Data Acquisition Using a Scintillation Detector Interfaced to a Personal Microcomputer

Lawrence Davis, John P. Wexler, Ari Rabinowitz, Thierry LeJemtel, Mi-Kyung Lee, L. Rao Chervu, and M. Donald Blaufox

Departments of Nuclear Medicine and Medicine, Albert Einstein College of Medicine; and Montefiore Medical Center, Bronx, New York

A method is described for interfacing a cadmium telluride semiconductor nonimaging detector to a personal microcomputer in order to store and display nuclear medicine data. There was virtual identity between the count rates stored in the computer and those recorded from the detector's display, demonstrating that the computer accurately acquired data from the probe without erroneous loss or addition of data. Interfacing a nonimaging detector to a microcomputer may provide an extremely versatile method of acquiring, storing, and displaying nuclear medicine data.

J Nucl Med 26: 85–87, 1985

Nonimaging scintillation detectors can be used to measure various physiologic parameters such as blood flow (*1,2*) and left-ventricular function (*3,4*) after injection of the appropriate radiopharmaceutical. The output pulses of these detectors are commonly stored either as digital data in minicomputers dedicated to acquiring nuclear medicine data, or as analog data using strip-chart recorders or magnetic tape.

Dedicated minicomputers are expensive. Analyzing data acquired on analog devices is time-consuming, cumbersome, and subject to errors during transposition. Recently there have become available microcomputers that are significantly less expensive than dedicated minicomputers and that can acquire, store, and analyze large amounts of data rapidly. Many of these microcomputers also have sophisticated software for manipulating and displaying data in graphic form. Because of the low cost, availability, and capabilities of personal microcomputers, interfacing a nonimaging detector to a microcomputer could create a highly versatile and useful system. We describe a method of interfacing a cadmium telluride (Cd/Te) semiconductor nonimaging probe to a personal computer in order to acquire, store, analyze, and display count data.

COMPUTER EQUIPMENT

A personal microcomputer* was equipped with 512-kbyte random-access memory, dual 320-kbyte disk drives, graphics interface card, and monitor. A commercially available programmable peripheral interface board† was added; it permits digital data from peripheral sources to be transferred directly to the computer.

DETECTOR ELECTRONICS

The detector‡ used is a Cd/Te semiconductor, 1.5 cm in diam and 1.0 cm thick. It is connected through a preamplifier to a counter scaler (Fig. 1). The first stage of the counter scaler is a high-gain amplifier whose output is fed to a single-channel pulse-height analyzer (PHA). The output of the PHA is connected to a counting system consisting of six cascaded binary coded decimal (BCD) counters.

Each BCD counter expresses a single decimal digit as a 4-bit binary number. Each stage of the cascaded system counts up to nine, resets to zero and sends a pulse to the next higher stage of the counting system. A decimal number such as 75 requires two BCD counters and is represented as 0111 (7) 0101 (5). The output of each BCD counter is fed to a series of BCDs to seven segment decoders and then to a 6-digit liquid-crystal display.

COMPUTER INTERFACE

The output of each BCD counter is wired directly to the peripheral interface board on the computer bus. A control signal from the counter scaler is used to tell the computer that counts are being acquired. The probe continues to count for a preset time determined by the counter scaler's timer. At the

Received May 22, 1984; revision accepted Aug. 31, 1984.

For reprints contact: J. P. Wexler, MD, PhD, Hospital of the Albert Einstein College of Medicine, Dept. of Nuclear Medicine, 1825 Eastchester Rd., Bronx, NY 10461.

