Age Group Estimation Based on the Transition Count of 3rd Order Neighborhood using V and Inverted V Patterns

Moka Uma Devi, Uppu Ravi Babu

Abstract: Age Classification is used in so many applications like crime detection, face detection and so on. The age leads to significant variation in human face. The variation depends on many factors like gender, exposure to sunlight, drinking, weight loss or weight gain. In our paper the performance of face aging is established based on v pattern and Inverted v pattern by using the transition count of third order neighborhood. In our proposed method the age of the person is divided into 5 categories. 1. Childhood (0-12years) 2. Young Adults (13-25years) 3. Middle Age Adults (26-40years) 4. Senior Adults (40-60years) 5. Senior Citizens (more than 60 years). The quantitative evaluation and analysis is performed in our proposed method when compared to other existing methods after applying on 4 different facial image databases.

Key words: V pattern, Inverted V pattern, transition count, age estimation, third order neighborhood

I. INTRODUCTION

The Age is very important for the human appearance. Age classification becomes challenging due to anatomical changes. Aging is divided into two types. i) Intrinsic aging ii) Extrinsic aging. Intrinsic aging is the natural aging process which can be identified by the skin lines, dryness of skin, furrows and laxity of the skin. Extrinsic aging is identified due to sleeping position, smoking, sun exposure and so on. The Age synthesis is important for identifying face after several years such as passport renewal and border security. Age estimation is also used to predict rejuvenating results. The remainder of the paper can be organized as follows. In section 2 related work in age estimation and in section 3 about proposed method and in section 4 about Results and Experiments and in section 5 we conclude.

II. RELATED WORK IN AGE ESTIMATION

A recent survey on automated age estimation can be found in [1]. KwonandLobo[2] first worked on the age classification problem. They referred to cranio -facial research, the article makeup, plastic surgery. The publicly available FG-Net aging database is commonly used in many previous works for age estimation in order to evaluate performance[ 6, 7, 8, 9, 10]. The recent texture based approaches [11, 12, 13, 14, 15, 16] for age classification and face recognition attained high accuracy and classification rate over the other existing methods.

To find out the success rate the proposed method used u

Revised Manuscript Received on November 15, 2019

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Morph Data base [18] and the percentage of success is about 91.86. V V Kumar et al., [19] proposed Topological Texture Features (TTF). Based on the TTF facial image is classified into five categories those are: child, young-adults, middle-aged, senior aged and Senior citizens SasiKiran et al.,[20] Proposed SICFRG model, which reduces the dimensionality of the image. The SICFRG was done in three steps. The 5×5 sub face is compressed into a 2×2 sub face without losing any substantial attributes.

V. Vijaya Kumar et al., [24] proposed a method called Fuzzy IDRSP (FIDRSP). It is used to estimate the facial images into five categories with Texture Shape Features (TSF). In the FIDRSP approach the percentage of success is 95.6%.

Pullela et al., [26] proposed a method for adult and child classification based on Morphological Pattern Representation Schemes. The proposed method is tested on three datasets: Google, Fgnet, and Scanned images.

U Ravi Babu et al., [27] proposed method for estimating the age group of a person based on the shape features. The proposed method mainly consists of 5 steps i.e. cropping, conversion in to grey level, finding features and so on.

III. PROPOSED METHOD

The present method contains 4 important steps. In Step 1, extract the skin region for a given image. In step2 Have to convert the color image into gray scale image. In Step 3, convert the TNP on 5×5 sub image into two valued matrix and find transition trends of ‘v’ and inverted ‘v’ patterns. Based on the trends of transition, derive the user defined Age estimation algorithm for estimate the age group of a person’s facial image in step 4. The Block diagram of the Age Group Estimation system is shown in figure 1.

Figure 1: Block diagram of the Age estimation Approach

A. Detect the skin region of the face

By using Hue-Saturation-Value color model identify the skin region of a given image. This step plays key role in
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facial expression identification system. Skin region detection is sensitive to lighting conditions and background clutter. The proposed method also considers the lighting conditions and illumination changes. In HSV model, two parameters namely p and q are calculated based on the following equations (1) and (2).

\[ p = 0.148 * H - 0.291 * S + 0.439 * V + 128 \]
\[ q = 0.439 * H - 0.368 * S + 0.071 * V + 128 \]

The pixel is identified as a skin pixel based on the values of the p, q and H. The p value is in between 140 and 195, q value is in between 140 and 165, and H values is in between 0.002 and 0.1. The processed images in this step are shown in figure 2.

