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Texton Based Shape Features on Local Binary Pattern for Age Classification

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Abstract**—** Classification and recognition of objects is interest of many researchers. Shape is a significant feature of objects and it plays a crucial role in image classification and recognition. The present paper assumes that the features that drastically affect the adulthood classification system are the Shape features (SF) of face. Based on this, the present paper proposes a new technique of adulthood classification by extracting feature parameters of face on Integrated Texton based LBP (IT-LBP) images. The present paper evaluates LBP features on facial images. On LBP Texton Images complex shape features are evaluated on facial images for a precise age classification.LBP is a local texture operator with low computational complexity and low sensitivity to changes in illumination. Textons are considered as texture shape primitives which are located with certain placement rules. The proposed shape features represent emergent patterns showing a common property all over the image. The experimental evidence on FGnet aging database clearly indicates the significance and accuracy of the proposed classification method over the other existing methods.

Index Terms**—** Shape features, LBP, Texton, Texture primitives, Emergent patterns

I. INTRODUCTION

Facial images are studied intensively in the literature for many applications like face recognition , predicting features of faces , reconstructing faces from some prescribed features , classifying gender, races and expressions from facial images, and so on. Facial aging has been an area of interest for decades [1,2,3,4,5,6], but it is only recently that efforts have been made to address problems like age estimation, age transformation, etc. from computational point of view [7,8,9,10,11,12,13,14,15]. Kwon and Lobo [8] classified input images as babies, young adults and senior adults based on cranio-facial development and skin wrinkle analysis. Some of the significant applications of studying age progression in human faces are face recognition across age (homeland security), automatic age estimation (parental control, age based Human-Computer interaction), prediction of one's appearance across age (finding missing individuals) etc. Developing models that characterize age progression in faces is a very challenging task. Facial aging effects are predominantly manifested in the form of shape variations during one's younger years and as wrinkles and other textural variations during one's older years [16].

Automatic age-progression is the process of modifying a face image in order to predict the future facial appearance of the corresponding person. In computer vision literature, age progression in human faces has been addressed from two perspectives: 1) Towards automatic age estimation and age based classification from face images [17]; 2) Towards computer-assisted age progression systems that could reliably predict one's appearance across age. The present paper focused on first. Automatic age progression involves the estimation of modification of the shape and texture features of a person's face in order to reflect cross-population age-related trends. The main issue in this subject is the accurate prediction of the facial appearance of a person along the time [18]. The present paper assumes that the ability to produce accurate age-classification depends on varying trends of shape features as age progresses. This ability has not been pursued in the computer vision community. To address this very important area of research, the present paper carried out the task of adulthood classification of a mug shot facial image into a child and adult. The present paper assumes the facial image of a person as a complicated texture. That's why new shape based texture classification methods is proposed on the IT-LBP facial images. The FGnet [7] contains images from a wide variety of lighting conditions and age-groups. In addition, the number of images under a particular lighting condition is unbalanced.

The paper is organized as follows. The methodology is introduced in section II. In Section III, contains experimental results and some discussions. Concluding remarks are given in section IV.

II. METHODOLOGY

Texture, on its own does not have the capability of finding similar images, but it can be used to classify textured images from non-textured ones and then combined with another visual attribute like color to make the retrieval more effective. Analysis of texture requires the identification of those texture attributes which can be used for segmentation, discrimination, recognition, or shape computation. To evaluate micro texture features of face and to make texture features of face relatively invariant with respect to changes in illumination, image rotation, the present paper integrated the features of textons and LBP for age classification. The textons are having 1) a close relationship with image features 2) emergent patterns sharing a common property 3) local distribution properties. LBP represents precisely local textural information with respect to changes in illumination, image rotation. The proposed method of age classification consists of four steps as shown in the block diagram of figure 1.

