Present-Day Multimedia High – End PCs on the Developments In Medical Diagnostic CT Scan Machines

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Abstract:

Since the days of Hounsfield' s EMI scanner, there have been rapid advances in the use of data acquisition systems, from the early date (seventies) mainframes and the later naked minis to the PC, as the architecture of the PC was also developing since the late eighties. With the arrival of more powerful PCs and also reasonably priced data acquisition (DAQ) boards and user-friendly software, older CT measurement systems were soon converted into an Olivetti 486 DX2 PC with 2 free slots for DAQ boards. The other two slots were occupied by an Ethernet board and an IEEE 488.2 interface board for communication with instruments connected on the general purpose interface bus (GPIB). This system was mounted on a trolley so that it could be easily transported between the various control rooms.To complement these systems, they also added a Toshiba T4850 CT laptop computer which was equipped with two PCMCIA data acquisition cards. In the office it is connected to the local area network via the desk station IV and in order to use the full length ISA boards it can be docked on to the DacPac which can hold two such boards.

Key Words: **GPIB Bus, *Programmable gain*, DAPL Interface, FFT, Medical Imaging, CT Scanners**

1.INTRODUCTION

1.1. THE HARDWARE CONFIGURATION

The hardware configuration of each PC depends on the type of measurement we want to make. The older 386 machine is used primarily on the electron cooling testbench [4] for the control and acquisition of the main parameters. It has one 100 kHz 16 channel A/D board and a 6 channel D/A board. The 486 is used in the control rooms for making measurements on instruments using RS232 and GPIB interfaces. It also uses a faster (333 kHz) A/D board for the observation on the Scinti signals. The laptop, which is designed to be fully portable, is equipped with a GPIB interface card and an 8 channel 100 kHz A/D card, both of which use the PCMCIA interface. It can also be attached to the DacPac which has two high speed D/A boards installed in it. Signal conditioning units

are used for filtering and amplifying the input signals on the A/D board and a screw terminal accessory board is used for distributing the output signals. In addition we have made a number of anti-aliasing filters having different cut-off frequencies for all measurements where an FFT is needed to be made on the input signal.

1.2. SIGNAL-CONDITIONING FEATURES INCLUDE

- Current sensor excitation: 4 mA at up to 28 Volts
- Voltage sensor excitation: 1, 2, 5, and 10 Volts at up to 70 mA
- Quarter-, half-, and full-bridge resistor networks
- 120 and 350 ohm resistors as standard options
- Any value resistor networks, sensor by sensor
- 10 full-scale options: 10 mV, 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, and 1, 2, 5, and 10 Volts
- Programmable gain with auto-calibration
- Programmable AC/DC coupling for ICP sensors

1.3. SOME EARLY DATE DATA ACQUISITION AND INTERFACE BOARDS

- The KPC-488.2 board is a high speed IEEE-488 interface (GPIB) for the PC/XT/AT and compatibles. This interface can read or write data at rates up to 1.5 Mbytes per second with 64 kbytes block transfers [1]. On the laptop the KPC-PCMCIA performs in much the same way.

- Analogue output is provided via the DDA-06 analogue output board. This board provides 6 channels of 12 bit analogue output and 24 lines of digital I/O. Each analogue input has an independent D/A converter and each is individually switch selectable to any of the following ranges :

0 to +10 V, 0 to +5 V, -2.5 V to +2.5 V, -5 V to + 5V, -10 V to + 10 V, 4 to 20mA current loop.

24 bits of digital I/O are provided on the rear connector consisting of 3 ports of 8 bits. Each port can be programmed independently as an input or output and is TTL/CMOS compatible.

- The DAS-1802 HC is a high performance DAQ board offering 64 single-ended or 32 differential inputs at up to 333 ksamples/s. The analogue inputs are multiplexed into a high-speed 12 bit analogue-to-digital converter and all inputs are software configurable for single-ended or differential inputs and bipolar or unipolar input ranges. The model used on our system has software programmable gains of 1, 2, 4 and 8 allowing input ranges from ±1.25V to ±10 V.

The board offers flexible clocking, triggering and gating modes. It will accept an external pacer clock input or use the onboard timebase to provide a conversion rate from 4.32 samples/hour to 333 ksamples/s. The burst mode capability enables one to acquire data from a series of channels at high-speed with a programmed interval between scans thus emulating a simultaneous sample-and-hold function. External trigger and gate inputs allow precise control over when data is acquired. Several triggering modes, including the following: post-trigger, pre-trigger and about-trigger, allow the user to acquire data in relationship to a specific event.

Also available are 8 digital outputs, 4 digital inputs, and 2 12 bit analogue outputs with output voltage ranges of ±10 V, as well as a strobe signal for latching the digital output signals into external circuitry.

