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Age Estimation from Face Image using Wrinkle Features

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Abstract

Age progression is generally indicated by skin texture, face structure, skin color. The face features changes with age progression of a human. This paper provides a methodology to estimate the real age of a human by analyzing wrinkle area of face images. Wrinkle geography areas are detected and wrinkle features are extracted from face image. Depend on wrinkle features, each face image is clustered using fuzzy c-means clustering algorithm. Then, estimated age is calculated using their clustering membership value and average age of each cluster. The obtained results are significant and remarkable.

1. Introduction

The biometric features of the human being are unique for each of them. Identification and verification is becoming interesting area of research. Face recognition is one useful method to identify any person by features of the face. Fingerprint, face, voice, iris, retina are vastly used for authentication. For a long time research work has been carried out in these areas. In old days, face recognition was used for identification of documents such as land registration, passports and identification of a person in high security zone. But with age progression, the face features changes as shown in Fig. 1 and the database should be updated regularly, which is a tedious task. So it is required to handle this issue of facial aging and try to find a method that identifies a person in spite of the changes in facial image. Age progression is generally indicated by the skin texture, face structure, skin color. The face features changes with age progression of a human.

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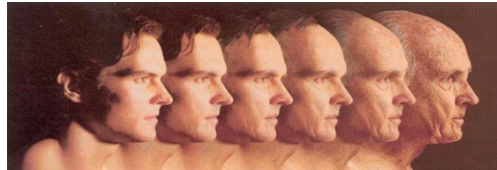E-mail address: ranjan.rcciit@gmail.com

Fig. 1. Age Progression of a Human

This paper provides a methodology to estimate the real age of a human by analyzing wrinkle area of face images. This process involves four stages: pre-processing, facial feature extraction, classification, and age estimation. The system uses two types of face images: training face images where age is known and test face images where the age is unknown. Wrinkle features of all training face images as well as test face images are taken as input in the system. Using Fuzzy C-means clustering algorithm, all wrinkle features are clustered with their membership value. Then, estimated age is calculated from their membership value. The final results are acceptable. Also, this method is applicable for predicting future faces. This paper proceeds with following sections. Section 2 reflects the previous work on this topic. Section 3 includes implementation details for this work. Experimented results are depicted in section 4. Finally, section 5 contains conclusions.

2. Previous Work

Principal component analysis (PCA), linear discriminate analysis (LDA) was used in face recognition previously [1, 2]. These methods detect facial features from a face image and search the face database for images with similar features. A skin texture analysis technique containing visual information like unique lines, patterns, and spots of a person's skin into a mathematical model is done [3, 4]. Effect of age of a human face has been analyzed for two main reasons: (1) Automatic age prediction from face image, and (2) Automatic age progression for face identification. To cluster face images three different age groups are considered: infants, young adults and senior adults[5] and significant face points were identified from face images and distances between those face points are calculated. Then infants or adults were classified using those distances ratios. This paper describes a method for wrinkle identification in specified areas in face images for classifying adults into young and senior. The first real human age estimation theory was proposed using aging function [6, 7]. Those used a quadratic function for performing the task of automatic age prediction. 3-D sensors are used in 3-D technique to gather information about the structure of a face [8, 9]. To find unique features in a face, region of the eye, nose and chin were used. A Bayesian age difference classifier classifies face images of a person depending on age differences and verifies faces along with age progression [10, 11]. Coordinate transformation and deformation of local facial feature were the tools for those methods. But according to gender, human may have various face patterns. The Aging pattern Sub-space method for automatic age estimation is proposed [12]. It describes the age pattern in a 2 dimensional sub-space and then the same is used for determining the age. A 3 dimensional age structure is proposed to generate some missing images of different age[13]. Feature extraction depending on face identification, sex and age grouping is proposed [14]. Frontal view of face generates an isosceles triangle that is a combination of the two eyes and mouth [15, 16, 17]. This triangle is very useful for face identification and age group estimation. The mentioned triangle is unique for each human and can be used for face identification with age. Based on the geometric features of a human face, age range classification is made using K-Means clustering algorithm [18]. Age groups are classified depending on number of groups taken from user.

