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Age Group Estimation using Face Features

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Abstract*— Recognition of the most facial variations, such as identity, expression and gender has been extensively studied. Automatic age estimation and predicting future faces have rarely been explored. With age progression of a human the face features changes. This paper concerns with providing a methodology to estimate age group using face features. This process involves three stages: Pre-processing, Feature Extraction and Classification. The geometric features of facial images like wrinkle geography, face angle, left eye to right eye distance, eye to nose distance, eye to chin distance and eye to lip distance are calculated. Based on the texture and shape information age classification is done using K-Means clustering algorithm. Age ranges are classified dynamically depending on number of groups using K-Means clustering algorithm. The obtained results were significant. This paper can be used for predicting future faces, classifying gender, and expression detection from facial images.

***Index Terms*—Age estimation, eyeball detection, face angle, wrinkle feature**

I. INTRODUCTION

Face recognition is one of the biometric methods to identify individuals by features of the face. The biometric has a significant advantage over traditional authentication techniques as the biometric characteristics of the individual are unique for every person. A problem of personal verification and identification is an actively growing area of research. Face, voice, fingerprint, iris, ear, retina are the most commonly used authentication methods. Research in those areas has been conducted for more than 30 years. Traditionally, face recognition uses for identification of documents such as land registration, passports, driver's licenses, and recognition of a human in a security area. Face images are being increasingly used as additional means of authentication in applications of high security zone. But with age progression the facial features changes and the database needs to be updated regularly which is a tedious task. So we need to address the issue of facial aging and come up with a mechanism that identifies a person in spite of aging. In this paper, effective age group estimation using face features like texture and shape from human face image are proposed. For better performance, the geometric features of facial image like wrinkle geography, face angle, left to right eye distance, eye to nose distance, eye to chin distance and eye to lip distance are calculated. Based on the texture and shape information, age classification is done using K-Means clustering algorithm. Age ranges are classified dynamically depending upon number of groups using K-Means clustering algorithm. This paper is organized into the following sections. Section II describes an overview of previous work. Implementation details for age range estimation are mentioned in section III. Experimented results are mentioned in section IV. Finally, the conclusions are in section V.

II. PREVIOUS WORK

Traditional face recognition includes methods like eigen face or principal component analysis (PCA), fisher face or linear discriminate analysis (LDA) in [1], [2]. These techniques extract facial features from an image and using them perform search in the face database for images with matching features. Skin texture analysis technique [3], [4] uses the visual details of the skin, as captured in standard digital or scanned images, and turns the unique lines, patterns, and spots apparent in a person's skin into a mathematical space. In human-computer interaction, aging effects on human faces has been studied for two main reasons: (1) Automatic age estimation for face image, and (2) Automatic age progression for face recognition. A system has been developed to classify face images into one of the three age groups: infants, young adults and senior adults in [5]. In this paper, key landmarks were extracted from face images and distances between those landmarks are calculated. Then, ratios of those distances were used to classify face images as that of infants or adults. This paper also proposes a method for wrinkle detection in predetermined regions in face images to further classify adult images into young adults and senior adults. The first real human age estimation theory was proposed in [6], [7]. Those used an aging function (quadratic function) based on a parametric model of face images and performed tasks such as automatic age estimation, face recognition across age progression. 3-D technique uses 3-D sensors to capture information about the shape of a face in [8], [9]. This information is then used to identify distinctive features on the surface of a face, such as the contour of the eye sockets, nose, and chin. This technique is robust to changes in lighting and viewing angles. [10], [11] developed a Bayesian age difference classifier that classifies face images of individuals based on age differences and performs face verification across age progression. Those used coordinate transformation and deformation of local facial feature landmarks. But males and females may have different face aging patterns depending on nature effects. The AGES (Aging pattern Sub-space) method for automatic age estimation is proposed in [12]. It models the aging pattern in a 2D sub-space and then for an unseen face image to construct the face and determine the age. A 3D aging modeling technique which automatically generates some missing images in different age groups is proposed in [13]. Feature extraction based face recognition, gender, and age classification is proposed in [14]. [15], [16], [17] proposed that the frontal face view form an isosceles triangle combining the two eyes

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and mouth. This isosceles triangle is quite useful for face recognition and age range estimation. The face triangle is unique for every person and this face triangle can be used for face recognition with age.

