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A COMPUTER CONTROLLED MICRODENSITOMETER

A.V. Ananth

Abstract

The paper describes an interface as well as application program developed for logging of digitized data from a Carl Zeiss Microdensitometer on the TDC-316 Computer. This has been developed to meet certain requirements of digitization of photographic plates containing stellar spectra.

Key words: Microdensitometer, TDC-316 computer interface

Introduction

For computer analysis of photographic plates and images a fast and accurate digitizer is necessary. A system using table top programmable calculator was developed earlier on the Micro - 2200 (Viswanath, 1980). The present system is developed as a peripheral instrument for the TDC-316, the in-house computer available in the Institute at Bangalore.

Scope of the Program

The purpose of the program is to scan spectrum plates and to digitize the information corresponding to the transmittance of the information on the plate. This information is stored on the magnetic tape for further analysis either on the same computer or elsewhere.

The entire process has been split into three distinct programs or phases.

1. The first phase consists of a program for digitization and dumping of information on to the magnetic tapes.
2. The second phase consists of a conversion program for translating the data obtained from phase (i) into the disk operating system standards of TDC-316 computer.
3. The last phase consists of the actual analysis program. This could be an user program.

The present paper gives a description of the programs (1) and (2) mentioned above along with flow charts (Appendix).

Program - I

The purpose of the first program is to scan the photographic plates in one dimension and to acquire the data corresponding to the digitized values of the transmittance of the plate. This program has been written in the BASIC Assembly language under the key board tape monitoring system, a primitive operating system for the TDC-316 computer. This has been done because, it provides the following advantages over the normally used disk operating system:

1 Accessibility to various device registers
2 Locating program segments at the desired physical locations

These features are essential for low level input/output handling as there are no set procedures provided by the disk operating system for handling real time devices

A The hardware requirement for the program is as under:
   a) TDC 316 Cpu
   b) 28 KW Memory
   c) One magnetic tape unit
   d) One teletypewriter
   e) The real time subsystem consisting of:
      Real time clock
      Analog input subsystem
      Digital input/output subsystem with functional modules comprising of contact interrupt and Monoshot driver[10]

B The Basic Instrument consisting of:
   a) Spectrodensitometer
   b) One strip chart recorder and a power supply for the lamp source

The arrangement of various sub systems, illustrated in the form of a block diagram is as shown in Fig 1

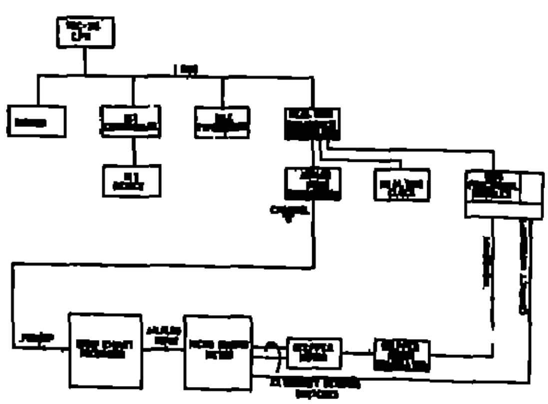


Fig 1 Block diagram illustrating the arrangement of various sub systems

The instrument in its present stage of developement can handle only one dimensiona scanning of the photographic plates The photographic plates are positioned between a source sensor assembly The movement of the table, is achieved by means of a stepper motor which is moved at a controlled speed by the computer The analog output proportional to the transmittance of the plate, is derived from the pen output of a stripchart recorder connected to the densitometer and is fed to the Analog input subsystem of the computer

The command for digitization is initiated once in every step of the stepper motor, or once in several steps, depending upon the required resolution The best resolution attainable in the present set up is about 4 microns This has been found to be within ± 1% error during trials conducted

The length of the plate that can be scanned at one stretch varies from the minimum of 1mm to maximum of 120mm The basic Zeiss microdensitometer has movement range of 200mm but the modified instrument can use only a restricted range of 120mm to accommodate the positioning of gears and stepper motor assembly

In the computer controlled mode the table is prevented from colliding with the gears by means of extremity-sensing switches which interrupt the machine when the table touches the switch

In the manual mode the users have to take precautions while positioning the plates, so that the table does not hit the gears while scanning the plates

The 0 to 10v signal available at the output of the strip chart is fed to the channel '0' of the analog to digital converter The analog to digital convertor is a 12 bit binary

2's complement output successive approximation type, with a conversion time of 40 microseconds.

