24

Apparent Age Estimation System Based on Age Perception

Hironobu Fukai, Hironori Takimoto, Yasue Mitsukura, and Minoru Fukumi
Ritsumeikan University
Okayama Prefectural University
Tokyo University of Agriculture and Technology
The University of Tokushima
Japan

1. Introduction

Recently in the world, age estimation is widely studied. Especially, when we use face images, subject's resistance and psychological loads of the age estimation method are smaller than the method by using any other method by using the non-face image. Because faces are always opened to the society compared with other bodily features. Thus, the age estimation method by face image and appearance information is actively researched. By the way, sight information that faces, hairstyle, clothes, and appearance appears the feature of the age and the gender. Especially, face information is thought to be the most much feature information of the age. Because, human see the face and estimate the age when they communicate with somebody else. Therefore, many of the age estimation method by face image is studied [1-10].

In the study on a physical shape change of the face from the age, todd show that contour of skull are approximated by cardioid transform (Todd, Mark). On the other hand, age estimation by computer are performed. Kanno shows that the man was identified by the neural network for four ages (12 years, 15years, 18 years, and 22 years). Y.H.Kwon is reported that the theory has only been implemented to classify input images into one of three age-groups: babies, young adults, and senior adults. The computations are based on cranio-facial development theory and skin wrinkle analysis. Burt studied the age perception that uses the averaged face from 25 to 60 years. Especially, he used texture and shape. Ueki are reported that the age-group classification by the dimension compression.

However, there are some problems in these techniques. It has only the characteristic of roughly classifying the person. Thus, it was assumed that the reliability of the recognition accuracy was a doubt. Because there were possibilities to be classified into a different class in 19 and 20 years old. However, 20 and 29 years old were classified into the same class. In this case, the age is very far from 20 and 29 years old. Therefore, it is necessary to be classified into a different category. Furthermore, it is necessary to classify the same category 19 years old and 20 years old. Actually, it is very difficult to classify as mentioned above. This difference is important problem in the age estimation. Furthermore, in the method of extracting a lot of characteristics, it is difficult to extract these accurately. Then, in this paper,

we propose age estimation every age by using the overall feature of the face. There are few studies for age generation but there is no study to investigate the every age for person. Moreover, feature data for age estimation is the normalized based on the both eyes. Furthermore, we want to analyze what features of the face decide the apparent age. Therefore, we pay attention to the mechanism of the human perception. The main motivation, in this study is to obtain the feature for age and apparent age. The second motivation is to classify the every age like human skill automatically by the proposed method.

First of all, the apparent age based on person's subjectivity in the face image is given. Next, the apparent age is estimated by the computer simulation. The estimation method used supervised self organized map (SOM). It delimits from 15 to 64 years old, and we create an age estimation map of one dimension. Thus, the continuous estimation is possible. The problem by clustering at the age can be solved by estimating in one of every age. Moreover, the feature data that becomes important for the age estimation is extracted by the genetic algorithm (GA). The individual feature that the person has and the feature at the age are extracted by using genetic algorithm for the image that does fast Fourier transform (FFT). To compare all face images as much as possible on the same condition, we propose an original normalized technique of the face image. The rotation angle is corrected to the inclination of the face in normalization. An area necessary for recognition is extracted and to compare it on the same scale, a centre part of the face is cut out. Thus, the background part that is unnecessary information can be reduced. Furthermore, information thought to be related to age excluding face information like the hairstyle and clothes, etc. can be reduced. Finally, it is thought that the age estimation limited to face information can be done.

In order to verify the effectiveness of the proposed method, we show the computer simulation based on the real data.

Size	640×480 [pix.]
	24 bit color
Gender	150 images for each
Age	30 images per 5 years old
Emotion	neutral

Table 1. The detail of the face image database

Fig. 1. Example of original images

2. Preprocessing

To compare faces, we need face normalization and apparent age database creation.

