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SCANNING SCREEN MORPHOMETRY BY A PERSONAL COMPUTER AND A MODIFIED MOUSE

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ABSTRACT

Scanning screen morphometry has proved to be a technically simple and reliable way of image analysis. In order to avoid laborious and often incorrect counting, a new system has been developed using statistical methods. This system works with every IBM compatible personal computer and a slightly modified RS232 mouse. For counting and evaluation a computer program written in SAA standard was developed. Except for the scanning screen no further instrumentation is needed. It was the aim to create a system which is economical in every respect and easy to use for diagnostic purposes.

Keywords: image analysis, modified RS232-mouse, personal computer, scanning screen morphometry

INTRODUCTION

The scanning screen morphometry is a technically simple method to register morphological changes on an optical and electronoptical level. For this reason it is very useful in cell biology. Test points or points of intersection are counted by point or line scanning screens. These numbers are a measure for the volume and the surface of a structure. The theoretical background has been described several times (e.g. Haug, 1980, Hennig, 1956, Weibel, 1980).
Since the new fully automatic image analysis systems available on the market cannot be applied in all cases, because they cannot possess all capabilities of the human eye, a new semi-automatic scanning screen morphometric system was developed. In 1976 a semi-automatic morphometer was introduced which counted easily and faultlessly the exact number of test points and points of intersection according to Weibel's theorems (Wolf, 1976). Later the morphometer was further developed to work together with a CPM 80/86 computer (Wolf, 1983a, 1983b, 1985a). Based on this developement, a modernized system has evolved using modern tools and the speed of personal computers.

It fulfills the following requirements:

- It is easy to learn.
- It can be applied without a lot of practice.
- It works with a normal personal computer.
- It gets along without further expensive auxiliaries.
- It is flexible.
- It not only counts but also evaluates.

MATERIALS AND METHODS

The PC working together with the scanning screen morphometry system has to be IBM compatible and use MS-DOS from the version 3.0 on as operating system. The scanning screen which is made of a transparent foil is superimposed on the picture to be investigated. The lines of the scanning screen are printed with a metallic paint by a special silk-screen process.

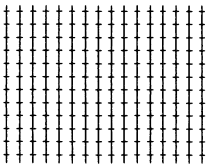

Figure 1. A part of a scanning screen, modified quadratic test system

The vertical lines count the points of intersection; with the short horizontal lines, the test points are registered. The metallic lines and a contact pencil are connected with a RS232 mouse. An optocoupler was installed to separate the circuit in order to prevent electrical hazard. Furthermore a Lithium cell was installed to supply the optocoupler with voltage. The normal mouse is not impaired by these modifications. An ordinary pencil can be used as a contact pencil.
The structures on the picture are followed with the contact pencil. When one of the lines is crossed, an impulse is sent via the mouse to the computer where it is counted.
The computer program was written in the SAA standard with integrated help functions. The computer not only receives and counts the impulses but also permits some statistical evaluations relevant to biological questions, for instance mean value, standard deviation, frequency distribution or Student's t-test.
The program contains some important features for image analysis such as estimation of relative volumes and surface areas of cells, nuclei and some cell organells. Using the well-known formulae of morphometry (e.g. Weibel, 1980), the following calculations can be quickly made: the relative volume of a structure within a superstructure, for example volume of the nucleus to cell volume, and the determination of the surface area to the volume ratios of cells and organelles.

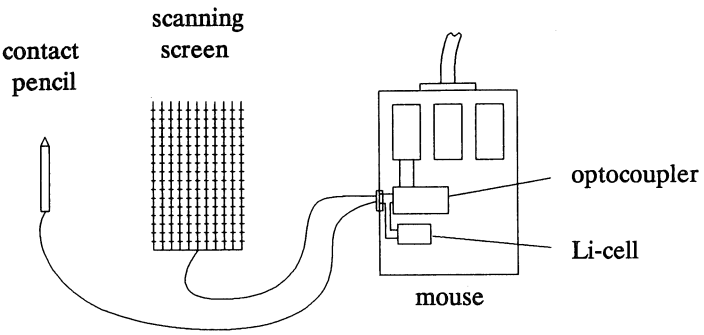

Figure 2. A block-circuit diagram of the modified RS232-mouse

RESULTS

The system described here rationalizes the elementary but time-consuming method of scanning screen morphometry. The transparent foil as scanning screen can also be fixed on a screen to analyse an image directly from the screen using a video system for example. Negative films can also be projected on a sheet of white paper superimposing the foil. The system neither makes high demands on the computer nor does it need expensive auxiliaries. It combines the human eye's high resolution and ability to differentiate of with the simplicity of the instrumentation required by the scanning screen morphometry and the possibilities of the personal computer.

DISCUSSION

The analysis of electron microscopic photographs for example is very difficult because of the many different grey values. They are easy to differentiate and to compare for the human eye, but not for the computer. The same applies to artifacts which can also only be distinguished by the human eye. In addition, for most of the fully automatic image analysis systems a lot of time for learning and practice and often expensive accessory units like video systems are needed. But video systems can easily be adapted to this new technique thus saving on photomaterial. Photopaper can also be saved when a projector is available.

The introduced system was developed as an alternative to the conventional image analysis systems. It is easy to learn, it does not require a lot of practice and it is low-priced and flexible. In the past it has proved to be good not only for research but also for extensive histopathological investigations (Wolf et al., 1985b, 1985c, 1987). The now improved hardware is facilitating the clarification of extensive diagnostic problems based on the comparison of numerical image data. The orientation on the software standard allows an easy exchange of these data.

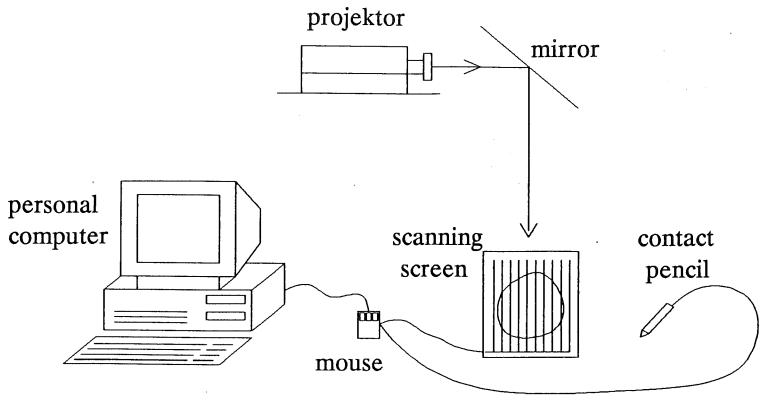

Figure 3. The scanning screen morphometry system for projecting negative films

All hard- and software is available from Bernd Lexow, Oberrieder Str. 7, D-7800 Freiburg i. Br..

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