Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 10, October 2014, pg.291 – 303

RESEARCH ARTICLE

Age Classification from Facial Images System

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Abstract: In Computer vision system, rapidly expanding various applications. The goal in this paper is to develop a designing age classification system from the characteristics and information that can extract from the human face images for both sexes. The system proposed new algorithm that merging two features techniques (local and global) features. The local features including (primary face features), so the global features including (secondary face features). The new method in this paper present (local binary pattern) as a new technique uses in wrinkle analysis , so as this method uses to classify the input face images into one of four age groups: Baby, young, young adult and senior, and eight age categories: [1-6, 7-11, 12-19, 20-29, 30-39, 40-49, 50-65,66++]. This method based on human face region which contains a lot of information and properties that describe the head growth and face aging pretenses. These information can be used by the human brain to estimate the face age dependent on the external features that shows the craniofacial changes in geometrical characterize results by the growth of the head that changes the primary face features locations, the primary face features are: the center of the two eyes, nose peak, mouth peak, top head, face sides and the chin point, from these primary features we compute the geometrical ratios that distinguish babies faces from the three age groups: young, young adult and senior. The other changes that appear when the face aging is the texture changes which are the secondary features can be used to estimate the age of the face. The secondary face features may be the wrinkle appearance, duple chin, and eye bags. The wrinkle lines are calculated in the curliest five regions these are: for head, under two eyes and cheeks regions. These lines are computed and used to distinguish young, young adult, and senior age groups and age categories.

Keywords: Computer Vision, Digital Image Processing, Face Image analysis, Age progress, Craniofacial, Wrinkle analysis, Age estimation, Age categories, Local binary pattern

1. INTRODUCTION

One of the important applications of face recognitions systems is age group classification from facial features. This system commonly used by the vending machine which refuse to sell alcohol or cigarettes to the underage people and services that suit the customer's age: a web browser can determine by itself whether the user satisfies the age limitation to view certain web pages [1 , 2].

An improvement of our understanding of how humans may classify age from visual images can be used in the domain of indexing into a face database by the person's age, in the area of newspaper-story understanding, and in the application areas such as gathering population

age-statistics visually (for example, getting the ages of patrons at entertainment and amusement parks or in television network viewer-rating studies) [3].

Face recognition techniques have always been a very challenging task for researches because of all difficulties and limitations. Human faces are not an invariant characteristic; in fact, a person's face can change very much during short periods of time (from one day to another) and because of long periods of time (a difference of months or years). One problem of face recognition is the fact that different faces could seem very similar; therefore, a discrimination task is needed. On the other hand, when we analyze the same face, many characteristics may have changed. Ones of the most important problems are changes in illumination, variability in facial expressions, the presence of accessories (glasses, beards, etc.); finally, the rotation of a face may change many facial characteristics [4, 5].

2. METHODS AND MATERIAL

A. **The integral projection function (IPF)** in both types (vertical and horizontal) is used to detect the initial face oval and obtained it through the sum of a given set of pixels along a given direction. Horizontal and vertical integral projections are most commonly used, although they can be applied on any direction [6, 7].

IPh (i)=IPh(i)+bw(i,j); horizontal projection

IPv (i)=IPv(i)+bw(I,j); vertical projection

B. The enhancement algorithm RETINEX

The effect of lighting condition on the face in the recognition system performance was studied by a lot of researchers. The image for same face is different when taken under different illumination condition, the light correction is an important stage that used to evaluate the system performance in the recognition and the detection of used features, we use single scale retinex and multi scale retinex algorithms(SSR single scale retinex and MSR multi scale retinex) to adjust the illumination variation, enhance the light and contrast in the input color images of the used database. By using this algorithm perfect results to the system processing stage were obtained [8, 9,10].