2.1 Face image database

The face database is provided from Human and Object Interaction Processing (HOIP) organization in JAPAN [11]. These subjects are the people with a wide age group that doesn't sport a pair of glasses. The background and proof were made the same condition for all subjects. Subject was directed to make the lens of the camera see, and it took a picture with that look of natural (Table 1). Fig.1 shows the example of the original image. 252 people who gave the preprocessing beforehand are used as subject. In this paper, the face database has obtained the use permission from corporation SOFTOPIA JAPAN. It is prohibited to copy, to use, and to distribute without the authorization of the right holder.

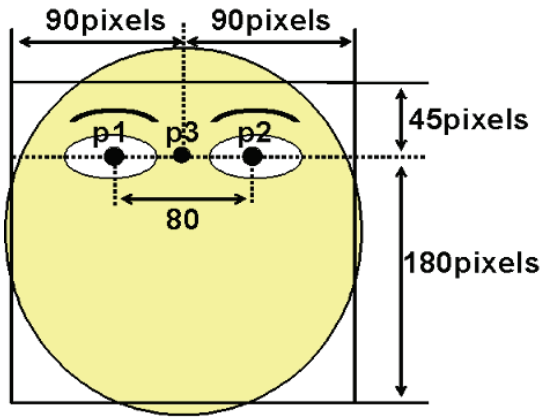


Fig. 2. The outline of the normalization method

2.2 Normalization

It is necessary to normalize the face image to the age estimation. The normalization method of face image in the paper is shown. The face image is normalized based on both eyes. The reason for having used the eye for normalization of face image is as follows. The first, eyes are having been easy to perform the normalization about a rotation and a size, compared with other features of face. Next, many researches of extracting the region of an eye are proposed [12], [13]. Therefore, to use eye for normalization of face image is efficient.

First of all, an original image (640 × 480 pixels, 24bit color) is changed into 8bit into the gray scale image, and median filter is performed in order to remove the noise.Next, center positions of both eye s are extracted. Then, the line segment joining both eyes is rotated so that it matches the horizontal line. Furthermore, the distance between both eyes is made 80 pixels by scale change (Fig.2). Moreover, in order to diminish influence of hair and clothes, an image is cut out. That is, letting the midpoint of the segment joining both eyes be a standard point, the region spreads by 180 pixels (by 90 pixels in right and left direction, respectively) in horizontal direction, and by 225pixels (by 45pixels in the upper part and by 180 pixels in the lower part) in the vertical direction. Finally, the image in a center part of the

face like Fig.3 (180 × 225pixels) is obtained by this processing. Furthermore, in this paper, we make low-resolution images like Fig.4 (12 × 15pixels).

Fig. 3. Normalization of the face images

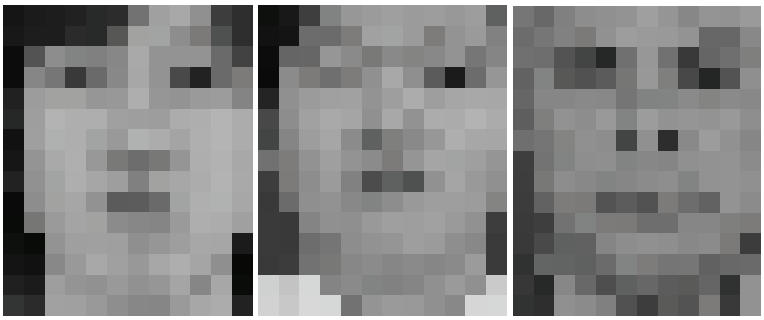


Fig. 4. Low-resolution images

2.3 Apparent age database

In this paper, the apparent age was given by doing the questionnaire survey to 38 subjects. It was thought that the objectivity of the apparent age to which the person evaluated the subjectivity went up by giving the questionnaire survey a lot of subjects. Moreover, the error margin of age estimation for each age can be reduced by having elected various generations and gender questionnaire subjects.