140 < q < 165 --- eq (3); 140 < p < 195 --- eq (4); 0.02 < H < 0.1 --- eq (5)

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Figure 2: a) original image b) Detect the skin region of original image

B. Cropped skin region

After detecting skin region, crop the skin region from whole face by eliminating the unnecessary parts of the skin region such as neck, hair and so on. Once skin region is cropped, size of the image may changes. So the proposed approach can be identified irrespective of size of the image. Then convert the cropped facial image into grayscale image. The resultant images in this step are shown in figure 3.

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Figure 3: a) Skin Region identified image b) Resultant cropped image c) Gray scale image

2.3 RGB image to Grey level facial mage:

The present paper utilizes HSV color model for changing over the facial color image into grey scale, in light of the fact that the present study is expected to assess the human age into five groups in light of the progressions on the facial skin as recognized on the grey scale image. HSV color space isolates the colors into three classifications i.e. Hue, Intensity, and Saturation. The changing over conditions for RGB to grey level transformation are given in the condition from 6 to 10

\[ V = \max (R, G, B) \]
\[ H = \frac{G-B}{2S} \sqrt{1+\frac{4R-G-B}{2S}} \]

\[ V = \min (R, G, B) \]

\[ H = \frac{B-G}{2S} \sqrt{1+\frac{4G-R-B}{2S}} \]

\[ V = \frac{R-G-B}{2S} \sqrt{1+\frac{4R-G-B}{2S}} \]

\[ S = \frac{C}{V} \]

\[ p = 0.148 * H - 0.291 * S + 0.439 * V + 128 \]

\[ q = 0.439 * H - 0.368 * S + 0.071 * V + 128 \]

Where Hue (H) component range is from 0 to 255, range of S is from 0 to 1 and range of the V is from 0 to 255. The present work treats the H component as grey component.

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C. Third order Neighborhood (TPN)

The most significant job in the classification system is Image analysis and image understanding. The main purpose of Image analysis and image understanding is to extract information from the images to allow the discrimination among different objects of interest. The classification process is mainly based on grey level intensity, color, shape or texture. Image classification is of great interest in a variety of applications, for instance analysis of aerial satellite multispectral and medical images.

![Figure 4: Neighborhood patterns with central pixel (a) 1st Order Neighborhood pattern (b) 2nd order Neighborhood pattern (c) TNP (d) 4th order Neighborhood pattern](image)

Most of the image analysis problems are related to the neighborhood properties i.e. edge detection, segmentation, dilation, closing, opening, LBP, Texture Unit (TU), etc. Each pixel in a neighborhood or image is considered as a random variable, xr, which can assume values xr € {0, 1…G 1}, where G is the number of grey levels of the image. The probability P (xr = xf (r)), where r is the neighbor set for the element xr. The figure 4 illustrates different orders of neighborhood for a central pixel. Most of the research involved in image processing is mostly revolved around second order neighborhood only. This is because all the 8 neighboring pixels are well connected with central pixels and the methods based on second order neighborhood are given extraordinary results in various issues. The present approach considering the difficulties and complexities involved in the third order neighborhood and derived a new, simple and efficient model for image analysis based on transitions. The considered third order neighborhood is formed in 5x5 by window. The Third order Neighborhood (TN) has thirteen pixels of twenty five pixels of 5x5 neighborhood as shown in Figure 5.

![Figure 5: Third order neighborhood considered pixel positions](image)

D. Transition count on ‘V’ and inverted ‘V’ patterns of the facial image of TNP

In literature, the various patterns based methods on the third order neighborhood and integrated them with Grey Level Co-occurrence Matrix (GLCM) and derived features for efficient age classification. To overcome and address this on third order Neighborhood the present paper uses transition count of ‘V’ and inverted ‘V’
patterns in each TNP.