III. IMPLEMENTATION

The face images of 50 persons are captured by means of a digital camera (NIKON Coolpix L10). This paper proposed a novel and effective age group estimation using face features from human face images. This process involves three stages: Pre-processing, Feature Extraction, and Classification.

A. ***Pre-processing*****:** The face image of a person is captured by a digital camera as shown in Fig. 1(a). Crop the detected rectangular face area as shown in Fig. 1(b) using Matlab in-built object function. Then, detect the eye pair, mouth, nose, and chin as shown in Fig. 1(c), Fig. 1(d), Fig. 1(e), and Fig. 1(f) respectively.

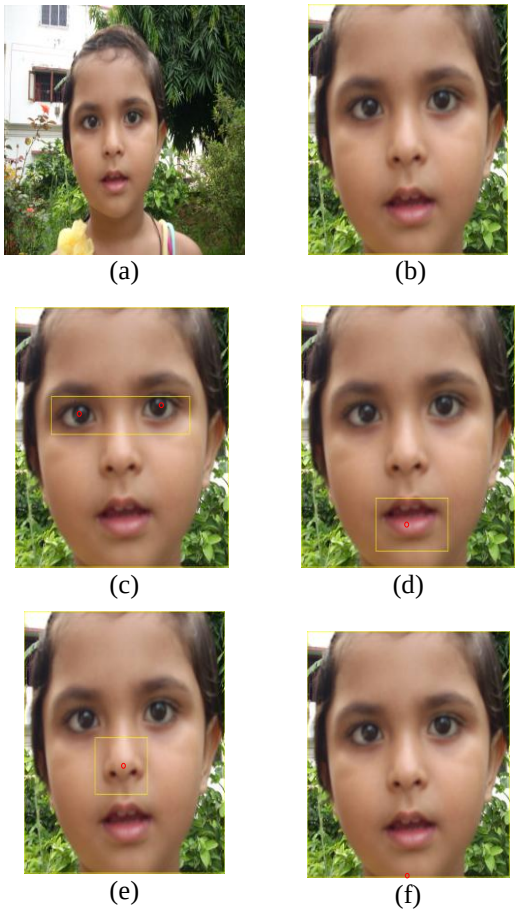

Fig 1: (a) Face image (b) Cropped face image (c) Eye pair detected image (d) Mouth detected image (e) Nose detected image (f) Chin detected image

B. ***Feature Extraction*****:** A combination of global and grid features are extracted from face images. The global features such as distance between two eye balls, eye to nose tip, eye to chin, and eye to lip is calculated in Fig. 2. Using four distance values, four features F1, F2, F3, and F4 is calculated as follows:

F1 = (distance from left to right eye ball) / (distance from eye to nose)

F2 = (distance from left to right eye ball) / (distance from eye to lip)

F3 = (distance from eye to nose) / (distance from eye to chin)

F4 = (distance from eye to nose) / (distance from eye to lip)

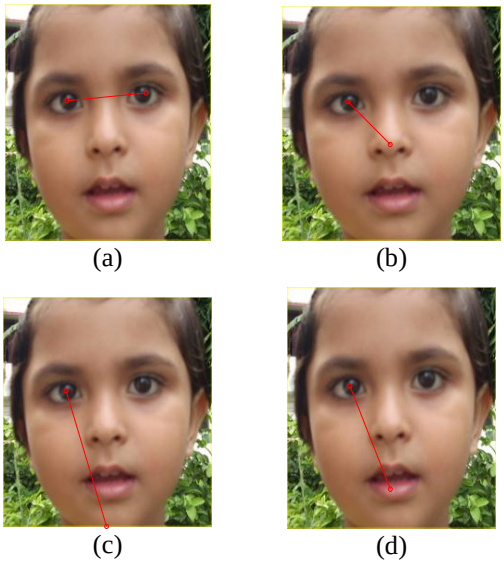

Fig 2: Distance between (a) two eyeballs (b) eye to the nose tip (c) eye to chin (d) eye to lip

