BIOMEDICAL IMAGE ANALYSIS BY PROGRAM “VISION ASSISTANT” AND “LABVIEW”

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Summary This paper introduces application in image analysis of biomedical images. General task is focused on analysis and diagnosis biomedical images obtained from program ImageJ. There are described methods which can be used for images in biomedical application. The main idea is based on particle analysis, pattern matching techniques. For this task was chosen sophistication method by program Vision Assistant, which is a part of program LabVIEW.

Abstrakt Príspevok uvádza aplikáciu obrazovej analýzy v oblasti spracovania biomedicínskych obrazov. Hlavná úloha je zameraná na analýzu a diagnostiku biomedicínskych obrazov získaných z programu ImageJ. Popísané sú metódy, ktoré možno použiť pri obrazoch z biomedcínskeho prostredia. Hlavná myšlienka je založená na čiastkovej analýze a technike rozpoznávania objektov. Pri riešení a prezentovaní možností bola zvolená sofistikovaná metóda využívajúca program Vision Assistant, ktorý je súčasťou programu LabVIEW

1. INTRODUCTION

Very good tools from most imaging task are IMAQ Vision Builder and NI Vision Builder for Automated Inspection (NI Vision Builder AI). IMAQ Vision Builder is from version 7.0 called Vision Assistant. The IMAQ Vision Builder helps build image processing and analysis applications by constructing a script file and converting it into LabVIEW and IMAQ Vision programs. We have used the Vision Assistant 7.1. in some of our experiments because in some cases it s easier to get quick and reliable result, although it is possible to program all of those experiments in LabVIEW an Vision Assistant as well.

2. BASIC PROGRAM FEATURES

2.1 Pattern Matching

Pattern matching is arguably one of the most important image analysis tools and is very often the first step in a Machine Vision application. In general, pattern matching provides information about the position and the number of instances of a previously defined template called pattern.

The mathematical basis of pattern matching is the cross correlation function. The correlation is defined as:

$$C(i,j)=\sum_{x=0}^{l-1}\sum_{y=0}^{k-1} w(x,y)\,f(x+i,y+j)$$

where :
w(x,y) is a sub-image (template) of the size k x l;
f(x,y) is the original image of the size m x n (where $k \leq m$ and $l \leq n$);
I = 0,1,…m-1, j = 0,1,…n-1[2].

2.2 Shape Matching

Shape matching (binary) is a tool that can be used if a Machine Vision application has to detect corresponding or similar shapes; for example, if different parts in a production process have to by sorted or defective parts should by detected.

The image, which is the base for the shape matching process, has to be binary; so it has to be converted from a gray-level or colour image.

2.3 Morphology Analysis

Distance and Danielsson

The IMAQ Distance and the IMAQ Danielsson functions, for example, provide information about the distance of an objects (white areas) from background border (black areas) and display this information by using colours of the binary palette.

The Danielsson function is based on an algorithm called Euclidean Distance Mapping.

Danielson himself calls the algorithms he developed “Four-point Sequential Euclidean distance Mapping” (4SED) and “Eight-point Sequential Euclidean distance Mapping” (8SED).

Labeling and Segmentation

There is function IMAQ Convex, which require “labeling” of objects in a binary image, which means that these objects are classified and numbered.

The function IMAQ Segmentation requires a labeled binary image and expands the objects until each object reaches its neighbors. The expanding is done by multiple dilatation function until the image contains no more background areas. The segmentation can be interpreted as the calculation of an influence region of each labelled object.

Circle detection

The next function, IMAQ find Circles, detects circles in inary images and is therefore very similar to the function IMAQ Find Circular Edge. The only difference is that IMAQ Find Circles searcheds not only for edges, but for the entire circle area. We test this function in the next exercise. Circles Data is an array of clusters, one cluster for each detected circle, consisting of the following elements:

- the *x* coordinate
- the *y* coordinate
- the radius of the detected circle
- the entire circle area

Morphology Function

In Vision Assistant are there two different types:
- Basic and Adv. Morphology (binary)
- Gray Morphology (gray-scale)

Basically, morphology operation changes the structure of particles in an image. Therefore, we have to define the meaning of "particle"; this is easy for a binary image. Particles are regions in which the pixel value is 1. The rest of the image (pixel value 0) is called background.

