Remote Control of Processes Using Computer Networks.

YuvaKumar.P and Muthiah.A , NITT.

October 10, 2003

---

1 Abstract:

The problem we aim to solve is: "To enable simple scalable mechanism to connect hardware to computers and hence allow an almost universal control of that hardware using computer networks from anywhere and everywhere" The paper aims to highlight, how we control processes at the distant areas via computer-process interfacing.We assume that there is a computer at that distant location interfaced to the process,and also ,connected to the INTERNET. Now we can use computers from long distances to communicate with this host computer, and thus change/view/control the current status of the process.This is a very generalized idea which can be tailored to suit many a problem,as we will show in a simple example in the paper. We show that such computers at faraway locations can allow certain people [across networks] to change/view/control the processes.Authentication mechanisms can also be added.

2 Introduction

We have an idea to combine computer networking with the hardware interfacing of microprocessors to real world devices and thus enable a remote process control. We assume a typical IBM PC in the following discussion when we talk of a computer. The idea is basically divided into 3 parts:

1. Data acquisition and process control
2. Storage and computation.
3. Networking mechanisms.

The figure-1 illustrates the overall mechanisms in a block diagram.

3 Data Acquisition and Process Control

This section interacts with the process and it gets the data in a format that the computer can use and can send the signals from the computer to the process in a format in which it can understand.

3.1 Data Acquisition

This means converting the data from the process into TTL signals and sending it to the computer serial or parallel port. For example the LPT1 parallel port we can read five input signals and eight outputs at a time. Similarly with the serial port like COM1,COM2,etc we can also read the parallel data from the data converter using a UART(parallel to serial converter).

The data can also be acquired from devices using tiered de-multiplexers as shown in the figure-2.In this case we can have'n' bus lines of TTL range,then we can have 2^n devices to be interfaced with the computer system for either Input or output systems.This is a big winner for large interfacing systems. How the data is acquired to the microprocessor system is our need. For example we may need to measure the brightness of a glyph in the character to see its meaning for OCR scanning.This means that the hardware used will give a current signal equivalent of the brightness of the character.Then we use custom circuits that can convert this data to a value in a scale within some bounds.The bounds are generally set by the ADC/DAC used, V to Frequency, I to V ,V to I converters which condition the input signal from the device to be sent to the computer as some 8 bits of data.Then the computer which simply gets the numeric value can decode the number by a simple substitution in the formula.

3.2 The process control

The setup in figure-2 same can also be use for data output to control the process. Here the computer selects a process by using the tiered demux architecture shown. Then the latch connecting process's data bus to the data bus of the computer is enabled.Now the computer systems can communicate with each other and hence setup a nice dialogue to translate commands from faraway places to actions.This is the most challenging part.Remote control of these systems.

For example when we have sent an instruction from the computer to be actuated by the device we have to use some components like a DAC to convert the resulting digital signal to a analog signal and send it to a actuator device like a stepper motor,voice coil circuit for providing linear motion output.If we want to dynamically change the memory locations of a display RAM then nothing is really needed as mentioned above.The computer simply writes into the RAM used by the process, and the effective changes take place almost immediately.The same problems become difficult when we need to perform different kinds of output functions.We could also use the DAC converters to control Home electronic appliances which is a popular hobby. This technique makes use of the relay circuit which can be switched on or off by the logic supplied from the microprocessor circuit/computer system.This is also in our view, a type of process control. We can have a simple C program to enable the ports like LPT1 or COM1 or even a custom device so that we can communicate with the process.

```
/* Function definitions for similar functions are skipped for sake of brevity */
int init_ports(void)
{
  if (ioperm(DECODER_PORT,1,TRUE)!= 0)//sets permission for the input and decoder ports.{
      printf("Error,Cannot Open DecoderPorts\n");return -1;}
  if( ioperm(INPUT_PORT,1,TRUE)!= 0)
     { printf("Error,Cant Open InputPorts\n");return -1;}
  return 0;
}
int  monitor_temperature(void)
{
  int value,temperature;
  FILE *fp;
  fp=open_file("temperature.txt");
  if ( fp == NULL)
    return -1;
```

```
  value=inb(INPUT_PORT);//reads value of the input port.
  temperature=0.56*value/vref;//assuming a linear correspondence to temperature
  fwrite(temperature,''%d'',fp);
  fclose(fp);
  return 1;
}
/* other functions have a similar code so we skip them*/

int
main(void)
{
  int count=0;
  init_ports();
  while(1)
    {
      /*writes data from the port into count*/
      outb(count,DECODER_PORT);
      switch(count)
{
case 0:
  monitor_rainfall();break;
case 1:
  monitor_temperature();break;
 case 2:
   monitor_pressure();break;
case 3:
   monitor_humidity();break;
case 4:
  monitor_windspeed();break;
}
      count++;
      count=count%MAX_DEVICES;
      sleep(60*60);//sleep for 1hr before next sampling.
    }
  return 0;
}
```

