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ON APPLICATION OF DTP SOFTWARE IN IMAGE ANALYSIS

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ABSTRACT

A rapid progress in computing power of PC computers enabled expansion of powerful and inexpensive software for desktop publishing (DTP). DTP software includes modules for preparing illustrations which comprise many useful image analysis routines, usually with well optimized code.
Possible application of these programs in image analysis for stereology is discussed and a few illustrative examples are attached. From the stereological point of view the main disadvantage of DTP software is a complete lack of measurement routines. It can be solved by a user developed software. Thus, it is demonstrated how to build a relatively powerful image analysis system, suitable for teaching and simple, routine measurements, practically without investment (assuming there exists a hard copy of the analysed picture and a working DTP system, i.e. PC, scanner, printer and software).

Keywords: desktop publishing, image analysis, image transformations, software, Windows.

INTRODUCTION

Image analysis systems are based on high-end hardware and software technology. It enables high efficiency in transformations and morphological operations, automation of feature and structure recognition, sophisticated measurements and presentation of results. It causes however, considering a limited market, very high prices for such apparatus. As a consequence, limited access to image analysis tools confines the spread of appropriate knowledge and limits practical application of image analysis.
So, one should look for cheaper solutions, especially in case of training, simple routine measurements and quality control. It can be solved by development of simplified image analysis systems or by application of DTP software or, more precisely, its part dedicated to image processing. In the current paper it will be shown what are the prospects and limitations of this solution as manufacturers of image analysis systems are not interested in production of cheap systems of reduced capacity.

SYSTEM COMPONENTS

There are marketed and used various computer and software systems. The following system configuration has been chosen for this study:

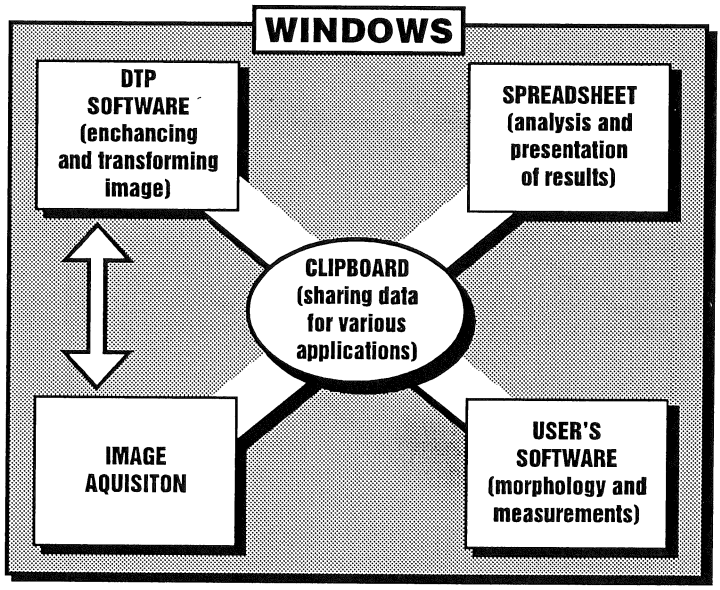

Fig.1. Relation among applications running under Microsoft Windows™

- PC 386/486 compatible computer with 8 MB RAM and SVGA graphic card,
- A4 format, resolution 600 dpi, flat color scanner (Tamarack 6000C),
- software running under Windows™ 3.1.

Total cost of the above listed components is about US$ 6,000 which seems to be unbeatable when compared with any existing image analysis system. A PC 386/486 computer has been chosen due to its good price-to-value ratio and open architecture which enables attaching various scanners and frame grabbers for image aquisition.

Proper choice of software is essential for correct work of the system discussed. Microsoft Windows have been chosen due to flexibility and multitasking ability. From practical point of view the Windows allow separate programs to work like subroutines in a large system (see Fig.1). Various frame grabbers and scanners can be used for image acquisition; images stored in files can be applied as well. Images can be read by DTP software directly or through the clipboard which enables quick and easy data transfer among different Windows applications. All the results can be analysed and presented by any of the existing spreadsheets. As data can be transferred through the clipboard, all the necessary programs can be running simultaneously and are available at fingertips like simple subroutines.

