

The applications of computer graphic filters to determine irregular pathology area

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Abstract — The paper presents practical applications of computer filters for identification and determination of ulcerous gastropathy size. The proposed method is based on the analysis of brightness and contrast between a healthy tissue and the pathology. Boundary and band graphic filters have been used to separate the pathology area. The determination has been performed on the basis of the histogram analysis of a particular endoscopic image.

I. INTRODUCTION

Miniaturization and growth of importance computer techniques in image treatment caused that today picture registering devices are used in all life domains. Furthermore, we can use them in almost every circumstances. Similarly, in the gastroscopy, where the gastroscopy and endoscopy cameras are used to identify illness. Despite stomach interior pictures have been taken from tens of years, the size of a given illness has been estimated on the basis of doctor's experience.

We obtain two-dimensional images from video cameras and do not know the distance between the camera and the examined object. This makes the real size determination particularly difficult. Nowadays, the pathology size evaluation is performed on the basis of comparison to another element in a stomach. This means on the basis of doctor's perception and experience. The presented work proposes a method to describe sickness change sizes on the basis of two photos of the same pathology taken from a different distance.

Gastrosopic images taken from patients in the Institute of Rural Medicine in Lublin, Poland have been used to present the results of this method.

II. METHODS AND RESULTS

The purpose for this research is to create applications that enable fast determination of the size of examined pathology. Computer graphic filters and convolution image conversion methods have been used during tests.

The following computing algorithm is used in the programme to determine the size of pathology area:

1. The isolation of the pathology area.
2. Convolution conversion of the obtained image section to unify the colour of pathology area.
3. Image conversion from colour to 256 shades of grey.
4. The application of graphic filters to determine areas of established brightness.
5. Calculation of the pathology size.

A. The isolation of the pathology area

The isolation of the pathology area consists in visual identification of interesting area. Two points are marked on an original image (Fig. 1):

$$A(x_1, y_1) \text{ and } C(x_2, y_2),$$

which are the ends of diagonal of the isolated area within:

$$A(x_1, y_1), B(x_1, y_2), C(x_2, y_2) \text{ i } D(x_2, y_1),$$

where: x_1, x_2, y_1, y_2 – point coordinates..

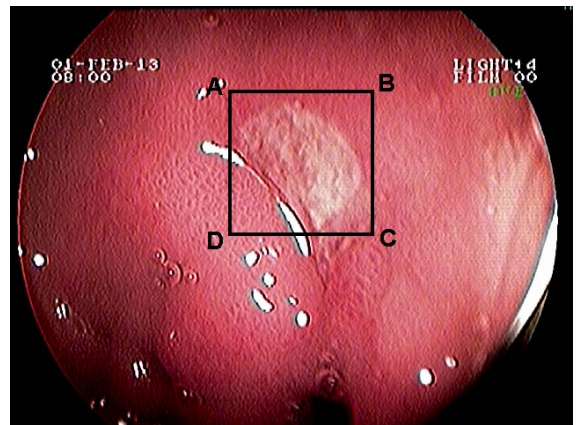


Fig. 1. The isolation of the section of interest from the original image [1]

This is to reduce the image subjected to further analysis. Thanks to this, one can shorten the analysis, reduce files and eliminate areas influencing computational precision.

B. Convolution conversion of the obtained image section to unify the colour of pathology area [2]

The Convolution conversion of images is a process, in which a new value of pixel brightness is computed on the basis of pixels neighbouring to the convolution nucleus, according to Equation 1.

$$P_5' = \begin{bmatrix} P_1 & P_2 & P_3 \\ P_4 & P_5 & P_6 \\ P_7 & P_8 & P_9 \end{bmatrix} \times \begin{bmatrix} K_1 & K_2 & K_3 \\ K_4 & K_5 & K_6 \\ K_7 & K_8 & K_9 \end{bmatrix} = \frac{\sum_{k=1}^9 P_k \cdot K_k}{wsp.normalizacji}, \quad (1)$$

where: P_5' – new brightness of pixel,

$P_1 \div P_9$ – brightnesses of pixels before transformate,

$K_1 \div K_9$ – convolutions index.

