MICROMORPH
A MATHEMATICAL MORPHOLOGY TUTORIAL SOFTWARE

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MATHEMATICAL MORPHOLOGY AND IMAGE ANALYSIS

What is mathematical Morphology?

During the past twenty-five years, mathematical morphology has developed under various forms. From the start, its favored field of application has always been image analysis: images were first provided by microscopy (mainly biology and metallography), then, images came from an ever increasing variety of fields as the method gained in refinement and diversification (satellite imagery, scene analysis, ...). This methodology has been constructed, step by step, from different and sometimes ancient mathematical knowledge: integral geometry, set theory, topology, probability theory, graph theory, etc. . The conceptual body that has become MM has been set up thanks to the combined efforts of several researchers, among whom, G. Matheron [Matheron 67], J. Serra [Serra 82, 88], stand in the forefront, joined afterwards by the researchers of the Centre of Mathematical Morphology of Fontainebleau.

Transformations and measurements

The methods of MM are designed to quantify geometric structures. The set notion is an appropriate representation of geometric structures: a porous medium, for instance, is made of two complementary sets, grains and pores. Thus, MM is first a set discipline and the mathematical objects it handles are sets. Quantifying any structure then comes down to measuring sets. But measuring means transforming, if only because the objects under study cannot be directly measured. Therefore one has to define the objects or structures to be studied, or in other words, one has to construct the set on which the measure will be performed. Such a construction is obtained by successive transformations which, from the initial image, will progressively reveal (at least we hope so) the set to be measured. These transformations are combinations of elementary morphological operators.

Transformation complexity versus ease of use

A text is constucted with sentences, themselves made of words according to precise rules, and the words themselves are formed of letters. Similarly, the image transformations used in MM

combine simpler transformations, themselves derived from elementary transformations.Using the same analogy, the elementary transformations available to us are relatively few as are the alphabet letters. This small number of transformations does not limit however the morphologists' imagination. Combining elementary transformations to define a new one allows, as writing does, to introduce new concepts which transcend the initial definition. Someone who pronounces the word "boat" has a precise concept in mind (which may depend on the context). At this stage, the fact that this word is composed of a determined combination of the letters o, b, a and t does not really matter. The spelling is only there to make sure people speak of the same thing. In MM, this phenomenon is very commonly observed. A transformation such as the "skeleton" is used as a precise concept presenting certain properties apt to achieve a given purpose. The fact that the "skeleton" combines "thinnings", themselves composed of "erosions" and "intersections", "erosions" being made of "shiftings" and "intersections", is of little significance.
From all that has been said in the preceding, one could conclude that MM only applies to images with two components. This is not the case, as the transformations defined on binary images can be generalized to greytone images.

MICROMORPH TUTORIAL SOFTWARE

What is MICROMORPH ?

MM has always been developed on two levels : a theoretical level, with the development of new concepts, but also a practical level by applying MM to the solving of concrete problems in image analysis. The practical study of images was made possible by the designing of specific image analyzers allowing to perform MM transformations on digitized images. As computers, these image analyzers, have gone through several generations, more and more sophisticated as electronics improved. First, they were rather rudimentary machines only able to perform one or two elementary transformations on an image. Later, with the addition of image memories, transformations could be iterated allowing more complex processing. The latest analyzer versions can process images of increasing size (512 x 512 and even 1024 x 1024) and variety of tone at increasing speeds.
Learning MM means to get familiar with elementary transformations (alphabet), then learn how to combine them in order to obtain more complex transformations (words), and finally, to organize these transformations to solve a given problem (i.e. learning grammar and syntax).
Acquiring this know-how is almost impossible without using one of these image analyzers mentioned above.
Unfortunately, these machines are rare and often very expensive. Their use is therefore reserved for more profit-oriented tasks rather than teaching activities. Moreover their increasing performances and processing speeds do not allow the beginner in MM to observe the different steps of the transformations.
In view of all this, we thought it necessary for the user to have a pedagogical tool not too expansive but performing enough not to be discouraging because of two long processing time. The use of a microcomputer APPLE II, and now of an IBM PC compatible along with the designing of MICROMORPH Software allows, at least we hope so, to meet these needs.
MICROMORPH is more than a teaching software to learn MM. It is a true language allowing to construct more and more complex morphological transformations from a limited number of primitives. The language is structured so that the user can create his own words, and construct

his own dictionary. According to our preceding analogy, MICROMORPH provides the alphabet, the novice morphologist is then free to compose words and next sentences.