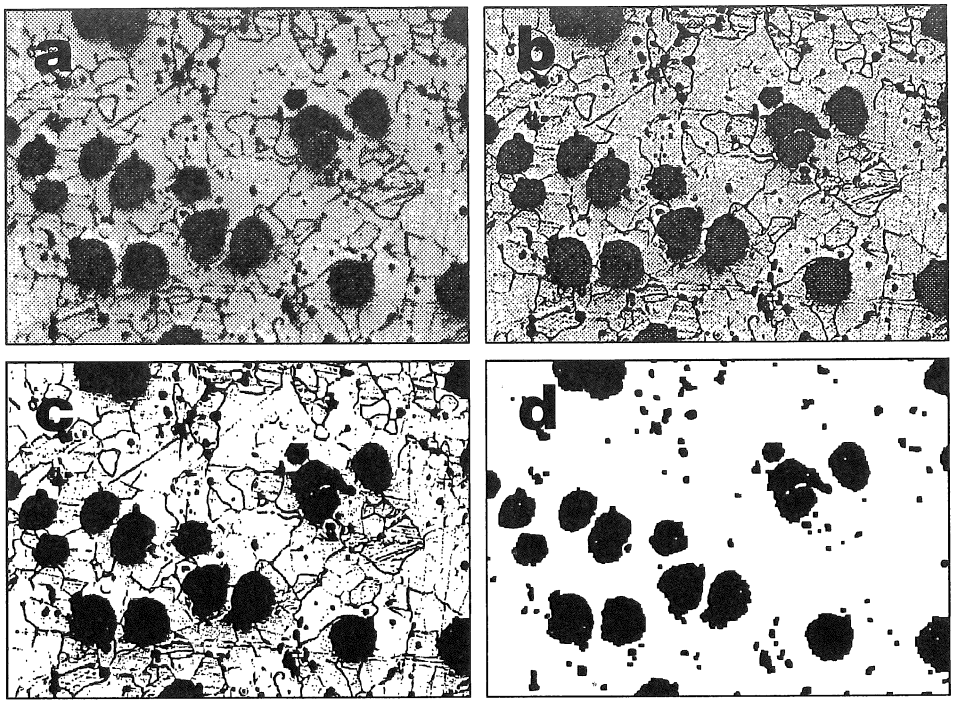

Fig.2. Application of Aldus PhotoStyler in image analysis. Original image (a) has been sharpened (b), thresholded (c) and finally opened (maximum and minimum filters - d). Final image (d) can be used for measurements of particle size and shape.

"White spot" in this system are measurements. There is a lack of low-cost software for stereological measurements on binary images. Thus, the only solution is (currently) application of a user-prepared software. Software for measurements is quite complex, but due to the existence of spreadsheets one should not bother with modules for statistical analysis, charts etc. This situation simplifies the necessary range of self-developed software, which will be discussed later. Essential for proper work of the discussed low-cost image analysis system is quality and performance of the available DTP software. This item will be now discussed in more detail.

DTP SOFTWARE AND IMAGE ANALYSIS

Commercially available DTP software for analysis of bitmaps, like Aldus *PhotoStyler* and CorelPHOTO-PAINT offer numerous tools for image processing. Many of them can be useful in stereological applications:

- pre-processing of the image: brightness/contrast and hue/saturation control, grey/color correction, gamma modulation, negative,
- advanced image treatment: sharpening, edge detection, softening, equalizing,
- filters (some of them perform morphological operations): minimum, median and maximum filters, mosaic (resolution change), thresholding, posterizing (grey scale operations) and user defined filters (useful mainly for artistic purposes).

