Facial Recognition of Identical Twins Using Zernike Moment

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Abstract*- Face recognition is one of the most challenging area in the domain of image processing and pattern recognition. The face recognition system is critical when individuals have very similar faces or identical twins. In this paper, the facial area in an image is detected using Ada Boost approach. After that the facial area is divided into some local regions. Finally, facial-based identical twins feature extractor based on the geometric moment is applied into local regions of face image. The utilized geometric moment is Zernike Moment (ZM) as a feature extractor inside the local regions of facial area of identical twins images. The method is evaluated on two different datasets, Twins Days Festival and Iranian Twin Society which contain scaled and rotated facial images of identical twins in different illuminations. The results prove the ability of proposed method to recognize a pair of identical twins.*

Keywords- Face Recognition , Identical Twins ,Invariant Moment, Zernike Moment

I. INTRODUCTION

Human face is considered as a suitable attribute to identify people from his (her) image. Along with this attribute, recognition of facial of identical twin and similar face is one of the most challenging problems in pattern recognition applications because of the similarity between the pair of twin.

In the domain of facial identical twins recognition, previous works are listed as: in, Klare and Jain introduced a face detection algorithm which includes three levels. In the first level, an overall appearance of the face is constructed; in the second level, exact geometric and structural embedment of face with differentiating between two similar faces are performed; and finally, the third level consists of process of skin disorders such as wounds, and so on. Sun et al.utilized Cognitec FaceVACS system to recognize identical twins from CASIA Multimodal Biometrics Database and they obtained the true accept rate of approximately 90% at a false accept rate greater than 10%. Park et al. proposed an identical twins recognition algorithm that consists of three steps: in first step, the proposed method consists of face images which are marked using normal geometric methods; in the second step, the Euclidean distance between a pair of markers are measured and compared; and the final step involves finding the strong similarity on the marked regions. Srinivas et al. studied on distinguishing of twins using marks on the face image. Martin et al. Employed DNA approach to recognize identical twins.

In this paper, we study on a pair of facial images in order to determine whether the images belong to the same person or to a pair of identical twin. For this purpose, we propose the geometric moments to extract feature vector from facial images of twins to recognize identical twins.

II.FEATURE EXTRACTION TECHNIQUE

Each face detection system contains four steps: 1.preprocessing 2. face localization, 3.feature extraction 4. classification. Feature extraction is a process which is employed to collect useful information from raw data and so this process is necessary for the pattern recognition problems. Since the feature extraction methods are not public and depend on application, feature extraction step may show different results. There are two different types for the feature extraction methods: structural features and statistical features [11][19]. In the first type, local structure of input image takes into account where these structural features deal with local data [7].

In the second type, the statistics-based feature extraction techniques create a set of feature vector according to the global data of input image. Extraction of irrelevant information from facial image may create unappreciated set of feature vector elements such as hair, shoulders, and background should be regarded in the feature extraction phase. Some of statistics-based feature extraction methods are listed as Principle Component Analysis (PCA), Legendre Moment (LM) and Zernike Moments (ZM) ,Pseudo-Zernike Moment (PZM). Legendre functions are Legendre differential equation. It is important that Legendre moments are orthogonal, independent of each other and free of data redundancy.

Zernike Moment (ZM) is a set of orthogonal polynomials which are defined into a unit disk. The ZM technique is independent of scale and rotation of face in image. The Pseudo-Zernike Moment (PZM) is the similar to

ZM but the feature vector elements extracted by PZM is more than the feature vector extracted by ZM and so is more suitable than ZM for recognition of identical twins. In this study, PZM is utilized to extract feature vector in order to recognize identical twins. The PZM will be described in the next Section.

III. PROPOSED METHOD

In this paper, the goal is distinguishing of identical twins and different person with similar faces using facial image. Forthis purpose, at the first step, a boosting method named AdaBoost [18] technique is employed to localize the facial area of input image and also create subimge. In the next step, the PZM is applied on each subimage to create feature vector elements for each subimage and this step is performed for all images in dataset. In the final step, the feature vectors of test image is compared to feature vectors of all images in dataset and the image of dataset with the minimum distance to the test image is selected as the pair of test image. In the next Section, the processes of face detection and feature extraction will be described in detail.

PZM is based on the geometric moment and used to create feature vector according to the global data of an image [9]. The advantages of PZM is that its orthogonal moments are shift, rotation, and scale invariants which are suitable for pattern recognition problems [6][5][8][17]. Also, PZM includes several orthogonal sets of complex-valued polynomials defined as

$$V_{nm}(x,y) = R_{nm}(x,y)\exp\left(jm\tan^{-1}\left(\frac{y}{x}\right)\right)$$

where $x^2 + y^2 \leq 1$, $n \geq 0$, $|m| \leq n$, and the radial polynomials $\{R_{nm}\}$ are defined as

$$R_{nm}(x,y) = \sum_{s=0}^{(n-|m|)} D_{n,|m|,s}(x^2+y^2)^{\frac{n-s}{2}}$$

where

$$D_{n,|m|,s} = (-1)^s \frac{(2n+1-s)!}{s!(n-|m|-s)!(n-|m|-s+1)!}$$

The PZM of order n and repetition m is calculate as

$$PZM_{nm} = \frac{n+1}{\pi}\sum_x \sum_y f(x,y)V_{nm}^{*}(x,y)$$

It is important that PZM is calculated for positive m because $V_{nm}(x,y) = V_{nm}^{*}(x,y)$. The reason of rotation invariance of PZM is that with the rotation of image, phase of moments in PZM will be varied and so its absolute value remains constant [4]. Therefore, feature is rotation invariance if the absolute value or value of PZM is considered as the feature. In the next Section, the process of feature vector creation using PZM will be described.