The used filters are averaging, making possible to smooth the contrast and remove the noise. This makes possible to unify the colour of pathology and of the healthy tissue. The result from smoothing filters is presented in Fig. 2 and Fig. 3.

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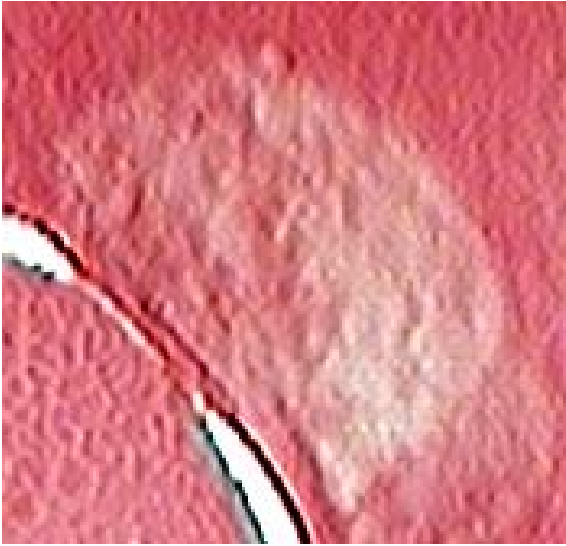


Fig. 2. The pathology area image before averaging filter treatment [1]



Fig. 3. The pathology area image after averaging filter treatment

C. Image conversion from colour to 256 shades of grey

The image conversion from colour saved in 24 bit format into a photo in 8 bit picture of 256 shades of grey is performed according to:

$$\text{grey}(RGB) = 0,3 \cdot R + 0,59 \cdot G + 0,11 \cdot B, \quad (2)$$

where: R – brightness of red,
 G – brightness of green,
 B – brightness of blue.

The histograms (Fig. 4., Fig. 5.) showed why, presented procedure make possible evaluate pixel brightness limit k .

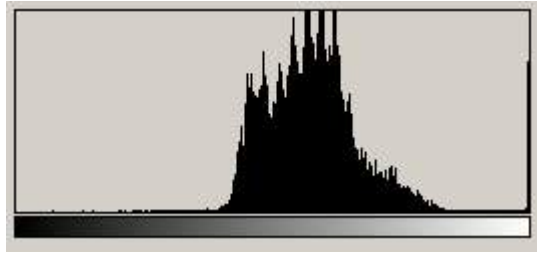


Fig. 4. Picture of histogram in RGB

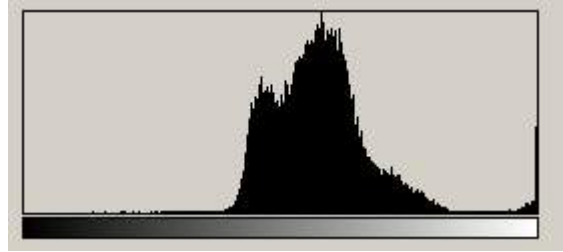


Fig. 5. Picture of histogram in BW

D. The application of graphic filters to determine areas of established

The programme checks each point of the picture and performs the condition:

$$\text{grey}(RGB) \geq k \Rightarrow \text{grey}(RGB) = 255 \quad (3)$$

$$\text{grey}(RGB) < k \Rightarrow \text{grey}(RGB) = 0 \quad (4)$$

where: k – pixel brightness limit.

The task for this condition is to isolate the pathology area and to mark it white. The isolated pathology area is presented in Fig. 6. The pixel limit is $k = 139$.



Fig. 6. The isolated pathology area image

E. Calculation of the pathology size

The method to compute pathology areas is the analysis of two photos of the same pathology taken from a different distance. To perform computations in this method, camera position distance pitch must be known between both photos (Fig. 7).