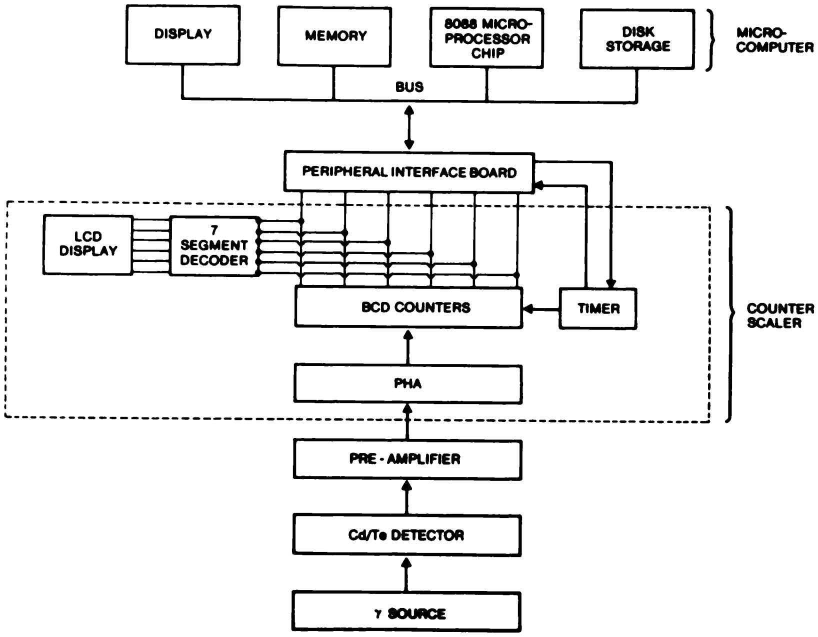

FIGURE 1
Block diagram of system hardware. Outputs of binary coded decimal (BCD) counters input data to both peripheral interface board and to liquid-crystal display (LCD) of counter scaler. Data input to peripheral interface board are then transferred to computer bus

end of that time, the output of the probe is transferred directly to the peripheral interface board. These data are then accessed by the computer using an input/output program written in BASIC (program available on request) (Fig. 2). The BASIC program reads data from the computer bus and converts BCD data to a 16-bit binary number that is then stored in computer memory.

Once data are stored within memory, the computer signals the probe's counting electronics to reset the BCD counters to zero and to resume counting. The time interval between the termination of counting and the start of the next counting interval was determined using an external timer inserted in parallel between the counter scaler's output and computer input; it was 11.6 ± 0.7 (s.d.) msec. While the detector is counting, data acquired during the previous time interval are displayed on the monitor as a time-activity curve.

SYSTEM CALIBRATION

The counting characteristics of the detector were determined by counting, in triplicate, samples of Tc-99m varying in activity between 0.065 and 9.2 mCi in 0.5 ml of saline. The detector showed a linear counting response up to ~17,000 cps (Fig. 3). Detector deadtime was determined by an incremental count method (*5*). The system deadtime was 3.95 ± 0.02 (s.d.) μsec.

The accuracy of the date storage and retrieval programs was determined by comparing for each data acquisition the liquid-crystal display of count rates, obtained in triplicate, at ten different sample activities (0.66 to 9.2 mCi Tc-99m), with count rates stored in the computer memory. There was virtual identity between the rates stored in the computer memory and those recorded from the probe's liquid-crystal display. This demonstrated that the computer accurately acquired data from the probe's counter-scaler without erroneous loss or addition of data.

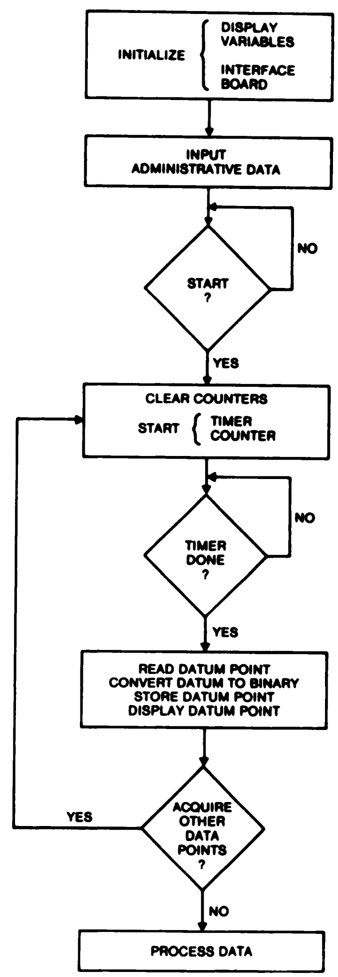

FIGURE 2
Flow chart of software logic. Initiation of data acquisition is controlled by computer operator

