DETECTION OF CELLS ORIENTATION FACTOR FOR CANCER DIAGNOSTICS

A.Nedzved, A.Belotserkovsky, S.Ablameyko

United Institute of Informatics Problems, NASB, Surganova str., 6, 220012, Minsk, Belarus,
NedzvedA@newman.bas-net.by, http://www.uiip.bas-net.by

The quantitative measurement is basic part of histological cancer diagnostics. Measurement of orientation from tissues images allows to determinate symptoms of diseases. In this paper the algorithm for determination of cells orientation is proposed. This algorithm consists of three stages: segmentation of cells, measuring and classification.
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INTRODUCTION

Low frequency of early staged cancer recognition requires new and more efficient methods of oncodiagnostics. The transformation of qualitative indices of pathological changes in cells to a quantitative form with the help of the computer morphometrical method is one of the most perspective ways to solve this problem. Morphometrical study of thyroid gland makes possible to reveal a number of quantitative regularities of pathological changes of specialized cells in patients with malignant and benign nature of a disease.

Morphological changes of standard cell in tissues are one of important factors for diagnostics of oncological diseases. They can be related to pathological effects caused by the cancer. However, histological investigations are currently limited to qualitative or semi-quantitative analysis, based on visual inspection of stained microscopic samples and subsequent interactive measurements of relevant features.

Though the main task of histological diagnostics is the question about the presence of malignant tumor, the problem of differential diagnostics of the main forms of diseases, such as papillary and follicular cancer, adenoma and etc. remains to be open. To solve this task, it is necessary to conduct the histological differential diagnostics of diseases by measuring and analysis of geometrical and morphological parameters.

On the first stage of histological investigations the basic diagnostic factors are tissues characteristics: difference of cells by shape, size, orientation and texture description. Instead, the structural analysis of cells populations in tissue is often performed by methods of mathematical morphology [1,2], particularly by morphological filters for their shape , rather than frequency-oriented operations [3]. These versatile tools can be used at different stages of the automated feature quantification process such as preprocessing [4], segmentation [5], and feature extraction [6].

The cells features are described by many standard geometrical characteristic. But traditional measurement do not permit to correct orientation description of cells in tissue because simple statistic of cells orientation in tissue do not correspond to orientation dominant.

The algorithm for determination of cells orientation which includes segmentation of cells, measuring and classifications is proposed in this paper.

1. SEGMENTATION OF CELLSPAPER SIZE

Segmentation means partitioning an image into non-overlapping regions according to the interpretation of human observers. With respect to a population of cells in tissue, segmentation is supposed to yield two regions: cells and image background. Typically, graylevels occurred within objects differ significantly from those in the background and histogram thresholding technique may be applied as long as the background appears homogeneous.

Unfortunately, illumination and dye concentration may vary significantly in light microscopy of histological samples (fig. 1). This leads to poor segmentation results by global thresholding.

It is necessary using special methods for quality segmentation of cells. The methods of segmentation are selected by properties of cells on image [7].
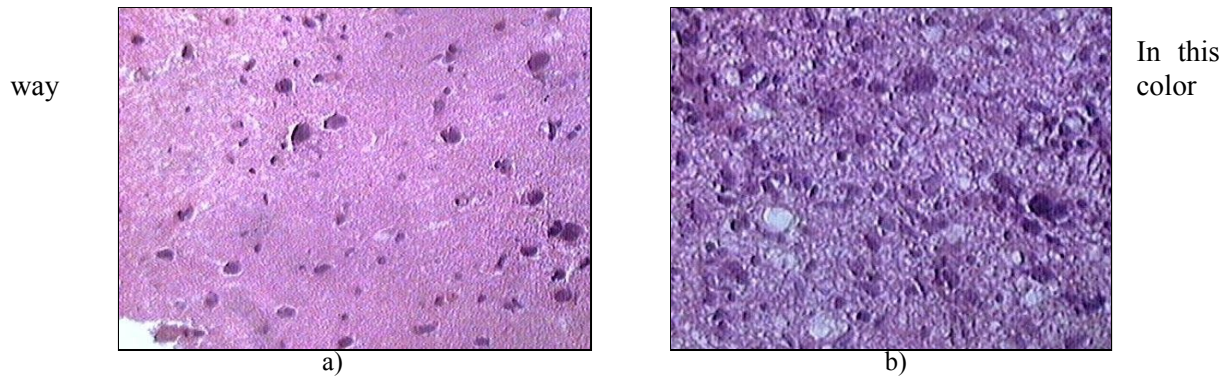
way