The single scale retinex for a point (x,y) in an image is defined as equation

$$R_i(x,y,c) = \log[I_i(x,y)] - \log[F(x,y,c) \otimes I_i(x,y)] \quad (1)$$

Where $R_i(x, y, c)$ is the Retinex output of channel i ($i \in R,G,B$)

3. RELATED WORKS

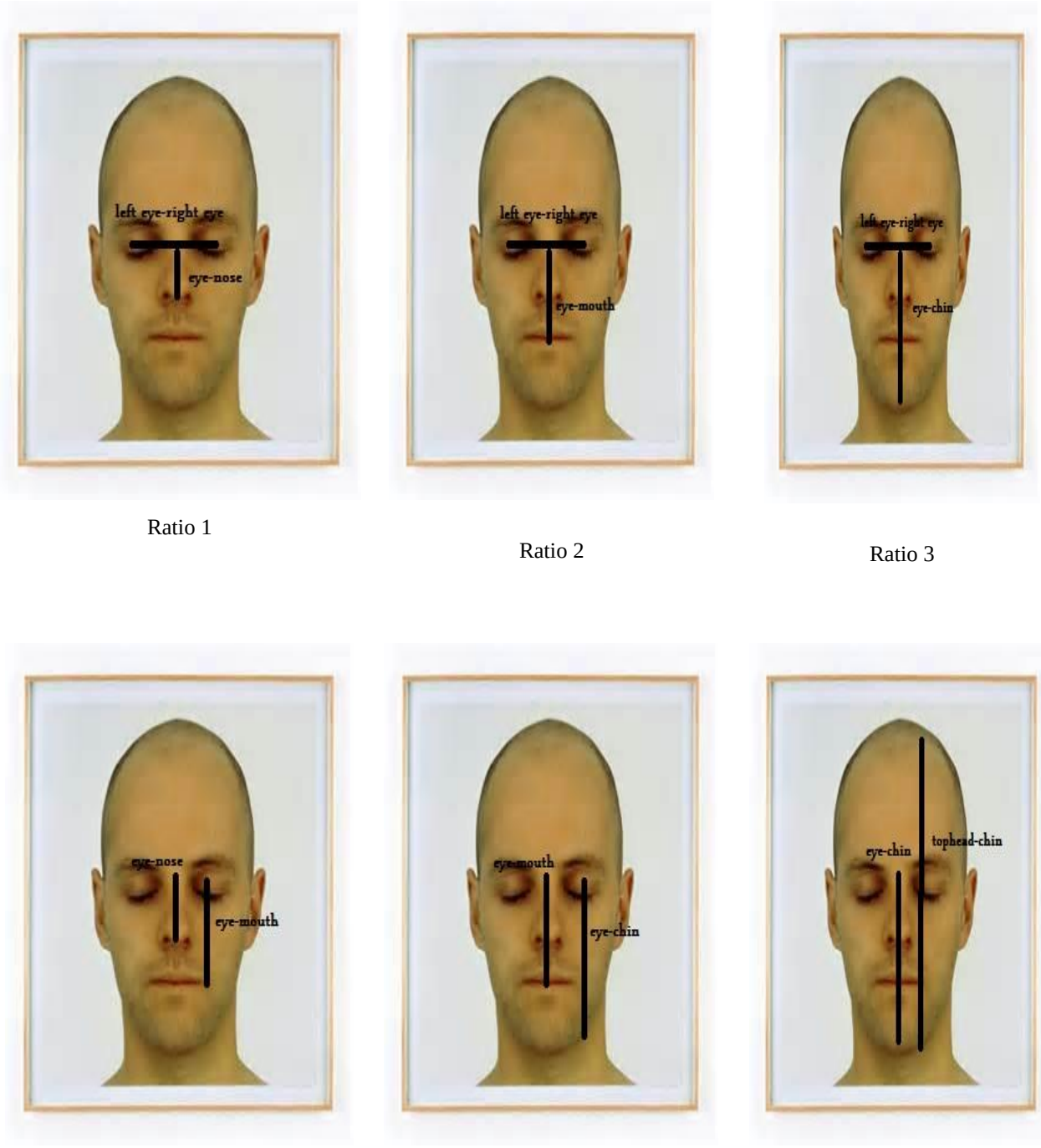
A few methods have been reported on age estimation based on information in images of human faces. The age classification systems divided into two types:- the classification methods using the local geometrical face features, these methods localized the primary face features which are: [two eyes, nose, mouth] and compute the distances between these features to distinguish the age groups and age categories [11]. Attempts at performing automated analysis of facial images using geometrical features date back to Bledsoe [11]. A subsequent attempt at this task was undertaken by Kanade . He started by detecting 16 features. Then he analyzed inter- and intra-class variances, finding that some of the parameters were in-effective [12]. The remaining 13 parameters were used for the recognition task.