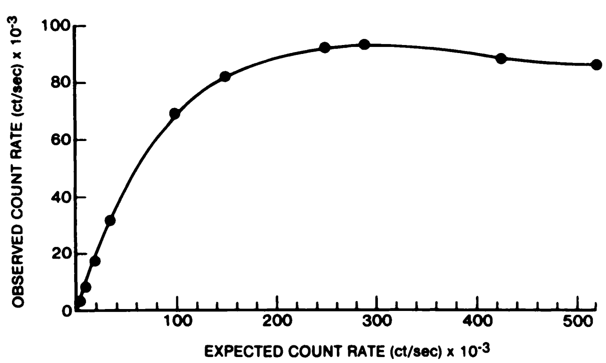

FIGURE 3
Comparison of expected compared with observed counts using Cd/Te detector and Tc-99m source. Direct, 1:1 linear relationship was demonstrated between detector's counter scaler display and computer's acquired counts

DISCUSSION

This report details the interfacing of a microcomputer to a scintillation detector for clinical use. The interface we describe is specific for a laboratory device that provides output of digital data and a timing signal. Many detectors do not provide digital data. When only analog data are available, analog-to-digital conversion must be performed before computer acquisition of the data. Analog-to-digital convertors are available for several personal microcomputers; they are capable of handling multiple data channels, and several can write data directly into memory. The analog-to-digital conversion rate, as well as the time to write into memory, must be considered when choosing a device for a specific application.

In the absence of timing signals generated by the laboratory device, the timing of the data acquisition must be controlled by the computer. Although each computer has an intrinsic clock, the minimal interrupt time of this clock may not be small enough to provide adequate temporal resolution of data capture. Under these circumstances an auxiliary clock can be added to most computers to control data acquisition.

For the interface we describe, no data are acquired during the time interval (11.6 msec) needed to reset the counter scaler and recycle the acquisition program. The acquisition program described here did not correct for this 11.6-msec interval. Under circumstances where this deadtime would cause data distortion, modification of the timing of the acquisition program can be made.

In order for a computer interface to be successful, at least two criteria must be satisfied. First, the data transfer must be accurate. No data loss or insertion of noise into the data sample may occur. Second, once data are acquired, they must be stored in a file structure that permits easy recall for analysis. The interface we describe satisfies both of these criteria and shows the ease and flexibility of acquiring and processing laboratory data on a personal computer.

FOOTNOTES

* I.B.M. Personal Computer, IBM, Inc. (Boca Raton, FL).

† Personal Computer Mate Base Board—Techmar Inc. (Cleveland, OH).

‡ CTC-4-Radiation Monitoring Devices, Inc. (Boston, MA).

REFERENCES

1. Cerretelli P, Blau M, Pendergast D, et al: Cadmium telluride ^{133}Xe clearance detector for muscle blood flow studies. *IEEE Trans Nucl Sci* 25:620–623, 1978
2. Gruskin AB, Auerbach VH, Black IFS: Intrarenal blood flow in children with normal kidneys and congenital heart disease: Changes attributable to angiography. *Pediatr Res* 8:561–572, 1974
3. Wexler JP, Blaufox MD: Radionuclide evaluation of left ventricular function with nonimaging probes. *Semin Nucl Med* 9:310–319, 1979
4. Hoffer PB, Berger HJ, Steidley J, et al: A miniature cadmium telluride detector module for continuous monitoring of left ventricular function. *Radiology* 138:477–481, 1981
5. Arnold JE, Johnson AS, Pinsky SM: The influence of true counting rate and the photopeak fraction of detected events on Anger camera deadtime. *J Nucl Med* 15:412–416, 1974