International Journal of Information, Control and Computer Sciences
ISSN: 2517-9942
Vol:8, No:5, 2014

# An Image Matching Method for Digital Images Using Morphological Approach

Pinaki Pratim Acharjya, Dibyendu Ghoshal

***Abstract*—**Image matching methods play a key role in deciding correspondence between two image scenes. This paper presents a method for the matching of digital images using mathematical morphology. The proposed method has been applied to real life images. The matching process has shown successful and promising results.

***Keywords*—**Digital image, gradients, image matching, mathematical morphology.

## I. Introduction

IMAGE matching [1]-[3], or comparing images in order to obtain a measure of their similarity, is an important computer vision problem [4]-[5] with a variety of applications. In this research paper a method for digital image matching between two real life images has been proposed by extracting the features [6] from the images. Feature extraction from digital images includes extracting the significant knowledge from the images. Biggest benefit of feature extraction [7] is that it meaningfully decreases the information to represent an image for comprehending the content of that image. It uses various technical skills to extract the features like for example structural, concavity features and gradient, which criterions the image attributes at local, medium and large scale. Mathematical morphology [8]-[14] has been brought into the proposed approach of this research paper for feature extraction, edge extraction and finally for image matching or finding the similar images. The proposed approach as the present one is not so far available in published or online literature, and it is worthwhile to investigate the effects of morphological gradients capable of finding edges and the effectiveness of morphological gradients [13] in image matching.

The mathematical morphology [15], [16] is a nonlinear branch of the signal processing field and concerns the application of set theory concepts to image analysis. Morphology refers to the study of shapes and structures from a general scientific perspective. In this research paper mathematical morphology is used for generating gradients for image matching purpose. In mathematical morphology and digital image processing the gradient of an image is a directional change in the intensity or color in an image and the difference between the dilation and the erosion of a given image forms a morphological gradient [17]-[22]. Mathematical formulations of morphological gradient are discussed in Section II. It is an image where typically each non-negative pixel value indicates the contrast intensity in the close neighborhood of that pixel. Image gradients are very much useful to extract different information from images, edge detection of different objects and for several image segmentation applications.

The paper is organized as follows. In Section II, morphological gradient has been discussed. Proposed method has been discussed in Section III. Experimental results display the successful matching process in Section IV. Conclusions are added in Section V followed by the references.

Pinaki Pratim Acharjya is with Department of Electronics and Communication Engineering, NIT, Agartala, India (phone: +918348841764; e-mail: ppacharjya@gmail.com).

Dibyendu Ghoshal is with Department of Electronics and Communication Engineering, NIT, Agartala, India (phone: +919436767185; e-mail: tukumw@gmail.com).

## II. Mathematical Formulations of Morphological Gradient

Morphological gradient can be accrued by image erosion and dilation. Erosion and dilation are two fundamental operations in morphological image processing from which all other morphological operations are based on. It was originally defined for binary images, later being extended to grayscale images. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. More complicated morphological operators can be designed by combining erosions and dilations.

The processing is done on the shape (set) $A$ using a structuring element (set) $B$.

$$A \oplus B = \{x | (\hat{B})_x \cap A \neq \varnothing\} \quad (1)$$

$$A \ominus B = \{x | (B)_x \subseteq A\} \quad (2)$$

Dilation gives the original set plus an extra boundary. The size and shape of the boundary depends on the shape and size of the structuring element. Erosion gives the points for which the structuring element is contained in the original set. The outer boundary of the original shape is removed by erosion. Dilation is the complementary operation of erosion and vice versa.

$$\begin{aligned}(A \oplus B)^c &= \{x | (B)_x \subseteq A\}^c \\ &= \{x | (B)\_x \cap A^c = \varnothing\}^c \\ &= \{ x | (B)\_x \cap A^c \neq \varnothing\} \\ &= A^c \oplus \hat{B} \quad (3)\end{aligned}$$

Morphological gradient:

$$(A \ominus B)^c = A^c \oplus B \tag{4}$$

## III. Proposed Method

The flow diagram of the proposed approach has been shown in Fig. 1. In proposed methodology, first two real life images are chosen as input images and accordingly converted into gray scale images. In next step the morphological gradients are generated for feature extraction and edge detection. To find out the matching of two images the morphological edge values of two images have been compared pixel by pixel. If the matching is greater than 90 Percent of the total pixels of two different images, it can be considered that the images are same; otherwise two images are different images.

