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Mathematical Methods applied in Image Enhancement using Matlab

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Abstract**—***In order to characterize complex engineering problems involvinging image data acquisition, different techniques in image processing can be used. One of those techniques is called the Laplacian Filter, commonly used to reduce noise and improving images. Based on that, image segmentation is a widely applied tool in engineering and it can greatly contribute in the acceleration of processes instead of adopting conventional methods, thus providing applications of such technique in the medical, spatial and other sectors linked to engineering. Therefore, this work aims to use image segmentation through differential equations (Laplacian Filter) in different images using Matlab mathematical software in order to enhance images details.*

Keywords**—*****convolution; differential equations; image enhancement; image processing; Kernel; Laplacian; matlab.***

I. INTRODUCTION

Image processing is widely used for task automation, data thinning, noise reduction, and dozens of other engineering applications. Thus, this work aims to use on of the images segmentation processes know as Laplacian filter through the Matlab software. This filter consists of the application of a Laplacian formed by second order differential equations used for image refinement, detailing important data that often does not appear visible in images collected by various devices or images whose details are lost due to several other factors.

II. LAPLACIAN

Laplacian consists of second order differential equations for each pixel of an image, both on the x-axis and the y-axis as indicated by the following equations (1) and (2) below:

$$\frac{d^2 f}{dx^2} = f(x+1,y) + f(x-1,y) - 2f(x,y) \qquad (1)$$

$$\frac{d^2 f}{dy^2} = f(x,y+1) + f(x,y-1) - 2f(x,y) \qquad (2)$$

Thus, the sum of equations (1) and (2) result in the Laplacian as shown in equation (3) below:

$$\nabla^2 f = \frac{d^2 f}{dx^2} + \frac{d^2 f}{dy^2} \qquad (3)$$

Accordingly to this, one method to represent those differential equations in a matrix can be seen in the equation (4) that follows:

$$\begin{bmatrix} (x-1,y+1) & (x,y+1) & (x+1,y+1) \\ (x-1,y) & (x,y) & (x+1,y) \\ (x-1,y-1) & (x,y-1) & (x+1,y-1) \end{bmatrix} \qquad (4)$$

Consequently, when replacing the values of (3) within (4), one obtain the following Kernel, as shown in equation (5).

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix} \qquad (5)$$

Where Kernel is a term used for matrices who are used in image filtering through the mathematical method known as convolution.

III. CONVOLUTION

In many cases, when working with images, it is recommended to convert it to grayscale system, where each of its pixels accumulate values ranging from 0 to 255 in intensity degree, with “0” corresponding to black and “255”corresponding to white color.

Hence, these values allow that any image can be represented as a numerical matrix as illustrated in figure (1) below:

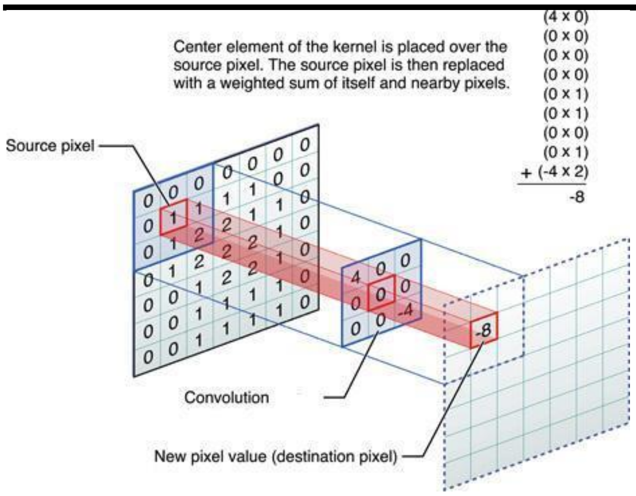

Fig.1: Exemplo de uma convolução.

Figure 1 shows that the Kernel multiplies the value of each of its pixels by the value of the corresponding pixel in the figure that will undergo the convolution, adding them to the end of the process that is repeated for each pixel where the Kernel can fit in completely.

Based on that, a new matrix having two rows and two columns shorter than the original one is generated, and the new values contained for each pixel of this new matrix are able to produce a range of effects on the original image.

