

THE USE OF A MICROCOMPUTER IN DATA PROCESSING FOR LIQUID
SCINTILLATION COUNTING

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ABSTRACT

A microcomputer has been developed to collect and transmit data from five liquid scintillation counters to the main University computer. The system can accommodate fifteen users. The microcomputer is controlled from a Decwriter, and floppy discs are used to enter the programmes and for temporary data storage. This ensures that no information is lost when the main computer is not in service. The components of the microcomputer are connected by an Andromeda bus system. The Central Processing Unit is an 8-bit Z80 chip. The microcomputer has 64 K of random-access memory and 2 K of read-only memory. Six serial input/output ports connect the microcomputer to the counters and the Decwriter. The Control Programme for Microcomputers (CP/M) is the main operating system. The instructional programme, which contains a priority-interrupt system, is written in Z80 assembly language. The system will permit efficient data processing and automatic transfer of this information into separate user files within the main computer, which allows ready access for further calculations.

INTRODUCTION

The Department of Pharmacology at the University of Alberta consists of ten staff members and changing numbers of scholars, postdoctoral fellows and graduate students. Research interests range from liposome drug-delivery systems to the pharmacology of the central nervous system. In many research projects radioactive chemicals are used, the main labels being ^3H and ^{14}C but in some cases ^{22}Na , ^{45}Ca , ^{42}K , ^{51}Cr and ^{32}P are the tracers of choice. Departmental equipment for the determination of radioactivity consists of five liquid scintillation counters (LSCs), the Beckman LS 100, LS 230, LS 330, LS 6800 and LS 7500 systems. Single-label, double-label and even triple-label liquid scintillation spectrometry can thus be carried

out. These LSCs are all located in one room. The data from all LSCs are printed out on paper. In addition, the data from the LS 230, the LS 330 and the LS 7500 are also punched on paper tape, using teletypes. For most experiments the results are converted from counts per minute (cpm) to disintegrations per minute (dpm) and further calculations can then be done. To decrease the time required for data manipulation, use is made of the University's main computer, an Amdahl model 5860, which is located in another building. Communication with this main computer is carried out using a variety of terminals, e.g. LA36 Decwriters, Lectromedia and Couriers. A teletype with a paper tape reader is also used as one of these terminals to allow transfer of data obtained from the LSCs to the Amdahl. The Michigan Terminal System (MTS) permits the sharing of this large computer by several hundred terminals. Generally, the data from the counters are transferred to the Amdahl using the adapted teletype. The LS 230, the LS 330 and the LS 7500 are therefore in much greater demand than the LS 6800, because this instrument does not produce data on punched paper tape. Teletypes are not really very efficient for data collection and paper tape is not the best way to store data. In addition, transferring data from the tape to the main computer is a time-consuming and noisy process, and not completely reliable with the old teletypes. It was therefore decided to develop a microcomputer to transfer the data from the LSCs directly to the Amdahl.

REQUIREMENTS FOR THE MICROCOMPUTER

The requirements which had to be met were the following:

1. The microcomputer would have to collect and transmit data from at least four LSCs.
2. Some mechanism for temporary storage of the data was required. The main computer is not in service between 4 AM and 8 AM on Mondays to Saturdays and on Sundays is only operational from noon to 8 PM; at nights and on weekends the use of the LSCs is particularly heavy.
3. The data transmitted from the LSCs should be reformatted to be compatible with the programmes already stored in the host computer.

4. A protocol should be established so that data associated with any user on any of the four LSCs could be transmitted to the appropriate files.

HARDWARE

The microcomputer is controlled from a LA 36 Decwriter and uses a floppy disc system for entry of the programmes and for temporary storage of the data. Data can be collected from five LSCs and fifteen different users have access to the system.

