AUTOMATED PICTORIAL PATTERN ANALYSIS - DATA ACQUISITION

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ABSTRACT

This paper covers the data acquisition portion of a project designed to identify and count the various types of cells in a given volume of tissue.

Video data are acquired from selectively stained histological sections by means of a T.V. camera mounted on a microscope. The outputs from the camera are modified by means of an interface and fed to a commercial video analyzer unit which in turn is controlled by a Linc-8 computer.

The analogue outputs from the analyzer are converted to binary format and stored on Linc digital tape for subsequent analysis by the IBM 360/50 computer.

TEXT

The purpose of this project, part of which is reported here, is to identify and count various types of cells and cell inclusions present in histological sections. We intend to use the method for analyzing autoradiographs of muscle and gland tissues. When this has been accomplished we intend to use the method for the 3-dimensional reconstruction of individual cells and organs.

The overall system (Fig. 1) consists of a microscope on which is mounted a vidicon camera whose outputs are fed to an interface and thence to a video analyzer. The analyzer is controlled by a Linc-8 computer which also serves as the data gatherer. The data gathered by the Linc-8 is stored on magnetic tape pending processing by the IBM 360/50.

Referring to Figure 1, the camera used is a GE model TE-20. It has been modified in order to bring out the Horizontal, Vertical and Blanking signals since these were not already available. These three signals are amplified by the interface, which is mounted on top of the camera, to the 4 volt input levels required by the Colorado Video Inc. video analyzer. To operate, the analyzer requires Horizontal, Vertical, Blanking and Video signals from the camera, Horizontal and Vertical sample position information from the computer. Origin, position, frame size and spot size are selected by means of analyzer front panel controls. The analyzer has two outputs. The first is an analogue signal representing the mean intensity over an area whose spot size has been preselected and whose position is defined by the co-ordinates of its upper left hand corner. The second is a composite video signal (with a cross hair superimposed) suitable for display on the Conrac Monitor. The monitor display allows us to view the camera

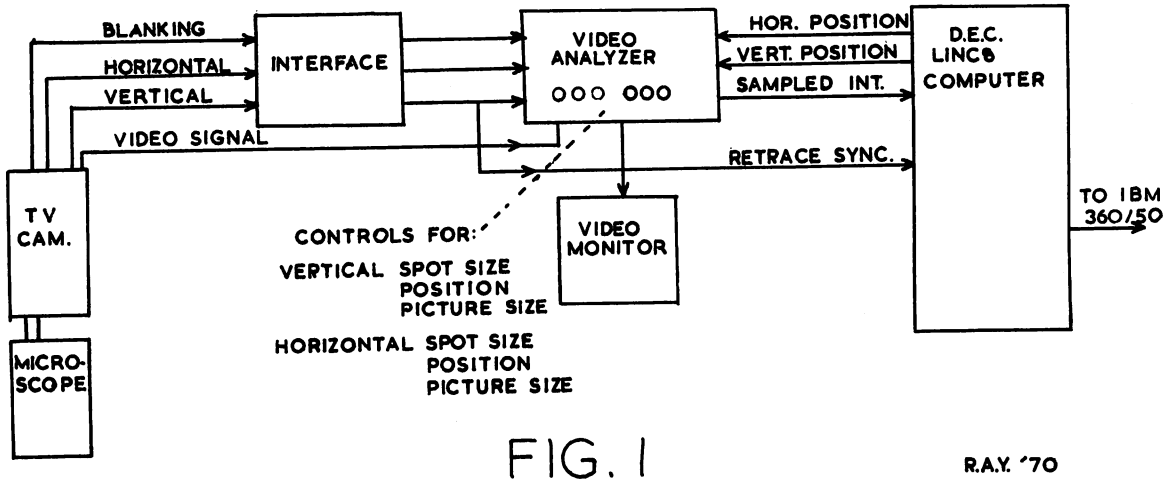

FIG. 1

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field while the computer subroutine outlines the frame being sampled by driving the cross hairs to diagonally opposite corners. This aids selection of the frame to be scanned.

The Linc-8 computer provides the Horizontal and Vertical sample position voltages required by the analyzer and accepts the video intensity information. Vertical retrace signals from the interface are sent to the Linc-8 so that all computations and changes in X,Y values can be carried out during the T.V.'s vertical retrace.

For each sampled element of the frame being scanned its X and Y co-ordinate reference values and the converted intensity value are stored sequentially in core as unsigned binary values. If desired, the average intensity of two or more consecutive scans of the same location X,Y can be selected to reduce errors caused by noise. We can scan the entire area of interest and store the data, simply by changing the values of X,Y and we can take as few or as many samples of an area of interest as we desire, all under computer control.

The data stored on Linc tapes are transferred to the computing centre by cable where they are recorded on digital tape in IBM compatible format for subsequent batch processing on the 360/50.

The Linc-8 employed has a memory of only 4K which limits the practical number of samples to about 986 with co-ordinate locations. This limitation has been overcome by transferring partial pictures or frames from core to Linc tape for subsequent transmission to the 360 and letting the 360 accumulate the full frame. With the resolution of the present TE-20 camera there is no reason to take a matrix larger than 512 x 512 since there are only 500 usable horizontal lines in a regular T.V. picture. A 512 x 512 matrix yields 26×10^4 intensity words per frame. Thirty consecutive cross sections would give a total of 78×10^5 intensity values without co-ordinate references. At present a 32 x 32 matrix is used giving 1024 intensity words and 2048 address words. Having each intensity value tagged by its X,Y co-ordinates has been useful during the development of the data transmission and analysis programs. With stabilized transmission and analysis programs it will be possible to leave out co-ordinate values; this increases the effective core capacity by a factor of 3.

The control program is written in PDP-8 machine language to conserve core space, and uses under 256 core locations. This includes the subroutines for outlining the area to be scanned, automatic counters, and the program itself.

This data gathering system is presently working quite successfully and with proper camera adjustments is capable of resolving about 12 different levels of intensity and scanning an area of approximately 100 μ^2.

Work on the data analysis for this project is reported in another paper given at this conference by Mrs. E. J. Karchmar and Dr. J. V. Milligan entitled, "Automated Pictorial Pattern ANalysis - Programming Methods".

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