However, the features were not always accurately located. More recently, Yuille, Hallinan, and Cohen [13] used deformable templates to detect features of faces, in particular, eyes and lips. External energy functions of valley, peak, edge, and image intensity are defined. These external images are computed from the original intensity image. The internal energy consisting of the template parameters interact dynamically with the external energy. The best fit occurs when the total energy equation, consisting of internal and external energy, is minimized. The second classification methods are dependent on the texture analysis of the face one of these methods are: Kwon and Lobo [3] used facial feature detection and wrinkle detection to classify age to the three age groups: babies, young adults and seniors. They carried out experiments with the faces of 5 babies, 5 young adults, and 5 seniors. Using the locations between detected facial features and the number of wrinkles on the face they determined the age group of the face. Classification was successful for all 15 faces. Ueki et al. [14] presented a classifier based on two phases using 2D-LDA and LDA to classify age. The benefit of their classifier is that it is robust under various lighting conditions. They experimented by using age ranges of 5 years, 10 years, and 15 years. The respective classification rates for each range were 46.3%, 67.8%, and 78.1%. Besides classification to age groups it is also possible to estimate the exact age of the person.

4. THE PRIMARY FACE FEATURES

The main theory in the area of cranio -facial research is that the appropriate mathematical model to describe the growth of a person's head from infancy to adulthood. The development into adulthood is that, relative to the margins formed by the eyes and the mouth the position of the nostrils (nose) drops. Hence, to distinguish baby faces from the three older groups, this research has evaluated a set of ratios. These ratios only require the automatic localization of primary features, namely the eyes, nose, mouth, chin, and virtual top of the head [3]: **Ratio 1** is the T-ratio formed by two segments: the segment T1 joining the two eyes and the segment T2 between the midpoint of T1and the nose. **Ratio 2** is the T-ratio formed by two segments: the segment T1 as above, and the segment T3 between the midpoint of T1 and the mouth. **Ratio 3** is the T-ratio formed by two segments: the segment T1 as above, and the segment T4 between the midpoint of T1 and the chin. **Ratio 4** is the ratio of the segment representing the difference in height between nose and eye-midpoint, and the segment representing the difference in height between mouth and eye-midpoint. **Ratio 5** is the ratio of the segment representing the difference in height between mouth and eye-midpoint, and the segment representing the difference in height between chin and eye-midpoint. **Ratio 6** is the height of the eyes within the top and bottom head-margins see fig. 1.

After statistical analysis of these ratios on different age groups input images the values describe that changes caused by craniofacial growth are: Forehead slopes back, shrinks and releases spaces on the surface of the cranium, Facial features expand their areas and cover the interstitial spaces, Cheeks extend to larger areas, Chin becomes more protrusive. With the six ratios computation we perceive with experiments that the aging process of human face was affected with the changes in these ratios and the distances between face primary features (eyes, nose, mouth, chin and the top of the head).



Ratio 1 Ratio 2 Ratio 3

Ratio 4 Ratio 5 Ratio 6

Fig. 1. face features ratios

5. SECONDARY FACE FEATURES

As local features, wrinkle and skin features were frequently used in many previous works. The wrinkle and skin features are generally appeared by high frequency components on face images. Therefore, edge detector or high frequency images are used to extract local features. The face texture binary regions were determined for the curliest regions these regions consist of characteristics that represent the age progression of the face [15]. Because local features indicate the characteristics of age group rather than entire range of age it is used in classification systems [16]. In order to improve the performance of age estimation, the research about detailed age estimation using local features and comparison of various local features extraction methods are required. Of which, the Horng classification of age group by using

density and depth of wrinkle, average variance of canny[17,18] filtered images is employed in this paper , in fig. 2 explain face wrinkle regions .