MICROMORPH releases

MICROMORPH runs on any PC compatible computer. There exists txo versions of this software: a old MSDOS version (Figure1) but with a lot of capabilities and a Windows version (Figure 2) which allows to handle images of larger sizes and to design real image analysis applications in the Windows environment.

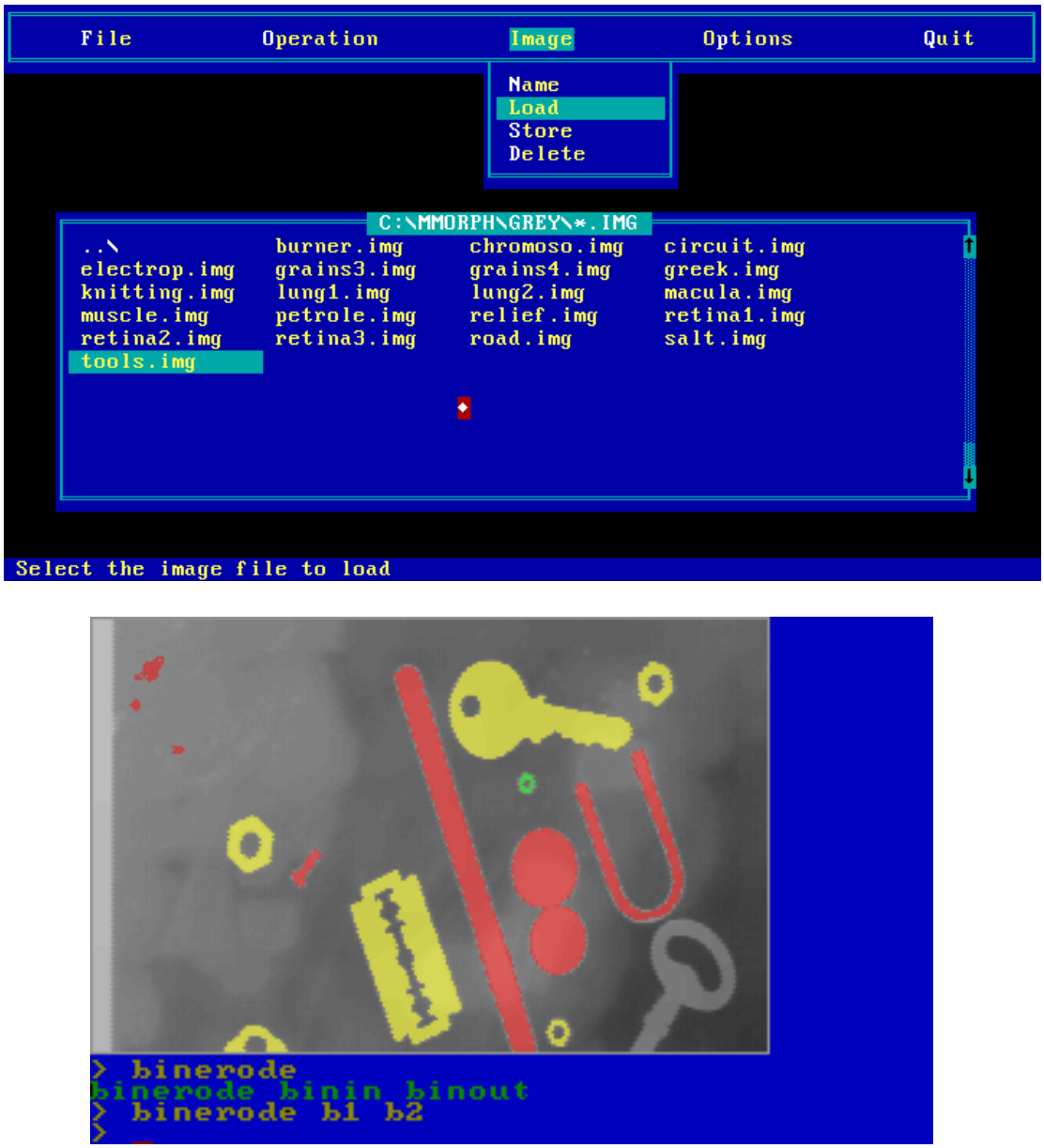

Figure 1 : MICROMORPH, MSDOS version- Main menu (top view) and working screen (bottom view).

MICROMORPH comes with a complete documentation made of three handbooks [Gratin & Beucher 