E. Identify ‘V’ and inverted ‘V’ patterns:
The each 5×5 sub image is converts to two valued image by comparing the each pixel of TN grey level sub image with the mean value of TN grey sub window. For converting grey level to two valued, the equation 11 is used.

\[ V_i = \begin{cases} 0 & \text{if } P_i < V_0 \\ 1 & \text{if } P_i \geq V_0 \end{cases} \quad \text{for } i = 1, 2, \ldots, 13 \]

(11)

Where \( V_i \) is the average value of the 13 considered pixels. On each 5×5 window, identify ‘V’ and inverted ‘V’ patterns. Both ‘V’ pattern and inverted ‘V’ pattern of TNP consists of five pixels. The considered ‘V’ pattern pixels of TNP are indicated by blue color and inverted ‘V’ pattern pixels of TNP are designated by green color and the corresponding patterns are shown in the Figure 6(a) and 6(b) respectively. The Positions at P5, P10, P13, P12, and P9 form ‘V’ pattern of TN and the positions at P5, P2, P1, P4 and P9 forms inverted ‘V’ pattern of TN. Figure 6: patterns on TN (a) considered ‘V’ Pattern (b) Considered inverted ‘V’ Pattern In each ‘V’ and inverted ‘V’ patterns, count the number of transition in the pattern. The transition means value is changed either from one-to-zero or zero-to-one in pattern. The present paper considers the transitions in circularly. While considering the pattern circularly, three types of transitions are occurred i.e. 0, 2, and 4 transitions. For example, the considered pattern ‘00000’ or ‘11111’ has 0 transitions, while patterns ‘00001’, ‘00010’, and so on… have 2 one-to-zero or zero-to-one transitions. The patterns like ‘00101’, ‘01001’, ‘01011’ and other circularly pivoted bitwise turned renditions have 4 one-to-zero or zero-to-one transitions. The present approach uses 5 bits to from ‘V’ and inverted ‘V’ patterns of TNP. So, totally forms 32 distinct patterns with one of the 3 transitions i.e. zero, two and four transitions. The present approach evaluated the frequency occurrences of transitions on ‘V’ and inverted ‘V’ of TNP on the facial images for estimating the age groups.

Figure 6: patterns on TN (a) considered ‘V’ Pattern (b) Considered inverted ‘V’ Pattern

F. Derive a user defined Algorithm for estimate Age group of Facial image

From the data in FV tables, define a user defined algorithm for estimating the age group of the input facial test image. The algorithm classify the facial test input image into one of the pre-defined class group such as Childhood (0-12 years), Young Adults (13-25 years), Middle-aged Adults (26-40 years), Senior Adults (40-60 years) and Senior Citizens (more than 60 years). The derived user defined algorithm is defined in algorithm1.

Algorithm 1: Age group estimation (image)
Input: facial test image for Age group estimation
Output: Age group

Start
Step 1: extract the skin region of the face using HIS model
Step 2: Crop the Skin region of the facial image.
Step 3: Convert the Crop color image into grey level image by using HIS color model
Step 4: Convert each 5×5 sub image of TNP into two valued matrix
Step 5: find transition trends of ‘V’ and inverted ‘V’ patterns in each 5×5 sub image of TNP.
Step 6: Based on the transition count, estimate the age group of the test image. Let VC be ‘V’ pattern count, IVC be the inverted ‘V’ pattern count, 0 be the zero transition count, 2 be the two transition count. 4 be the four transition count.

If ((VC (0) <= 815)) and ((IVC (0+4 > 1270 1410)) \&\& (IVC (0+4 < 1410)))
Print (“Facial image is considered as Childhood aged group”);
Else if ((VC (0) < 930) and (IVC (0+4 > 1410)) \&\& (IVC (0+4 < 1660))
Print (“Facial image is considered as Young adult aged group”);
Else if ((VC (0) < 1010) and (IVC (0+4 > 1165)) \&\& (IVC (0+4 < 1206))
Print (“Facial image is considered as middle aged group”);
Else if ((VC (0) < 1125) and (IVC (0+4 < 1125))
Print (“Facial image is considered as Senior aged Group”);
Else if ((VC (0) < 1325) and (IVC (0+4 > 1205)) \&\& (IVC (0+4 < 1270))
Print (“Facial image is considered as Senior Citizen aged Group”);
Else
Print (“Unknown age group”);
End

