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RESEARCH ARTICLE

DESIGN AND IMPLEMENTATION OF MULTIPLE SENSOR INTERFACE USING ETHERNET

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Abstract: ***Data Monitoring Application using Cortex M3 Core Processor" We combine the mature technology of Web with the embedded and fully utilize the advantages of both. The System can complete the remote monitoring and maintenance operations of equipment through the network using Web browser. Through introducing 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 for equipments.***

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 misbehavior of the systems. To accurately control process temperature without operator involvement, a temperature control system relies upon a controller, which accepts a temperature sensor.

1. Introduction

Patient monitoring helps increasing the mortality by timely notification of exceeding vital signs. By using the vital sign data the critical care staff can make necessary life saving interventions. This requires the underlying network to be very robust so that timely and error free information flow can be guaranteed. Moreover there is a need for a cost effective and robust network technology for continuous and real- time vital signs monitoring in resource constraint settings in developing countries. In this paper we proposed a system of hospitals with interconnected intensive care units. Each intensive care unit employs Controller Area Network (CAN) as underlying technology for networking of bedside units. The data of these bedside units can be communicated with other hospital using higher level protocols such as Ethernet. This allow the hospital staff to share the health information of the patients with the specialized staff in another hospital to provide better cure to the patient and consequently can increase the mortality.

In the critical care units, the patient bedsides are equipped with devices to continuously inform the intensivists and other medical staff about the current vital signs parameters of the patients. By this information, the paramedic staff can make necessary interventions for the prevention and cure of disease. Nevertheless, this critical care is vital for seriously ill patients but it often prove to be costly for resource poor countries. As a consequence, there is always lack of necessary critical care needed for the people who need it. There is a need to focus on the technological solutions that are affordable and sustainable. In addition to the effective critical care services these countries lack specialized staff and other medical equipments for large number of patients during situations of mass disaster. On account of these, every hospital should provide emergency critical care in coordination with the regional hospitals and other medical entities to do this in more effective way.

Controller Area Network (CAN) is a low cost, light weight broadcast network protocol. It was designed for automobiles but its applications are now expanded to many other industries including hospital. CAN networks are used also in intensive care units including patient beds, in operating rooms, and in other healthcare equipment.

2. Background and requirements of data acquisition and I/O

As used in this paper, the term data acquisition and industrial I/O refers to the process of acquiring and measuring real-world signals from sensors, transducers, and devices. Data acquisition and I/O devices typically consist of some combination of analog and digital input and output capabilities, including signal conditioning, analog-to-digital (A/D) converters, digital-to-analog (D/A) converters for analog outputs, and timing I/O. Data acquisition and I/O products are commonly used to interface directly to sensors, such as thermocouples, RTDs, strain gauges, load cells, pressure sensors, flow meters, and 4-20 mA transmitters. High-speed data acquisition devices can capture waveform signals, such as electrical transients, vibration and audio waveforms. Today, data acquisition and I/O products are usually used in conjunction with a desktop, industrial, or notebook PC. Plug-in boards with high-speed data acquisition capabilities are widely available for PCI, ISA, and even PCMCIA. External data acquisition devices typically connect to the PC using a serial (RS-232), IEEE-488, or USB connection. Products used in more industrial application provide I/O and control with interfaces for industrial networks, such as DeviceNet, Profibus, or other fieldbus. The demands put on the communications interface by data acquisition and I/O applications vary widely. Many process and environmental monitoring applications involve relatively low bandwidth signals that are sampled at less than 10 Hz. Higher speed data acquisition applications such as audio and vibration measurement involve the capture of waveforms at sampling rates up to 100 kHz per channel. Electronic data acquisition applications with A/D sampling rates in the multiple-megahertz range are becoming more and more common. Measurement devices for these higher speed applications typically include local memory for temporary storage of data before it is transmitted over the communications port. While the focus of this paper is on data acquisition and industrial I/O, a closely related function is that of real-time control, in both the equipment used and the nature of the functionality. Traditionally, real-time control devices integrate the processor and I/O into a single device, ensuring deterministic behavior in the execution of input measurement, control algorithm calculation, and control output generation. The use of remote I/O, however, requires a communications link between the control processor and I/O.