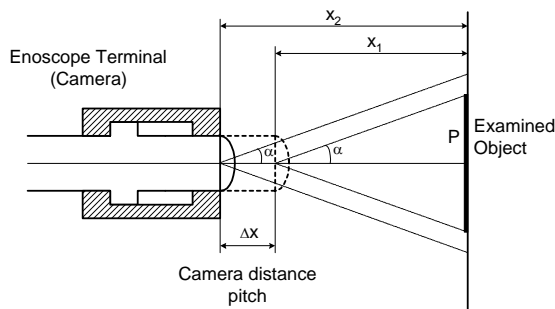


Fig. 7. Measurements of pathology size by means of camera position changes

The distance from the endoscope terminal to the examined pathology is determined on the basis of the dependence:

$$x_1 = \frac{\Delta X \cdot \sqrt{\frac{P_2}{P_1}}}{1 - \sqrt{\frac{P_2}{P_1}}} \quad (5)$$

where: x_1 - distance between a camera and a pathology,

ΔX - camera distance pitch,

P_1, P_2 - pathology areas in two camera positions in *pikselach*.

Calculations of real pathology area can be performed by means of the dependence:

$$P = \frac{P_1}{P_C} \cdot x_1^2 \cdot \operatorname{tg} \alpha \cdot \operatorname{tg} \beta \quad (6)$$

where: P - pathology area in mm^2, cm^2 ,

P_C - camera resolution in *pikselach*,

α, β - shooting angle of a camera – horizontal and vertical.

The verification of established dependencies (5) and (6) has been performed by means of a test stand (Fig. 8). Its main element is a digital camera Sony DCR-TRV27. The tests have used images of circles and triangles for the purpose of measurements.

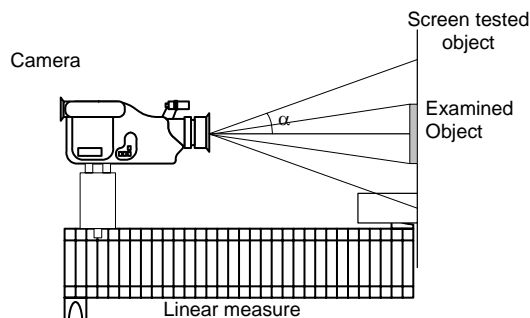


Fig. 8. Test stand model

Tested objects have been introduced in the distance of $x = 26$ cm from the camera. The second photo has been taken after position pitch of $X = 5$ cm. Mean results for circles, rectangles and triangles are presented in table 1.

TABLE I. EXEMPLARY MEAN MEASUREMENT RESULTS OF AREAS AND DISTANCES RELATED TO OBJECT SHAPES

Type of object		Circle	
Value	real	calculated	
Distance x_1	26,0 cm	26,3 cm	
Absolute error of area measurements P	1,2 %		
Camera pitch ΔX	5 cm		
Object area P	16,6 cm^2	16,7 cm^2	
Absolute error of area measurements P	0,6 %		
Type of object		Rectangle	
Value	real	calculated	
Distance x_1	26,0 cm	25,3 cm	
Absolute error of area measurements P	-2,7 %		
Camera pitch ΔX	5 cm		
Object area P	20,9 cm^2	20,4 cm^2	
Absolute error of area measurements P	-2,4 %		
Type of object		Triangle	
Value	real	calculated	
Distance x_1	26,0 cm	26,6 cm	
Absolute error of area measurements P	2,3 %		
Camera pitch ΔX	5 cm		
Object area P	12,9 cm^2	13,0 cm^2	
Absolute error of area measurements P	0,8 %		

III. CONCLUSIONS

1. Presented method, which employ digital conversion of images by means of graphic filters enable independent measurements of pathology of irregular shape instead of recently used estimation in diagnostics.
2. The presented method gives less error measurements but requires a special terminal on endoscopes to make camera lens travel possible.
3. The presented method can also be applied in other fields of medicine and technology where it is necessary to calculate the size of a tested object from its picture.

REFERENCES

- [1] Gastric pathology photos – courtesy of the Institute of Rural Medicine in Lublin.
- [2] Gutek D., Buczaj M.: "Computer visualisation in endoscopy (Wizualizacja komputerowa w endoskopii)", VI Lubelskie Akademickie Forum Informatyczne LAFI2002, s.109-115.
- [3] Jahne B.: "Digital Image Processing", Springer 2002, ss. 585.