Morphology functions in Vision Assistant:

- Erosion and Dilatation
- Proper Opening and Proper Closing
- Proper Opening and Proper Closing
- Hit-Miss Functions
- Gradient Function
- Thinning and Thickening
- Particle Filtering
- Fill Hoes and Convex
- Separation and Skeleton Functions

2.4 Character Recognition

Vision Assistant provides some tools for the machine recognition of character. In the basic version of the IMAQ Vision toolkit, only the functions for bar code reading are implemented. The reading of text character, or optical recognition (OCR), can only by implemented by addition of the IMAQ Vision OCR toolkit.

Text Reading (OCR)

OCR is a method that converts images containing text areas into computer editable text files. The IMAQ Vision OCR toolkit can read text in capital and printed letters. An additional group of function can be used to "unwrap" characters that are not located in a straight line, before the OCR process begins.

Bar Code Reading

Bar ode reading is included in the basic IMAQ Vision function. The function that performs the bar code reading is *IMAQ Read Barcode*. In general, the program works with the following bar code languages:

- UPC-A (Universal Product Code-A)
- MSI or MSI-Plassey
- Interleaved 2 of 5
- EAN 13
- EAN 8
- Code 128
- Code 3 of 9
- Code 9 of 3
- Codabar

2.5 Particle Measurements

The following functions deal with various kinds of particle measurements, such as counting, clamping (measuring distances), and making other more complex measurement.

Counting Objects

It is possible to adjust various parameters, such as the search rectangle, the type of objects (bright or dark), whether holes in objects should by filled, or whether objects touching the border of the image are to be ignored. Because the function requires a gray-level image as input, the threshold value also has to be specified.

Particle Measurements

The two functions IMAQ BasicParticle and IMAQ ComplexParticle, can be used for a detailed analysis of particles (objects) in binary images. The *basic particle* functions provide only the following information:

- Area (pixels): Surface area of particle in pixels
- Area (calibrated): Surface area of particle in user units
- Global Rectangle, defined by the limits
    - left value,
    - top value
    - right value
    - bottom value

The complex Particle function provides the following parameters:
- Area (pixels);
- Area (calibrated);

- Perimeter: Length of outer contour of particle in user units;
- Number of holes;
- Hole perimeter: Perimeter of all holes in user units;
- Global rectangle;
- SumX: Sum of the *x* axis for each pixel of the particle;
- SumY: Sum of the *y* axis for each pixel of the particle;
- SumXX: Sum of the *x* axis squared for each pixel of the particle;
- SumYY: Sum of the *y* axis squared for each pixel of the particle;
- SumXY: Sum of the *x* axis and *y* axis for each pixel of the particle;
- Longest segment coordinates with
    - Longest segment (X);
    - Longest segment (Y);
- Projection X;
- Projection Y;