3. Background of Ethernet Technology

Less than 20 years ago, Xerox, Intel, and DEC published a specification that defined a networking technology intended for linking computers in an office environment. The specification evolved into IEEE Std 802.3 (and ISO/IEC 8802.3), and ISO/IEC8802.3, published in 1983 and 1985, respectively. These standards refined the original Ethernet specifications, defining a 10 Mbps network available on a variety of physical implementations, or media. These media included, among others, 10Base5 and 10Base2 (coax), fiber optic (10BaseFP), and 10Base-T (unshielded twisted pair). Table 1 summarizes the key attributes of some of these media. While coax and fiber are common for medium and long distances, usually as the backbone of a network, inexpensive telephone wire is becoming the de factor standard for direct connection to desktop computers and other Ethernet devices. In particular 10Base-T (10Mbps) and 100Base-TX (100 Mbps) utilize unshielded twisted-pair wiring (UTP). The growing popularity of UTP, combined with the availability of multiport repeater hubs, has replaced the original trunk line topology of Ethernet with a star topology using point-to-point connections. Ethernet defines a mechanism for resolving transmission conflicts on the wire, referred to as CSMA/CD (Carrier Sense Multiple Access with Collision Detect), whereby colliding devices back-off from an attempted transmission and retry after a random delay. This random delay ranges from 0 to 102 microseconds for the first retry, to 0 to 51 milliseconds on the2 sixteenth consecutive retry. For Fast (100 Mbps) Ethernet, the ranges are reduced to 0 to 10 microseconds, and 0 to 5 milliseconds for the sixteenth retry. Therefore, it is impossible to exactly predict the amount of time for colliding devices to successfully transmit information. This consequence of the CSMA/CD collision mechanism has brought up concerns over determinism, particularly in the areas of real time control and data acquisition.

Devices on a single Ethernet segment belong to the same collision domain, meaning that network access and transmission is governed by the CSMA/CD mechanism. The evolution of intelligent network bridges and switching hubs now enables segmentation of networks into separate collision domains. Strategic use of these technologies can therefore decrease the occurrence of collisions and yield significant performance improvements on loaded networks Ethernet performance has continued to evolve with the development of Fast Ethernet and Gigabit Ethernet. Fast Ethernet, defined in IEEE 802.3u, increases throughput by an order of magnitude to 100 Mbps. In addition, the reduced collision recovery delays of

Fast Ethernet benefit loaded networks in particular. Fast Ethernet can run on fiber or UTP, Category 5 wiring, and is commonly used for high-traffic data servers, or as a backbone connection. Gigabit Ethernet, defined in IEEE 802.3z, is an emerging technology that further ups the bandwidth to 1000 Mbps.

4. Moving Ethernet into Industrial Environments and Applications

Measurement, control, and I/O applications often require industrial grade components that can endure temperature extremes, shock and vibration, high levels of EMI, etc. This is now beginning to be addressed by network suppliers recognizing this opportunity. However, this current lack of industrial-grade media components (hubs, switches, routers, etc.) may at least temporarily slow the acceptance of Ethernet into the harsher industrial applications.

A number of proprietary and open field bus networks are in use in industrial automation applications today. Ethernet is also poised to penetrate the market for these high-speed control networks, such as Profi bus, Device Net, and Control Net, and FOUNDATION Fieldbus. While an in-depth comparison of Ethernet to these networks is beyond the scope of this paper, it is worthwhile to note some key comparisons. When compared to these control networks, the main strengths of Ethernet are its total installed base, cost per node, and high data rate. On the other hand, some control networks include standardization the user/application layers of the OSI model, providing higher level of interoperability of devices. Also, these control networks tend to support solid determinism, redundancy, and bus-powered devices.

Of course, one additional, very important advantage of Ethernet is its openness, worldwide connectivity, and built-in compatibility with the dominant PC platform, Microsoft Windows. For example, you can connect measurement nodes to an Ethernet network and almost automatically have access to the data across the world via the internet.

5. Implementation and Device Requirements

Implementation of an Ethernet-based measurement system can be classified into one of two broad categories, referred to here as Networked PC Measurement Systems, and Ethernet- Based I/O Devices.

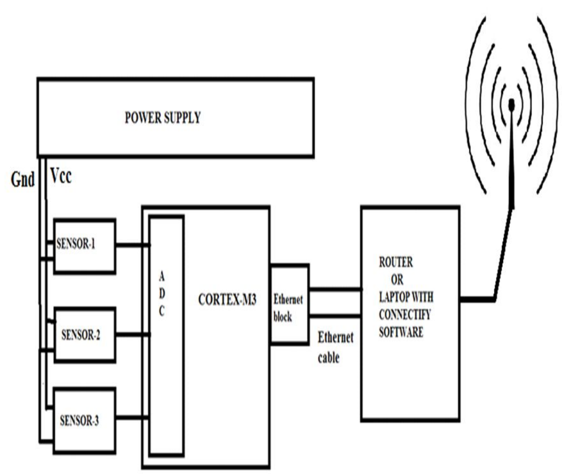
A. Networked PC Measurement Systems

The first approach to Ethernet-based measurement systems is to apply standard, commercial PC networking technology and measurement technology to turn PCs into networked measurement servers. In other words, a Networked PC Measurement System is simply a PC-based data acquisition or measurement system, with the necessary network interface card and software to serve measurement data over Ethernet.

