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Image Shape Matching Based on FM Transformation Technique

KEYWORDS: Image Shape Similarity, Image Matching, Image Similarity, Hausdorff Distance

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ABSTRACT *Image shape matching is prime concern in object recognition and identification methods. the objects are recognized based on their shape similarity. In this paper an image shape matching method based on Fourier Mellin (FM) transformation is given. The outline of the given input images are first registered in the same spatial coordination space before comparison. The performance of this method is evaluated by computing overlap similarity and hausdorff distance measures. The experimental result shows that the proposed image comparison method produces accurate comparison result.*

I. Introduction

An image matching is a means of determining the resemblance of one image with the other image. Images are matched based on their shape and texture and it finds variety of applications ranging from image retrieval, object recognition, remote sensing, image classification, image analysis and so on. Images are needed to be compared qualitatively and/or quantitatively to find the similarities. For qualitative comparison an image may be overlaid transparently with the other one to visualize the similarities and differences. Quantitative comparison is carried out with some quantitative measures such as similarity and distance measures.

In general, image matching techniques are classified into structure-based [1] [2] and feature-based [3][4] methods. Structure-based methods compare the shape/structure and the size of the images, whereas the feature-based methods examine the image features like color and texture in addition to size and shape. Therefore, the image shape and size are the most essential component in automatic image matching systems. Moreover, the image comparison can not be done directly on image shapes, it require an image registration process to align the image within the same coordinate space. Image registration is one of the fundamental tasks in image matching process. The output of image registration is a geometrical transformation which is a mathematical mapping of one image with the other. There are many image registration methods are available in the literature [5][6]. Fourier-based image registration method are efficient and accurate to estimate the image transformation such as rotation, scaling and translation. Fourier-based method [7] uses information in the frequency domain to match the images.

The proposed image comparison method uses Fourier Mellin (FM) [8] [9] transformation to register the image structure in the same coordinate space. After that the images are compared by calculating the similarity and distance measures. The remaining part of the paper is organized as follows: In section 2, the methodological detail about the proposed method is described. In section 3, the experimental results and discussion are given. The conclusion is given in section 4.

II. Methods

Image matching is a challenging process because of their varying morphology, size and spatial coordinates. The proposed method aims to compare the image structures after registering the given two images in the uniform coordinate space. In this method the input images (Image 1 and Image 2) are first converted into binary form. An image binarization method proposed in [10] is used to convert the given image into binary image. Then the holes in these binary images are filled with the hole filling algorithm [11] that uses morphological reconstruction and are defined by:

$$g_m(x,y) = \begin{cases} 1 - g(x,y) & \textit{if } (x,y) \textit{ is on the border of } g \\ 0 & \textit{Otherwise} \end{cases} \qquad (1)$$

$$g_{HF} = \left[R_f c(g_m)\right]^c \qquad (2)$$

where, g denote the binary image, g_m is the marker image and has 1 on image border and 0 for every where except border, $R_f c$ is a reconstructed image of g_m and g_H is the hole filled binary image.

After filling the holes in the binary images, it needs to detect the edges in the binary image. This proposed method compares the shapes of the images and therefore, it is required to produce the image outline. It uses canny edge [12] detector to get the image outline. Canny is a well known edge detector and is still used in research. It uses a multi-stage algorithm to detect edges in the image. It results with fine edges after suppressing the noises present in the image. After detecting the image outline, they are aligned in the same coordinate space using the image registration method. To register the image outlines, the FM transformation technique is applied. FM transformation uses Fourier transformation, log-polar transformation and phase correlation methods. The process of image registration is illustrated in Fig.1.