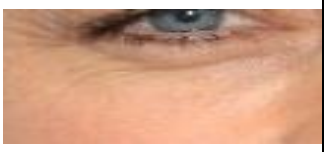
	0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 0	
Forehead region	Forehead region data	Forehead canny edges
	1 0 0 0 0 1 1 1 1 0 0 0 1 1 1 0 1 0 0 0 0 0 0 0 0 1 1 1 0 0 1 0 1 1 1 0 0 0 0 0 0 0 0 0 0	
Under left eye region	Left eye region data	left eye canny edges
	0 0 0 1 0 0 1 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0	
Under right eye region	Under right eye region data	Right eye canny edge
	1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 1 1 0	
Left cheek region	Left cheek region data	Left cheek canny edge
	1 0 0 0 0 1 0 0 0 0 1 1 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1	
Right cheek region	Right cheek region data	Right cheek canny edge

Fig. 2. face wrinkle regions

6. THE SYSTEM LIMITATIONS AND SETTING

Age classification system need not extra tools to execute, we use to implement it Scanner for image acquisition (Scanner HP Disk jet F 3300), the other system requirement of the face images to achieve the preprocessing steps must have few limitations and these are:-

1. The input face images must be frontal with minimum pose variation.
2. Face in the input image must have less expressions.
3. The proposed system has been implemented using MATLAB (version 7.14.0.739-R2012a),in a computer with CPU Intel® Pentium®, 2.50GHz, 4.00 GB RAM memory and Operating System: Windows 7 professional, 32-bit Operating system. The images scanning limitation is to set the scanner into 300dbi for best resolution to the system processing.

7. IMPLEMENTATION

In this paper we used new algorithm that merging between the **local binary pattern** [19] to describe the texture of the face that used to classify input face image into one of eight age categories with the geometrical changes in the craniofacial growth that used to model the face image into one of four groups which are: Baby, young, young adult and senior faces.

A high level description of the steps in the approach taken in this research is presented next.

1. Image Acquisition stage.
2. Image resize to (250×250) pixels stage.
3. If gray image go to 6.
4. Light correction stage.
5. Convert to gray scale level stage.
6. Apply both Integral Projection Functions (Vertical and horizontal) to detect the initial face oval stage.
7. Crop the face region.
8. Apply the IPF to detect the eye region stage.
9. Find left and right eye coordinate stage.
10. If angel between two eyes is zero go to 12.
11. Rotate the face with angel then go to 10.
12. Find the mouth and nose y_ coordinate stage.
13. Compute features ratios stage.
14. Compute wrinkle analysis stage.
15. Conclude age group and age category.

First we use image database intended for research aims contains image for different ages and both sex, image name is the age of the face this database is online named [20] [Web,2007], and the other images is from real life albums with CBIR images for celebrities that involve their age with shot date. The image either is in gray scale or color image, the color one is enhanced by using the (Retinex) algorithm for color enhancement and then it converted into gray level image that can be easy used in mathematical computations. The integral projection functions are applied into the image to detect the initial face oval, the face oval is cropped then we find the two eyes coordinates, the nose peak and the mouth coordinate to compute the geometrical ratios that shows the head growth see figure1. Table 1 displays the results of the ratio computation stage. The secondary face features are computed by cropping the curliest regions represented by: for head, under two eyes, two cheeks regions Table 2 displays the results of wrinkle analysis stage. After these processes the age group and age category conclusion is determined to estimate the face age category.

Table 1: the face geometry ratios

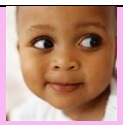
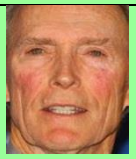
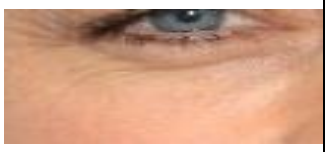
Image	R1	R2	R3	R4	R5	R6
B1 	1.603175	0.990196	0.655844	0.617647	0.662338	0.578947
B2 	1.603448	0.93	0.570552	0.58	0.613497	0.636719
B3 	1.987654	1.364407	0.821429	0.686441	0.602041	0.678201
Y1 	1.212121	0.923077	0.585366	0.761538	0.634146	0.634675
Y2 	1.2941	0.9362	0.5714	0.5789	0.7234	0.6104
Y3 	1.273585	0.957447	0.594714	0.751773	0.621145	0.594241
S1 	1.5263	0.9355	0.6042	0.5979	0.6129	0.6458
S2 	1.614035	0.958333	0.621622	0.59375	0.648649	0.571429
S3 	2.489362	1.193878	0.680233	0.479592	0.569767	0.653992