For example, using plug-in PCI data acquisition boards, or RS-232 devices linked to a PC, you can use standard data acquisition software on the PC to collect the data, process and minimize the data as needed, and then publish the data to the network. Network communications can be accomplished using a number of different approaches. For example, the PC system could utilize standard networking software provided by Microsoft, such as TCP/IP protocol, remote procedure calls (RPC), distributed component object model (DCOM), or OLE for process Control (OPC). These different software approaches require a varying degree of end-user development and expertise. Two high-level approaches that can require little networking expertise are OPC and RPC. OPC, developed and maintained by a consortium of suppliers in the industrial automation marketplace, provides a standard interface for application software packages to communicate with I/O devices [5]. Because OPC is built upon COM and DCOM, OPC operates transparently over the network. As an example, if the PC Measurement System is outfitted with I/O devices and an OPC server for those I/O devices, clients with OPC capabilities on the network can read and write data to and from the server.

B. Ethernet-Based I/O Device

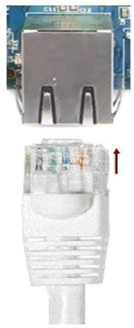
Much attention has been focused on the use of Ethernet technology directly at the device level. The decreasing cost and increasing capabilities of network interfaces and microprocessors have accelerated the movement of communications network connections down to the instrument and device level. The Ethernet-Based I/O Device is a measurement or I/O device with an Ethernet connection directly on the device itself (see Figure 2.b). This approach provides a relatively inexpensive option for networked data acquisition, and provides greater versatility in terms of locating the measurement device in size-constrained areas or harsh environments. Compared to some other simpler communications links in use today, Ethernet does typically require a more powerful microprocessor and more memory to execute the communications stack. However, the evolution of Ethernet technology indicates that the implementation cost will continue to decrease. The commercial availability of Ethernet-Based I/O Devices is increasing rapidly as manufacturers convert existing systems over to Ethernet. Typically, the Ethernet-Based I/O Device is a measurement device with a standard Ethernet interface, usually 10Base-T, incorporated into the communications interface. An Ethernet-based measurement device does have a unique set of requirements, relative to a standalone or PC-based measurement system. Reliable, autonomous operation of a distributed measurement device requires a more intelligent device with a local microprocessor that handles communications, system management, and diagnostics. This is in addition to the needed components to collect and process the actual measurements. Many devices also implement embedded data servers, improving the efficiency and ease-of-use of accessing collected measurement data. For example, shows the functional diagram of a typical Ethernet-Based I/O Device .

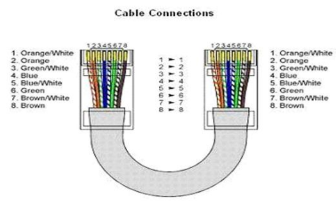


Block Diagram

6. Ethernet Hardware Description

The correct way to plug the connector is given in the figure. Press the connector in the direction shown and the connector will lock up properly when it is fully connected. An Ethernet straight through cable is used for testing. The recommended connection of the cable is also given.





7. Operation of Ethernet

Each Ethernet-equipped computer, also known as a station, operates independently of all other stations on the network: there is no central controller. All stations attached to an Ethernet are connected to a shared signaling system, also called the medium. Ethernet signals are transmitted serially, one bit at a time, over the shared signal channel to every attached station. To send data a station first listens to the channel, and when the channel is idle the station transmits its data in the form of an Ethernet frame, or packet. After each frame transmission, all stations on the network must contend equally for the next frame transmission opportunity. This ensures that access to the network channel is fair, and that no single station can lock out the other stations. Access to the shared channel is determined by the medium access control (MAC) mechanism embedded in the Ethernet interface located in each station. The medium access control mechanism is based on a system called Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

8. Result

The first step to dealing with a problem is recognizing that you have one. So, I have to come clean with you, my reader. I have a problem: an addiction to… detail. Every time I set out to write about a particular protocol, technology or concept, I start with a modest goal regarding how much I want to write. I always begin knowing that I really need to control myself, to prevent my project from going on forever. But as I explore each subject, I learn more and more, and I start to say to myself things like…"this is important, I simply *must* include coverage for it" and… "If I am going to cover subject #1, I also should cover subject #2, because they are related".

However, even though self-control in this area is a weakness for me, even i realized I could not possibly cover everything related to TCP/IP in this Guide. Consider that the TCP/IP suite contains dozens of protocols and technologies that have each had thick books written about them. Thus, I had to limit the scope of this Guide somewhat, both to preserve what remains of my sanity and to spare you from having to wade through a ridiculously large document. Here are a few different points that will help explain decisions that I made to limit the scope of The TCP/IP Guide:

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