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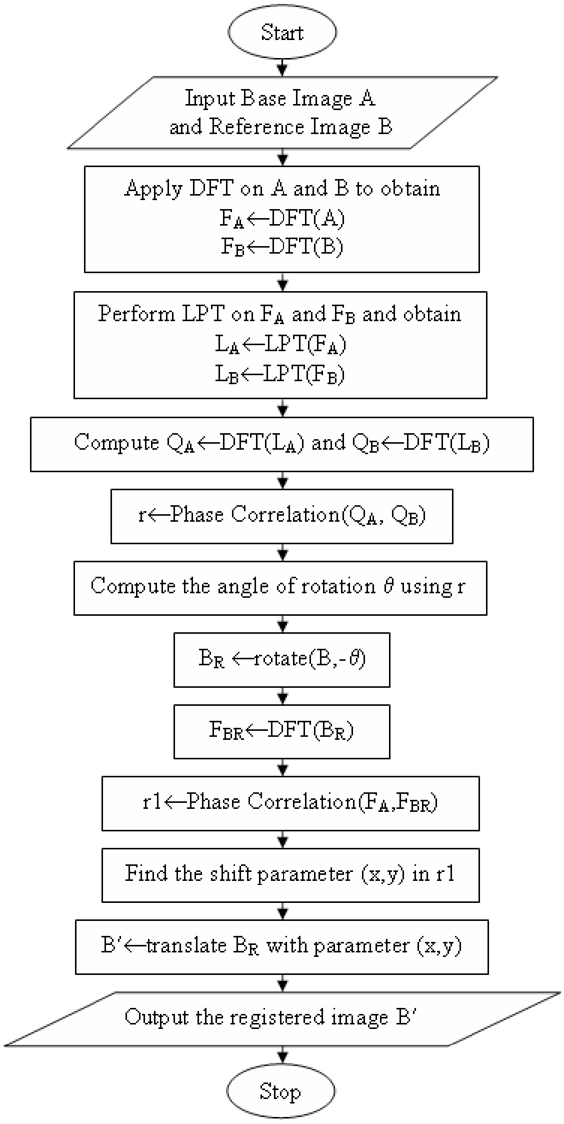

Fig. 1: Steps in image registration process

This Image registration method takes two images, base image (outline of Image 1) and reference image (outline of Image 2) as an input. Discrete Fourier Transformation (DFT) is then applied on the outline of Image 1 and Image 2 and is referred as F_A and F_B respectively. Then the Log-Polar Transformation (LPT) is applied on F_A and F_B. The LPT(r, θ) at any arbitrary point (x,y) is given by:

$$r = \log_{base}\left(\sqrt{(x - x_c)^2 + (y - y_c)^2}\right) \quad (3)$$

$$\theta = tan^{-1}\left(\frac{y - y_c}{x - x_c}\right) \quad (4)$$

where, r denotes radial distance from the center(x_c y_c)) and θ denotes the angle of rotation. This method uses base 10 logarithm to obtain the polar coordinates. Then the phase-correlation method is used to find the translation and it uses Fast Fourier Domain approach to estimate the relative translation between two images. Correlating the magnitude of FMT, it is possible to obtain an image registration method invariant to translation, rotation and scaling. The scale and rotation parameters are obtained by calculating the cross-power spectrum (R). The cross-power spectrum (R) of two images f and f^1 with Fourier transforms *F* and F^{-} is defined as:

$$R = F\left\{\frac{F F^{1*}}{|F F^{1*}|}\right\} \quad (5)$$

where, F^{1*} is a complex conjugate of F^{*-}. Then the rotation Δx and the scale Δy is computed by:

$$(\Delta x, \Delta y) = \arg \max_{(x,y)} \{R\} \quad (6)$$

where, (x,y) is the location of the peak in R. After computing the rotation and scaling parameters, the referenced image is rotated and scaled to register with the base image.

The steps involved in the proposed method are summarized as follows:

Step-1: Read Image 1 and Image 2

Step-2: Convert the images into binary form using the method given in [9]

Step-3: Fill the holes in the binary images by the Eqns. (1) and (2)

Step-4: Find outlines in the binary images

Step-5: Apply image registration steps given in Fig.1 to register the images

Step-6: Compute the similarity and dissimilarity between the given two images using the overlapping similarity and the hausdorff distance by the Eqns. (7) and (8)

A. *Image Comparison Evaluation Metrics*

The images are quantitatively compared by calculating the overlapping similarity ratio and hausdorff distance measures. The overlapping similarity is computed by:

$$similarity(A,B) = \frac{T(A \cap B)}{T(A \cup B)} \times 100 \quad (7)$$

where A and B are the input images and T(X) denotes the total number of pixels in the image X. The similarity value lies between 0 to 1. The value 0 denotes that the images are completely different and 1 represents the images are identical.