4 Storage and Computation

Storage and computation section performs the following functions:

1. Data Interpretation
2. Signal storage

3. Error notification

4.1 Data Interpretation

The data obtained from the Raw device through the data acquisition will be just a representation of the parameter estimated.For example, in the case of measuring the temperature,if we use a temperature sensor IC,it will give a output voltage that is a linearly related to the temperature.This signal we receive through an ADC converter as a number at the computer.For this particular case, this section,precisely convert the number to the proper temperature by substituting the received value to the formula we already know for that device.

4.2 Signal Storage

The signal along with the converted parameter [eg:temperature,pressure..]is stored into the computer in a database or file for later recovery.Here data mining can be performed.The calculation's,statistics and various analysis can be performed on this data, with this stored format.The same is made available to the person across the network also.

4.2.1 Error Notification

Whenever we find that the data is wrong, or the data is not being sent to us, we can post an error notification to the person manning the station from his/her home via the network [email,web].Also in the meanwhile we can stall the process depending on the severity of error.

5 Networking Mechanisms

The network mechanisms are the essential part that make this remote system work. We have the option of using full fledged computer at this distant place,or a simple microprocessor based system.
1:Computer System 2:Microprocessor System

5.1 Computer System

The full fledged computer system can be used in times of the mission-critical projects. They have the capacity to support networking in the forms of
1: TCP/IP networking [INTERNET] 2:Mobile Networks [Wireless]

Now that we have some means of sending the data we can have the data sent as simple raw packets over TCP/IP,SLIP,PPP etc. or can be sent over the HTTP and such higher level protocols with the help of XML.Here we can define our own tags and make a DTD to match the grammar of the document that contains the data.Now we can send the data along with the grammar [DTD] in the HTTP service to the client machine.If we have a suitable XML parser we can reconstruct the files into meaningful data form the grammar and use it for our own needs.Thus we have achieved transportation across networks.

5.1.1 TCP/IP networking

This mechanism is based on the 4 layer model,that allows the whole networking to be split between the application layer, TCP,IP and physical layers.This is a useful form of abstraction form the programmers point of view.Lots of methods can be used to receive the data from the user after authentication.A few ideas of using this network is via application layer protocols like

1. TELNET
2. RLOGIN
3. HTTP/WWW

5.1.2 Mobile Networks

This mechanism is also similar to the one above.Instead of connecting generally to the internet, the computer can choose to use this special network with very few clients who have access to this machine and can work on this.

5.2 Microprocessor system

These systems have the the microprocessors that can be connected to networks using **RS-232C serial,RS-434 serial protocol,Telephone Lines** Generally we need to have a modulator/demodulator that can encode the signals and send

them to the destination modem.This modulator/demodulator can be implemented using a microprocessor system.In the case of the 8085 system we have the SID,SOD bits of the instructions that can be used to send and receive 1 bit at a time.By using a multi processor system we can use the separate dedicated microprocessor for the modem system to communicate using the RS-232c or RS-434 protocol. The microprocessor systems offer no security and can be used in the case of a local system, for reducing the cost of a dedicated computer.This is a simple system design.

6 General Description

The scenario,where our solution will work is as follows:
A host computer located at a far off place is connected to the process/hardware or the system. There are a remote computers that are used by the controller to monitor and change this process.These remote machines will be authenticated by the host machine to control the process happening at the other end.This authentication mechanism is based on a protocol that works on top of the TCP/IP layers.Once the authentication is over,we are able to send the commands to the remote computer from the remote machine.Now the host computer can receive the commands and interpret them to mean certain hardware operations to be preformed.How the remote computer is performing these operations is using memory mapped or I/O mapped device interfacing. Once the operation is performed we can make use of the web server that is running at the remote computer to publish the result of the operation/command requested by the host on its site.

