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Age and Gender Detection System

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Abstract: We developed extraction functions of a face individual region with color information and elements of its face and combined them with the gender and age estimation algorithmic program we tend to had already developed so the algorithmic program is applied to real time captured face pictures. The experimental results have shown touching ratios of 94.2% and 59.4% for gender and age respectively.

Keywords: Face image, Gender estimation, Age estimation, Skin color extraction, Wrinkle texture.

1. Introduction

In recent years, it is expected that gender and age estimation from facial images is useful for automatic marketing data collection. Many research papers have been published. We have developed an algorithm which estimates gender and age with classifiers using support vector machine (SVM) classifiers and voting based on features, such as geometric arrangement, texture and luminosity patterns extracted from facial images.

The algorithm has been tested with 300 persons of Softpia Japan HOIP facial image database (150 men and women, frontal face, normal expression, 15-64 years old). As the result, hitting ratios were 97.3% and 67.4% for gender and age, respectively.

The algorithm uses extracted features at 37 feature points on a face. The 37 points designed to represent principal points of face parts. Therefore, in order to apply the algorithm in real environment, a process which finds out face parts in facial images might be needed. We have developed functions which extract a face candidate region based on color information and detect face parts with graph matching method so that our system can work in real environment.

In order to evaluate the accuracy of the system, we conducted an experiment with 101 persons consist of men and women whose age are distributed from 22 to 66. We used classifiers which were trained with the HOIP database. As the result, the hitting ratios were 93.1% and 58.4% for gender and age respectively. This result shows that realization of automatic gender and age estimation is possible, although they are less than hitting ratios by human (gender: 100%, age: 68%).

In Chapter2, we describe the gender and age estimation algorithm. In Chapter3, we executed an evaluation experiment of the system. Finally, in Chapter4, we give our conclusion and outline of our future work.

2. Algorithm

2.1 Process flow of the system

Figure1 shows the processing flow of the gender and age estimation system.

First, a rough face candidate region (see Fig.1-b) is extracted based on skin color information from an input image (see Fig.1-a), in order to limit a processing region.

Next, 37 points, i.e. 8 points on both eyebrows, 10 points on both eyes, 4 points on the nose, 8 points on the mouth and 7 points on the face outline are detected as feature points in a face detection process (see Fig.1-c).

Lastly, features for estimation are extracted based on the detected feature points (see Fig.1-d), and gender and age are estimated with them (see Fig.1-e).

In this paper, we mainly describe the face candidate extraction and the feature points detection.

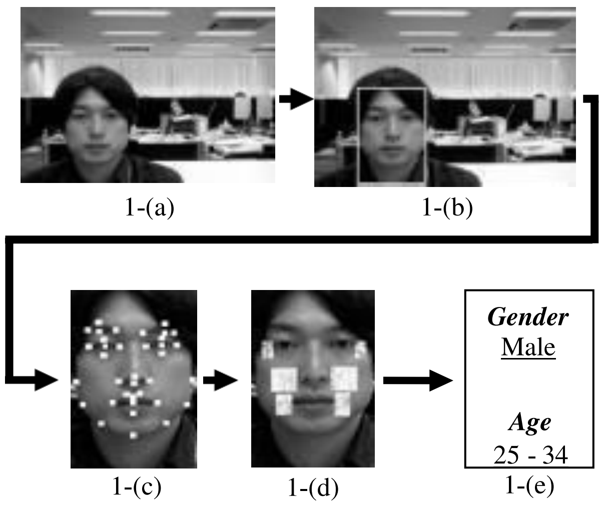


Fig.1: The processing flow of the system.

2.2 Extraction of the face candidate region

The face candidate region is extracted based on skin color information. In order to extract the skin color region, we used the modified HSV color system which Matsubashi and others proposed. The conversion formula from the RGB color system to the modified HSV color system is written as the formula (1), where, each factor *H*, *Qc* and *I* is hue, modified saturation and intensity and expresses color, saturation and brightness, respectively. Since *H* and *Qc* components are independent of brightness, they are widely used for extraction of the face candidate region as components which cannot be easily influenced of illumination change.

