free RTOS is successfully ported to the Cortex M3 Core of LPC 1768 Header Board. We designed another task for Switching on an LED at User's Perception. Whenever such an situation occurs the Ethernet application would be temporarily halted and "Switch LED" task take place. This was possible due to implementation of Free RTOS Kernel which helps to prioritize the tasks. Hence we successfully implemented the Free RTOS Kernel on Cortex M3 core module for Data Monitoring Application.

Also we have chosen Keil IDE for compilation of Free RTOS code. No prior example demos have been available for such compilation. This has definitely delayed our process of debugging. We also configured the Host computer which is the main Client to be a router using HOTSPOT and shared the information using Wi-Fi. It was observed that the abrupt changes in results are first observed on secondary clients than the main PC to which the Embedded Web Server is connected.

As more and more devices appear, the issue is no longer if it will have embedded Web technology but, how and to what extent it will be used. We need to pay close attention to the features and functions that are allowed through these remote interfaces, and the requirements that make the device production feasible. It is clear, that the technology was already invented.

11. Conclusion

With the rapid development of the field of industrial process control and the wide range of applications of network it is necessary to make a higher demand of the data accuracy and reliability of the control system. This embedded system can adapt to the strict requirements of the data acquisition and control system such as the function, reliability, cost, size, power consumption, remote access and so on. In order to transmit the data from an existing device to network, an embedded Ethernet monitor and controlling system based on web browser is designed. These Embedded Ethernet modules are having the capacity to perform as a true Ethernet device. It is possible to interface different kind of sensors with these modules and make various applications. So it can monitor embedded

system operation state through Internet, achieving network monitoring purposes. The Cortex M3 Core helps for low power consumption and high performance.

Also another basic code for Switch LED demonstration has been developed. This reduces the need of employing an extra system to cater the industry needs (no new controller needed).To prioritize such increased number of tasks on microcontroller, adoption of FreeRTOS has been made. The porting of FreeRTOS to the Cortex M3 Core is done and is successfully tested.

Such systems developed using multiple constraints can be deployed in remote fault diagnosis system, weather forecasting systems, etc. In order to make the system more intelligent and reduce human burden, concepts of Artificial Intelligence can be incorporated. Based on juxtaposition of the collected statistical information with the current measured data, we can define methods for error correction. Determination of the correlation between processed quantities, there will be possible to realize an algorithm for automatic Process Management in Industrial Scenario. However concepts like Fuzzy Logic requires need for expanding operational memory of microcontroller. This can be overcome by adopting concepts of DBMS etc., used in Commercial Software Analytics into the Embedded Systems and making them more efficient.

- Power has been reduced by 13.71% in output buffer using MTCMOS technique.
- Overshoot and undershoot has been reduced by slow discharging of PMOS and NMOS in Nand and nor circuit respectively.
- Maximum frequency of operation is limited to 150MHz due to inductive effect.
- The buffer can drive a MAX current of 3Ma with a delay of 9ns.
- Bulk control circuit used in I/O buffer leads to reduction in Gate oxide stress.
- The buffer achieves a faster rise time of upt0 30% with a 2 times current driving capability due to PMOS and inverter connected in parallel to driving stage
- Output buffer performs level shifting to 1.8V when input voltage changes between (1.8-5)V.

12. References

1. Jean J Labrosse, “Embedded Systems Building Blocks” R&D Books, pp 61100
2. An Axelson “Embedded Ethernet and Internet Complete” Lakeview Research LLC, 2003
3. Joseph Yiu “The Definitive Guide to ARM Cortex M3” Newness,©2007
4. Pont, Michael J “Embedded C”, Pearson Education ©2007
5. Richard Barry “Using the Free RTOS Real Time Kernel”
6. “LPC 17xx User Manual”, NXP Semiconductors.
7. “Web Convert User Manual”, Precidia Technologies, ©2002
8. HTML Coding from w3schools.com
9. Arul Prabahar A, Brahmanandha Prabhu, “Development of a Distributed Data Collection System based on Embedded Ethernet”