In this color

Fig 1. Images of histological samples: a) normal tissue, b) gliablastoma with cells polymorphism.

became an important feature in cell image segmentation. To increase the stability and efficiency of the detection of the cells, a hierarchical processing architecture is adopted for the segmentation and recognition. For segmentation Lab space are combined to segment cells. By this method, both the nucleus and cytoplasm of cells can be separated from background by thresholding using Lab space.

Thresholding technique may be applied within the local adaptive window to group the window's center pixel to the object or to the background. For the segmentation of cells by the histogram thresholding technique Otsu algorithm is optimal [8]. Then, the candidate cells are selected using some morphological features of nucleus. For remove false objects and restore shape of cells it is necessary to use morphological reconstruction filters.

The initial image segmentation is determined by classifying the image local variation information obtained with dilation and erosion operations. A scrap operation is using for remove false objects by size. A smoothing filter is applied for correcting possible classification errors inside the cells. An erosion operation is finally used to restore the cell regions (fig.2).
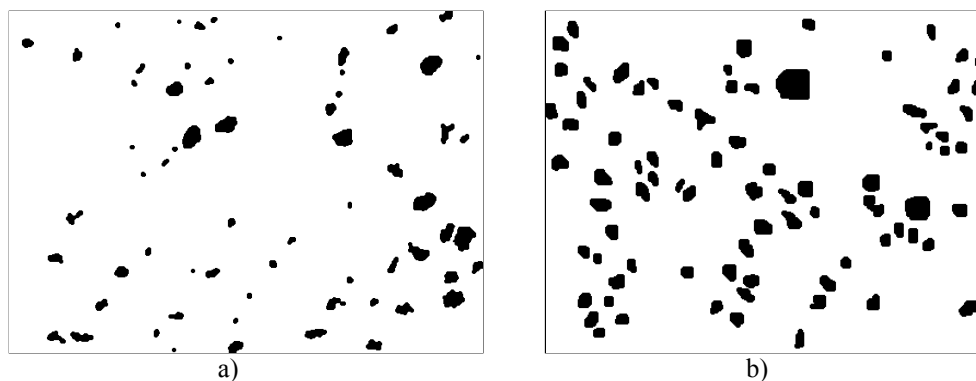

Fig 2 Binary images of histological samples after thresholding: a) normal tissue, b) gliablastoma with cells polymorphism.

2.

MEASURING

Shape measurements are physical dimensional measures that characterize the appearance of an object. The goal is to use the fewest necessary measures to characterize an object adequately so that it may be unambiguously classified.

When dealing with images containing numerous objects, such as histological or cytological cell images, shape descriptors are calculated for all the individual cells. Global shape measures can be calculated from the individual image descriptors:

For cancer diagnostic more usefulness objects characteristics are: area, major axis, angle, form factors and brightness.

For investigation of cells orientation of major axis and its angle play important role.

The major axis is the endpoints of the longest line that can be drawn through the object. The major axis endpoints (x_1, y_1) and (x_2, y_2) (fig.3) are found by computing the pixel distance between every combination of border pixels in the object boundary and finding the pair with the maximum length:

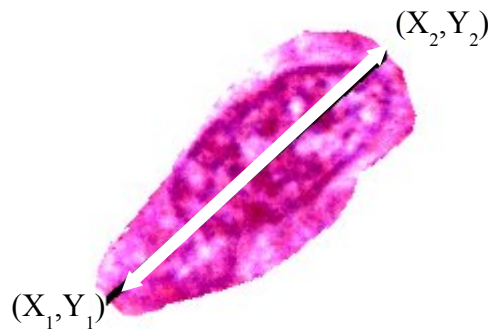$$major\ axis\ length = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}\ . \tag{1}$$

Fig. 3 Illustration of major axis

Angle is calculated by major-axis too. It is the angle between the major-axis and the x-axis of the image. The angle can range from 0° to 180° as:

$$angle = \tan^{-1}\left(\frac{y_2 - y_1}{x_2 - x_1}\right). \tag{2}$$

This angle is a measure of object orientation.