Especially Qc avoids the problem that the color similar to black whose saturation in the HSV color system must be low shows the high saturation. The modified system is effective in separation of a skin and a hair region. We used the hue component H and the modified saturation component Qc in order to extract the skin color region in the system.

$$H = \cos^{-1}\left\{\frac{(R-G)+(R-B)}{2\sqrt{(R-G)^2+(R-B)(G-B)}}\right\},$$

$$Qc = \sqrt{\left(\frac{2R-G-B}{2}\right)^2+\left(\frac{\sqrt{3}(G-B)}{2}\right)^2}, \qquad (1)$$

$$I = \frac{R+G+B}{3}.$$

Our algorithm of face candidate region extraction is as follows.

(1) Calculate a difference between a background image registered in advance and an input image (see Fig.2-a), and binarize the subtracted image with a threshold. The result image of the binarization is used as a mask image for the next process. This process removes pixels in the background that have color similar to skin (see Fig.2-b).

(2) Extract a region whose H and Qc component are within a range of constant values from the unmasked regions in the input image (see Fig.2-c).

(3) A region that has the maximum area among the extracted region is regarded as the face region since we assume that a frontal face surely exists and the face has a certain size which is large enough to extract features that has high frequency components such as wrinkles and spots.

(4) Fill holes of the skin color region.

(5) The extracted region is tested whether the region is likely a face region with geometrical features, i.e. area, circularity and the aspect ratio. With this test, unsuitable skin color region such as arms and too small faces can be removed.

With the process from (1) through (5) a face region is extracted if it exists. The rectangle region circumscribed to the region (see Fig.2-d) is used as a face candidate region. Each threshold used in above process was decided empirically.

2.3 Detection of the face feature points

We used the graph matching method with Gabor wavelet transformation (GWT) in order to detect the accurate position of the face and parts by detecting feature points in the candidate region .

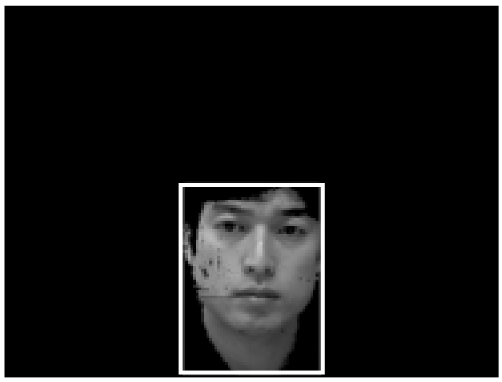
The detection algorithm is following.

(1) Changing position and scale of the input image, sum of similarity factors between the image and an average graph at feature points is calculated for each position and scale. The maximum similarity case is regarded as the rough position of the face. 8 points on the both end of eyes, the nose and the mouth, are used for this search.

2-(a)

2-(b)

2-(c)



2-(d)

Fig.2: Extraction of the face candidate region.

These points are included in the set of the 37 feature points. The average graph had been generated with image data of the HOIP data base.

(2) Using 16 feature points, the position and the scale of the face is determined more accurately. To do 16 points graph matching, 30 graphs of individual in the HOIP database are used for the model search. For each graphs varying position and scale slightly, similarity of each feature points are measured.

(3) The 16 feature points are fixed with the above search. The rest of the feature points, i.e. 21 points, is searched with the model based on the 16 points.

Figure3 shows a search result of the 37 points graph.

Fig.3: Search of the feature points.

2.4 Feature Extraction and Estimation

We describe briefly about the algorithm which we had developed .

(1) Feature Extraction

We used 6 kinds of information, i.e. GWT, geometric arrangement, texture, skin color, hair and mustache, as the features in the algorithm. The extraction methods of the features are followings.

GWT

By applying the GWT which used filters which have various resolutions and directions, periodicity and directivity of density character around the feature points can be extracted . GWT is applied at the 37 points, and the coefficients are used as the features. 40 Gabor filters (8 direction x 5 frequency) are used at each point.