As the questionnaire method, the subject sees the face image after normalization, and the apparent age is given. The face image prepares the one arranged at random, and the subject estimate the age from the edge by intuition sequentially. Fig. 5 represents a actual questionnaire. When the age that obviously outlier was given compared with the age that many other subjects gave the apparent age, it excluded it from the object of the apparent age as a outlier. The apparent age was assumed to be a mean value of the age that the subject had given except outlier. In proposed method, this age is adopted for the teacher data as apparent age.

2.4 Feature data extraction

In this paper, we think that the shape of the face and information on wrinkle are important for the age characteristic. Then, the feature at the age is extracted by the FFT (Fig.6). In this paper, spectrum data was used for a feature data. However, unnecessary data for age estimation are included in the all spectrum. Then we select the feature data for the age estimation by using the GA (see 3.1).

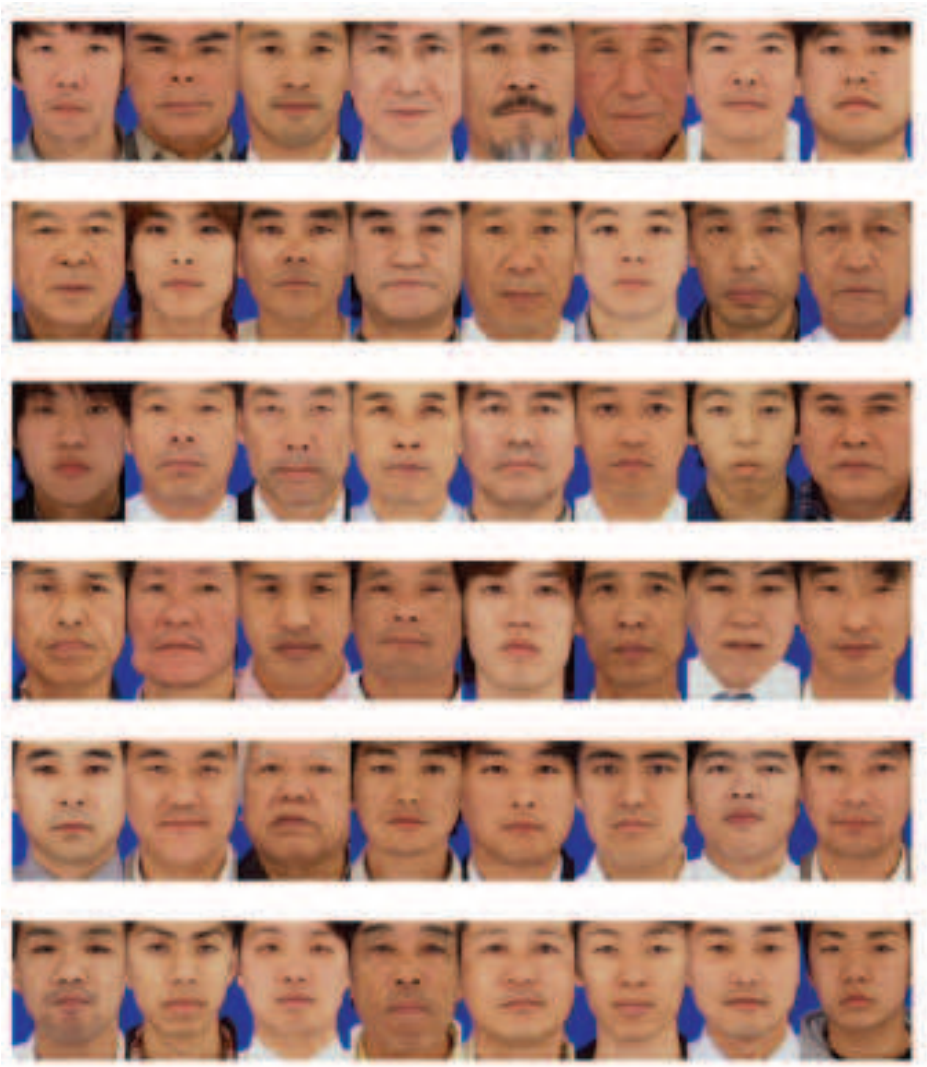


Fig. 5. Actual questionnaire

3. Age estimation system and feature data selection

Feature data by spectrum after the FFT are left a lot of feature data. However, this data has not important data for age estimation. Then, it is necessary to select the feature data. Therefore, we use the GA for feature selection in the proposed method. An age estimation system that used little feature data was developed to the combination of an age estimation system by the supervised SOM. The feature data selection by the GA and an age estimation system by the supervised SOM are described in as following processing.

3.1 Feature data extraction

Age feature are appear in skin texture. Then, the feature data is extracted by Fourier transform.

