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Fast Face Extraction from Near-Infrared Camera Images

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Abstract: The purpose of this research is to recognize a face with an near-infrared camera. The face detection that used images from near-infrared camera is comparatively difficult to be don, because they are gray scale images. In this paper, the filter by using GA is designed, and the method of detecting the face and the position from the near-infrared images is proposed. It is demonstratet that our approach is effective for vehicle driver monitoring.

Keywords: near infrared camera image, face extraction,

1. INTRODUCTION

In this paper, we propose a new method to examine w hether or not human faces are included in near-infrared camera images by using the filter with the genetic al gorithm (GA). By the way, when the individual ide ntification and the expression recognition are carried out by using the face, the face area is detected as a preprocessing, and the operation that accurately r ecognizes its position is needed. To do these proces sing, it is necessary to decide the exactly feature e xtraction and select the exactly templates. However it is a serious problem. It is very difficult to know the image filter that achieves the best image data processing beforehand. Therefore, to obtain the dem anded image filter, a huge trial and error is needed.

It is a problem to obtain the best filter in a shor t time. In conventional methods, the technique for m aking the series filter by using the GA was propose d (in the conventional method) [1]. However, this t echnique occupies most by the one that a basic filt er operates brightness and the connection of the pix el, and is weak to the illuminance change. Moreove r, the technique for detecting the face of the person who was suitable for an arbitrary direction change from the static image is proposed. However, this t echnique has detected the face area with a template set of 12 faces suitable for various angles made fr om the person. It is not automatic [2]. Then, in thi s paper, we proposed the method of making the im age filter that appeared facial characteristics most b y using the near-infrared camera. The GA and the Gabor Wavelet are used in the proposed method.

In this paper, we propose the new face extraction system using the gabor-filter with GA. By using t his filter, we can get the faces correctly when the f aces turn below. Furthermore, in order to show the effectiveness of the proposed method, we show si mulation examples. Moreover, for the purpose of co mparing the amount of calculation time, we adopt t he conventional gabor-filter and proposed method. F urthermore, in order to show the effectiveness, we adopt the conventional face detection methods. By the simulation example, we confirmed that the pro posed method works well.

2. The proposed method

2.1 Near-infrared images

The wavelength of the near-infrared radiation is longe r than that of visible light. Therefore, it is not easy to sca tter.
Moreover, it is possible to find an object as an infr ared image in the dark because it is radiated natura lly from any one. We propose the face detection m ethod in the dark by using the near-infrared image. Fig. 1 is a sample of the near-infrared images. We use the animation image. Sample images are static image. This is one scene of the animations.

Fig. 1 A sample of the near-infrared image.
These images are one scene in the animation image.

It is possible to take a picture of the image obtained from the near-infrared camera unlike the image that has been obtained from a usual camera even at night.

Therefore, it is possible to take a picture in the car such as running at night. In this paper, we aimed at the doze prevention in the car.

2.2 Gabor Wavelet

The Gabor Wavelet transformation is an excellent method by which information in an arbitrary direction can be extracted. The Gabor filter $g(t, s)$ is given by the next equation.

$$g(t,s) = \frac{1}{2\pi\sigma^2}\exp\left[-\frac{1}{2\sigma^2}(t^2+s^2)\right] * \sin\omega_0 \dot{t}$$

$$\dot{t} = t\cos\theta + s\sin\theta$$

where, θ is an angle that takes Gabor Wavelet co nversion.

2.3 Image processing by using the GA

Genetic algorithm (GA) is an optimization algorit hm that technologically imitates the mechanism of t he inheritance and the evolution of the living thing.

The identification number of an integer is given to the basic filter prepared beforehand, and the gen e G_k is shown by the bit string of the length of 4 0 bits in total as follows.

$$G_k = \overbrace{001\ldots}^{n}\overbrace{0101\ldots}^{r_1}\overbrace{1011\ldots}^{r_2}\overbrace{1001\ldots}^{r_3}\overbrace{0001\ldots}^{r_4}0$$

The combination of target filters can be obtained b y getting the best individual specified by using GA. The Gabor filter of every one degree from 0 to 1 80 degrees was prepared in a basic filter.

The parameters of GA is as follows:
[generation number] 100
[individual number] 100
[mutation rate] 0.02
[crossover rate] 0.8.

In the generation, from 0-50 generation, we do the elite strategy, and then we do the roulette strategy.

2.4 The GA used in this study

The image that shows facial characteristics is assumed to be a target image by the gabor wavelet transform. The target image is made from the original picture image. (Fig. 2 and Fig. 3)

Fig. 2 A sample of input image.

Fig. 3 A sample of the target image.

The fitness function is defined by the sum total of the absolute value of the difference with the step value of the correspondence point on the image that applies the filter to the step value and the original picture image of each pixel of the target image. The fitness function is calculated by the following equation.

$$f(I_k) = \sum_{k=1}^{n}\sum_{l=1}^{m}\left| f(k,l) - t(k,l)\right|$$

As for this calculation, the addition and subtraction is the dominant. In addition, if it breaks off the calculation when the threshold with partial of the threshold is exceeded during the addition and subtraction, the calculation time can be drastically reduced.
A high fitness value is given to the individual that shows a filter near the target image data processing. Individuals which have a low value of fitness are gradually weeded out in the selection, and individuals are repeated for crossover and mutation. Then the individual with the fittest filter remains.