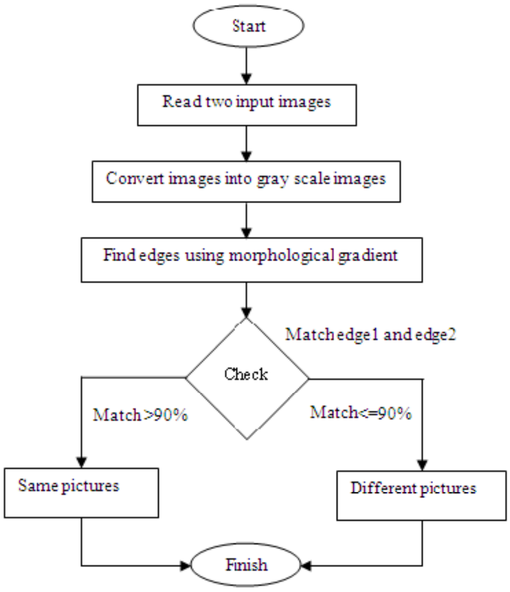


Fig. 1 Flow diagram of the proposed method

## IV. Experimental Results and Discussion

Two real life images of “Laure” of 256 x 256 dimensions and “Lena” of 512 x 512 has been chosen to do the experimental work. In Fig. 2 image of Lena has been chosen as two input images and their grayscale images has been shown in Fig. 3. In Fig. 4 the morphological gradient images has been shown and on application of the proposed approach it has been found that the two images have the same similarity of 100%. Hence we can conclude that the two images are same. In Fig. 5 two different images has been taken (Lena and Laure) and accordingly their grayscale images has been shown. In Fig. 6 the morphological gradient images has been shown and on application of the proposed approach it has been found that the two images have similarity of0 %. So we can conclude that the two images are different. The statistical measurements are also calculated with entropy, peak signal to noise ratio (PSNR) and mean square error (MSE). The statistical measurements are shown in Table I. Image entropy is calculated with the following formula.

$$Entropy = \sum_i P_j log_2 P_j \tag{5}$$

The PSNR is the value of the noisy image with respect to that of the original image. The value of PSNR and MSE for the proposed method is found out experimentally. The PSNR and the Mean Square Error of the retrieved image can be calculated by using (6) and (7):

$$PSNR(Img, Org) = 10log10_{10} \frac{S^2}{MSE(Img,Org)} \tag{6}$$

$$MSE(Img, Org) = \frac{(\Sigma c{=}1 \Sigma i{=}1\ \Sigma j{=}1\ [Org(i,j,c) - Img(i,j,c)]}{3NM} \tag{7}$$

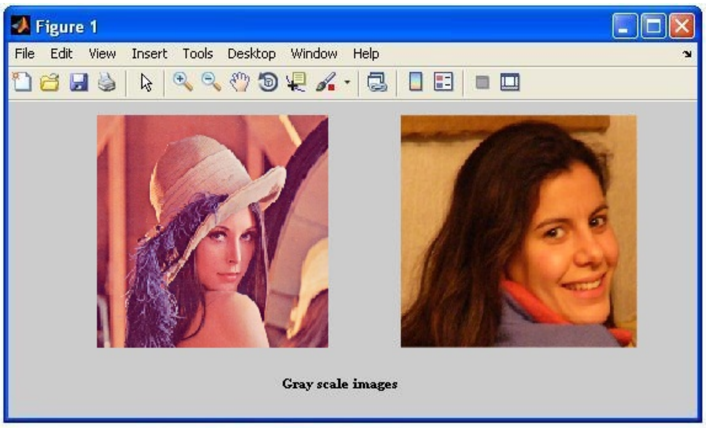


Fig. 2 Original color images of Lena and Laure

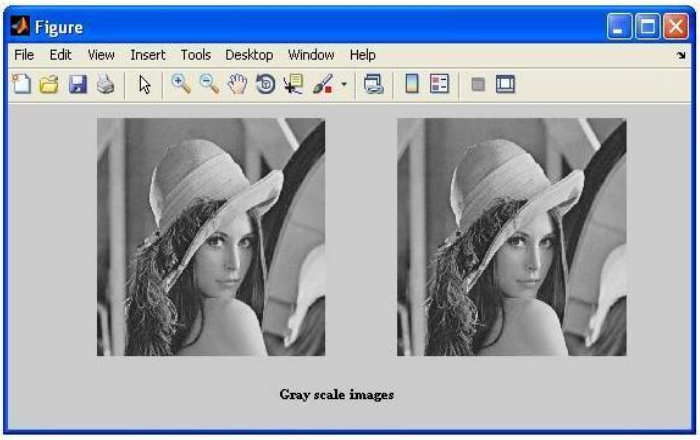


Fig. 3 Gray scale images of Lena image (input images)

