Improvement of facial recognition method for identity confirmation in the shelter considering facial aging

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I. INTRODUCTION

When a large-scaled disaster occurs, the safety confirmation of the residents is important for grasping missing persons. Because the conventional safety confirmation method takes time, the discovery of the missing persons is delayed and their survival rate decrease. In this paper, we propose faster safety confirmation method using face recognition technology. In the proposed method the face image of the victim photographed at the evacuation shelter at evacuation time is compared with the face image list of the resident registered in advance. A resident who has a face that was not among evacuees is recognized as a person who is not confirmed to be safe. However, this method has a problem that the recognition rate of face recognition decreases with the passage of years from the time of photographing. Therefore, we examine a method to improve the recognition rate of faces by using only feature amounts not affected by time lapse.

II. SAFETY CONFIRMATION SYSTEM

The overview of the safety confirmation system using face recognition technology is shown in Fig.1. First, local government staffs take photos of evacuees' face who evacuated the shelters. Next, the system compares the photographed face image of the evacuee with the face image registered in the residents list. If an evacuee is identified as a resident, by finding the evacuee's face image from the residents list, the system registers the evacuee in the evacuees list. By comparing these resident lists with evacuees list, the system identifies the persons who are unconfirmed safety such as missing people.

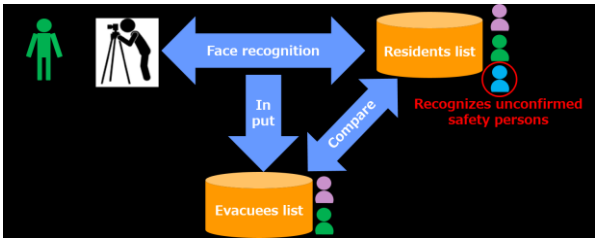

Fig. 1. The safety confirmation system using face recognition

III. FACE RECOGNITION METHOD

Tadokoro et.al proposed a method for continuous face recognition while tracking faces [1]. This method extracts 68 feature points from outline, eyebrows, eyes, nose, mouth etc. Based on these facial feature points, it is tracked using open source machine learning and image processing library "Dlib" [2]. Next, to perform face recognition, the extracted feature points are connected by lines and a 195-dimensional feature vector (f_1, f_2, ... f_i, …, f_{195}) is generated. They performed experiments on the recognition performance using 10 input images, and 10 registered images taken 1 week ago. As a result, the recognition rate reached 95%. The registered images assumed by our proposed system are usually stored for a long period. For example, the face images registered in "My Number System" are stored for about 10 years. Therefore, there is a possibility that the face may have changed during that period, and the recognition rate may be decrease.

IV. PROPOSED METHOD

In this paper, we aim to improve the recognition rate by excluding features that change significantly due to change over the years such as aging. First, using existing face image dataset, we analyze the yearly changes of the feature amounts in the face. Face recognition is performed using feature amounts other than feature amounts that are likely to change due to aging obtained by this analysis.

A. Face image dataset

A Cross-Age Celebrity Dataset (CACD) [3] is known as a face image dataset including yearly changes of facial features. CACD records front images of famous people from 16 years old to 62 years old photographed every year from 2004 to 2013. In this paper, we extract 200 data from this CACD and analyze the change of the features in the face image every year from 2004 to 2013.

B. Analysis of face's feature change

In order to identify features susceptible to aging, we analyze the change in feature quantity based on the image of the face taken in 2004. First, we calculate the finite difference g_i of each feature amount i for each year from 1 year ago to 9 years ago using formula (1). i represents the number of the feature quantity, j represents the photo shooting year, and k represents the elapsed years since 2004.

$$g_{ik} = | f_{ij} - f_{i2004} | \quad (1)$$

Second, we calculate average value h_i of 9 years of g_i. Finally, we calculated average r_i of h_i for 200 people by formula (2). The larger the r_i, the easier the feature amount is to change over time, and the smaller the r_i, the harder the feature amount tends to change over time. Therefore, we specify the feature amount which tends to change over time, based on r_i, increase authentication rate by excluding them.