Geometric arrangement

It is reported that 2-dimensional arrangement information on parts of a frontal face and gender and age have correlation .Based on the coordinates of the feature points, 118 fea- tures are used as geometric arrangement information. Those features can be categorized in 3 classes. The first class consists of 43 features representing absolute sizes of parts and distances between parts such as width and height of eyes, the mouth and the nose and distance between both eyes and so on. The second class consists of 42 features representing relative sizes of parts and relative distances between parts. The features are generated as ratios of the features in the first class. The third class consists of 33 features representing relative position between parts and the outline of face.

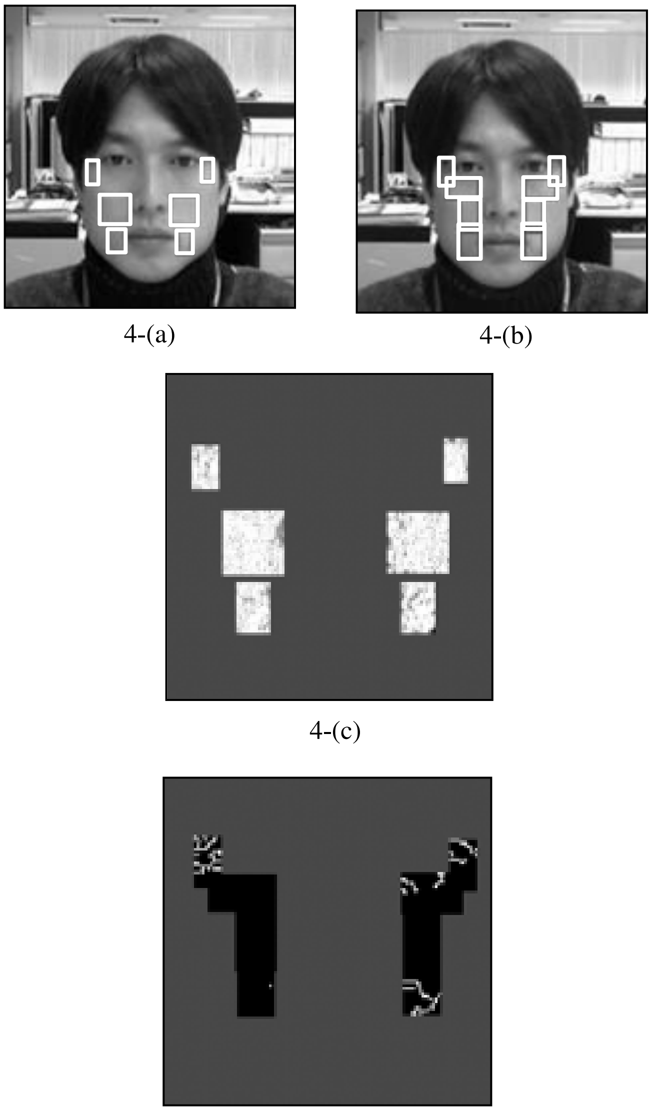
Texture (spots, wrinkles, flabs)

It is known that the features of age will appear as skin texture variation, such as large wrinkles, flabs, small wrinkles, and spots notably in the adult whose frame is stable.

Components of small wrinkles and spots are equivalent to the high frequency component of the spatial frequency of density. Since its amplitude is small, it can be considered as small fluctuating noise. İ-filter is one of filters which extract such components effectively .

We applied the İ-filter to 6 regions, i.e. the regions of tail of eyes, both cheeks and both sides of the mouth (see Fig.4-a). The average values for each region are used as features. These are regarded as the features of small wrinkles and spots (see Fig.4-c). In order to remove glasses and hair from the region of a face, the regions were limited only to the skin regions.

The area of edges in the block regions of tale of eyes, just under eyes, sides of the nose and sides of the mouth obtained from the feature point coordinates (see Fig.4-b) were used as the features of large wrinkles and flabs (see Fig.4-d).