7 Example

Example:

The idea of implementing a remote weather station suits this scenario. Using the chips like temperature sensor,pressure sensor we can convert the readings into analog or digital equivalent depending on the chip specifications. So we can measure the temperature, air pressure, wind speed and wind direction, humidity, rainfall, radiation etc.

For example we can use the following chips:

ADC chips:ADCO801 —- from National Semiconductor.

DAC chips:AD7801 —- from Analog Devices.

Temperature sensor:

DS18S20 —- from Dallus Semiconductor.

TMP04 —- from Analog Devices

S-8110 —- from Seiko Instruments

Wind speed sensor and Wind direction senosor:

TV114 —- from Texas Electronics

Rainfall sensor:

TB200 —- from Greenspan Tech

Humidity:

TH2013 —- from Texas Electronics

Pressure sensor:

MAX1450 —- from MAXIM-IC Dallas Semiconductors

7.1 Designing the circuits:

Temperature measurement:

The temperature sensors will convert the temperature within a certain range like -30 C to 100C to a corresponding linear voltage with some fixed scaling factor, called the temperature co-efficient,that are a few millivolts per degree increase in the temperature. The output voltage from these devices is somewhere between 0.78V to 5.4V. This voltage can be converted to a corresponding 8 bit digital value by a ADC chip.Then we can read them in the computer using a UART or a port.

Wind Speed sensor:

The wind speed sensor measures speeds between 0-100Kmph.They generally do not convert the values to analog.Hence we have to build custom circuitry to convert the rotations into a voltage/digital input to the computer.But the sensor from Texas Electronics TV114 can convert the measured values to a serial o/p compatible with the RS-232C standard which is also fed directly to the computers serial port.

Rainfall Sensor:

The TB200 rainfall sensor measures the tipping of a small bucket with a max capacity of about 700mm/hr.The TB200 chip is also capable of transferring this information to the computer via the same RS-232C serial data.Outputs

can also be got through the parallel port, in a digital form.

Humidity Sensor:

The TH2013 from Texas Electronics, is a humidity sensor that gives the values between 0 to 1v outputs corresponding to 0-100% humidity in the atmosphere.This is fed to the computer via the ADC.

Pressure Sensor:

The pressure sensor is either a absolute/relative sensor.In these cases we have a direct relation between the pressure measured and the output voltage/current produced outside.Hence we can feed the same using an ADC to the computer.

Signal Conditioning:

Since the signals from the raw inputs may have some noise added we need to condition these signals to be of use to us,before we use the ADC.

Hardware-interface program:

The computer hardware needs to have at least two I/O ports.One parallel another of any type. Without the loss of generality we can assume the two I/O ports to be parallel.Now our program can simply monitor the status of these devices by properly selecting them via the decoder.Then the routines "ins", "out" in assembly or the high level C functions.Thus we can read / write the bytes from the devices. The values read/written correspond to the scaled temperature,humidity,pressure,wind speed,rain fall. Hence we can make sense and store the values in a database.This is a very nice method to save data in a structured and easily retrievable method.

8 Possible System Utility Area's:

Simple printer connected to a INTERNET.where anyone from anywhere can use the printer.
Maintaining a Radio Telescopes for data aggregation
Remote machine designing via robot control.
Remote medical surgery.
Remote weather monitoring.
Seismic observatories.
Show traffic queues and congestion at a place.
Monitoring Washing Machine loads in Public Laundries.
Programmable Scrolling displays.
Automated Voice Announcements in bus stands,railway stations,airport.

Technologies used:
XML,HTTP;for passing commands and authenticating.
TCP/IP :the Internet.
IC,PCB's,Custom Hardware etc.:Interfacing hardware to remote computer.

---

9 References

Device Specifications: www.analogdevices.com,www.ns.com,www.max-ic.com,www.mit.edu
Books: 8085 Microprocessors .. Gaonkar,x86 Intel architecture ..B.Brey
Papers: from Delft University,Netherlands on OCR conversion of Braille to computer data based on a Microprocessor systems,presented in 1985.