The dissimilarity of the images is estimated by computing the distance measures. This proposed method uses hausdorff distance to measure the dissimilarity. The hausdorff distance is the maximum distance of a set to the nearest point in the other set. Hausdorff distance from set A to set B is a maximum function and is defined as:

$$h(A,B) = \max_{a \in A}\left\{\min_{b \in B}\{d(a,b)\}\right\} \quad (8)$$

where a and b are points of image A and B respectively, and d(a,b) is the Euclidian distance between a and b.

III. Result and Discussions

The proposed image comparison method is evaluated by calculating the similarity and distance measures before and after registering the images. The selected sample six set of images labeled 1 to 6 and their corresponding image

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matching results are shown in Fig.2.

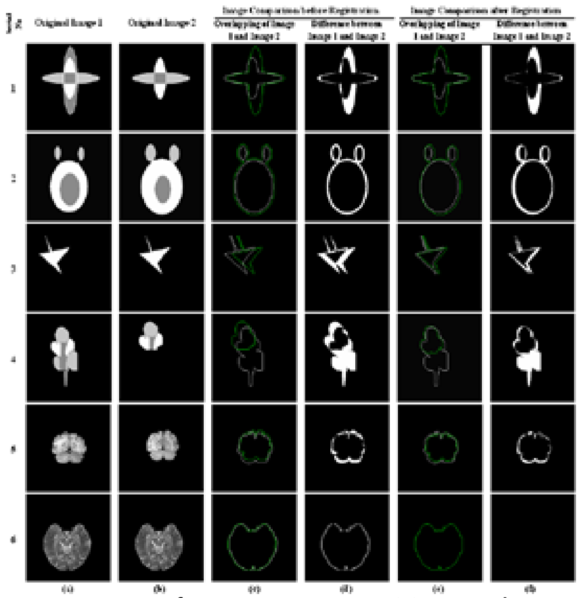

Fig. 2: Output of image comparison, (a) Original Image 1; (b) Original Image 2; (c) Overlapping of Image 1 (green color) and Image 2 (white color) before registration; (d) Difference of Image 1 and Image 2 before registration; (e) Overlapping of Image 1 (green color) and Image 2 (white color) after registration; (f) Difference of Image 1 and Image 2 after registration

In this figure the first two columns (a) and (b) are the input images. If the input image is a color image then it is converted into gray scale image. The input images are then converted into binary image to obtain the image outline because the proposed method aims to find the structural similarity between the images. The outlines of the images are overlaid to compare the structural similarity. Fig. 2 (c) represent the outline of Image 1 (green color) overlaid with outline of Image 2 (white color) before applying the image registration method. The differences between the input images before the registration are shown in column (d) of Fig. 2. From Fig. 2(d), it is observed that some regions in image are not properly matched even when they have similar structure due to their varying spatial coordinates. To overcome this, the proposed method uses image registration method based on FM transformation to register the image structures to lie in the same coordinate space before comparison. The results obtained after registering the image are shown in column (e) of Fig. 2. The green line in Fig. 2(e) represents the outline of Image 1 (base image) and white line in the same figure represents outline of image 2 (reference image) after registration and the differences are shown in Fig. 2(f). Compared to the images in Fig. 2(d), the images in Fig. 2(f) were compared accurately.

The computed similarity and dissimilarity (distance) using the Eqns. (7) and (8) for the selected images of in Fig. 2 before and after registration are given in Table 1. The Image 6 of Fig. 2 has similar structure with little deviation in the spatial space (Image 6 of Fig. 2(d)) but the proposed method accurately registered the images and produced similarity value as 1 representing 100% similarity and 0 distance (that is the dissimilarity) between these images (Image 6 of Fig. 2(f)). Thus the proposed method has efficiently compared the given images and has produced accurate comparison results. The drawback of this method is that for some images it fails to register the images correctly when the difference in spatial coordinates is high and is illustrated in Fig. 3.