4-(a) 4-(b)

4-(c)

4-(d)

Fig.4: Texture information.

Skin color

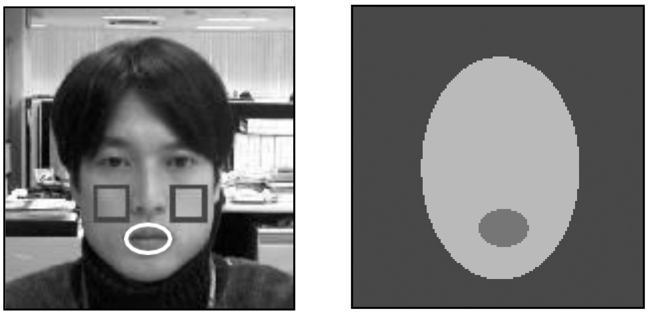
Information of the skin color caused by makeup or somber has correlation to gender and age. A representative color of each region (see Fig.5-b) is decided by a histogram of a cheek and a lip region (see Fig.5-a) extracted based on the feature point coordinates and the color information of a face. Hue, saturation and luminosity in the HSV color system of each region, and their differences between the regions were used as the features.

Hair

As shown in Fig.6-a, 26 block regions of the circumference of the face are determined based on the face feature point coordinates to extract hair features. After extracting hair region (see Fig.6-b), area of the hair region in each block was used as the features.

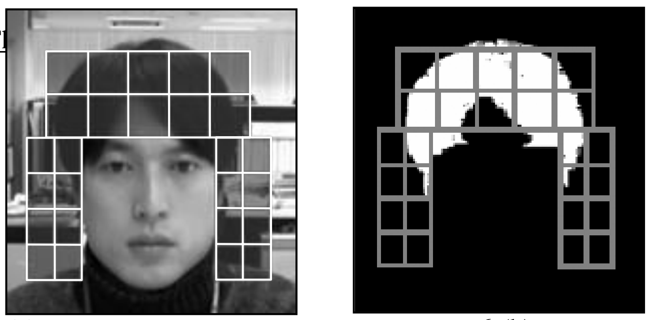
Mustache

It is thought that mustached information has correlation to gender. When mustaches exist clearly, it can be distinguished using the GWT features . When the mustaches were shaved, create the image which emphasized (see Fig.7-a.) based on a color histogram of the mustached portion (see Fig.7-b.), and the GWT features of the mustached region were used as mustached information.



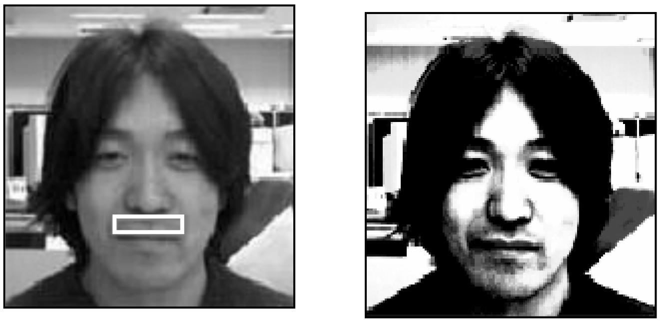
5-(a) 5-(b)

Fig.5: Skin color information.



6-(a) 6-(b)

Fig.6: Hair information.



7-(a) 7-(b)

Fig.7: Mustache information.

(2) Estimation

As shown in Fig.8, estimation is executed from gender phase. For age estimation, we prepared two classifiers corresponding to gender. Each age classifier had been trained with male or female data only. Based on the output of gender classifier, suitable age classifier is applied.

We used the features of GWT, geometric arrangement, color, hair, and mustache for gender estimation, and the features of GWT, texture (spots, wrinkles and flabs), geometric arrangement, color, and hair for age estimation. For each estimation process, SVM classifiers with one or a few kinds of those features are created and trained. Estimation results are obtained by voting of results of the classifiers.

