# TEXTURE RECOGNITION AS A QUANTITATIVE ANALYSIS OF UNDERDOSES IN PHARMACOLOGY AND MEDICINE

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*Abstract*

*When obtaining histological preparats or compounds containing underdoses of a matter, the problem on analysis of their specimens arises. Electron microscope and special software allows us to obtain images of such patterns and save them as files in graphic formats. The images may be considered as textural ones, i.e. images consisting of elements (or several classes such elements) which may be identified on perception. The authors have implemented a method based on texture analysis and expert knowledge, which allows us to classify patterns using their graphical representations.The method was applied to distinguish among three classes of brain tumours (astrocytoma, oligodendroglioma and nevrinoma) and classify compounds containing underdoses of a matter.*

## 1. INTRODUCTION

The analysis of histological preparations and compounds containing underdoses of a matter concerns to the problem of pattern recognition that is crucial issue in many applications. To solve the problem neural networks [1] and texture analysis [2] are often used.

It is well known that textual and visual information happens to be redundant: one may delete as stable words combinations from a text as inconsequential details from a visual image without loss of meaning.

From geometrical point of view one can consider both metric and topological properties of an object. Metric properties usually vary when the object is transformed by a continuous mapping that changes its size and form, whereas topological properties are main invariant properties of the object.

It looks like our perception at first fixes topological properties (visual invariants) adding to them minor details afterwards. Many of pattern recognition methods are based on finding visual invariants of an object.

Invariance of a sign or a value means that it is the same for a class of systems (objects). So, to find an invariant means to classify systems (objects) according to this sign (or value).

It should be noted that there are widely used numerical invariants of processes that are applied to investigation of dynamical systems behaviour: correlation dimension of restored attractor and entropy. In [3] correlation dimension of restored attractor was used to reveal $\alpha$-synchronization phenomenon in EEG records.

Experienced people (professional experts included) mostly give accurate solutions for recognition and diagnostic problems using neither the objects features revealed by classic mathematical techniques nor morphometry. While working with the experts analysing both EEG records to diagnose the evoked potentials and histological preparations, we have realised them to *perceive a record as a picture, an image*. Accumulating a clinical experience in reading and analysing EEG and tumour recognition the experts have shown to form mentally visual invariant underlying their solution of a diagnostic problem.

Basing on our own experience in research into human information processing in perception and thinking we have developed a *mimetic* approach to an automated image analysis and processing aimed at duplicating, quantitating, and extending of human analysis process [4].

## 2. MAIN NOTIONS

Image (pattern) is a group in a classification system uniting a set of objects in accordance with a feature. Image perception of the world is one of the properties of the brain that allows it to investigate and sort endless informartion flow. When perceptting external world we classify an information, i.e. quantize it such that any group consists of similar but not identical objects.

Images have a feature: if you acquainted with a finite number of objects from a group you can recognize a great deal of reprezentatives of the group. Moreover, images have objective properties in that different people which use different data of observation for the most part classify the common objects in the same manner and independently of one another.

To recognize a pattern means to identify an object or obtain some of its properties using visual image or audiorecord.

Texture is a structure of a pattern. In this work we assume that texture is a regular (in a way) structure of a pattern.

There are various methods to reveal features in a pattern using its structure (texture analysis).

## 3. METHOD OF ANALYSIS

The recognizing algorithm uses both an expert knowledge in the correspondent subject area and the texture analysis. The expert knowledge is formalized as a generalized feature that is significant for patterns recognition and classification. For example, it may be the ratio of areas with high and low brightness. The method we realised lies in construction of associative image series. By this series we mean the sequence of images, each of them is the coded input image and depicts some information sign. Solving our problem we coded this sign by a colour according to some scale.

The images of histological preparations were obtained with the help of special software of electronic microscope. The images of compounds with different doses of Ag were obtained with the help of software for atomic-force microscope.

An input image *(associative series 1*) of a preparation is transformed to a brightness matrix with 256-by-256 pixels (the pixel brightness being measured in 256 gradations: 0–255). According to the developed algorithm an input matrix is partitioned into equal parts, being the part size depends on the microscope magnifying power. In our experiments we select part size equal 16. The generalised normalised brightness is calculated for each part; its value is determined as a natural number from the row 1, 2, .., 8. It appeared enough to represent the part brightness range by only eight gradations.

We obtain a simplified variant of the input image (*associative series 2*). By applying to this image the program implementing formalized expert knowledge we obtain *associative series 3*.

So, we impose the input preparation image and two coded pictures together. Simultaneous presentation of all images allows originating the associative series with desired directionality. Thus, a visual invariant of a texture is formalized as some numerical value and used for classification process.

In what follows figures 1-3 show associative series for nevrinoma.