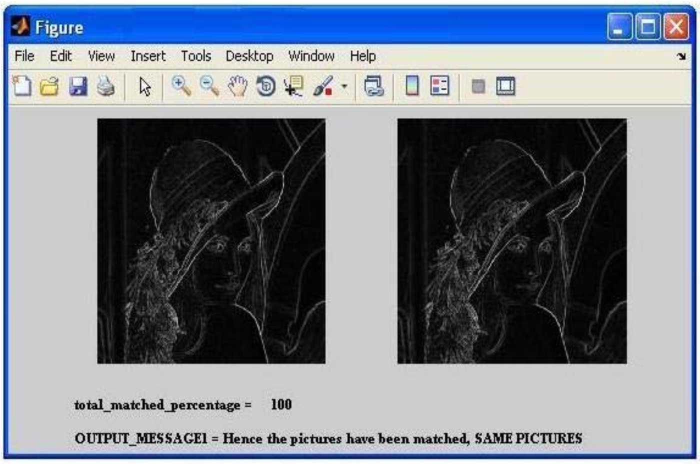


Fig. 4 Grayscale images of Lena and Laure (Total matched percentage = 100, hence same images)

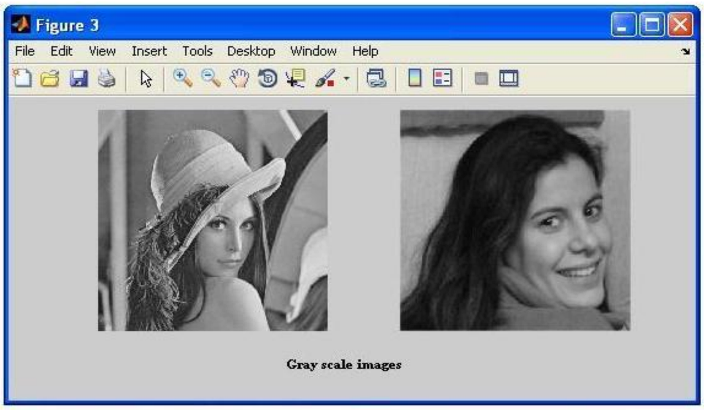


Fig. 5 Grayscale images of Lena and Laure (input images)

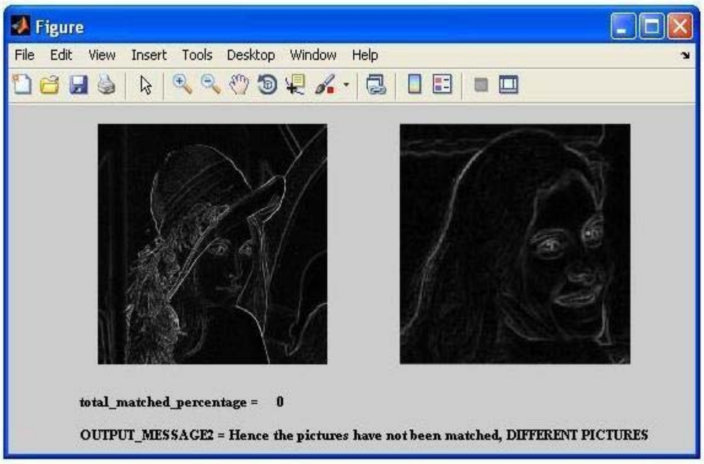


Fig. 6 Final output images of Lena and Laure image (Total matched percentage = 0, hence different images)

TABLE I
STATISTICAL MEASUREMENTS

| Fig. No | Image | Entropy | MSE | PSNR |
|---|---|---|---|---|
| Fig. 3 | Lena (input grayscale image) | 5.8364 | 0.2184 | 54.7375 |
| Fig. 3 | Lena (input grayscale image) | 5.8364 | 0.2184 | 54.7375 |
| Fig. 4 | Lena (output gradient image) | 4.6217 | 9.1035e+003 | 8.5387 |
| Fig. 4 | Lena (output gradient image) | 4.6217 | 9.1035e+003 | 8.5387 |
| Fig. 5 | Lena (input grayscale image) | 5.8364 | 0.2184 | 54.7375 |
| Fig. 5 | Laure (input grayscale image) | 4.3964 | 0.1786 | 55.6129 |
| Fig. 6 | Lena (output gradient image) | 4.6217 | 9.1035e+003 | 8.5387 |
| Fig. 6 | Laure (output gradient image) | 3.5044 | 4.2245e+003 | 11.8730 |

## V. CONCLUSION

Accuracy in real time operations for image matching is demanded by more and more applications. Both, area based and feature based algorithms walk towards this objective. A digital image matching approach involving mathematical morphology is presented in this paper. The main thrust of the proposed work lies on the rigidity property used in the object matching decision. The proposed approach or methodology is an avenue for future research which will further enhance the mathematical morphology based digital image matching technique.