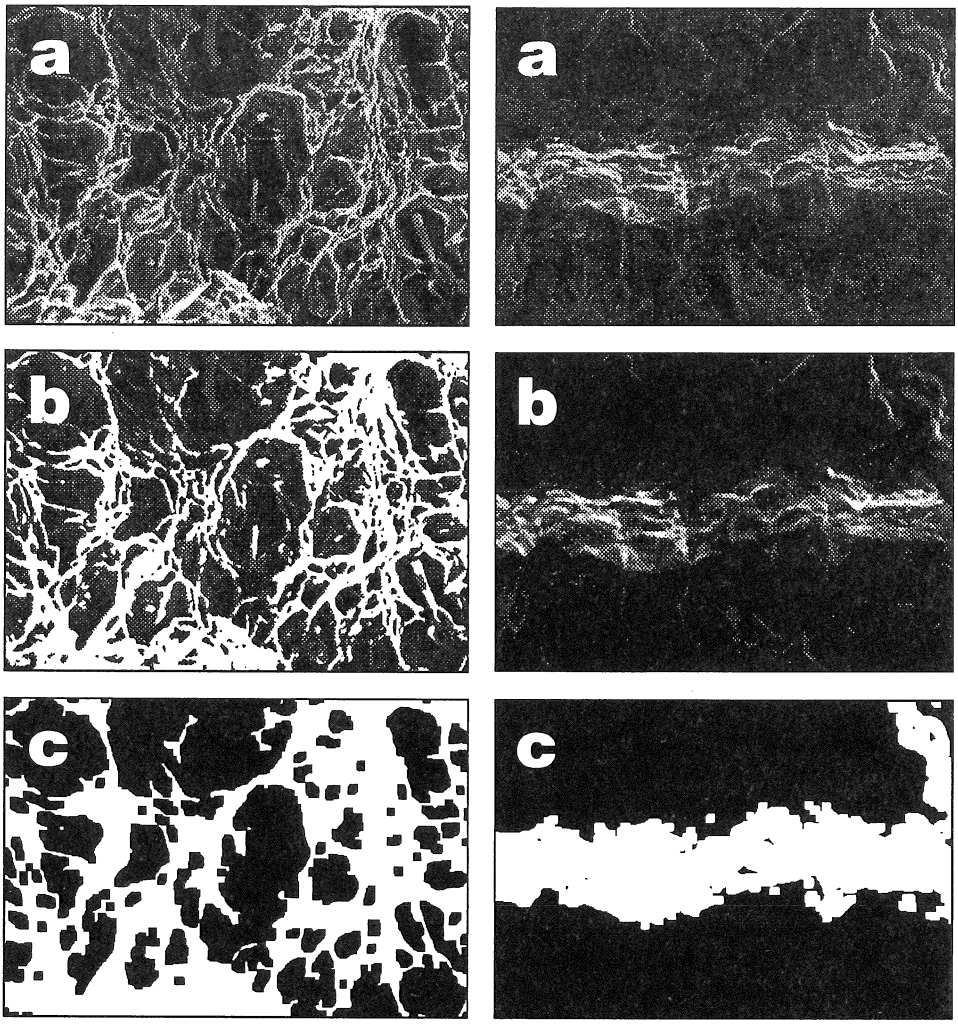

Fig.3. Two examples of similar transformation applied in fractography - void counting (left) and stretched zone width analysis (right). In original image (a) there is reduced a number of grey levels (b), the image is thresholded and closed (c).

As it can be seen from the above list, DTP software offers most of the tools necessary for image analysis with one exception: nearly no transformations of mathematical morphology are available. Maximum and minimum filters can perform erosion/dilation and opening/closing. More advanced transformations, like skeletonization, are not available.

In spite of the above mentioned lack of morphological transformations many routine and simple measurements can be done on images prepared using DTP software only - see Figs 2 and 3.