3. Implementation

A digital camera is used for capturing face images. Total 75 frontal face images are captured for training the system whose actual ages are known and 20 frontal face images are captured whose actual ages are unknown. This research work shows a significant age estimation technique that uses four stages: pre-processing, feature extraction, classification, and age estimation.

3.1. Preprocessing

The rectangular face area is cropped from face image as shown in Fig. 2(a) using Matlab functions. Different region of face like eye pair, nose, mouth, and chin are detected as shown in Fig. 2(b).
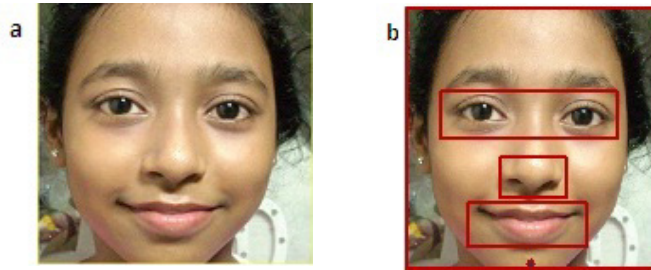

Fig. 2. (a) Cropped face   (b) Selected region of face

Wrinkle feature signifies age of a person. The wrinkle feature is calculated using forehead portion, upper portion of cheeks, eyelid regions and eye corner regions as shown in Fig. 3(b). Once the mid positions of the right eye (x_r, y_r) and left eye (x_l, y_l) have determined, the distance between two eyeball d is calculated as follows:

$$d = \sqrt{(x_r - x_l)^2 + (y_r - y_l)^2} \tag{1}$$

Based on the geometric structure of the face in figure as shown in Fig. 3(a), the vertical distance between eyes and eyebrows may be set to 0.4×d. Therefore, the proposed forehead portion above the eyebrows region is rectangle of size d × 0.5d. The region between the two eyebrows is selected. The regions beside two eyes corners are selected. The rectangular region on the human face exactly below the eyes that extends up to the nose is considered as the eyelid portion.
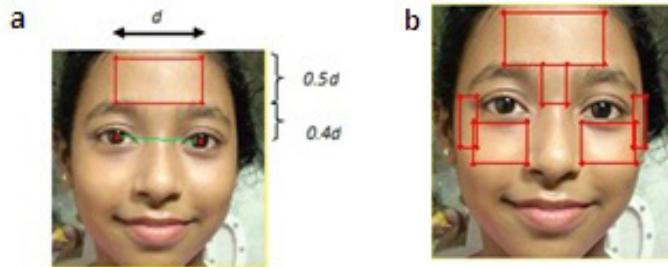

Fig. 3. (a) Forehead detection   (b) Wrinkle area on face image

3.2. Feature Extraction

Extraction of global and local features is made from face images. The global features include various distance ratios of all crucial facial objects like left eyeball, right eyeball, nose, chin, lip, and forehead. The local feature that is mainly used here is wrinkle feature of some particular portions of the face like forehead region, eye corners regions, eyelids, mid of eyebrows. Using five distance values, six features namely feature 1 to feature 6 are calculated in the following way:

Feature 1 = (left to right eye ball distance) / (eye to nose distance)
Feature 2= (left to right eye ball distance) / (eye to lip distance)
Feature 3= (left to right eye ball distance) / (eye to chin distance)

Feature 4= (eye to nose distance) / (eye to lip distance)

Feature 5= (eye to nose distance) / (eye to chin distance)

Feature 6= (eye to chin distance) / (virtual top of head to chin distance)

Using wrinkle features of face image, feature 7 is calculated. Edge detection is widely used for detecting discontinuities in an image. Feature 7 is calculated in following way. The input face image is first converted into gray scale image. Then it passes through canny edge detection technique. It provides a binary image with wrinkle edges as shown in Fig. 4(a). The white pixels of the wrinkle area give information about wrinkle present in the facial image. In binary image, binary value 1 is used for white pixel, and binary value 0 is for black pixel. So, sum of the pixel values of wrinkle area in binary face image is directly proportional to wrinkle present in the face as shown in Fig. 4(b).