The speed of scanning can be varied from 1 step/sec to 100 steps/sec (which in terms of linear movement correspond to 4 Microns/sec and 400 Microns/sec respectively). The movement of the stepper motor and the digitization are synchronised to interrupts from an internal Real time clock, provided in the system. The rate of interruption is decided by the scanning speed.

The timings are as illustrated in Fig.2.

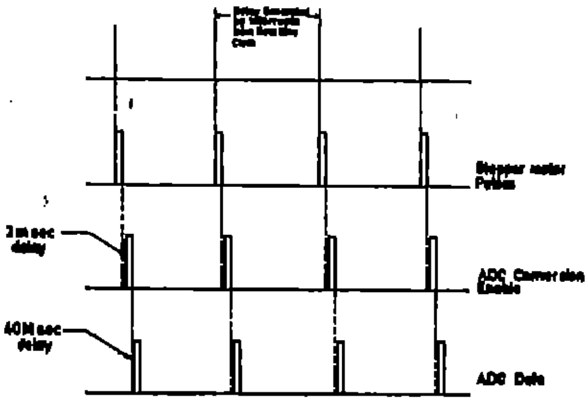


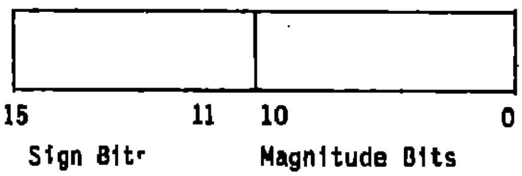
Fig. 2. Timing diagram

For every interrupt of the Real time clock, the stepper motor is moved by one step and after a fixed amount of delay (which is about 2 m sec), the analog to digital converter is enabled, if the resolution demands. The data is available after a further delay of 40 micro seconds, which is the conversion time of the analog and digital converter. The data so obtained is accumulated upto 8000 points in the system memory. Once this buffer is full, the scanning process is temporarily halted and the accumulated points are dumped on the magnetic tape. The scanning process is then automatically resumed after the dumping is done. This process continues till the specified length of photographic plate is scanned.

In addition to making available the data on the tape, the program also provides for, putting certain header information, which is provided by the user before every scan. This information is useful for identification purposes.

Data Structure on the Tape

The data pertaining to every scan goes as a file on the magnetic tape. The first record of the file is a header record of 2880 characters, that is thirty six eighty character cards. The header information is in ASCII code as the data is generated from a tele-typewriter. The data records have record sizes varying from 12 Bytes to 2K Bytes. But generally the data records have a size of 2K Bytes. (i.e., data is dumped as 1000 point records, unless the number of points available for dumping are less than 1000). The digitized numbers are available in the binary form as under:



Program Structure

The digitization program is structured such that there is an initial dialog phase, when various parameters are set for scanning. Once these parametrs are set, the actual scanning begins.

The scanning process comes to a halt under these conditions:

1) After the specified length of the table is scanned.

2) User initiated halt after noticing some abnormality.

3) System initiated halt on encountering the end of table condition as sensed by the extremity - sensing switches.

In all the three conditions, the accumulated data points are dumped on the magnetic tape and the current file is closed. The system also prints out the total number of records and the total number of points dumped.

On encountering condition (3), the system asks the user to reverse the direction of scanning. It is also moved about 25 steps automatically, so that in the following scan if the user again starts scanning in the same direction, the system can detect the fault.

Program-II

This program has been written in MACRO Assembly language under the disk operating system. The purpose of the program is to convert the non-standard tape generated by the previous program into standard disk operating system format. That is, it is fitted into standards file structure and compatible code.

As the Header is in ASCII and the data is in binary, the program translates them into standard EBCDIC characters. The output files are organised as unlabelled tape files and the record sizes are stored as 80 character, card images. This has been done, though it is not a very efficient way of storage, because the user buffer size can be restricted to a minimum at the time of analysis. The converted tape is structured as an unlabelled tape file, so that users can handle multiple files at one time by specifying file numbers rather than providing control cards for every file as in the case of a labelled tape file or disk file under the FORTRAN compiler.

At the time of converting binary numbers the program also stores the total number of points per record in the input file as the first number on the output file. That is, the digitized data can be read in a FORTRAN program as under.

```
READ (9,1)   N, (M (I),  I = 1,N)
```

where 9 is the device number assigned to the magnetic tape and 1 has a Format of (16 15). This will enable users to build up the data arrays easily.