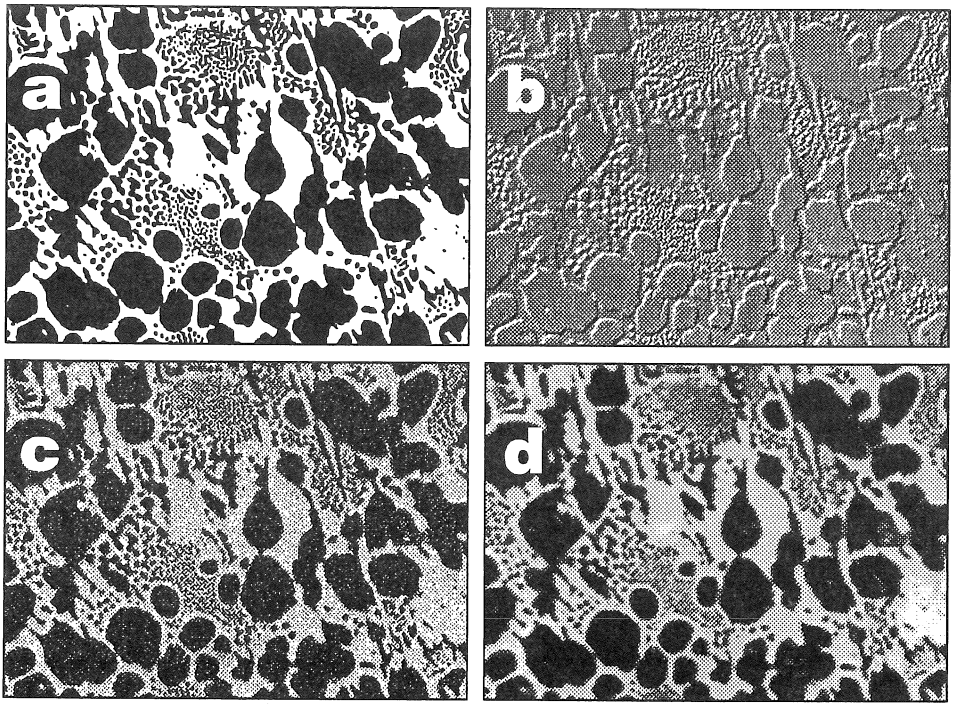

Fig.4. Simulation of varius modes and errors of observation. Original image (a), SEM - back scattered electrons (b), noise (c) and lack of focus (d).

Some transformations and filters in DTP are introduced for purely artistic effects - in CorelPHOTO-PAINT one can even transform any photograph into a pointillistic or impressionistic style picture. Some of these filters, however, can be used for simulation of various modes of observation (dark field, SEM/TEM etc) and various observation errors (out of focus, contamination etc.). The programs offer full control over these effects so it can be used for testing various analysis algorithms and more sophisticated image analysis systems with built-in noise reduction procedures. A few examples of such simulations are shown in Fig.4.

USER-PREPARED SOFTWARE

As it has been already mentioned, the weakest point of this concept - i.e. application of DTP software in image analysis - is a complete lack of measurement tools. It can be relatively easily solved if we take into account that the majority of measurements and analysis is based on the following measurements:

- particle count (number of particles),
- area (of individual particles),
- perimeter (of individual particles),
- Feret diameters (of individual particles),
- location of individual particles (first contact point).

These parameters allow estimation of such important stereological measures like volume fraction V_V, specific area S_V, number of particles per unit area N_A, different shape factors, size distribution, some nonhomogeneity measures, boundary length and can be used for calculation of other, more complex parameters.
Such software is already developed and is currently in use at Cracow Technical University. The software includes tools for mathematical morphology operations and measurements listed above. In Table 1 there is summarized critical evaluation of the simple image analysis system described in this paper.

Table 1. Advantages and disadvantages of the proposed image analysis system

ADVANTAGES	DISADVANTAGES
possibility to analyse images of various sizes, exceeding 512x512 etc.	long time necessary for advanced analysis and, especially, measurements
possibility to incorporate various image formats	necessity to use simultaneously many different programs
ideal tool for teaching	impossible on-line analysis
easy modification of the source code	limited industrial applicability
relatively low cost	lack of most sophisticated algorithms
ease of use	difficulties with defining macros

CONCLUSIONS

1. Simple image analysis system built on the basis of a PC computer and DTP software cannot replace the full-scale system, but one can obtain about 30% of its power for less than 10% of its price.
2. The system discussed can be applied in small laboratories for simple, routine measurements or for preparation of images for large analysers, in quality control, in schools and courses for training students and future users of image analysis systems and for simulation of different modes of observation as well as observation errors.

ACKNOWLEDGEMENTS

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