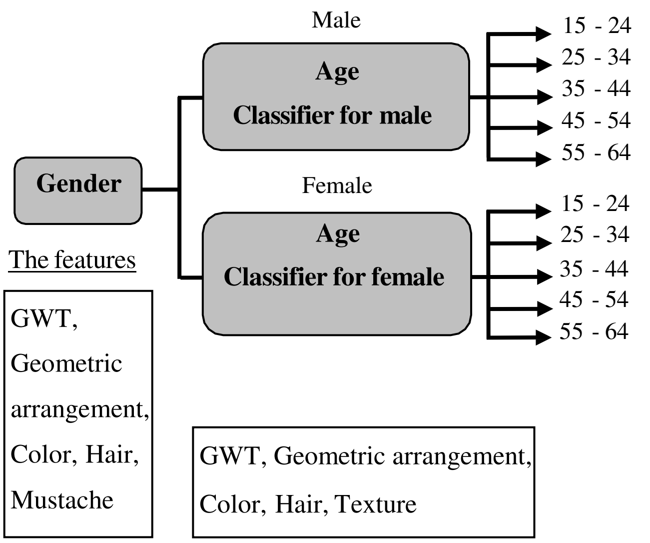


Fig.8: Estimation flow.

3. Experiment

3.1 System configuration

We built the system with a PC (Pentium III 1.0 [GHz], 640 [Mbytes] memory and Windows 10) and a camera (Intel Pro PC Camera, CCD, USB port connection, 310,000 [pixels] Resolution). Figure9 shows a general view of the system. Following guide sentences, users input their face images. The operation screen is shown in Fig.10. The system displays estimated gender and age.

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Fig.10: The operation screen.

3.2 Acquisition of images

The quality of image is varied because of change of illumination conditions depending on the place where the system was installed or time progress. Estimation results become unstable because of this variation. So, when illumination conditions changed, in order to cope with the problem, following parameter adjustments are required.

(1) Camera parameters

An adjustment dialog of the camera driver mounted in the system can adjust parameters inside the camera. In this function, parameters such as white balance, brightness, color tone, and so on can be adjusted for obtaining the stable quality of image. Generation of unnecessary shadow and saturation in the face region of the captured image can be avoided using this function.

(2) Skin color region extraction threshold

Upper and lower thresholds for H and Qc are adjusted to the skin color range corresponding to color temperature on that occasion. The adjustment enables to extract a face robustly when color itself changes with variation of illumination conditions.

(3) Wrinkle and stain extraction filter

Since features of wrinkles and spots use the density information of the image, they are greatly influenced by change of brightness or illumination direction. Those influences can be reduced by changing the threshold of edge

3.3 Experimental condition

We experimented with 101 people consist of man and woman whose age is distributed from 22 to 66 in order to evaluate the validity of the system. Table1 shows the distribution of the number of experimental images.

We acquired the images of 101 persons used for this experiment for 2 days. The experiment was conducted under indoor fluorescence illumination. Illumination conditions had been changing to some extent with time progress because of the sunlight inserted in the room. We had to adjust camera parameters several times. However other parameters had not to be adjusted. The acquired image has size of 640*480 pixels. We used images of 340*340 pixels as standard extracted from the original images automatically.

We used classifiers which trained with the HOIP database images, and cubic polynomial kernel as the SVM kernel function.

Table1: The distribution of the number of experimental images.

		Gender	
		male	female
Age	20 years	22	7
	30 years	30	3
	40 years	25	4
	50 years	6	2
	60 years	2	0

3.4 Experimental results

A range of an age estimation result is 15 to 65 years old, and divided into 5 classes with 10 years old range. If the class of the estimation result contains the real age of the subject, the result is considered as correct. The hitting ratios of gender and age estimation with 101 persons were 93.1% and 58.4% respectively. Compared with the case where it applies to the HOIP database, both down by5 points in percentage.

3.5 Discussion

Two reasons can be considered as factors of incorrect estimation.

(1) Miss identification of positions of the feature points caused by search failure.

(2) A Variation in a quality of image by change of illumination.

