A Multichannel Analyzer Interface for a Rectilinear Scanner

Christopher Ediss

University of Alberta, Alberta, Canada

An interface is described that allows images observed by a rectilinear scanner to be recorded with a dual parameter multichannel analyzer. A simple counting circuit is used to generate a position signal from the stepped motion of the scanner. No mechanical modifications to the scanner are required.

The availability of a dual parameter multichannel analyzer (MCA) has prompted the development of an interface to permit the digital storage of images generated by a rectilinear scanner. The number of observed events corresponding to discrete combinations of two parameters (X and Y) may be recorded as a three-dimensional array of data using such an MCA. By obtaining two signals corresponding to the position of the scanner detector, and a third signal corresponding to the detected count rate, sufficient information is available to define the activity profile of the subject being scanned.

Systems have been described in which optical shaft encoders (*1-3*) and measurements of elapsed time (*4,5*) have been used to generate position signals. O'Neill and Sorenson have pointed out that since such a wide variety of scanners are available, no universal scanner interface exists (*6*). Nevertheless since most of these instruments operate in essentially the same way, only minor modifications would be needed to allow the interface described to function with other scanners.

Interface Design

A rectilinear scanner traverses a scintillation detector across the subject in one direction (X), and records the observed activity as it travels. At the end of its path the detector is stepped forward by a small perpendicular motion (Y), and then traversed back across the subject. Thus the detector follows a serpentine path to eventually cover the entire area of interest.

For most rectilinear scanners an analog signal may be readily obtained from a potentiometer whose setting is directly related to the X position of the detector. The incremental nature of the perpendicular Y motion, however, presents some interfacing difficulties. If an analog signal is used to define this motion care must be taken to ensure that one step forward corresponds to exactly one channel of the MCA. If this one-to-one correspondence is not observed an uncertain number of traverses may be recorded for a single MCA location. This difficulty may be avoided by counting the number of forward steps digitally to provide an analog-to-digital converter (ADC) Y address. Most dual parameter MCAs can accept such external address signals through a memory configuration connector, which is normally used to assign ADCs to the data memory available.

□

The circuitry necessary to interface a Picker Magnascanner 500D (Picker Corp., Cleveland, OH) to a Northern Scientific NS636 (Tracor Northern, Middleton, WI) MCA is shown in Fig. 1. This interface was contructed on a single printed circuit board using conventional techniques and was installed within the scanner mainframe. Details regarding the connections between the interface and the MCA are given in Table 1. The X ADC is operated in the directly coupled coincidence mode. Only a gate signal is applied to the Y ADC, because the Y position information is conveyed through the memory configuration connector. The NS636 MCA has sufficient memory to allow a matrix of 64 by 64 channels to encompass the maximum area scanned. To retain equal X and Y scale factors the analog X gain is switched to correspond to the different Y step sizes provided by the scanner.

□

The standard scanner control circuitry generates an analog X position signal from a potentiometer coupled to the X drive. By using this existing X position signal, difficult mechanical modifications to the scanner were avoided. The integrating capacitors included in the operational amplifier feedback elements eliminate noise from this analog signal.

For reprints contact: C. Ediss, Faculty of Pharmacy and Pharmaceutical Sciences, University of Alberta, Edmonton, Alberta, T6G 2N8, Canada.