$$r_i = \frac{\sum_{l=1}^{200} h_{il}}{200} \tag{2}$$

V. PERFORMANCE EXPERIMENT

We evaluate the proposed system by experiments to recognize past face images from the present face image. It is confirmed whether the recognition rate improves using only the feature amount not affected by aging. These experiments use 13 present face images and 13 past face images (1 month ~ 5 years before). The present face image is used as the input image data, and the past face image is used as the registered image data. The age composition of these face images is 11 people of twenties, a person of thirties and a person of fifties. We carry out experiments using 6 methods in total including a method using all feature amounts in Ref. [1], and 5 methods (A) to (E) based on the reduced feature amounts. Table I shows the number of r_i and dimensions in each of 6 methods.

TABLE I. METHOD OF RECOGNITION

	Range of r_i	Dimensional Number (n)
Ref. [1]	$0 \le r_i < 0.3$	195
(A)	$0 \le r_i < 0.25$	194
(B)	$0 \le r_i < 0.2$	190
(C)	$0 \le r_i < 0.15$	172
(D)	$0 \le r_i < 0.1$	161
(E)	$0 \le r_i < 0.05$	94

Figure 2 shows the recognition rates of each of the 6 methods. First, we consider the results of method Ref. [1] and method (A). The recognition rate of method (A) is higher than that of method Ref. [1]. This is thought to be due to the fact that the feature amounts in the range of $0.25 \le r_i < 0.3$ which are susceptible to aging are excluded. However, the difference in recognition rate between methods (A) - (D) is not significant, and the recognition rate of methods (C) and (D) is only slightly higher than the other methods. This seems to be because there was no large difference in the dimensional number of method (A) - (D). The improvement of recognition rate of method (E) seems to be about 30% compared with method Ref. [1]. In this case, only feature amounts of $0 \le r_i < 0.05$ are used, and the dimensional number is much smaller than the method (D). Therefore, it is effective to use features with $0 \le r_i < 0.05$ against facial aging.

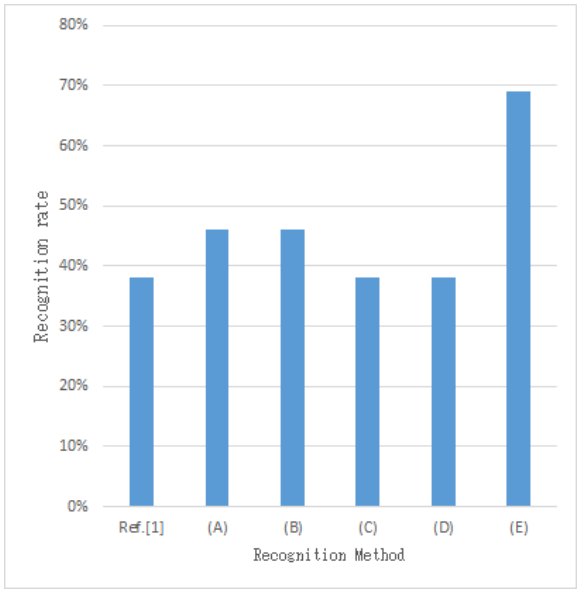

Fig. 2. Respective recognition rate of 6 methods

VI. CONCLUSION

In this paper, we proposed a face recognition method considering facial aging for safety confirmation operations in case of disaster. First, we analyzed 9 years change in facial features. Based on the analysis result, a feature amount with which the influence of change over the year is small is specified. We propose a safety confirmation system based on face recognition using these features. Since the recognition rate of the proposed method is higher than that of the conventional method, the proposed method is effective. In the future, we will increase the number of registered face images and evaluate the recognition rate using facial pictures with a change of more than 10 years.

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