3. CLASSIFICATION

Result of measuring of binary images of sells is table with geometrical characteristics (fig.4). But characteristics of simple statistics (for example mean) of angle not always show dominant orientation of cells, because it has averaging effect.

But we can contrast orientation by summation of major axis length. Result table construct by orientation angle and total length for every direction. Total length equal sum of major axis length for determinate direction:

$$Total\ length[orientation] = \sum_{objects} \begin{cases} major\ axis\ length, if\ angle = orientation \\ 0, else \end{cases}. \tag{3}$$
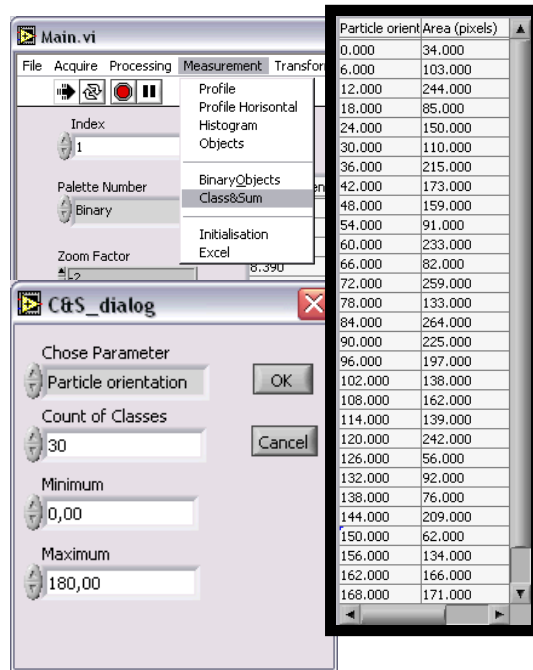
Fig. 4. Fragments of dialog windows for classification of orientation properties

Orientation diagram of cells in tissue is constructed after recalculation results table (fig.5)
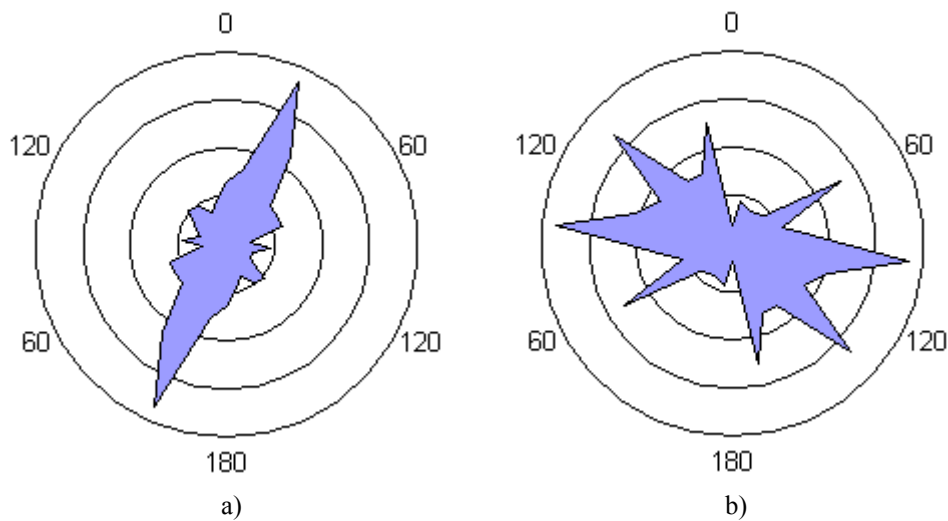

a)   b)

Fig. 5. Orientation diagram of cells in tissue: a) normal tissue, b) gliablastoma with cells polymorphism.

3. CONCLUSION

Constructing of orientation diagram of cells is additional method for histological cancers diagnostic. For normal tissue this diagram has only one dominant of cells orientation (fig. 5 a). For cancers case this diagram similar to star, because cells have many orientations (fig. 5 b). Diseased cells change orientation before resizing. Therefore this method is usefulness for early cancers diagnostic. `

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