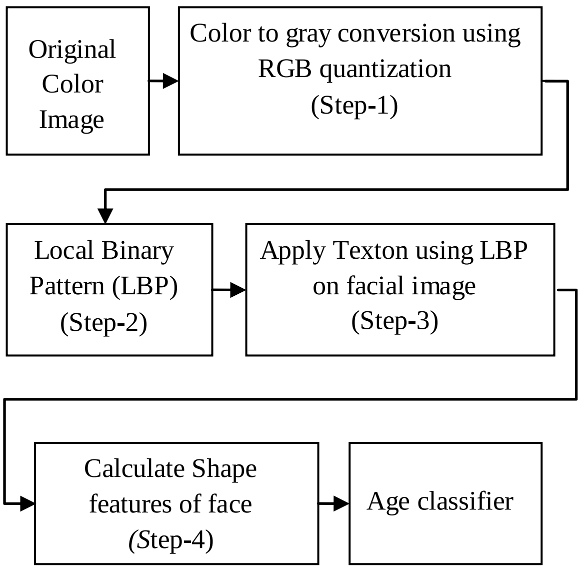

Figure1. Framework for age classification scheme using SF on IT-LBP faces images

A. Step -1: Color Quantization in RGB Color Space

To convert color facial image into grey level facial image the present paper utilized RGB color quantization method. Color provides powerful information for texture classification and recognition even in the total absence of shape information. In order to extract grey level features from color information the proposed IT-LBP method utilized the RGB color space which quantizes the color space into 8-bins to obtain 256 grey levels. The index matrix of 256 color image is denoted as C(x,y),given in the following Equation. Let I(R), I(G), I(B) be the index value of unit vectors along the R, G and B axes of RGB color space.

$$C(x,y) = 32 * I(R) + 4 * I(G) + I(B) \qquad (1)$$

where

$I(R) = 0,\ 0 \le R \le 32,$

$I(R) = i,\ ((32*i)+1) \le R \le (32*(i+1))\quad i = [1, 2, 3, \ldots, 7]$

$I(G) = 0,\ 0 \le G \le 32,$

$I(G) = i,\ ((32*i)+1) \le G \le (32*(i+1))\quad i = [1, 2, 3, \ldots, 7]$

$I(B) = 0,\ 0 \le B \le 64,$

$I(B) = i,\ ((64*i)+1) \le B \le (64*(i+1))\quad i = [1, 2, 3]$

Then each value of C(x,y) is 8-bits binary code, ranging from 0 to 255 respectively.

B. Step-2: Local Binary Pattern

In step2 LBP is evaluated on the quantized facial image for obtaining local information in a precise way. Local Binary Pattern (LBP) is based on the concept of texture primitives. This approach is a theoretically, computationally simple and efficient methodology for texture analysis. To represent the formations of a textured image, the LBP approach, models 3×3 neighborhood as illustrated in figure 2. A 3×3 circular neighborhood consists of a set of nine elements, P = $\{p_c, p_0, p_1, \ldots, p_7\}$, where p_c represents the gray level value of the central pixel and p_i $(0 \le i \le 7)$ represent the gray level values of the peripheral pixels. Each 3×3 circular neighborhood then, can be characterized by a set of binary values b_i $(0 \le i \le 7)$ as given in the following equation:

$$b_i = \begin{cases} 1 & \Delta p_i < 0 \\ 0 & \Delta p_i \ge 0 \end{cases} \qquad (2)$$

where $\Delta p_i = p_i - p_c$.

For each 3×3 neighborhood a unique LBP code is derived from the following equation:

$$LBP_{P,R} = \sum_{i=0}^{i=7} b_i \times 2^i \qquad (3)$$

Every pixel in an image generates an LBP code. A single LBP code represents local micro texture information around a pixel by a single integer code LBP ϵ [0, 255].

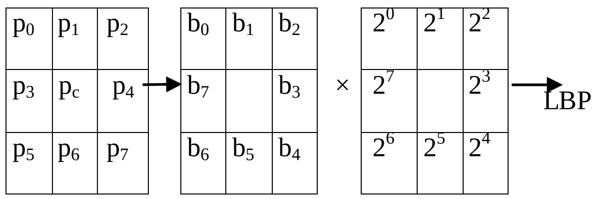

Figure2. Representation of LBP

The $LBP_{P,R}$ operator produces 2^P different output values, corresponding to the 2^P different binary patterns that can be formed by the P pixels in the neighbor set. Achieving rotation invariance, when the image is rotated, the gray values g_p will correspondingly move along the perimeter of the circle, so different $LBP_{P,R}$ may be computed. To achieve rotational invariance a unique identifier to each LBP is assigned in the present paper as specified in the following equation:

$$LBP^{ri}_{P,R}(x,y) = \min\{ROR(LBP_{P,R}, i)\} \tag{4}$$

Where i = {0,1,2,3,..,P-1} and the superscript 'ri' stands for "rotation invariant". The function $ROR(LBP_{P,R}, i)$ performs a circular bit-wise right shift on the P-bit number $LBP_{P,R}$ i times to the right ($|i| < P$).