- In addition there was also the use of the DAS 16F board which provides 16 single-ended or 8 differential analogue inputs with a maximum sampling rate of 100 kHz. 2 D/A channels with 12 bit resolution are also available along with 4 channels of digital output and 4 channels of digital input. The A/D inputs have switch selectable ranges enabling a maximum resolution on low amplitude signals. Similar performances are obtained on the laptop which uses the DASCard 1003 which has a maximum throughput of 140 kHz with 12 bit resolution.

2. THE SOFTWARE

The data acquisition software consists of two packages ; VIEWDAC and TestPoint [2] which allow data acquisition, instrument control and data analysis in the MS-DOS and Windows environment respectively.

2. EARLIER DATA DISPLAY SOFTWARE FOR THE CT AND OTHER INSTRUMENTS

2.1. VIEW DAC

VIEWDAC provides an extensive set of data analysis tools, graphics, control and application interface development capabilities as well as the ability to acquire data from DAQ boards [4] and GPIB-based devices. It runs in MS-DOS protected mode on 80386 and higher PCs using a windowing interface to provide the ability to tightly control timing and perform pre-emptive multi-tasking functions. Multitasking allows different parts of an application to run in parallel without complicated managers or disk-swapping methods.

Applications are created via point-and-click selections from menus and dialogue boxes. A function is selected using a mouse, and then the blanks on a dialogue box representing the application' s properties are filled in. In this manner an application program is ready for testing in a very short period of time (Fig. 1).

2.2. Data acquisition board with Graphic user interface on the Pentium PCs

Today, many scientific and medical instruments, much like the C.T. Scanner, employ the readily available second vendor products that have been perfected in the matter of such data acquisition and display on the computer, leading to user friendly instrument interface, hard copy handling and data storage of multiple patients and instant retrieval with the read-write CD and so on , which are commonplace advantages of the ubiquitous PC.

Boards of data acquisition as in [3] above are commonly available from several sources and it is but easy to choose the one meeting the requirements of data acquisition from the C.T. scanner, the counts acquired by the scientists.

GUIs are available from major vendors like Hewlett Packard for the display and processing associated with such data acquisition.

Changing to a data acquisition system provided by one Company, the Microstar Laboratories, for e.g., preserves any existing investment of money, time, and effort spent on developing skills in using industry-standard Graphical User Interfaces. DAP board drivers exist for all popular GUIs, including LabVIEW, VEE, DASY*Lab*, and Onboard intelligence -- implemented as DAPL on every DAP

board extends the power and reach of these standard GUIs in two ways. First, DAPL can execute all processing intensive routines in real time, responding to conditions as they arise, and performing

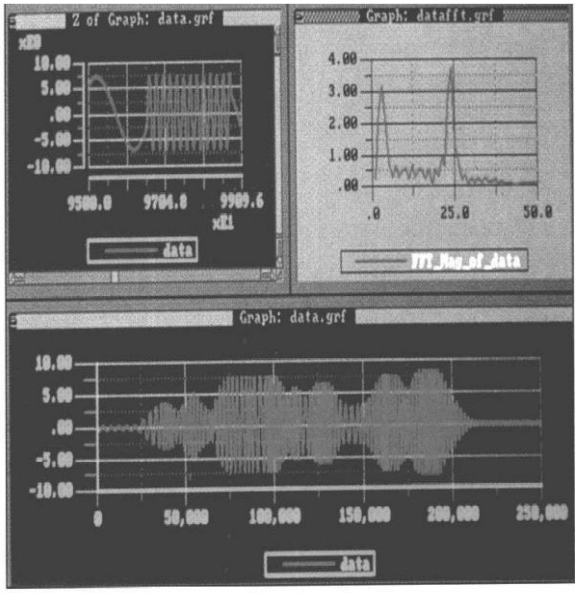


Figure 1. A typical VIEWDAC display showing a FFT of a zoom of an acquired trace.

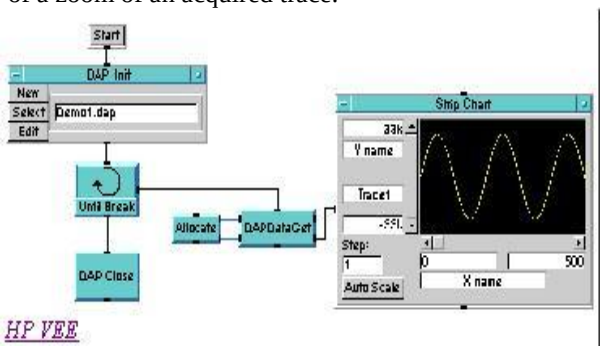
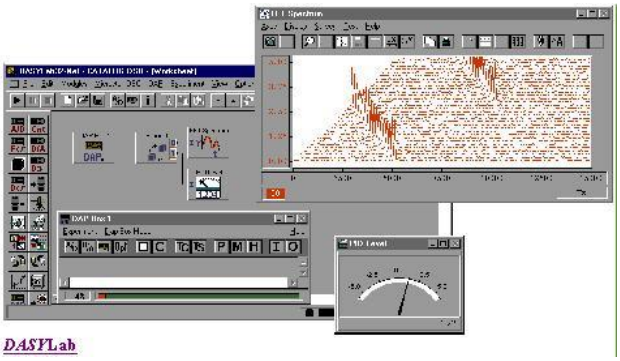