As a result of estimation by inputting 37 feature points correctly with manual operation in order to remove an influence of the first reason, the hitting ratios became 96.0% and 61.4% in each gender and age. In addition, for age estimation the number of incorrect estimations whose classes were far by 2 or more classes from its correct class was decreased byhalf. Though improvement of the hitting ratio was a little,

Table2: The number of age miss classification by 2 or more classes.

	Feature points	
The gap of miss classification	Auto detection	With manual correction
2 classes	18	6
3 classes	3	2

About the second reason, luminosity information was normalized by histogram equalization in the whole image histogram based on a conversion table calculated from a luminosity value of a skin region, and mitigation of influence was aimed. Figure11-a shows an original image, Fig.11-b shows an example of extracted face, Fig.11-c shows an example of equalized image. As the result of estimation with the frequency equalization image, in gender estimation, result difference was not seen, but in age estimation, the hitting ratio down to 47.5%.

In addition, as shown in Table3, the tendency for incorrect estimation caused by individual difference of appearance was also seen.

11-(a)

11-(b)

11-(c)

Fig.11: Equalization of the luminosity.

In the future, about (1), it will be coped with by improving face search algorithm. And about (2), it will be coped with byan improvement of the luminosity normalized method.

4. Conclusion

In this paper, we proposed a gender and age estimation system from frontal face images. We evaluated the system and achieved the hitting ratios of 93.1% and 58.4% in gender and age respectively.

a factor which cannot be expressed by the rate has beengreatly improved.

We have to work on finding the feature points more accurately. It will be coped with by improving face search algorithm. Also we will work on improvement of the luminosity normalized method, and must aim at improvement in accuracy.

Table3: The tendency of incorrect estimation by individual difference.

Gender	A man with roundness outline, A woman with keen outline, A clear-cut woman
Age	A real age differs from an impression (A baby face, A face which looks old), Wearing of glasses, Disappearance of wrinkles and modification of eyebrows by makeup

References

[1] M. Yasumoto et al, “A Method of Estimating Gender and Age using Average Face”, Technical Report of IEICE, PRMU2001-138, 2001

[2] S. Hosoi et al, “Gender and Adult Estimation System with Gabor Wavelet and Support Vector Machines”, SSII03 Trans., pp.243-246, 2002

[3] J. Hayashi et al, “Age and Gender Estimation from Facial Image Processing”, Proc. Annual Conf. SICE (SICE2002), No.SICE02-0035, Osaka, Aug., 2002

[4] Baback M et al坒”Gender Classification with Support Vector Machines”, Proceedings of the forth International Conference on Automatic Face and Gesture Recognition, pp.28-30, 2000

[5] K. Izumi et al, “A Gender and Age Estimation Algorithm from Several Features of Face Image”, IPSJ Conference, pp.79-80, 2003

[6] L. Wiskott et al, “Face Recognition by Elastic Bunch Graph Matching”, IEEE Trans. On Pattern Analysis and Machine Intelligence, 7(4), pp.775-779, 1997

[7] S. Matsuhashi et al, “A Proposal of the Modified HSV Colour System Suitable for Human Face Extraction”, The Journal of the ITEJ, Vol.49, No.6, pp.787-797, 1995, (in Japanese)

[8] S. Kawato et al, “Automatic Skin-color Distribution Extraction for Face Detection and Tracking”, Proc. Int. Conf. on Signal Processing, Vol. II, pp.1415-1418, 2000

[9] Y. Shiga et al, “Extraction of Facial Area and Facial Parts Based on Color and Motion Information and Detection of Its Movements”, T.IEE Japan, Vol.121-C, No.5, pp.912-919, 2001

[10] M. Yamaguchi et al, “Relationship Between Physical Traits and Subjective Impressions of the Face –Age and Sex Information”, IEICE Trans., J79-A, No.2, pp.279-287, Feb.1996

[11] H. Watabe et al, “A Nonlinear Digital Filter for Beautifying Facial Images”, Journal of Three Dimensional Images, Vol.13, No.3, pp.41-46, 1999