C. Step-3: Texton detection

The term ''texton'' is conceptually proposed by Julesz [19]. It is a very useful concept in texture analysis and has been utilized to develop efficient models in the context of texture recognition or object recognition [20, 21]. In step three textons are defined which are having a close relationship with image features and local distribution. Textons are considered as texture primitives which are located with certain placement rules. The textons are defined as a set of blobs or emergent patterns or shape features sharing a common property all over the image [19,22]. The different textons may form various image features. If the textons in the image are small and the tonal difference between neighbouring textons is large, a fine texture may result. If the textons are larger and concise of several pixels, a coarse texture may result. If the textons in image are large and consists of a few texton categories, an obvious shape may result. If the textons are greatly expanded in one orientation, pre-attentive discrimination is somewhat reduced. If the elongated elements are not jittered in orientation, the texton gradients at the texture boundaries are increased. To achieve this proposed IT-LBP utilized four texton types on a 2×2 grid as shown in figure 3. In figure 3 the four pixels of a 2×2 grid are denoted as V_1, V_2, V_3 and V_4. If two pixels are highlighted in gray color of same value, the grid will form a binary 1 texton otherwise a binary 0 texton. The four texton types used in the proposed IT-LBP approach are denoted as T_1, T_2, T_3 and T_4 respectively as shown in figure 3. The working mechanism of texton detection is illustrated in figure 4.

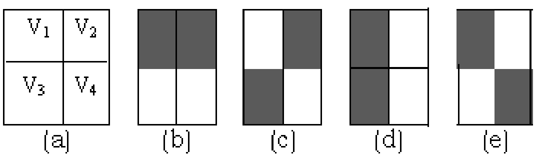

Figure3. Four special types of Textons: (a) 2×2 grid (b) T_1 (c) T_2 (d) T_3 and (e) T_4

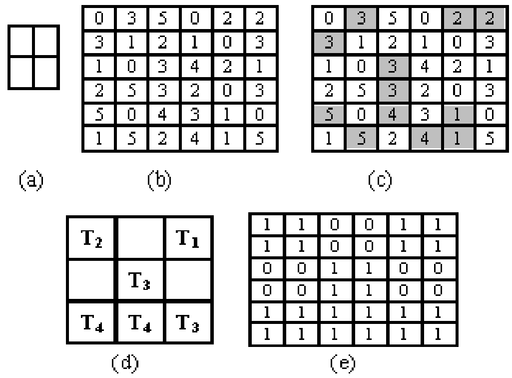

Figure4. Illustration of the Texton detection process: (a) 2×2 grid (b) Original facial image (c) & (d) Texton location and Texton types (e) Texton image of the face.

D. Step-4: Shape Features

Shape, as a significant factor of objects, is an important research direction in image classification and recognition. As the age progresses certain shape features of face will be changing. IT-LBP captures the local information with low sensitive to changes in illumination and shape features located with certain placement rules. The present paper evaluated four complex curve shape features i.e SF_1, SF_2, SF_3 and SF_4 namely circle, ellipse, parabola and hyperbola respectively on IT-LBP facial images for a precise age classification. Frequency of occurrences of these four SF on IT-LBP facial images will be evaluated and tabulated for classification purpose.

The new set of shape features are shown in figure 5 and they are represented by the equations as given from (5) to (8). All the loci of points (with the exception of the circle) are considered, using different main directions, by introducing a rotation angle of β.

$$SF_1 = circle = x^2 + y^2 = r^2 \tag{5}$$

$$SF_2 = Ellipse = \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \tag{6}$$

$$SF_3 = Parabola = \frac{-1}{c}x^2 + 2c = 1 \tag{7}$$

$$SF_4 = Hyperbola = \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \tag{8}$$

Where 'r' is the circle radius, 'a, b' are the semi major and semi minor axis lengths and 'c' is the distance between vertex and focus.