The components of the microcomputer are connected by an Andromeda STD-BUS Development system. The various cards are plugged into the motherboard of this bus system. The microcomputer uses the 8-bit Z80 silicon chip (Mostek M/OS-80 operating system) as the central processing unit (CPU). The microcomputer contains 64 K of random-access memory (RAM) which can be used by the CPU and can also store data from the LSC's into the user files. Only 2 K of read-only memory (ROM) was required. Two floppy disc drives are used, one loads the Control Program for Microcomputers (CP/M) onto the RAM memory via a bootstrap programme and the other is used for data storage. The microcomputer has six serial input/output (I/O) ports. Five of these are connected to the LSCs. The other I/O port interfaces between the Decwriter and the MTS. The Z80 CPU card, two 32 K memory cards, 3 dual serial I/O port cards and one floppy disc controller card are plugged into the mother board of the bus system.

SOFTWARE

The main operating system used is the CP/M, which is compatible with the Z80 chip. The programme instructs the CPU on how the various tasks should be performed; CP/M was chosen because of its flexibility in controlling the various operations required from the microcomputer. A special instructional programme was written in Z80 assembly language which allows interaction between the CPU, the LSCs and the large Amdahl computer. This programme also contains a priority-interrupt system which ensures that data from the LSCs are stored immediately in the microcomputer's memory. The CP/M and the instructional programme are stored on one of the floppy discs. The stored data are sorted

into files according to the LSC used and the user number, and are stored on the other floppy disc. When possible, the files are transferred into the Amdahl and the data are then erased from the disc.

INSTALLATION

It required about six months for the microcomputer to be built and the software to be developed. Installation was accompanied by a number of minor problems. The microcomputer was first tested at the Technical Services Laboratory before being taken to our building. After installation, although the system appeared superficially to be operating correctly, data could not be transferred to the floppy disc. This problem was found to be due to an increase in the ambient temperature of the counting room. This was caused by the use of incandescent lights which were installed to prevent phosphorescence in LS samples, and were switched on when the microcomputer was being tested. The switch for the incandescent lights now has a guard and these lights are only used when absolutely necessary. Also, ventilation of the Andromeda cabinet was improved and a larger fan was installed. Another problem became apparent which had not been anticipated. While the microcomputer was being developed, a new Beckman LS 6800 was installed and this counter came equipped with a parallel printer. This printer receives the data in code but gives a printout in normal format. Therefore, two conditions had to be rectified. First, since the signals generated by the LS 6800 were not compatible with the serial interfaces of the Andromeda, a special interface had to be provided. Second, since coded data were transmitted to the Amdahl, these had to be reformatted.

During installation, it was also noted that, without startup instructions, data from the LSCs still would be stored and transmitted to the main computer. It was therefore necessary to make a default file in which those data are stored. This file is checked frequently and any unwanted data are discarded.

USE OF MICROCOMPUTER

The system is easy to use. The instructional programme and the

memory are stored in volatile RAM, and would be lost if the microcomputer was switched off accidentally before the discs were removed. The microcomputer is therefore left on all the time with the discs in place. If the microcomputer has to be reset, it will first load the CP/M and then the instructional programme; this takes approximately 13 secs. A ready-light on the Gandalf LDS 105 modem indicates that the system is ready to accept information. The operating system will first have determined whether any files have not yet been transferred to the Amdahl. If this is the case, appropriate instructions are automatically given. Starting instructions include listing of the LSCs by code number and enquiries re: signon, password, experiment number, counter user number (for the LS 6800 and LS 7500) or last sample number (for the LS 230 and LS 330).

CONCLUSION

Storage of data from our LSC's has become more efficient by replacing the old teletypes with a microcomputer. In addition, the data can be directly transmitted to a large central computer storage in up to fifteen user files. The files are reformatted to be compatible with existing computer programmes for data manipulation.

ACKNOWLEDGEMENTS

The Department of Pharmacology would like to express its thanks to Mr. M. Magera of Technical Services for the development of the microcomputer.

The author appreciates the assistance of Miss H.B. Sit and Mr. D.A. Ogden of the Department of Pharmacology and Mr. C. Ediss of the Faculty of Pharmacy and Pharmaceutical Sciences at the University of Alberta in the preparation of this manuscript.

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