Genetic algorithm (GA) is an algorithm that technologically imitates the process of the evolution of the living thing. This is widely used as one of the optimization techniques. In this paper, the recognition error margin of the age estimation system by the supervised SOM was used in the fitness function of the GA. Then, the combination of the frequency band regions where the recognition error margin as decreases as possible is selected by the GA.

In this paper, the following fitness function was used. *error* is the age error margin by the supervised SOM, and $error_{\max}$ is the maximum age error margin. The maximum age error margin was determined by the experience to 20.

$$Fitness = 1 - \frac{error}{error_{\max}}$$

Using this fitness function, the feature data to obtain high recognition accuracy can be selected. Moreover, Table 2 shows the parameter of genetic algorithm used by proposed method.

The parameter of the genetic algorithm was decided in consideration of the calculation cost. In this paper, we used a roulette rule about the individual selection. Moreover, we used a uniform crossover method, and we used a elite strategy.

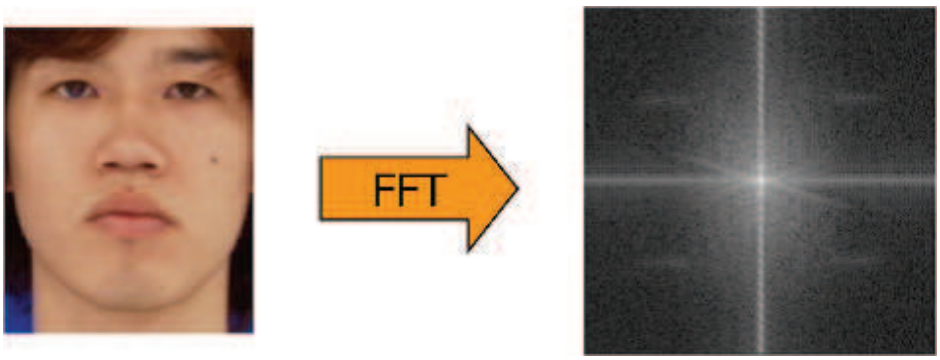


Fig. 6. Feature data extraction by FFT

Individuals	20
Generations	1000
Crossover method	Uniform crossover
Crossover rate	0.8
Mutation rate	0.02
Chromosomes	Decide by the GA

Table 2. Parameter of the GA

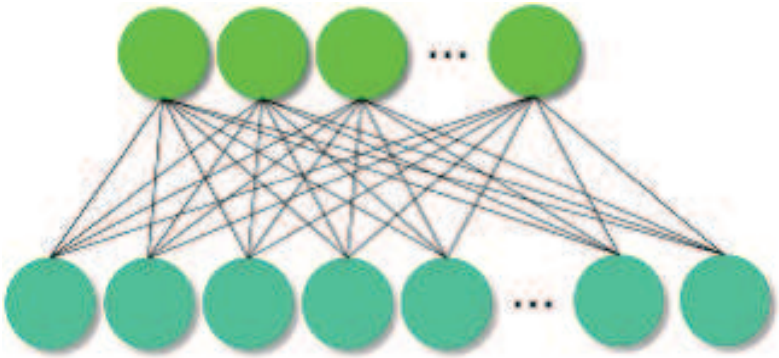


Fig. 7. Supervised SOM

Learning number	10000
Category	50
Input number	Decide by the GA

Table 3. Parameter of the supervised SOM

3.2 Feature data selection

Frequency feature has not only age feature. To extract age feature, feature data selection is necessary. Genetic algorithm (GA) is used for feature data selection.