3. RESULTS OF ANALYSIS

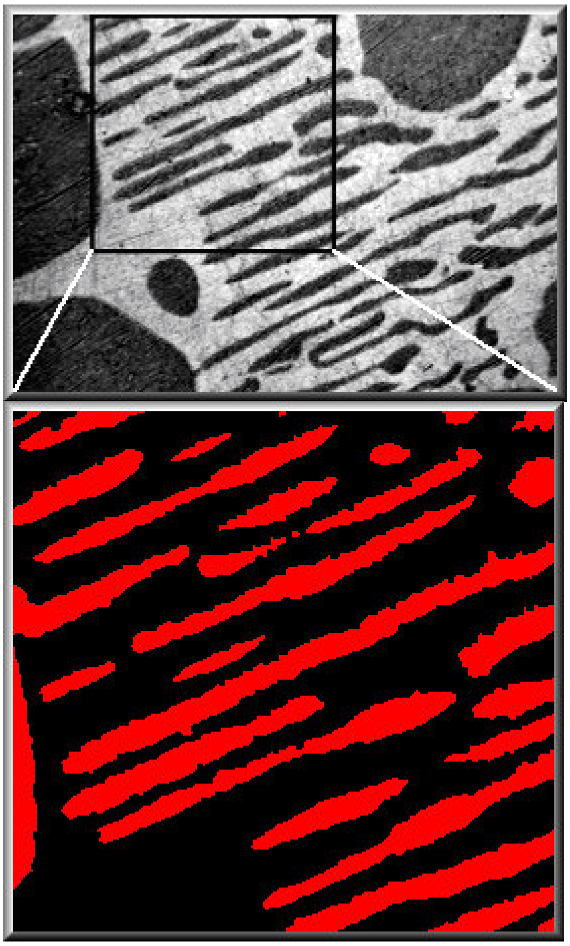

Fig. 1 . The structure of original image and its zoomed area after threshold.

In the Fig.1 is shown original image for particle analysis. Bottom of this image is zoomed area which is used for next example.

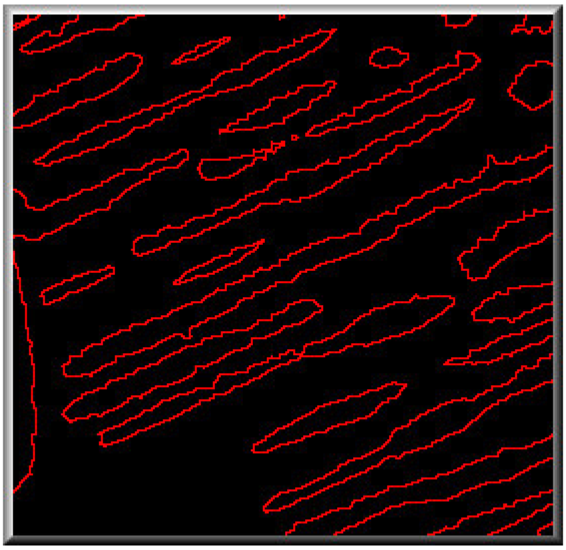

Fig. 2 . Structure of Image after image processing.

In Fig. 2. is processed image after inner gradient method shown . There are same regions which they are described by particle analysis.

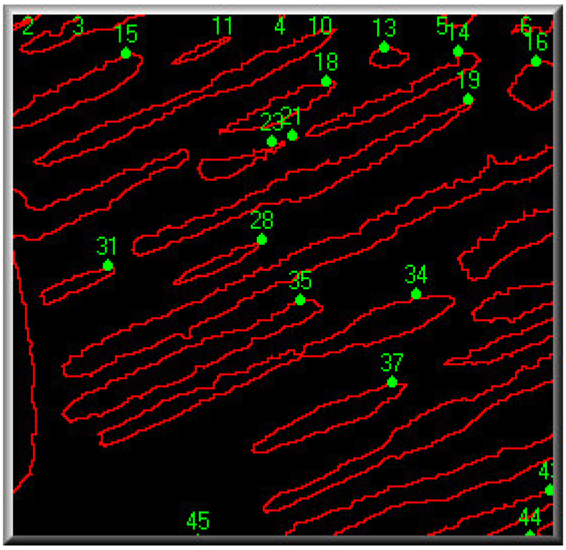

Fig. 3 . Final result of image after particle analysis.

Fig. 3 shown final image, where each region is described by parameter which are in Vision Assistant defined.

In Fig. 4., there is original image of cell colony which was used for experiment.

In Fig. 5., is final result of recognized cell colony.