Table 2: wrinkle analysis results

Region	Wrinkle lines no.	Wrinkle lines solidity
 Forehead region	24	6
 Under left eye region	20	9
 Under right eye region	39	13
 Left cheek region	56	4
 Right cheek region	28	8

8. THE USED DATABASES

FG-NET (Face and Gesture recognition research Network ,2007) database contains 1002 face image onto 82 different subjects ranging between one year to 69 years old labeled with age as an image name, used in the researchers studying the effects of aging that appears on face. However, ages between months to 40 years old are the most populated in the database. Images in the database were collected by scanning photographs of the subjects found in personal collections. As a result, face images in the FG-NET aging database display significant variability in resolution, quality, illumination, viewpoint, and expression. Occlusions in the form of spectacles, facial hair, men with long or feathery beard, and faces with black skin, Asian roots and hats are also present in a number of images. Because of the limited ages of the images in the database we collect images from CBIR database that contains the images of the celebrities with their ages and the date of the image so that we make our database rich with all ages. In this thesis we use the FG-net images. and the CBIR database images that agree with our system limitations(frontal face without expression , pose and illumination) cover extremely all age groups from

childhood to the adult period of life. Also the database includes images from personal album and natural life from different age groups (FG-NET) [Web,2007] .

9. THE SYSTEM RESULTS

Distinguishing rate used in this research is calculates as follows which are the two main measures that were used to evaluate our system:

1. True Accept Rate (TAR)=$\frac{True\ age\ category}{total\ image\ number}$ ×100 2

2. False Reject Rate (FRR)=$\frac{False\ rejected\ age\ category}{total\ image\ number}$ ×100 3

There are eight categories of aging progress of human face images that are deduced with this system; these categories were explained in the following experiments to evaluate the system, tables (3,4,5):

1. THE FIRST CATEGORY OF BABY [1_6, 7_11]:

Table (3) the results of Baby group categories

Age category	Number of images	TAR%	FRR%	Time(second)
1_6	45	90.0	10.0	0.0041
7_11	45	89.1	10.9	0.0346

2. THE SECOND CATEGORY OF YOUNG [12_49]:

Table (4) the results of young group

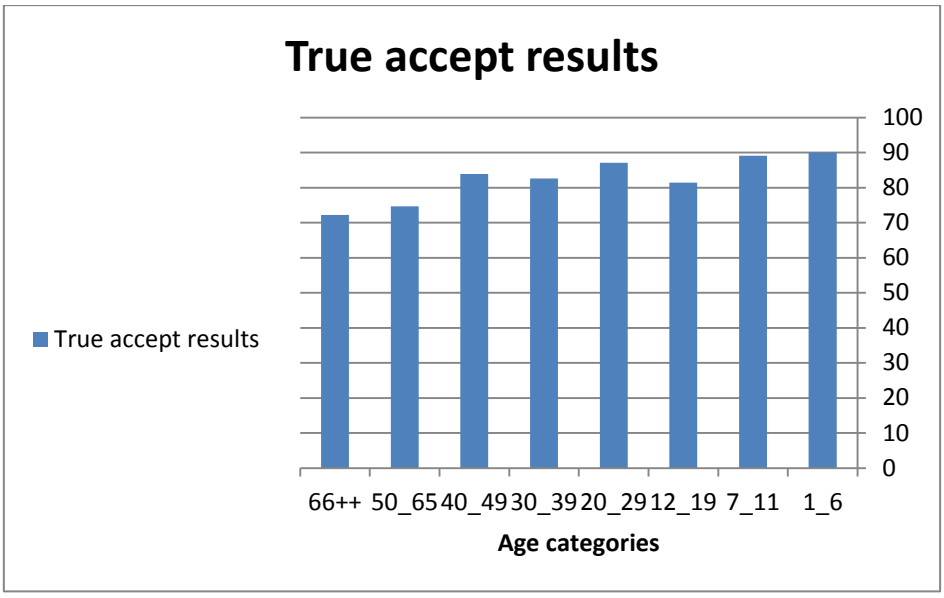
Age category	Number of images	TAR%	FRR%	Time(second)
12_19	45	81.4	18.6	6.125
20_29	45	87.1	12.9	6.0839
30_39	45	82.6	17.4	6.5683
40_49	45	83.9	16.1	6.3631