IV. EXPERIMENTAL RESULTS

The proposed method is evaluated on two datasets: Twins Days Festival [2] and Iranian Twin Society [1] which contain 520 and 600 pairs of identical twins images, respectively. The used datasets contain the scaled and rotated faces with different illuminations. Figure 1 shows the subimages of some twin test images. The results of identical twins recognition using ZM is compared with the results of LM [13]. Experiments have been carried out in three steps according to order of moment. In the first step, order n is in interval [1,6], in the second step, order n is in interval [6,8] and for third step, order n is in interval [9,10] (Table 2).

In this paper, N is set 10 (N=10) and j varies from 1 to 9. The misclassification rate of all geometric moments (LM and ZM) is presented in Table 3. The misclassification rate reported in the table are computed as

$$Error\ rate = \frac{No.\ of\ misclssification}{No.\ of\ total\ testing\ patterns}$$

Table 3 shows misclassification rates of LM and ZM. Comparison between geometric moments in Table 3 proves that higher order moments of the ZM have most information for face recognition while low-order moments have no significant effect on the system error. According to the table, LM achieves high misclassification rate on recognition of twins because the rotation of face in an image has bad effect on the performance of LM. As Table 3 shows, the misclassification rate of ZM is lower than the LM because ZM is rotation and scale invariant.

Table 1. Feature vector elements based on the ZM

j value	FV_j feature elements (ZM_{km}) K	M	Number of feature element
4	4	0,2,4	30
	5	1,3,5	
	6	0,2,4,6	
	7	1,3,5,7	
	8	0,2,4,6,8	
	9	1,3,5,7,9	
	10	0,2,4,6,8,10	
6	6	0,2,4,6	24
	7	1,3,5,7	
	8	0,2,4,6,8	
	9	1,3,5,7,9	
	10	0,2,4,6,8,10	
9	9	1,3,5,7,9	11
	10	0,2,4,6,8,10	

Table 2. Feature vector elements produced by geometric moments in each experiment

Cat.	LM feature elements	ZM feature elements
1	n=1, m=1 n=2, m=0,2 n=3, m=1,3 n=4, m=0,2,4 n=5, m=1,3,5 n=6, m=0,2,4,6	n=1, m=1 n=2, m=0,2 n=3, m=1,3 n=4, m=0,2,4 n=5, m=1,3,5 n=6, m=0,2,4,6
2	n=6, m=0,2,4,6 n=7, m=1,3,5,7 n=8, m=0,2,4,6,8	n=6, m=0,2,4,6 n=7, m=1,3,5,7 n=8, m=0,2,4,6,8
3	n=9, m=1,3,5,7,9 n=10, m=0,2,4,6,8,10	n=9, m=1,3,5,7,9 n=10, m=,0,2,4,6,8,10

Table 3. Error rate of each geometric moment in different categories. The bold values means the best values

Cat.	LM		ZM		PZM		LRPZM	
	No. of FE	ER	No. of FE	ER	No. of FE	ER	No. of FE	ER
n=1,2,…,6	15	10%	15	8.5%	26	4.5%	26	**3.98%**
n=6,7,8	13	9.1%	13	6.5%	24	3%	24	**2.86%**
n=9,10	11	6.1%	11	4%	21	1.3%	21	**0.76%**

Figure 1. Creating of subimage based on the ellipse formation.

V. CONCLUSIONS

In this paper, a system presented to improve the recognition of a pair of identical twins and different person with similar faces. The proposed method is based on the Local Region Pseudo-Zernike Moment (LRPZM) as a feature extractor to recognize a pair of identical twins and similar faces. For the face detection, AdaBoost method is applied on the facial image of twins and similar faces for different persons. After that, the obtained subimage is divided into some local regions and then the PZM is utilized to construct feature vector elements for each region. According to the experimental results, the proposed LRPZM system is able to extract informative feature vector from input image and also is robust to rotation and scaling and changing illumination.

REFERENCES

[1] Iranian twin society. http://www.irtwins.com/.

[2] Twins days festival. http://www.twinsdays.org.

[3] Arias, E., MacDorman, M.F., Strobino, D.M. & Guyer, B. (2003) "Annual summary of vital statistics2002", Pediatrics, Vol. 112, No. 6, pp. 1215-1230.

[4] Bailey, R.R. (1993) "Automatic recognition of handwritten numerals via orthogonal moments using statistical and neural network classifiers", Ph.D. thesis, Dallas, TX, USA (1993), aAI9331109.

[5] Belhumeur, P., Hespanha, J. & Kriegman, D. (1997) "Eigenfaces vs. fisherfaces recognition using class specific linear projection", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 19, No. 7, pp. 711-720.

[6] Belkasim, S., Shridhar, M. & Ahmadi, M. (1991) "Pattern recognition with moment invariants: A comparative study and new results", Pattern Recognition, Vol. 24, No.12, pp. 1117-1138, http://www.sciencedirect.com/science/article/pii/003132039190140Z.

[7] Bichsel, M. & Pentland, A. (1994) "Human face recognition and the face image sets topology"CVGIP Image Understanding, Vol. 59, No. 2, pp. 254-261.

[8] Zahra Ahmadi-Dastjerdi and Karim Faez "an efficient feature extraction method with local region zernike moment for facial recognition of identical twins", Informatics Engineering, an International Journal (IEIJ) ,Vol.2, No.1, March 2014