Using the Grid features of face image, feature F5 is calculated. It is entirely based on wrinkle geography in face image. The grid feature includes forehead portion, eyelid regions, upper portion of cheeks and eye corner regions as shown in Fig. 3(a). To calculate feature F5, the following steps have to be followed: The color face image is converted into gray scale image. Then canny edge detection technique is applied on gray scale face image. It gives a binary face image with wrinkle edges as shown in Fig. 3(b). The white pixels of the wrinkle regions in Fig. 3(b) give wrinkle information in the face image.

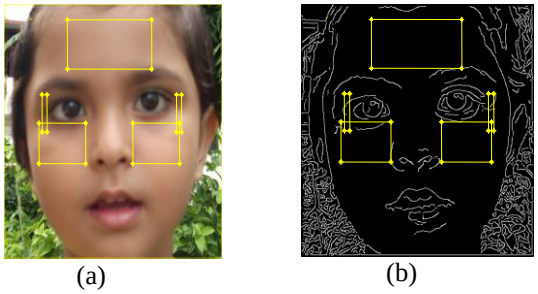

Fig 3: (a) Grid features region of face image (b) Canny edges of face image

In binary image white pixel is represented by 1, and black pixel is represented by 0 as shown in Fig. 3(b). So, sum of wrinkle region in binary face image is more when more wrinkle present in the face as shown in Fig. 4. Wrinkle feature signifies age of a person. Feature F5 is calculated as follows:

F5= (sum of pixels in forehead region / number of pixels in forehead region) + (sum of pixels in left eyelid region / number of pixels in left eyelid region) + (sum of pixels in right eyelid region / number of pixels in right eyelid region) +

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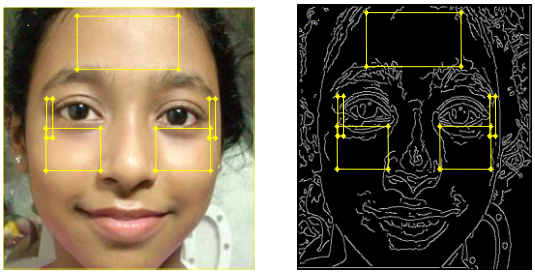
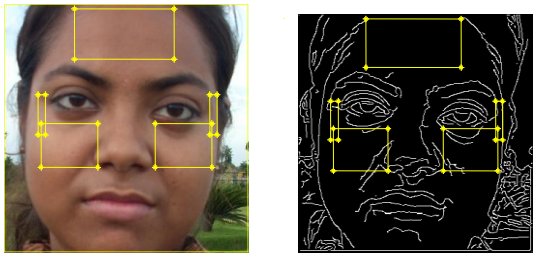
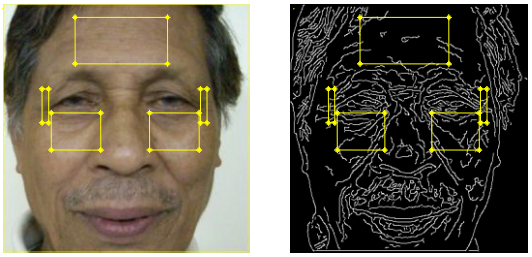
(sum of pixels in left eye corner region / number of pixels in left eye corner region) + (sum of pixels in right eye corner region / number of pixels in right eye corner region)



(a) (d)



(b) (e)



(c) (f)

Fig 4: (a), (b), (c) Wrinkle region features of face (d), (e), (f) canny edges of respective face

Feature F6 is the angle between right eyeball, mouth point, and left eye ball in face image as shown in Fig. 5.