The supervised self organized map (SOM) is one of the neural net works which have two layers. The network is a combination of an input layer and a rival layer of the processing unit. Furthermore, it is trained in study with the teacher. In this paper, the one dimension supervised SOM is designed to the age estimation (Fig.7). The age is continuously identified by the supervised SOM. The feature data for the age estimation was obtained from genetic algorithm, and is trained by supervised SOM. In this proposed method, the average of the error margin of the teacher data and the output result is assumed to be an age estimation error margin. Moreover, the parameter in the supervised SOM is shown in Table 3. These parameters were obtained from empirically as well as the parameter of the GA. To identify it from 15 to 64 years old continuously at intervals of one year old, the number of neurons of rival layers was assumed to be 50 pieces.

3.3 Age estimation

To estimate continuous age, we use the self organizing map (SOM). Moreover, proposed method is supervised SOM that is one of neural net works which have two layers.

4. Computer simulations

In order to show the effectiveness of the proposed method, we show the simulation examples.
In this paper, only 50 men estimated the age.
Furthermore, we examined the low-resolution images.
Here, the recognition accuracy was calculated by the cross-validation method.
Table 1 shows the age error margin when we use the extracted feature data by the genetic algorithm.
Moreover, age error margin by human's age perception ability is shown at same time.
From this result, the age estimation by few data is thought to be high recognition accuracy.
Moreover, the age error margin closes to human beings.

All feature	9.96 years old
Selected feature	6.8 years old
Human beings	4.94 years old

Table 1. Age error margin

Then, Table 5 shows number of feature data, and the Fig.8 shows the extracted feature point. The data chosen from the symmetry of data becomes below the half. The inside data is low frequency, and the outside data is high frequency. Therefore, both frequencies were chosen to be feature data. In addition, unnecessary data are reduced by the GA about 83%. Moreover, Fig.9 shows the result of inversed FFT by using extracted data. This image shows the possibility that can be estimate the age by blur image. In conclusion, it is thought that the human's atmosphere and shape of face is important in human's age perception, and it can be said that the age estimation by using low resolution image.
Next, we surveyed the weight of supervised SOM after learning. Fig.10 shows that the weight of the supervised SOM. X-axis indicates that the rival layer number, and that means the age. Small number suggest that the young people, and large number indicate that the old person. In addition, Y-axis indicate that the value of weight, and Z-axis suggest that the node number. It is considered to be this figure has that some rules. First, the weight value was decreased in the sixth node numbers by increased age. Furthermore, the weight value was increased in the 12th node numbers by increased age. Similarly, the weight value was increased in the 20th node numbers. From this result, it is considered that human's feature changes continuously along with increased age. Indeed, we surveyed the actual spectrum data. Fig.11 indicates three men's spectrum data (apparent age: 21 years, 39 years, and 55 years). In the sixth node numbers, the largest weight value was a 21 years man, and next large weight value was a 39 years man. Furthermore, in the 12^{th} and 20th node numbers, the largest weight value was a 55 years man and next large weight value was 39 years man. These results were the same as the weight of supervised SOM. Therefore, it can be said that the hypothesis that human's feature changes continuously along with increased age is correct even by actual data.

However, some subjects that have large age error margin exist. In this case, they have difference spectrum data compared with weight of supervised SOM. The reason is considered that the normalized image have unnecessary information for the age estimation, for example, clothes, hair, and so on.