1989]. The reference manual describes the different parts of the software package

and the programming language. The two other booklets present a large set of exercises, algorithms and applications in image analysis, most of them derived from real cases. In the solutions handbook in particular, the reader may follow up, step by step, the different phases of the image treatment leading to the final solution.

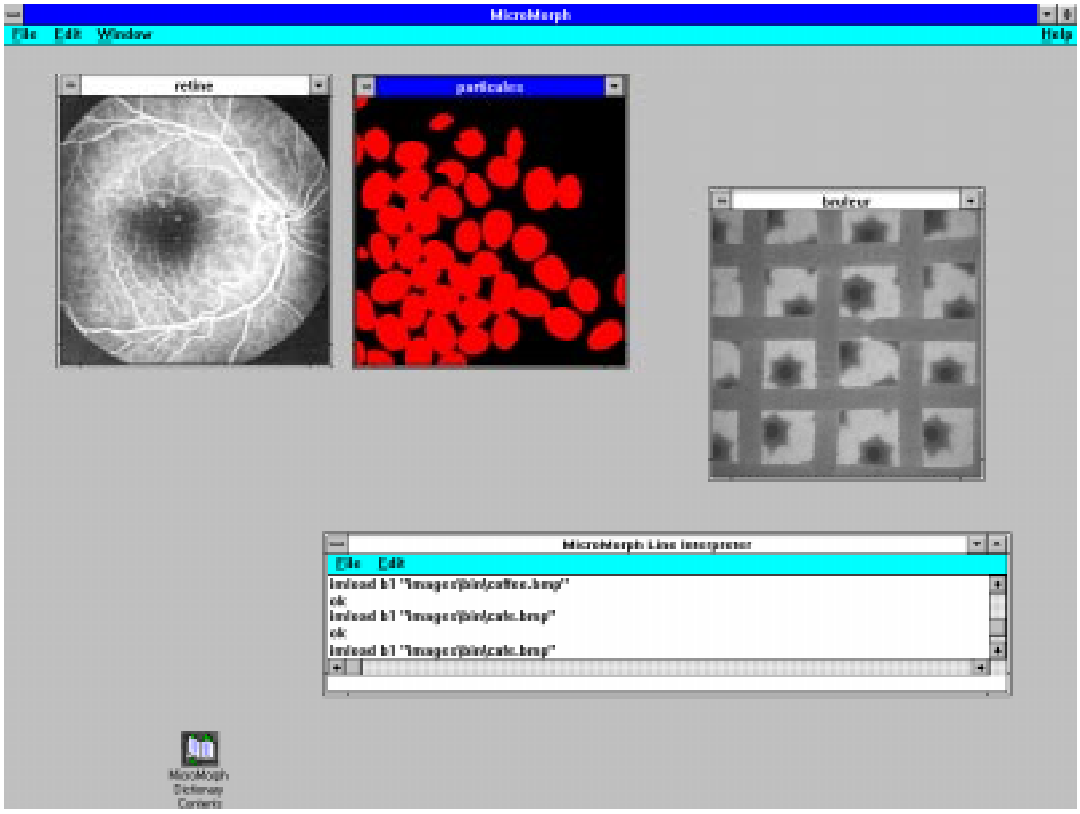

Figure 2 : MICROMORPH Windows version

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