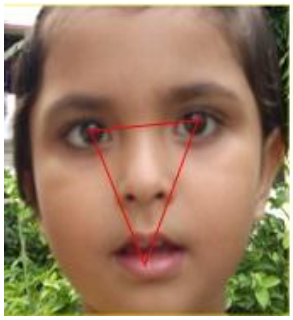


Fig 5: Image of Face angle

C. ***Classification*:** Age ranges are classified dynamically depending on number of groups using K-Means clustering algorithm. Based on the above six features F1 to F6, age classification is done into 2, 3, and 4 age range groups shown in Table I. Using five features F1 to F5, age classification is done into 2, 3, and 4 age range groups as shown in Table II. Only wrinkle features F5 is used for age classification into 2, 3, and 4 age range groups as shown in Table III.

IV. EXPERIMENTAL RESULTS

This section introduces the experimental results. Total number of faces in the database is 50. The result of the above implementation using K-Means clustering algorithm is shown in Table I, Table II, and Table III.

Table I: Age group classification using features F1 to F6

No. of group	Group No.	Age Range In years	No. of faces actually in this group	No. of faces falling in this group	Correct percentage
2	1	1-40	27	21	60%
	2	41-80	23	9	
3	1	1-30	22	15	50%
	2	31-45	8	3	
	3	46-80	20	7	
4	1	1-20	22	9	36%
	2	21-40	5	3	
	3	41-50	9	2	
	4	51-80	14	4	

Table II: Age group classification using features F1 to F5

No. of group	Group No.	Age Range In years	No. of faces actually in this group	No. of faces falling in this group	Correct percentage
2	1	1-30	29	27	90%
	2	31-80	21	18	
3	1	1-30	17	15	72%
	2	31-50	22	4	
	3	51-80	11	7	
4	1	1-20	14	10	64%
	2	21-30	15	6	
	3	31-50	14	10	
	4	51-80	7	6	

Table III: Age group classification using features F5 only

No. of group	Group No.	Age Range In years	No. of faces actually in this group	No. of faces falling in this group	Correct percentage
2	1	1-40	34	32	96%
	2	41-80	16	16	
3	1	1-30	29	27	84%
	2	31-45	10	5	
	3	46-80	11	10	
4	1	1-18	14	9	62%
	2	19-40	15	9	
	3	41-80	13	13	
	4	Mixed	8	Mixed	

Based on six features F1 to F6, age classification is done into 2, 3, and 4 age range groups using K-Means clustering

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algorithm as shown in Table I. Using five features F1 to F5, age classification is done into 2, 3, and 4 age range groups using K-Means clustering algorithm as shown in Table II. Only wrinkle features F5 is used for age classification into 2, 3, and 4 age range groups using K-Means clustering algorithm as shown in Table III. Experimental results prove that only wrinkle features is more important for age group classification.

V. CONCLUSION

In this paper, a method for age group estimation is thoroughly described. So the proposed technique provides a robust method that verifies the age group of individuals from a set of different aged face images. Crucial features such as distances between various parts of face, analysis of wrinkle geography and calculation of face angle are examined. All these ways are compared at last to find the best way to calculate age ranges of the face images in the database. After observing results of all features mentioned above, face images are clustered into 2, 3, and 4 groups using K-Means clustering algorithm. It is observed that wrinkle geography feature i.e., F5 gives the best result to estimate human age range in compare to other features. The above discussion leads us to the conclusion that wrinkle geography Analysis has been the best procedure to estimate human age range of an individual. For proper eye and eyeball detection, face in the image should be without spectacle. Image should be of a straight frontal face. Image should contain single human face only. This paper works with 96% accuracy for two age group clusters, 84% accuracy for three age group clusters, and 62% accuracy for four age group clusters. The accuracy of classification is decreased when the numbers of clusters are increased. So, it seems to be a definite possibility for further extension of the work which includes extracting more feature points those can improve accuracy of age group classification. By introducing more features the age range can be further narrowed. This paper can be used for predicting future faces also.

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