Fig. 4. (a) Edge detected face (b) Edges in wrinkle area

Feature 7= (sum of pixel values in forehead area / number of pixels in forehead area) + (sum of pixel values in left eyelid area / number of pixels in left eyelid area) + (sum of pixel values in right eyelid area / number of pixels in right eyelid area) + (sum of pixel values in left eye corner area / number of pixels in left eye corner area) + (sum of pixel values in right eye corner area / number of pixels in right eye corner area)
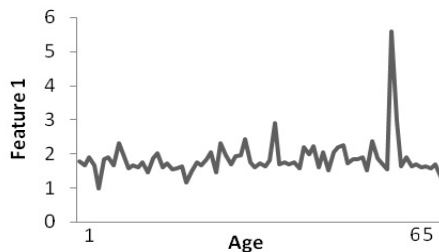
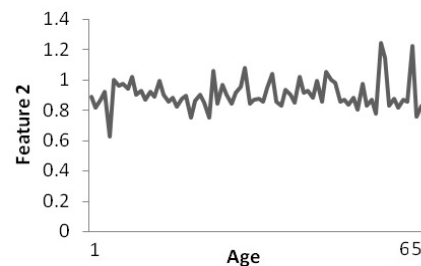Fig. 5. Age vs. Feature 1

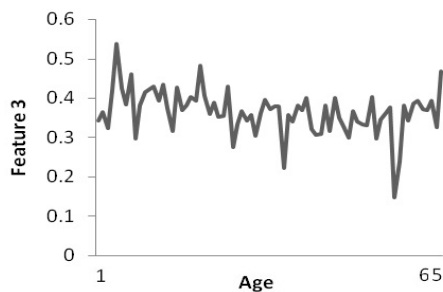Fig. 6. Age vs. Feature 2
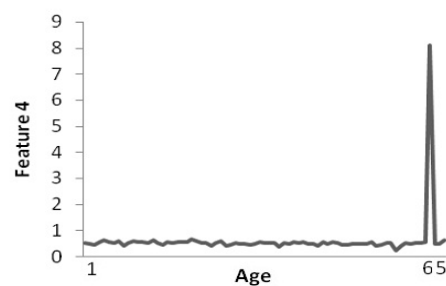

Fig. 7. Age vs. Feature 3

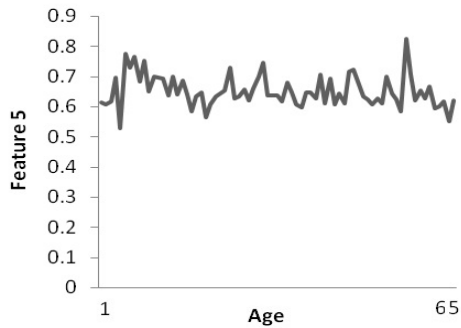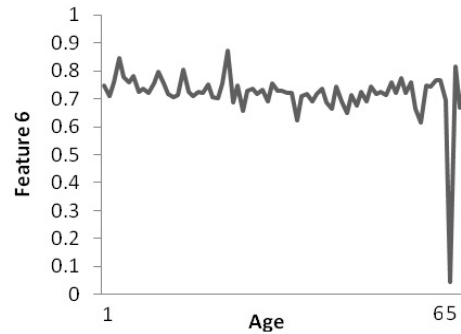Fig. 8. Age vs. Feature 4