IV. RESULTS

The selected images were extracted from the library of the Matlab software itself and the code developed to apply the Laplacian filter proved to be very effective. Thus, figures (2), (3) and (4), as shown below, proved that this mathematical method can be applied to reveal some details not visible to human eyes and to assist data analysis from several experimental studies.

Fig.2: Before and after Laplacian filter application.

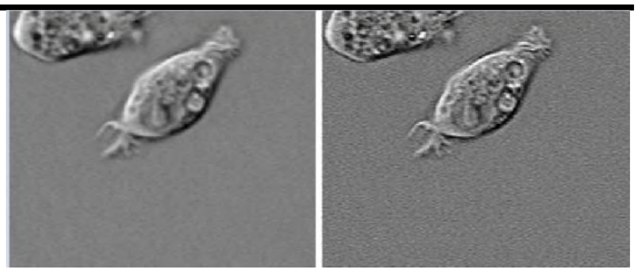

Fig.3: Before and after Laplacian filter application.

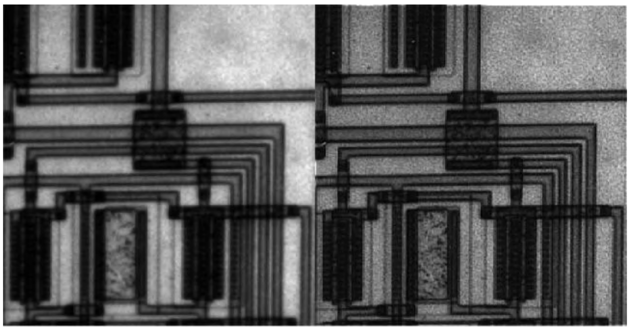

Fig.4: Before and after Laplacian filter application.

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REFERENCES

[1] Buenos, G; Albalá, A. M; Cosías, P. Fuzziness and PDE based Models for the Segmentation of Medical Images. Nuclear Science Symposium Conference Record, 2004 IEEE, doi: 10.1109/NSSMIC.2004.1466702

[2] Dusik, K; Junhee, Y; Changyoon, K. Automatic Photovoltaic Panel Area Extraction from UAV Thermal Infrared Images. Journal of the Korean Society of Surveying Geodesy, Photogrammetry and Cartography. 2016. https://doi.org/10.7848/ksgpc.2016.34.6.559

[3] Gonzales, R. C; Woods, R. E; Eddins, S. L. Digital Image Processing using Matlab. Pearson, 2nd ed.

[4] Khan W. Image Segmentation Techniques: A Survey. Journal of Image and Graphics Vol.1, No. 4, December 2013, doi: 10.12720/joig.1.4.166-170

[5] Kim, D; Youn J; Kim C. Automatic fault recognition of photovoltaic modules based on statistical analysis of UAV thermography. International Conference on Unmanned Aerial Vehicles in Geomatics, 4-7 September 2017, Bonn, Germany.

https://doi.org/10.5194/isprs-archives-XLII-2_W6-179-2017

[6] Neto, J. L. R; Junior, P. A. A. M. Utilização de Técnicas de Inteligência Artificial na Segmentação de Imagens para Análise de Modelos Fotoelásticos. XXXVII Iberian Latin American Congress on computational methods in engineering. Brasília, November 2016.

[7] Sasikala, N. Shruthi, G. Texture Analysis of a Color Image using Traditional and Circular Gabor Filters. International Journal of Advanced Engineering Research and Science. (ISSN: 2349-6495(P) | 2456-1908(O). https://dx.doi.org/10.22161/ijaers

[8] Tsanakas, J. A; Chrysostomou, D; Botsaris, P. N; Gasteratos, A. Fault diagnosis of photovoltaic modules through image processing and Canny edge detection on field thermographic measurements. International Journal of Sustainable Energy, 2015. http://dx.doi.org/10.1080/14786451.2013.826223

[9] Vale, G. M; Poz, A. P. D. O Processo de detecção de bordas de canny: fundamentos, algoritmos e avaliação experimental. Anais do Simpósio Brasileiro de Geomática, Presidente Prudente – SP, Brasil, 9-13 July 2002, p. 292-303.

[10] Wang, S; Xu, Y; Wan, L. Marine image enhancement using fuzzy algorithm based on modified fuzzy partition. International Conference on Photonics, 3D-Imaging, and Visualization, 2011, Guangzhou, China, doi: 10:1117/12.905914