IV. RESULTS AND DISCUSSIONS

Among the many available face databases around the world, four of them are considered which include substantial sets for aging individuals. The MORPH Database [18], FG-NET aging database [28]. 500 images of 50 individuals are collected from Google database (ages from 0 to 80), and 600 images are scanned photographs. Totally, it becomes 19102 face images. In the present method, the sample images are grouped into two databases i.e. training and test database. A few of them are shown in Figure7. The present paper utilizes 60% of the total images i.e. 11461 images are considered as training database. Calculate the transition count of the each training database facial image and the values to Feature vector (FV) for developing user defined algorithm based on the transition count occurred of the each facial image. Due to cropping the facial skin area, the resultant image size varies so that the transition count of the each image is normalized to 255×255. The transition count of the ‘V’ and inverted ‘V’ patterns on each 5×5 window of the sample database of the considered five groups are listed out in tables from 1 to 5. Based on the values in FV, an algorithm 1 is designed to estimate the
age group of the person to one of the five pre-defined categories: Childhood (0-12 years), Young Adults (13-25 years), Middle-aged Adults (26-40 years), Senior Adults (40-60 years) and Senior Citizens (more than 60 years).

Figure 7: Sample facial images used in the present approach

Table 1: Frequency occurrences of transitions on ‘V’ and inverted ‘V’ pattern of TNP for childhood aged facial images.

| Image Name | V Pattern Count (TC) | Inverted V Pattern Count (TC) |
|------------|----------------------|------------------------------|
| 1          | 0 2 4 6 8            | 0 2 4 6 8                    |
| 2          | 0 2 4 6 8            | 0 2 4 6 8                    |
| 3          | 0 2 4 6 8            | 0 2 4 6 8                    |
| 4          | 0 2 4 6 8            | 0 2 4 6 8                    |
| 5          | 0 2 4 6 8            | 0 2 4 6 8                    |
| 6          | 0 2 4 6 8            | 0 2 4 6 8                    |
| 7          | 0 2 4 6 8            | 0 2 4 6 8                    |
| 8          | 0 2 4 6 8            | 0 2 4 6 8                    |
| 9          | 0 2 4 6 8            | 0 2 4 6 8                    |
| 10         | 0 2 4 6 8            | 0 2 4 6 8                    |

Table 2: Frequency occurrences of transitions on ‘V’ and inverted ‘V’ pattern of TNP for Young adult aged facial images.

| Image Name | V Pattern Count (TC) | Inverted V Pattern Count (TC) |
|------------|----------------------|------------------------------|
| 11         | 0 2 4 6 8            | 0 2 4 6 8                    |
| 12         | 0 2 4 6 8            | 0 2 4 6 8                    |
| 13         | 0 2 4 6 8            | 0 2 4 6 8                    |
| 14         | 0 2 4 6 8            | 0 2 4 6 8                    |
| 15         | 0 2 4 6 8            | 0 2 4 6 8                    |
| 16         | 0 2 4 6 8            | 0 2 4 6 8                    |
| 17         | 0 2 4 6 8            | 0 2 4 6 8                    |
| 18         | 0 2 4 6 8            | 0 2 4 6 8                    |
| 19         | 0 2 4 6 8            | 0 2 4 6 8                    |
| 20         | 0 2 4 6 8            | 0 2 4 6 8                    |

Table 3: Frequency occurrences of transitions on ‘V’ and inverted ‘V’ pattern of TNP for Middle aged images.

Table 4: Frequency occurrences of transitions on ‘V’ and inverted ‘V’ pattern of TNP for Senior aged images.

Table 5: Frequency occurrences of transitions on ‘V’ and inverted ‘V’ pattern of TNP for Senior citizen’s facial images.

V. CONCLUSIONS

The present paper proposed a robust method for estimation of facial images of the human facial image. The present approach identified ‘V’ and inverted ‘V’ patterns with 5-bits on each 5x5 sub image. On each ‘V’ and inverted ‘V’ patterns calculate the transition count i.e. zero, two and for
transitions and add these values and treat them as FV. Based on these FV values, this paper defined an algorithm for estimating the predefined age groups. In future we can evaluate the performance by Using techniques or algorithms

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Published By: Blue Eyes Intelligence Engineering & Sciences Publication

International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-4, November 2019