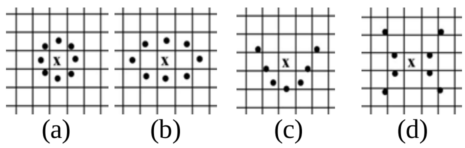

Figure5. Representation SF on a 5×5 neighborhood:(a) circle(b) ellipse(c) parabola (d) hyperbola

III. EXPERIMENTAL RESULTS

To show the significance of the proposed shape features (SF) on IT-LBP facial images the present paper considered various facial images. The facial images considered are 1000 images from FGnet aging database. Since it is not possible to show entire database, the present paper is chosen 36 facial images as sample data base from FGnet aging which are shown in figure 6. The present paper assumed that the childhood is from 0 to 18 years and from 19 years onwards as adulthood. To distinguish child faces from that of adult groups, a set of four shape features (SF) parameters i.e circle, parabola, ellipse and hyperbola are evaluated on IT-LBP facial images.

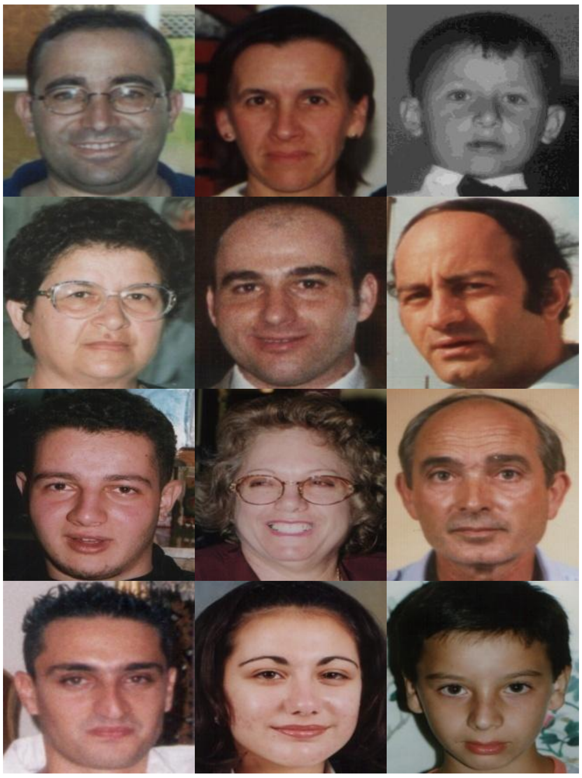

Figure6. 001A05, 002A05, 002A18, 004A21, 004A28, 005A18, 006A61, 008A08, 008A41, 010A18, 012A24, 012A30, 002A04, 032A13, 040A05, 041A19, 030A26, 047A13, 011A42, 023A05, 024A25, 025A12, 026A13, 027A16, 029A29, 034A44, 038A05, 039A50, 042A28, 045A32, 046A20, 047A55, 048A50, 051A24, 052A14, 035A12.

The frequency of occurrences of the proposed SF on the proposed IT-LBP facial images is listed in Table 1 and Table 2 for child and adults respectively. From the tables 1 and 2 it is clearly evident that as age progresses the frequency occurrences of SF on IT-LBP facial images shows an increasing trend. The increasing trend of SF is clearly visible from the graph of figure 7.From the figure 7 it is clearly evident that the above trend is more significant for the shape features SF_3 and SF1. The present paper derived an algorithm for child and adulthood classification based on SF_3 and SF1 features on IT-LBP facial images of Table 1 & 2.The proposed algorithm gives 95% of successful child and adulthood classification. The proposed method is compared with various other existing methods and listed in Table3.

Algorithm: Childhood and Adulthood classification based on Shape Features (SF) on IT-LBP facial mages

Begin

if (SF_3 < = 14) then
  facial image is child

else

if ((SF_3 > 14 && SF_3 <=18) && (SF_1 <= 17)) then
  facial image is Child

else

  facial image is adult

End

TABLE1. COMPUTED VALUES OF SF FOR SAMPLE CHILDHOOD IMAGES OF FGNET AGING DATABASE.

Ages	SF_1	SF_2	SF_3	SF_4
001A04	4	3	4	0
002A04	4	3	4	0
014A03	4	2	3	5
013A08	4	3	5	0
014A03	5	3	5	0
028A05	5	0	3	5
038A04	4	2	4	3
011A07	5	2	6	0
016A07	6	3	5	1
015A07	4	1	5	1
008A08	7	0	4	3
021A110	9	4	5	4
032A10	8	4	6	0
038A11	9	5	7	3
047A12	9	6	7	1
021A11	9	6	7	4
025A12	10	7	9	3
014A12	9	5	10	3
023A14	10	6	9	2
026A13	11	8	10	4
052A14	10	6	11	5
062A12	11	7	7	3
016A16	15	11	16	6
023A16	14	8	17	0
013A16	14	9	13	4
028A17	13	9	15	7
012A18	17	10	14	5
015A17	15	6	12	5

TABLE2. COMPUTED VALUES OF SF FOR SAMPLE ADULTHOOD IMAGES OF FGNET AGING DATABASE.