The program is capable of handling any number of files but for only single volume tape. It provides information on the line printer regarding the input record number and the size, at the time of conversion. Suitable commands for positioning of the tape, dumping and saving are available through the operator console.

Input and output statistics are provided at the end of the conversion.

<u>Following are the specifications of the Instrument:</u>

1) Length of the plate that can be scanned at one stretch: Max: 120 mm Min: 1 mm.
2) Highest Resolution: 4 Microns (± 1% Tol).
3) Digitization Resolution: 1 In 2048 of 10 volt.
4) Scanning speed: 4 Microns/sec to 400 Microns/sec.

DISCUSSION

The newly developed instrument has the following advantages, over the existing instrument on Micro-2200.

1) Speed of scanning: 10 to 100 times.
2) Better mechanical Resolution: 4 Microns instead of 8 Microns earlier.
3) Better digitizing Resolution: 1 In 2048 instead of 1 In 1000.

4) Less loss of time in the process of storing and dumping of information.
5) Ease of handling data for further analysis.

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Reference

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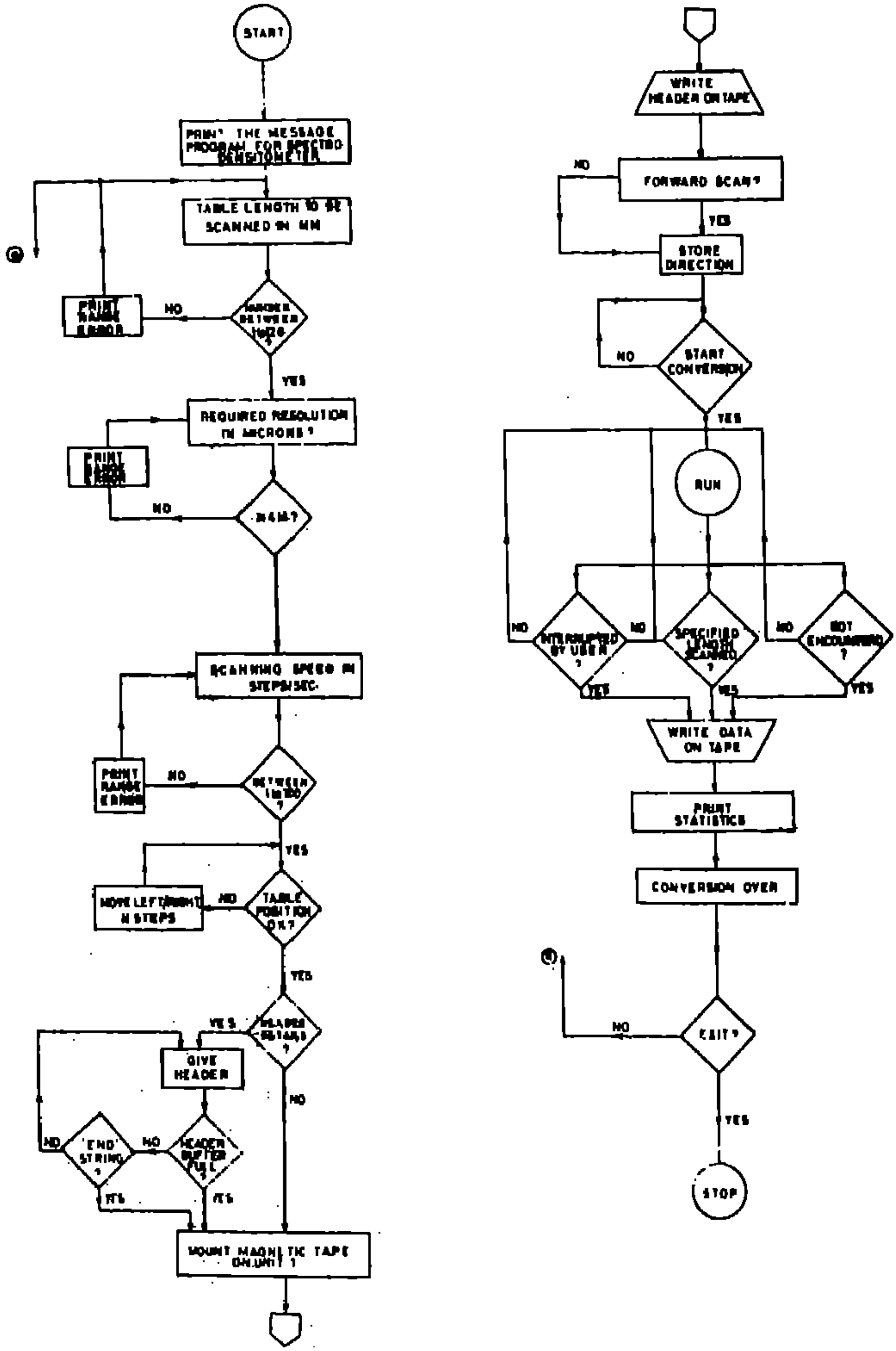
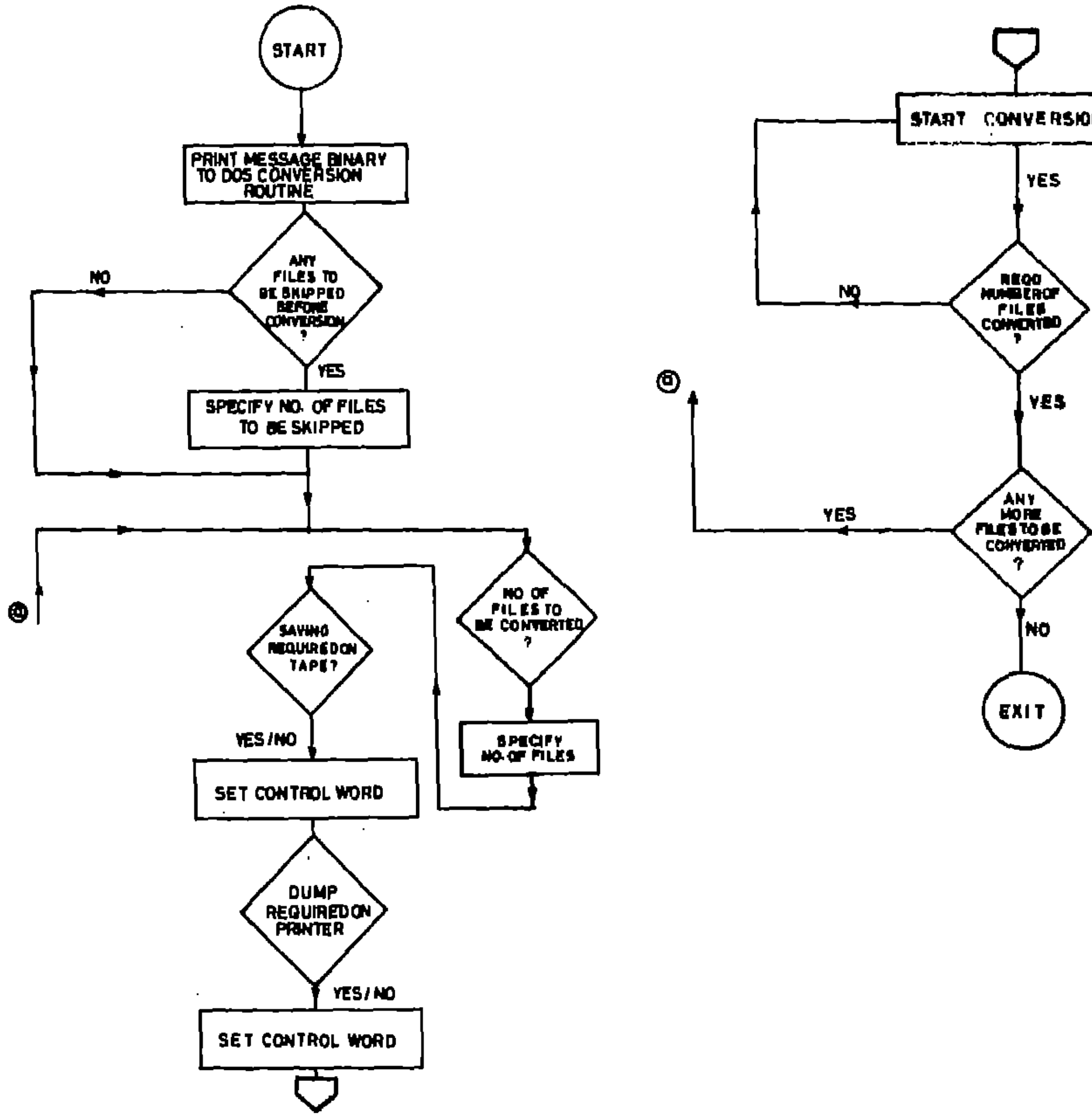
APPENDIX



Flow chart for program 1



Flow chart for program 2