## REFERENCES

[1] Joglekar J. V, Gedam S. S., "Area Based Image Matching Technique using Haudorff distance and Texture analysis", ISPRS WG III/4 International conference PIA11, Technical University of Munchen, Germany, 2011.

[2] A. Mojsilovic, J. Kovacevic, J. Hu, R.J. Safranek, and S.K. Ganapathy, Matching and Retrieval Based on the Vocabulary and Grammar of Color Patterns," IEEE Trans. Image Processing, vol. 9, no. 1, pp. 38-54, 2000.

[3] J.Z. Wang, J. Li, and G. Wiederhold, \SIMPLIcity: Semantics-Sensitive Integrated Matching for Picture LIbraries," IEEE Trans. Pattern Anal. and Machine Intell., vol. 23, no. 9, pp. 947-963, 2001.

[4] N. B. Kachare and V. S. Inamdar, Int. J. Comput. Appl., vol. 1, no. 1, (2010).

[5] T. Gong, "High-precision Immune Computation for Secure Face Recognition Security and Its Applications (IJSIA), vol. 6, no. 2, SERSC, (2012), pp. 293-298.

[6] M. Owis, A. Abou-Zied, A. B. Youssef and Y. Kadah, "Robust feature extraction from ECG signals based on nonlinear dynamical modeling", 23rd Annual International Conference IEEE Engineering in Medicine and Biology Society, (EMBC'01), vol. 2, (2001), pp. 1585-1588.

[7] W. Xu and E. J. Lee, "Human Face Recognition Based on Improved D-LDA and Integrated BPNNs Algorithms", International Journal of Security and Its Applications (IJSIA), vol. 6, no. 2, SERSC, (2012), pp. 121-126.

[8] S. Beucher, "Watershed, hierarchical segmentation and water fall algorithm," in Mathematical Morphology and Its Applications to Image Processing, Dordrecht, The Netherlands: Kluwer, 1994, pp. 69–76.

[9] Beucher, S., and Meyer, F. The morphological approach to segmentation: the watershed transformation. In Mathematical Morphology in Image Processing, E. R. Dougherty, Ed. Marcel Dekker, New York, ch. 12, pp. 433-481, 1993.

[10] F. Meyer, S. Beucher, "Morphological Segmentation," Journal of Visual Communication and Image Representation,vol. 1, pp. 21-46, 1990.

[11] C. R. Giardina and E. R. Dougherty, Morphological Methods in Image and Signal Processing, Prentice-Hall, Upper Saddle River, NJ, USA, 1988.

[12] Milan Sonka et. al. Image Processing, Analysis and Machine Vision. PWS Publishing, second edition, 1999.

[13] Pierre Soille, Morphological Image Analysis. Springer-Verlag, 2003.

[14] Rafael C. Gonzalez, Richard E Woods. Digital Image Processing. Prentice Hall, second edition, 2002.

[15] Santiago Velasco-Forero, Student Member, IEEE, and Jesus Angulo, "Random Projection Depth for Multivariate Mathematical Morphology", IEEE Journal Of Selected Topics In Signal Processing, Vol. 6, No. 7, November 2012.

[16] S. Velasco-Forero and J. Angulo, "Mathematical morphology for vector images using statistical depth," in Mathematical Morphology and Its Applications to Image and Signal Processing, ser. Lecture Notes in Computer Science, P. Soille, M. Pesaresi, and G. Ouzounis, Eds. Berlin/Heidelberg, Germany: Springer, 2011, vol. 6671, pp.355–366.

[17] Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB," Second Edition, Gatesmark Publishing, 2009.

[18] P. Jackway, "Gradient watersheds in morphological scalespace," IEEE Trans. Image Processing vol. l5, pp. 913–921, June, 1996.

[19] P. Soille, Morphological Image Analysis. New York: Springer Verlag, 1999.
[20] Image Analysis and Mathematical Morphology by Jean Serra, ISBN 0-12-637240-3, 1982.
[21] Image Analysis and Mathematical Morphology, Volume 2: Theoretical Advances by Jean Serra, ISBN 0-12-637241-1, 1988.
[22] An Introduction to Morphological Image Processing by Edward R. Dougherty, ISBN 0-8194-0845-X, 1992.