	12 ×15 pixels
Use all data	9.96
Use extracted data	6.8
Human's age perception	4.94

Table 4. Age error margin

	12 ×15 pixels
Use all data	256
Use extracted data	44

Table 5. Number of feature data

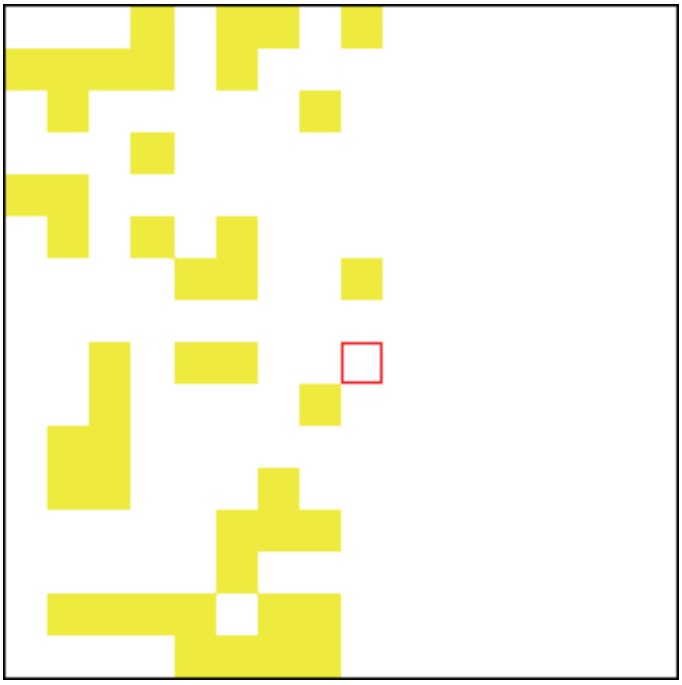


Fig. 8. Extracted feature data

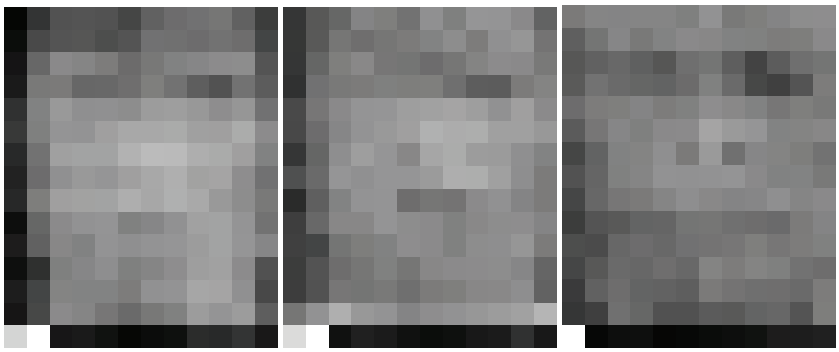


Fig. 9. The result of inversed FFT

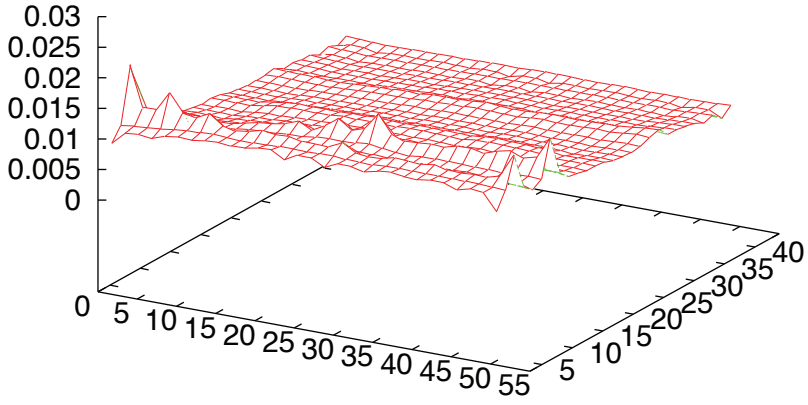


Fig. 10. Weight of the supervised SOM

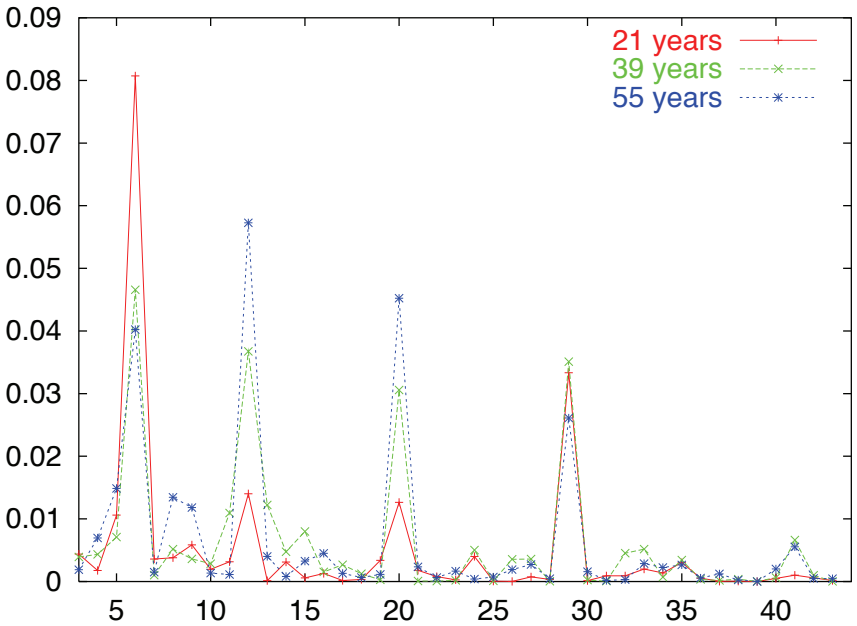


Fig. 11. Spectrum data

5. Conclusions

In this paper, we proposed a new age estimation system by the GA and the supervised SOM.
Then, the age is estimated continuously by the supervised SOM.
The GA is used for the feature selection based on the human sense.
To verify the effectiveness of the proposed method, we show the simulation examples.
From this result, unnecessary data are drastically reduced by the GA and recognition accuracy that closes to human beings.
Furthermore, the recognition accuracy by the low-resolution images has higher accuracy than the normalized images.
Indeed, it is difficult for the computer to get the same perception as human.
However, in this paper, not to mention complete, we unlimitedly achieved.
It is thought that this approached the research for the computer to have man's sense again by one.
Finally, this research is a one to make the computer judge the sense that man judges externals (human's perceptions).
It is thought it is possible in the near future though this is difficult.
From these results, we can get the relatively good results from the view point of the few data recognition and were able to obtain a result almost similar to human's perception.
Therefore, it was confirmed that the proposed method works well.
In the future works, we analyze the cause of the misidentification knowledge that exists now, and we improve the recognition accuracy of an age estimation system.

Moreover, we search for optimal image size because of the high frequency has been extracted in the low resolution image.
Furthermore, we thought the hypothesis that human's feature changes continuously along with increased age.
Therefore, we'll propose the statistical estimation method.
In addition, we'll increase the number of subject, and we'll survey the women subjects.

6. References

J. T. Todd, L. S. Mark, R. E. Shaw, and J. B. Pittenger, "The perception of human growth", *Scientific American Perception*, vol.242, PP.106-114, 1980.

L.S. Mark, J.B. Pittenger, H.Hines, C. Carello, R.E. shaw, and J.T. Todd, "Wrinkling and head shape as coordinated sources of age-level information", *Perception & Psydhophysics*, vol.27, pp.117-124, 1980.