Fig.2 Shows the Onboard intelligence -- implemented as DAPL on DAP board.



control DAP boards installed on DAPcell sever PCs anywhere on the network. Selecting a DAP becomes as easy as selecting a printer.

DAPL interacts with the driver and with DAPcell to take care of all the details of networking with standard PC GUIs. DAPL interacts with DAPtools OCX to take care of all the details of working with a user interface constructed with Visual Basic (32-bit) or with Borland Delphi. DAPL interacts with Accel32 to take care of all the details of working with any Windows software that can call DLL functions.

Fig.3. Shows the PC screen with DAPL Interface.

2.3. DSP Commands

The DAPL Command Summary groups commands into 11 categories. Two of these related to DSP applications: DSP Filtering and DSP Spectral Analysis.

data reduction so that the software on the PC can handle more demanding applications than usual. Second, DAPL provides a consistent interface to DAPcell software, and that enables network access. Standard PC GUI software can run unchanged on a DAPcell client PC and

The three DSP filtering [5] commands built into DAPL consist of a general finite impulse response digital filter routine, and two special cases optimized for speed where the application does not require the full range of the general purpose routine.

The five DSP spectral analysis commands built into DAPL consist of two fast Fourier transform routines, FFT and FFT 32, correlation and cross power routines, and a transfer function routine. Of the two fast Fourier

Microstar Laboratories provides at no charge a program -- FGEN for Windows -- that allows you to design a digital filter. The parameter vector that results from this visual design process exactly fits the DSP filtering commands in DAPL.

Of course library routines available elsewhere can emulate on a PC the eight DSP commands built into DAPL. The processor on the PC has to perform other tasks, however, and usually has to contend with the less-than-real-time characteristics of Windows, so it may have a hard time keeping up with an onboard AMD K6-2, for example [6, 7].

Microstar Laboratories produces a line of Data Acquisition Processor boards, each with an onboard processor, making every Data Acquisition Processor an intelligent solution for data acquisition and control applications.

Fig.5 Shows the photograph of the ADAP board (All Data Acquisition Processor Board)

All the data Acquisition boards the following features. Have onboard processors.

- Run DAPL, a multitasking, real-time operating system.
- Have onboard memory.
- Support external expansion boards to increase the number of data channels.

- The scanner both tilts and translates. The unique translation feature, combined with the scanner's small size, mobility, affordable price, and excellent image quality, establishes a new standard for clinical

All current Data Acquisition Processor boards [8] except the DAP 5400a and the DAP 4400a have onboard analog and digital inputs and outputs. The DAP 5400a and the DAP 4400a have high-speed analog inputs.

Onboard processors distribute intelligence to the Data Acquisition Processor. This frees data acquisition from the control of operating systems, such as Windows, which may not be available to the acquisition application when critically needed. By placing a processor onboard, data acquisition and control is implemented by its own operating system , DAPL, which is optimized for data acquisition.

Some Low-Cost PC Data Acquisition Boards are ideal for general-purpose data acquisition, test, measurement and control applications. They include all the basics: analog inputs and outputs, digital inputs and outputs, and a counter/timer. They also include premium DMA features not normally found in low-cost boards, such as:

- Triggered DMA capability for transient capture at up to 100kHz.
- Analog output DMA capability for waveform generation at up to 100,000 samples per second.

Concurrent analog input and analog output DMA for stimulus/response applications. Combined with the AI-MAX Analog Input Channel Expansion System, the PCI-20428W provides up to 256 analog input channels.

3. Medical Imaging Applications

The lightweight CT embodies many engineering advances, including a number of patented designs, that are applicable to future proprietary systems and subsystems we will design for our OEM customers [9].

- The lightweight aircraft construction techniques and materials employed in the CT enables us to provide a system that is lightweight and rugged. This reduces manufacturing and shipping costs as well as the considerable environmental modifications required to accommodate typical CT scanners.
- The light weight also enables us to mount the system on wheels, so it can easily be moved from room to room or facility to facility: a truly mobile scanning system.
  flexibility, opening new applications for CT in trauma centers, intensive care units, and
- The CT' s innovative geometry requires only about one demanded by conventional systems to

produce comparable images. This reduces x-ray costs as well as patients' exposure x-ray radiation.