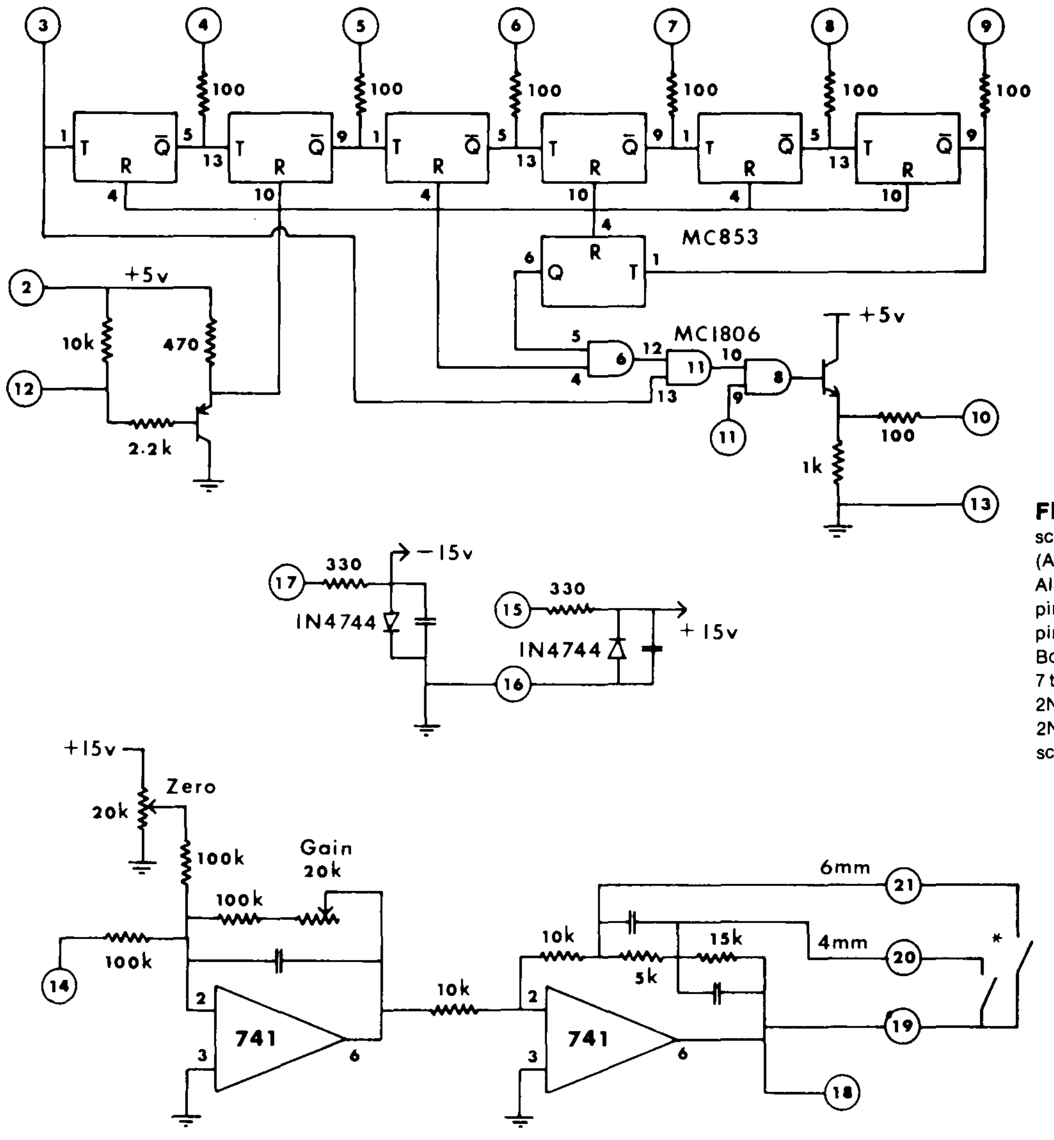

FIG. 1. Schematic of scanner-MCA interface. (All capacitors = 0.1 μf. All logic pins 7 to ground, pins 14 to +5v. All MC853 pins 2, 3, 11 and 12 to +5v. Both 741 pins 4 to -15v, pins 7 to +15v. PNP transistor 2N3906, NPN transistor 2N3904. *Spare contacts on scanner indexing switch).

Table 1. Edge Connector Pin Assignments for Scanner Interface.