Ages	SF_1	SF_2	SF_3	SF_4
046A20	18	12	17	6
051A22	19	13	18	7
004A21	18	11	19	6
006A22	17	10	16	7
009A23	18	12	16	4
012A24	19	9	17	0
013A24	18	12	16	4
051A24	19	13	19	0
024A25	19	10	19	5
027A25	20	15	18	7
032A28	19	14	19	8
004A28	18	11	20	5
024A28	19	10	19	6
061A29	20	12	19	7
042A28	21	9	19	6
018A29	23	8	19	10
062A30	21	13	17	9
012A30	19	6	24	12
045A32	22	10	19	0
029A33	22	13	18	6
008A41	19	10	23	3
006A42	21	12	25	5
007A42	23	11	24	9
028A46	22	14	20	6
034A44	22	6	31	6
047A43	19	10	29	0
069A46	24	15	27	6
039A50	28	12	30	10
006A51	19	14	24	6
005A52	25	8	24	8

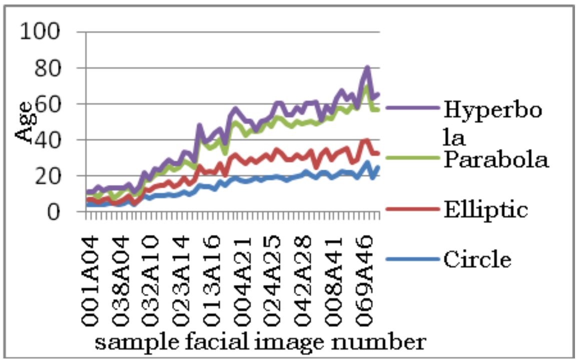

Figure7. Age classification of shape features.

TABLE3. COMPARISON WITH OTHER METHODS

S. No	Authors	Name of the Method	% of Classification Rate	Type of Age Classification
1	Proposed Method	Shape features on IT-LBP	95	Child and Adulthood
2	Chandra Mohan et al,	Novel Method for Child and Adulthood Classification(CAC) Based on Geometrical Features of Facial Image	94.5	Child and Adulthood
3	Chandra Mohan et al,	Novel Method for Child and Adulthood Classification Using Linear Wavelet Transforms	95.32	Child and Adulthood
4	Chandra Mohan et al,	Age Classification of Adults Based on Topological Texture Features	92.33	16-25, 26-35, 36-45, 46-55, 56-65, 66-75 and 76-85
5	Chandra Mohan et al,	Novel Method of Adult Age Classification Using(2-level) Linear Wavelet Transforms	93.8	16-25, 26-35, 36-45, 46-55, 56-65, 66-75 and 76-85
6	Young H. K won et al,	“Age Classification from Facial Images,” Computer Vision and Image understanding Vol. 74, No.1,April, pp.1-21,1999	78	Babies, adults, and Senior adults.
7	Tsuneo KANNO et al,	“Classification of Age Group Based on Facial Images of Young Males by Using Neural Networks,” IEICE Trans. Inf & Syst, VolE84-D, No 8,August 2001	80	Only young males are age groups considered for classifications are 12,15,18 and 22 years
8	Wen-Bing Horng Cheng-et al,	“Classification of Age Groups Based on Facial Features,” Tamkang Journal of Science and Engineering Vol. 4 No. 3 183-192(2001)	90.52	Classified age groups are babies, young adults, middle-aged adults, and old adults

IV. CONCLUSION

The Present paper evaluated complex shape features on a 5×5 mask using Integrated texton based LBP. The proposed method has low computational complexity and low sensitivity to change in illumination. The proposed complex shape features showing a steady increasing trend as age progress. This phenomenon reflects that as age progress there is a steady and gradual increase of wrinkle shapes on face. Many scholars evaluated pattern and shape based methods for age classification. The proposed IT-LBP approach is different from previous ones because, the complex shape features are evaluated on local texture operator LBP and on emergent patterns with close relationship with image features like Textons. The Table 3 reveals the high age classification rate of the proposed method when compared to other methods.

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