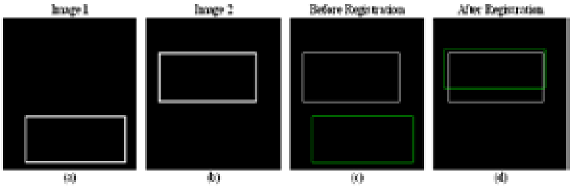

Fig. 3: Result of image comparison when the spatial difference between the image is high; (a) Image 1; (b) Image 2; (c) Overlapping of Image 1 (green color) and Image 2 (white color) before registration; (d) Overlapping of Image 1 (green color) and Image 2 (white color) after registration

TABLE I. Computed values of similarity and difference for the images shown in Fig. 2

Image	Before Registration		After Registration	
	Similarity	Distance	Similarity	Distance
1	0.59	46.32	0.65	45.54
2	0.77	10.77	0.77	7
3	0.28	22	0.54	12
4	0.27	21.26	0.40	6.4
5	0.78	8.06	0.85	2.82
6	0.94	3	1	0

IV. Conclusion

An efficient image comparison method based on FM transformation is proposed in this paper. This method accurately compares the two images and computes the overlapping similarity and hausdorff distance. For some images, the proposed method has failed to produce accurate result when the spatial difference between the images is high. This may be avoided in future by modifying the FM registration or by introducing a new image registration method. The proposed method compares only the structural similarities of the images, it may be extended further to compare the image features.

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REFERENCE [1] Belongie, S., Malik, J., Puzicha, J.: Shape Matching and Object Recognition using Shape Context. IEEE Transaction of Pattern Analysis and Machine Intelligence, 24 (2002). | [2] Simon, D.A., Kanade, T.: Geometric Constraint Analysis and Synthesis: Methods for Improving Shape-based Registration Accuracy. CVRMed-MRCAS '97, Springer-Verlag, 181–190 (1997). | [3] Baumberg, A.: Reliable Feature Matching Across Widely Separated Views. CVPR, 1, 774-781 (2000). | [4] Maes, F., Collignon, A., Vandermeulen, D., Marchal, G., Suetens, P.: Multimodality Image Registration by Maximization of Mutual Information. IEEE Transaction on Medical Imaging, 16, 187–198 (1997). | [5] Zitava, B., Flasser, J.: Image Registration Method: A Survey. Image Vision Computing, 21, 977-1000 (2003). | [6] Pan, W., Qin, K., Chen Y.: An Adaptive Multilayer Fractional Fourier Transform Approach for Image Registration, IEEE Transaction on Pattern Analysis and Machine Intelligence, 31, 400-413, (2009). | [7] Eddy, W.F., Fitzgerald, M., Noll, D.C. : Improved image registration by using Fourier interpolation. Magnetic Resonance in Medicine, 36, 923–931 (1996). | [8] Chen, Q., Defrise, M., Deconinck, F.: Symmetric Phase-only Matched Filtering of Fourier-Mellin Transforms for Image Registration and Recognition, IEEE Transactions on Pattern Analysis and Machine Intelligence, 16(12), 1156-1168 (1994). | [9] Kalavathi, P, Computation of Brain Asymmetry in 2D MR Brain Images, International Journal of Scientific & Engineering Research, 5(6), 1167-1171, 2014. | [10] Somasundaram, K., Kalavathi, P.: Medical Image Binarization using Square Wave Representation, Control, Computation and Information Systems, Springer, 140, 152-158 (2011). [11] Somasundaram, K. and Kalavathi. P.: Contour-Based Brain Segmentation Method for Magnetic Resonance Imaging Human Head Scans. Journal of Computer Assisted Tomography, 37(3), 353-368, (2013) [12] Canny, J.: A Computational Approach to Edge Detection. Pattern Analysis and Machine Intelligence, IEEE Transactions on, PAMI, 8(6):679–698 (1986). |