3. THIRD AGE CATEGORY IS SENIOR [50_65, 66++]:

Table (5) the results of senior groups

Age category	Number of images	TAR%	FRR%	Time (second)
50_65	45	74.7	25.3	6.6381
66++	45	72.21	27.79	6.6176

The Fig. 3 is a diagram that shows the accept age classification results of the (360) face images for both genders to the specific age categories:



Figure(3):Histogram display the accept results

The Table 6 shows the comparison of the proposed system with the previous approaches (for age classification problem solution). From this table we find the used algorithms in this project give good results in the age classification of the face images into accurate categories and four groups compared with other classification and estimation approaches by using the same database (FG-NET) with a lot of images from the CBIR and the real life albums.

Table (6): A comparison of age classification methods

	Approach	**Database**	**Classes**	**Accuracy**
Kwon and Lobo (1999)[4]	Age classification from facial images (texture &geometric)	47 face images	3 groups: Baby, young and senior	100%
Hlaing et. al. (2011)[16]	Aging groups classification based on facial features (NN)	Private database	10 classes from 15-70 years old	81%
Juha et. al. (2012)[17]	Age classification in unconstrained conditions using LBP variance(texture)	Image of groups	7 classes: 0-2, 3-7,8-12,13-19, 20-36,37-65,66++	88.7%
Lazarus et.al (2013)[18]	Age classification base on wrinkle analysis(texture)	Mug-shot	3 groups: Baby, adult ,senior	80%
Designed system (2014)	Automatic age classification system(texture& geometric)	FG-NET& CBIR	4groups: Baby, young ,young adult and senior , 8 categories: 1-6,7-11,12-19,20-29,30-39,40-49,50-65,66++	82.2%

10. DISCUSSION

A) The work at designing a system of age classification categories a lot of difficulties and effects that because of the environment factors that changes from person to person the aging process . Furthermore there are no appropriate indexed clear databases of human faces with age's numbers. The same people may look younger or greater than others in special factors . The most important issues with age classification process are:

1. The light enhancement algorithm and contrast enhancing prove best result in detecting the primary face features and then the secondary face features with low time wise ranging between (0.5-1.6) second according to the size of the images on the hard disk of the computer.
2. Two major characteristics of aging appearance to classify the age group and age category.
3. The craniofacial analysis information that describes the facial primary features growth by computing the distances then ratios between these features from one category to other.
4. we used facial texture properties that show the region of wrinkles in the frontal faces with age progression , in this algorithm the most thickness lines were selected to distinguish young face from senior face texture.
5. gathering of the ratio process with wrinkle analysis process is our algorithm that classifies the faces into one of eight age categories depending on the image processing technique .
6. the number of wrinkles and the solidity of the lines on the forehead , under two eyes and cheeks were selected as basic classifier , even if the number wrinkle lines on the face lessin young adult groups than in the young groups the solidity metric of these lines was gathered with the number lines metric as a classifier factor for best estimation.
7. the use of global features as primary features of the face technique was used to detect the main face features such as top head point , eyes , mouth , chin , and two sides of the face which were used a classifier that isolates baby face features distances from adult features distances.
8. the system of classification proves encouraging results o low time losing in detecting and classifying age groups then age categories of input face images after rotating the face to be in best pose for features best detecting the run time ranging between (5.3-30.23) seconds to preprocess the image then classifying it.

B) There are many advantages of using primary and secondary face features are -

1. There are large shape and texture variations over a long period, say 20-50 years: hair whitens, muscles drop, and wrinkles appear, and so on. it is hard to describe all of these variations.

2. The perceived face age often depends on global non-facial factors, such as the hair color and style, the boldness of the forehead, etc., while these non-facial features are usually excluded in face aging modeling.

3. It is very difficult to collect face images of the same person over a long time period and the age-related variations are often mixed with other variations (i.e, illumination, expression, etc.).

4. There exist large variations of perceived age within each biologic face group due to external factors , such as health, life style, etc.