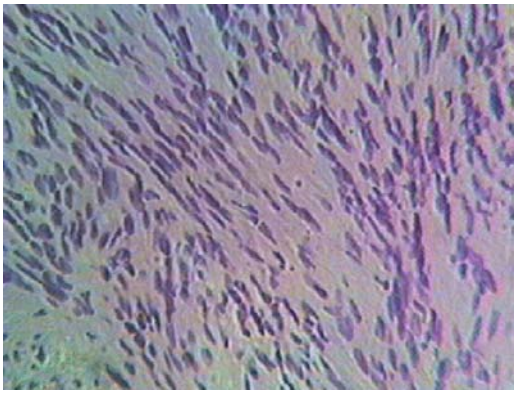

Fig. 1. Input histological prepara-tion

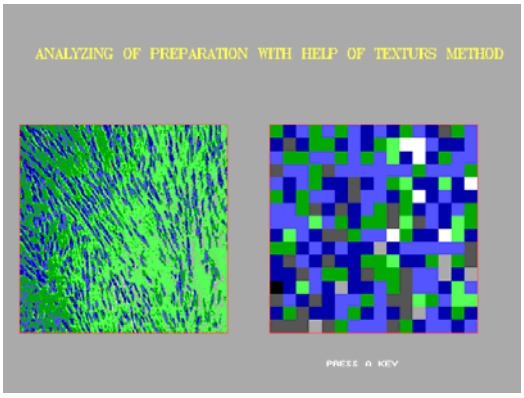


Fig. 2. The result of texture analysis

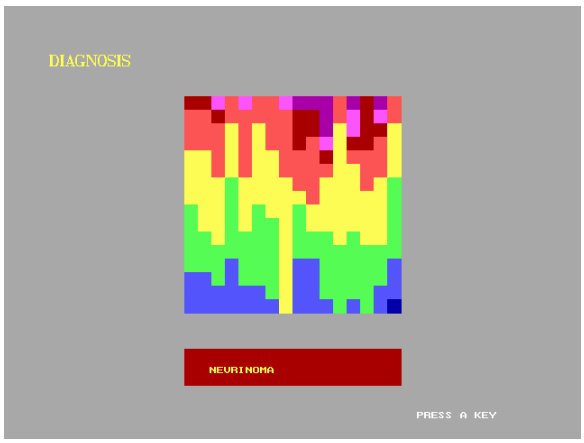


Fig. 3. The final result of analysis

Figures 4-6 demonstrate compounds with different underdoses of Ag. Dimensions are given in μm. The histogram in right side of a figure shows a saturation and is used for construstion of the image in 3D-format. In this work we use only images in 2D-format, but we have for an object to apply the described method for images in 3D-format, which may lead to more detailed analysis. For each pattern numerical characteristics that allowed classifying compounds with respect to a dose were obtained.

Numerous experiments show that adding Ag to a solution results in appearing a set of organized structures. One can say about processes of self-organization. Such processes on atomic-molecular level indicate rather complex system behaviour on a higher level.

In solutions with small concentration of Ag there are no complex structures. The solution not containing Ag do not demonstrate any self-organization at all.

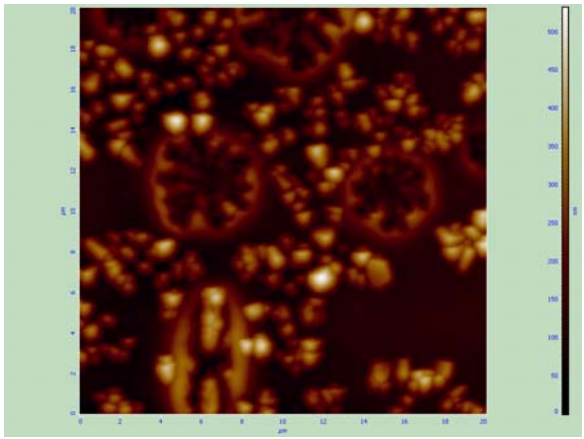

Fig. 4. Large dose of Ag. There is fractal structure of the pattern

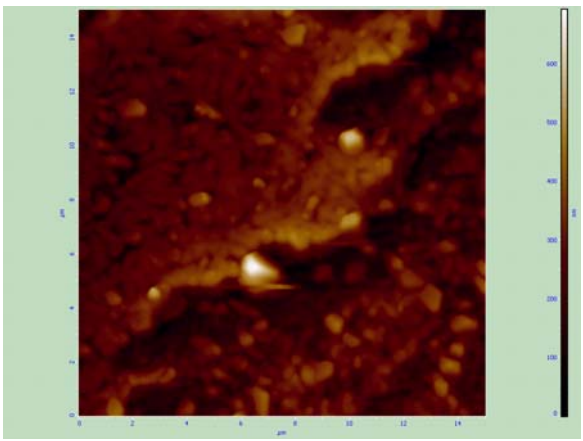

Fig. 5. Small dose of Ag. There is no regularity

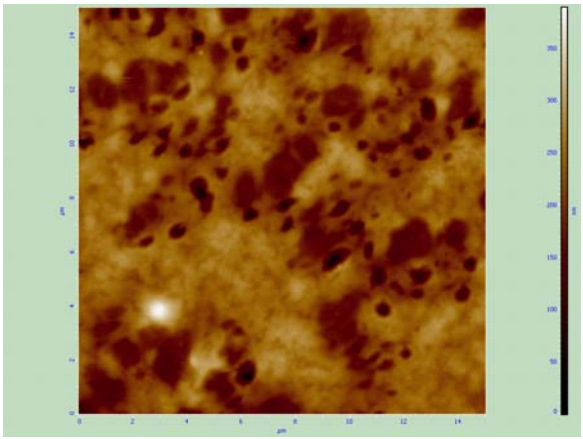

Fig. 6. Zero concentration of Ag

## 4. RESULTS

The developed algorithm allowed us to classify the brain tumors of three types: astrocytoma, oligodendroglioma and nervrinoma. This method may be also applied to classify other types of brain histological preparations. The patterns of pharmacological compounds whose graphic images are two-dimensional pictures were studied. The results show that such an approach allows us to recognize specimens of different classes as having different texture characteristics.

## 5. CONCLUSIONS

Our algorithms may be slightly modified and applied to classify patterns where a regular structure is found out. They may be applied to classify the compounds containing underdose of a matter depending on the dose. One of perspective application of described method of the classification of compounds with underdose is homeopathy.

## 6. ACKNOWLEDGEMENTS

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