2.5 Display of result filter

The best individual obtained by GA yields a filter that processes in a target image. The combination of basic filters that the selected by the GA is applied to the original image, and its result is shown in Fig. 4.

Fig. 4 Sample results by the proposed method.

The procedure to here looks like the method of t

he proposal already well. However, the method of the pre-proposed uses four directions to detect the face area. In this paper, facial characteristics are expressed from four directions in fewer directions. Therefore, the total of the combination of basic filters is as follows.

$$181^1 + 181^2 + 181^3 + 181^4 \cong 1.07 \times 10^9$$

On the other hand, GA is fixed the number of individuals to 100, and has evolved to the calculation end of GA by the 30th generation. Therefore, the search iteration becomes $100 \times 30 = 3.0 \times 10^3$ times. Therefore, it can be said that the use of GA is effective.

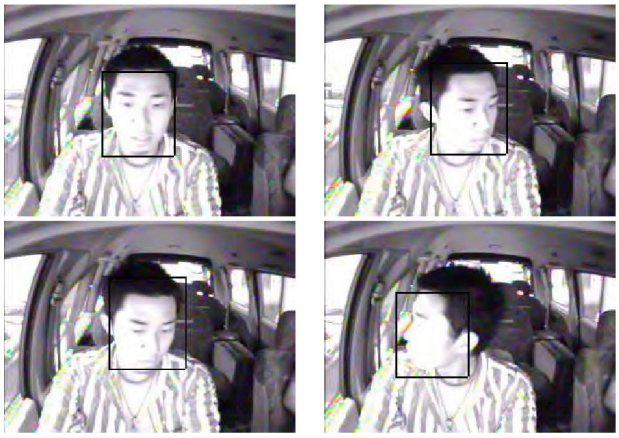
3. COMPUTER SIMULATIONS

3.1 simulations

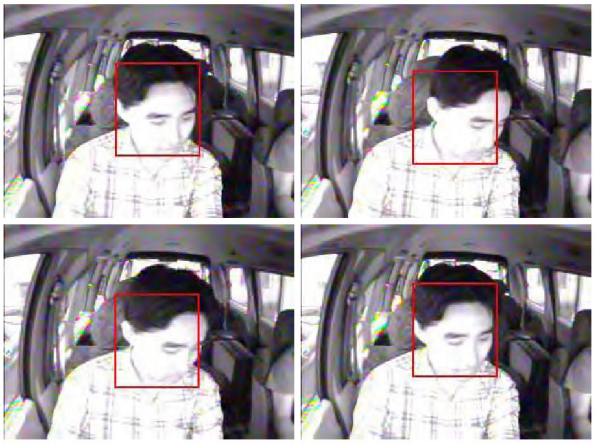
In order to show the effectiveness of the proposed method, we show the simulation.

Here, facial characteristics like eyes and outlines, etc. are almost extracted than time that used four filters for two filters as understood from the output image of Figure 4 previously detected. Then, the face area from the image can be detected by using the GA filter evenin case of two.

The results are shown in Fig.5. The face area was able to be detected almost, except when faces are out of the driver's seat.



sample images (a)



sample images (b)

Fig. 5 Samples of the result images.

Fig. 6 Selected filter angles by GA

Furthermore, the selected filter angle in the case of the sample (a) is shown in Fig.6. The selected filter angle by GA are 19 degree and 110 degree. Moreover, since it is composed by the application of the filter and the template matching with GA, the calculation time for convergence was able to be drastically reduced, and to apply a series of processing to a dynamic scene. We can get the relatively good results. Then, it aims at the face detection that uses four filters or less.

Furthermore, for the purpose of comparing, we used the 2 different way. One is using the template matching method. The other is using the neural networks.

[template matching method] ---- We use the four templates of the conventional method. We named the conventional method 1.
[neural networks] ---- We use the conventional face detection neural networks. We call this method conventional method 2.

*** computation time ***

[the proposed method] 1.2 sec / 30 slices
[conventional method 1] 4.6 sec/ 30 slices (4template is used)
[conventional method 2] 2.2 minutes / 30 slices

From the view point of the computation time, proposed method works well.

3.2 considerations

We compare the proposed method with the conventional methods.

conventional methods	proposed method
Design the series filter by the GA. (The most is a color image.) * There are a lot of numbers of filters and calculation costs are high. *It is weak to the illuminance change.	*Design the filter by Gabor and GA for the images from infrared camera. * The number of filters can be decreased, the calculation cost is few. * Gabor conversion is used, it is robust in the illuminance change.

From these results, we can confirm that the propos ed method works well.

4. CONCLUSIONS

Face detection system is a very important technology, and it is hoping as well to detect the existence and the position of a face image in an input image. Furthermore, many techniques which have been already proposed, in which there is an issue that mis-recognition was caused when a skin was contained in the background. The proposed scheme in this paper can obtain a comparatively high recognition rate. Finally, in order to show the effectiveness of the proposed scheme, simulations were performed. Moreover, for the purpose of comparing, the neural network (NN) and LVQ method was used for these simulations. From these simulation results, it is confirmed that the proposed scheme works well.

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