Tsuneo Kanno, Masakazu Akiba, Yasuaki Teramachi, Hiroshi Nagahashi, Takeshi Agui, "Classification of age Group Based on Facial Images of Young Males by Using Neural Networks", *IEICE Trans. Inf. & Syst*, Vol.E84-D, No.8, pp.1094-1101, August 2001.

Y. H. Kwon and N. D. V. Lobo, "Age classification from facial images", *CVPR'94*, pp.762-767, Seattle, US, June 1994.

D.M. Burt and D.I. perrett, "Preception of age in adult daudasian male faces: computer graphic manipulation of shape and colour information", *Perception*, Vol.259, No.1355, pp.137-143, January 1995.

K. Ueki, T. Hayashida, and T.kobayashi, "Subspace-based age-group classification using facial images under various lighting condhitions", *Proc. of IEEE Intl. Conf. on Automatic Face and Gesture Recognition*, PP.43-48, 2006.

Takayuki Fujiwara, Hiroyasu Koshimizu, "Age and Gender Estimations by Modeling Statistical Relationship among Faces", *KES2003*, LNAI2774, pp.870-876, 2003.

Noriko Nagata, Seiji Inokuchi, "Subjective Age Obtained from Facial Images -How Old We Feel Compared to Others", *KES2003*, LNAI2774, pp.877-881, 2003.

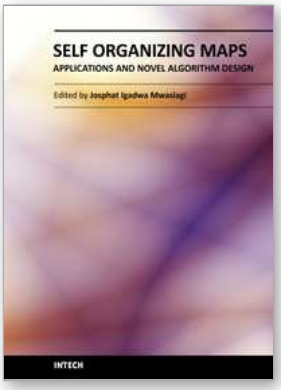
P.A. George and G.J. Hole, "Factors influencing the accuracy of age estimates of unfamiliar faces", *Perception*, vol.24, no.1, pp.1095-1073,Feb. 1995.

M. K. Yamaguchi, T. kato, and S. Akamatsu, "Relationship between physical traits and subjective impressions of the face - Age and sex information", *IEICE Trans.*, vol. J79-A, no.2, pp.279-287, Feb.1996.

http://www.hoip.softpia.pref.gifu.jp

S. Kawato, N. Tetsutani, "Circle-Frequency Filter and its Application", *Proc. Int. Workshop on Advanced Image Technology*, pp.217-222, 2000.

T. Kawaguchi, D. Hikada, and M. Rizon, "Detection of the eyes from human faces by hough transform and separability filter", *Proc. of ICIP 2000*, pp.49-52, 2000.



Self Organizing Maps - Applications and Novel Algorithm Design
Edited by Dr Josphat Igadwa Mwasiagi

ISBN 978-953-307-546-4
Hard cover, 702 pages
Publisher InTech
Published online 21, January, 2011
Published in print edition January, 2011

Kohonen Self Organizing Maps (SOM) has found application in practical all fields, especially those which tend to handle high dimensional data. SOM can be used for the clustering of genes in the medical field, the study of multi-media and web based contents and in the transportation industry, just to name a few. Apart from the aforementioned areas this book also covers the study of complex data found in meteorological and remotely sensed images acquired using satellite sensing. Data management and envelopment analysis has also been covered. The application of SOM in mechanical and manufacturing engineering forms another important area of this book. The final section of this book, addresses the design and application of novel variants of SOM algorithms.

How to reference
In order to correctly reference this scholarly work, feel free to copy and paste the following:

Hironobu Fukai, Hironori Takimoto, Yasue Mitsukura and Minoru Fukumi (2011). Apparent Age Estimation System Based on Age Perception, Self Organizing Maps - Applications and Novel Algorithm Design, Dr Josphat Igadwa Mwasiagi (Ed.), ISBN: 978-953-307-546-4, InTech, Available from: http://www.intechopen.com/books/self-organizing-maps-applications-and-novel-algorithm-design/apparent-age-estimation-system-based-on-age-perception

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821