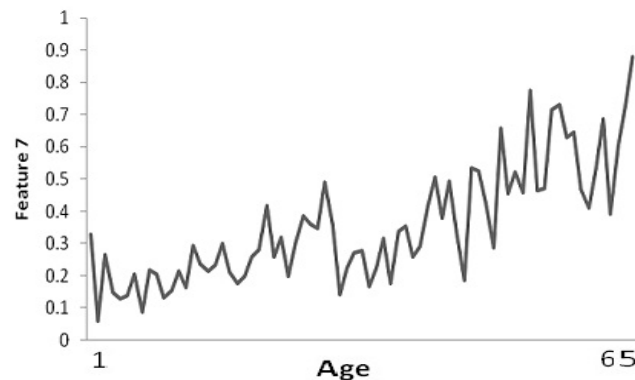Fig. 9. Age vs. Feature 5

Fig. 10. Age vs. Feature 6

Fig. 11. Age vs. Feature 7

Age versus all the features are individually plotted as shown in Fig. 5 to Fig. 11 accordingly. Feature 1 to feature 6 gives inconsistent result whereas feature 7 gives consistent result with respect to age. So, only feature 7 (wrinkle features) is used in this system for age classification.

AGE_i= actual age of the person of image i

F_i= feature 7 (wrinkle feature) of face image i

For m number of training face images, i lies between be 1 to m.

3.3. Classification

Using feature 7 (wrinkle features), faces are classified using fuzzy C-Means clustering algorithm to get the membership value for each cluster.

P_{ij} is the membership value of jth cluster of image i.

For n number of clusters, $\Sigma P_{ij} = 1$ for all i where j = 1 to n. For each image i, retrieve the maximum membership value of n clusters. If P_{ij} is the maximum of (P_{i1}, P_{i2}, P_{i3}, …, P_{in}) then image i belongs to cluster j. So, every image is clustered using their maximum membership value.

3.4. Age estimation

Average age of each cluster is calculated using training face images. Average age of cluster j (AVG_j) is calculated as follows.
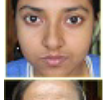
$$AVG_j = (\Sigma AGE_i) / N_j \tag{2}$$

Where AGE_i is the age of training face image i that belong to cluster j and N_j is the number of training face images those belongs to cluster j. Age estimation of test face image is calculated using the following formula.

$$EstimatedAGE_i = \Sigma (P_{ij} * AVG_j) \text{ where } j = 1 \text{ to } n \tag{3}$$

4. Results

This section shows the experimental results. The total face images in the database for training the system is 75. Only feature 7 is used for age estimation. From the experimental results, it is proved that wrinkle information is quite important for age estimation. Based on wrinkle features, the result of 20 faces using Fuzzy C-Means clustering algorithm is shown in Table 1.

Table 1.Experimental Result of Test Face Images

Image Number	Estimated Age	Actual Age	Age Difference	Face Image
1	40	38	2	
2	23	22	1	
3	14	14	0	
4	55	53	2	
5	70	75	-5	
6	13	12	1	
7	7	8	-1	
8	20	19	1	
9	65	62	3	
10	29	27	2	

11	23	33	-10	
12	22	31	- 9	
13	50	30	20	
14	64	57	7	
15	50	44	6	
16	19	16	3	
17	20	20	0	
18	35	30	5	
19	62	63	1	
20	10	8	2	

5. Conclusion

In this paper, a new methodology for estimating age of a person is described. The proposed method conveys a robust technique which estimates the age of a person from a set of face images with different age. Initially, most significant features such as distances between different facial objects, analysis of wrinkle area are considered. It is noticed that wrinkle area feature gives the best result to estimate a person's age compared to the other features. So, wrinkle area analysis is quite useful procedure to estimate the actual age of a person. The obtained results are significant and remarkable. Faces with spectacle creates problem for proper eye and eyeball detection. Images should be of a frontal view image with uniform light on each part of the face. Images should contain single human face only and forehead should be clear of hair. So, it needs to be extended further which will consider more facial feature that can improve the accuracy of age estimation. This research work can be used for prediction of future faces.

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