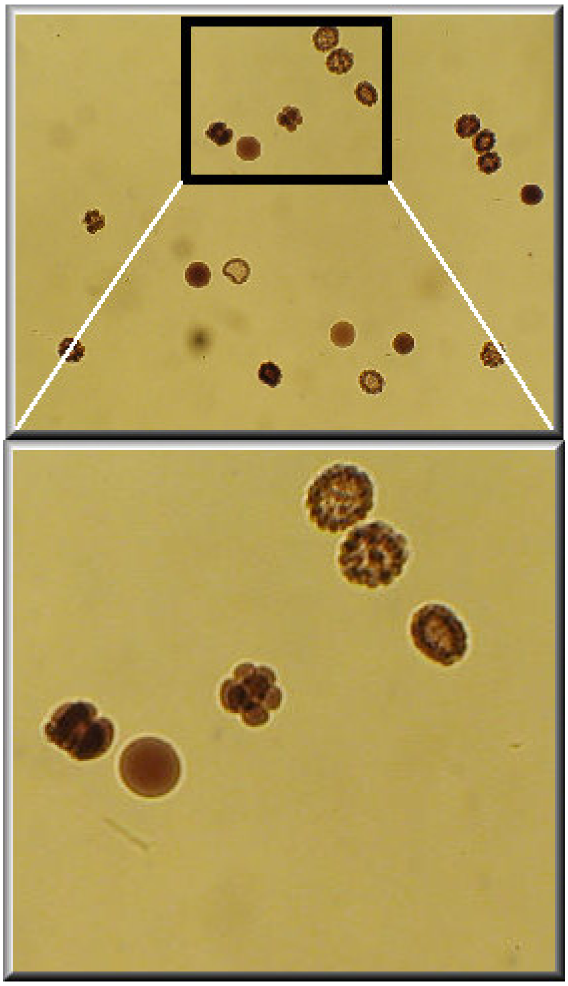

Fig. 4. Original structure layer of cell colony and its zoomed area.

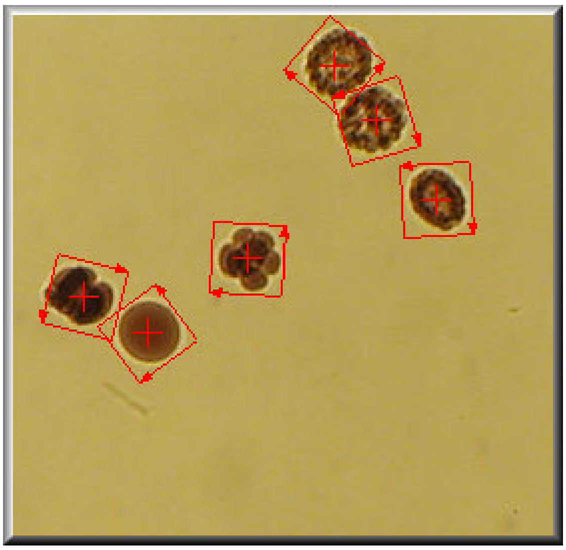

Fig. 5. Image of recognized cell.

Tab. 1., shown comparison of recognized method by sensitivity and minimum score. The best result was achieved by high sensitivity and minimum score from interval 600 – 725. There are all cells recognized, 19 cells, without false recognize. In other two method wasn't found all cells and there is more false cells recognizes as before method.

Tab. 1. Comparison of recognized objects in dependence on sensitivity and minimum score.

Minimum Score	High sen.		Med. sen.		Low sen.	
	✓	✗	✓	✗	✓	✗
1000	0	0	0	0	0	0
975	1	0	1	0	1	0
950	1	0	1	0	2	0
925	2	0	3	0	2	0
900	6	0	7	0	5	0
875	8	0	10	0	9	0
850	11	0	11	0	11	0
825	13	0	13	0	11	0
800	16	0	15	0	13	0
775	17	0	17	0	14	0
750	18	0	17	0	15	0
725	19	0	17	1	15	0
700	19	0	17	4	15	0
675	19	0	18	9	15	0
650	19	0	18	19	15	0
625	19	0	18	25	15	0
600	19	0	18	25	15	2
575	19	4	18	25	15	2
550	19	6	18	25	15	2

4. CONCLUSION

In this paper are methods for biomedical image analysis using of Vision Assistant and LabVIEW program. For experiment was used Particle Analysis and Pattern matching method.

This methodology allows for the opportunity to introduce new processes/methods of evaluating the quality of biomedical images.

These original images was used from program ImageJ and results were created by Vision Assistant program in Laboratory Department of Mechatronics and Electronics, Faculty of Electrical Engineering, University of Zilina, thanks to National Instruments Corporation, www.ni.com/czech.

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