Pin	Assignment
2	+5v scanner power rail
3	Line advance signal from pin F of motor logic board
4 5 6 7 8 9	Outputs to MCA memory address lines (2^6-2^{11} on the NS641 module)
10	Counting rate output to the Y ADC input and the X ADC coincidence input
11	Counting rate input from pin 18 of the PHA board
12	Motor start signal from pin H of the motor logic board
13	Ground
14	Analog X position signal input from pin 17 of limit switches and logic board
15	+20v scanner power supply rail
16	Ground
17	-20v scanner power supply rail
18	Analog X position signal output to X ADC input
19 20 21	From spare contacts on line spacing switch

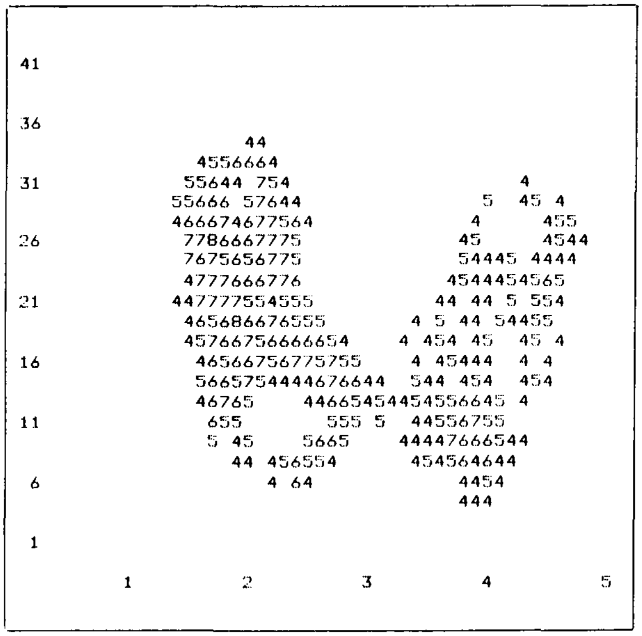

FIG. 2. Image of thyroid phantom obtained using scanner-MCA system.

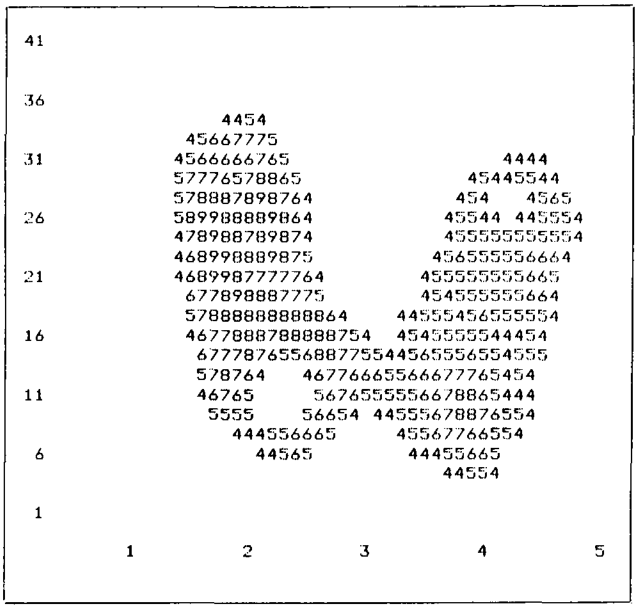

FIG. 3. Smoothed image of thyroid phantom.

Results and Discussion

To test the operation of the complete scanning system images were obtained of a thyroid phantom containing several microcuries of Tc-99m. A PDP11-05 minicomputer (Digital Equipment Corp., Maynard, MA) incorporated within the NS636 MCA system was used to generate Fig. 2. The observed counting rates were normalized so that a single decimal digit represents the activity at a particular location. The software accomodates the different X and Y character spacing of the particular printer used.

The usefulness of an on-line minicomputer is illustrated in Fig. 3. The raw data from Fig. 2 are smoothed using a weighted averaging algorithm to give a clearly improved image. When required, experimental data accumulated by the MCA are stored permanently using a cassette magnetic tape system.

The combined scanner-MCA system has been successfully used for a variety of projects over the last few years at the University of Alberta. The arrangement provides quantitative results whereas only qualitative pictures are provided by the scanner alone.

Although the interface was designed specifically to generate signals suitable for an MCA, only minor modifications should be required for these signals to be compatible with a nuclear medicine computer equipped with an ADC.

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