- Unique, universal low power requirements make this first scanning system that can be plugged into virtually any electrical outlet anywhere and begin scanning almost immediately. The system is also able to complete a scanning sequence even if external power is interrupted.
- Advanced volumetric scanning capabilities enable you to conduct volume studies of up to35 rotations and perform demanding multiple protocols within one volume acquisition. Acquisition times can be reduced by as much as 60%. The system includes over 100 complex anatomical protocols developed by analogue for data retrieval and customization.

All the capabilities of the rugged universally powered, highly cost efficient system described above are also available in a fixed lightweight scanner [10]. All these units are useful for various other applications in medical field including patient monitoring systems.

4. CONCLUSION

We have shown that a PC base data acquisition system can be used for C.T. scanners with the advantages rendered by the Multimedia PC today in providing medical records with the following facilities.

1. Unlimited data storage for scanned patients on RW CDs.
2. The generation of movies on CDs with the scanned slice images
3. The hard copy facilities using the colour jet and laser printers easily available on the PC today.

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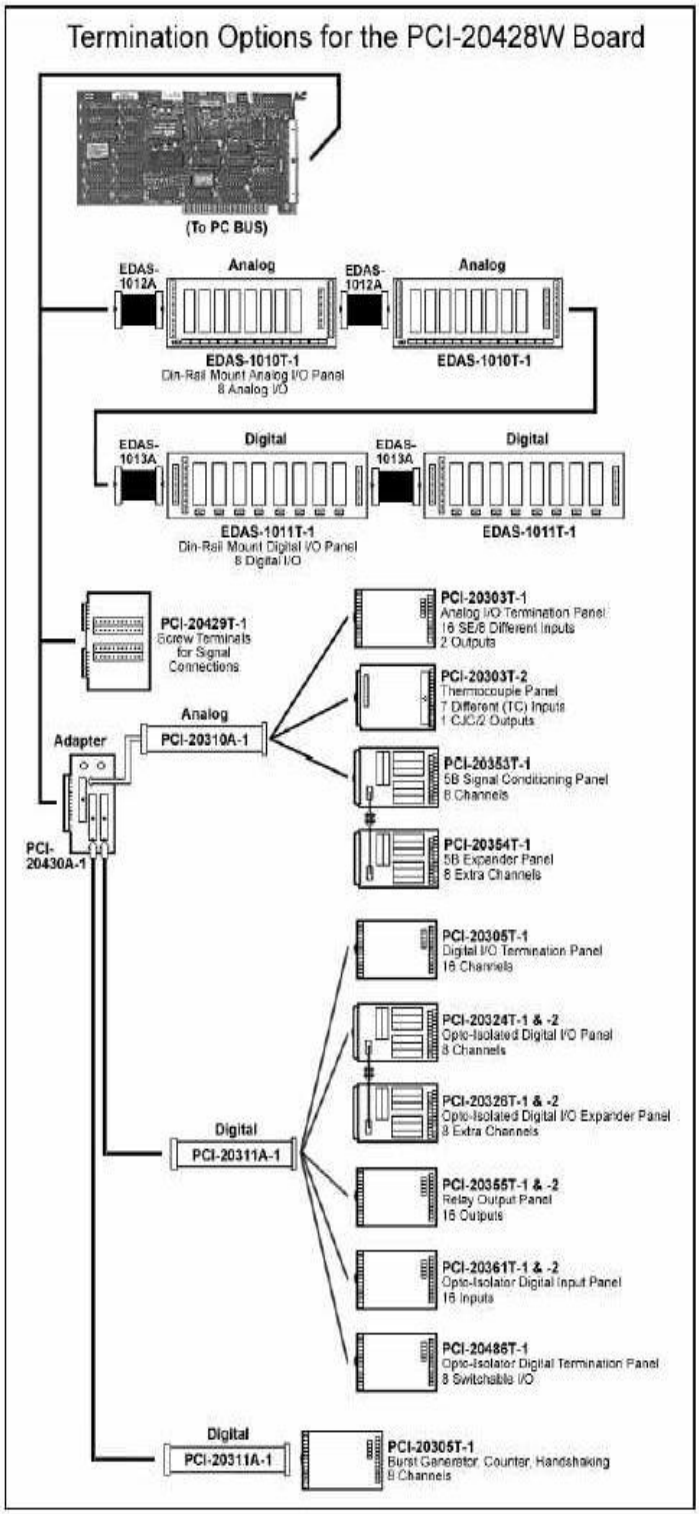
Fig.6. Shows PCI 20428W hardware specifications and their typical Applications



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