5. There is a lack of quantitative measurements for evaluating the aging results in the literature.

C. Referendum Results

We execute a referendum experiment to display the human decisions about age categories estimation by face images, by including face images in 100 frames in different ages and both genders. With these experiments we obtain the opinions of dermatologist, rheumatology and Cosmetic doctors. Also the referendum includes the barbers. Where the results of the referendum different in accuracy from the automatic system results, the results of the baby category were (86%) for the (1_6)category, the (7_11) category was (95.4%), (12_19) was (73.8%), the (20_29) was (65%), (30_39) category was (58.9%), (40_49) results was (64.7%), the (50_65) category was (38.4%) and the last category (66++) results was (17.2%). These results compared with the automatic classification system there were wide gab, where the system proved its efficiency in age categories estimation for face images by following mathematical equations dependent on medicinal basis for typical human faces images. The fig. 4 shows the distinguishing chart of the computer and the human estimations results.

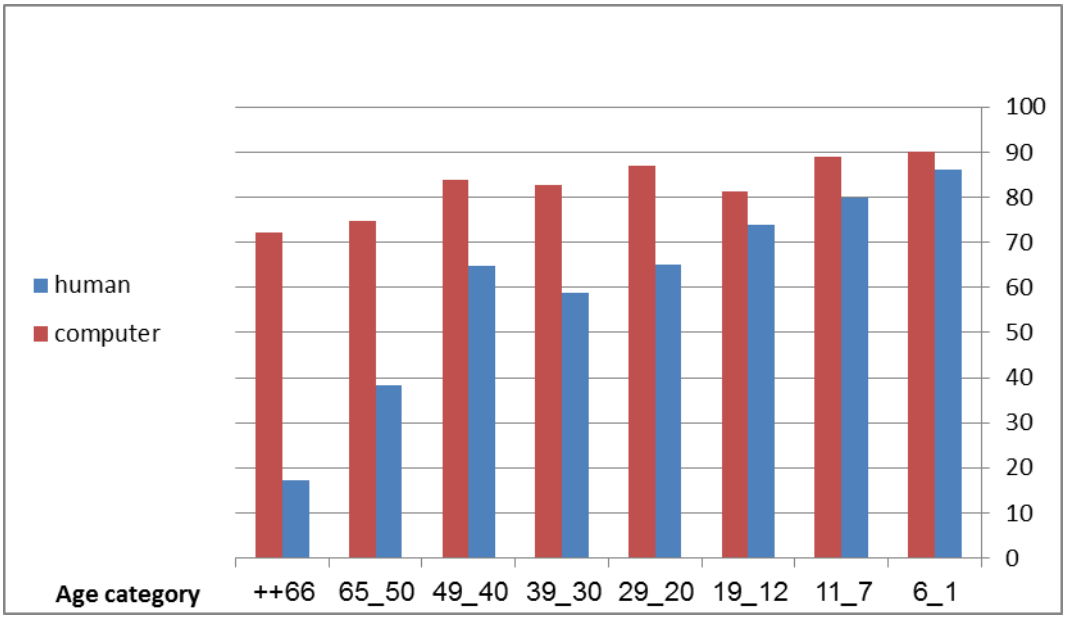


Fig. 4. Referendum results with system results

11. CONCLUSION

The subject of estimation of age from face characteristics is an important requirement that used to update the face recognition systems along time. And used in security applications to detect the illegal emigrants. Bu applying the age classification system we conclude that the face shape changes gathered with the texture aging are important features to estimate the age.

12. SUGGESTIONS FOR FUTURE WORKS

Through the work time on designing and implementing age classification system we find a lot of ideas that represent the future work for that research, as follow:-

1: Design a system for classifying age and gender of the input frontal images.

2: Simulate age progression and age regression process of the classifying images to predict the appearance of the current images in age indexing databases.

3: Use a system with digital cameras that print the date and age of faces in the snapshots.

4: Use (MORF database) which contains more face images with three images per subject.

5: Accepts all the input system images extensions such as (jpeg , pmb , gif, hdf, pbm, pcx, pgm, png , pnm, ppm , ras, etc.) to be the first step in each classifications systems of the computer visions world.

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