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Face image make up system by using ε-filter

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Abstract

Recently, it becomes easy for consumers to make up face images in photographs for special events through the spread of digital cameras and photo editing tools. However, it is still difficult to make up spots and wrinkles naturally. In order to solve these problems, many artificial make up systems have been proposed. One of these methods using filter has good performance. However, this method requires many parameter tunings for achieving good performance. In order to improve these points, we have developed auto parameter tuning system by using templates. As the result of simulations, it is proved that the proposed method has good performance with auto tuned parameters.

1 Introduction

In late years, it becomes easy for consumers who are not familiar with optical equipments and image editing on computers to make up face images in photographs for special events through the spread of easy-to-use digital cameras and photo editing tools. However, it is still difficult to clean up spots and wrinkles without artificiality because the excess face image smoothing breaks natural face texture. In order to solve these problems, many artificial make up systems based on signal processing methods have been proposed. One of these methods using -filters [1, 2, 3] and its filter banks [4] has good performance. However, this method requires many parameter optimization for achieving good performance. Therefore, it is not easy for users unfamiliar with signal processing technology to obtain good quality images. In order to improve these points, we have developed auto parameter tuning system by using ellipse templates for spots and line segments for wrinkles. As the result of simulations, it is proved that the proposed method has good performance with automatically optimized parameters.

2 Traditional method

In order to develop face image make up system, many methods have been proposed. In this paper, we have adopted the method using - filter as the basis. In this method, input face images are separated into some signal components in frequency domain and the components which include wrinkles and spots are eliminated. The overview about the -filter and its filter bank are as follows.

2.1 -filter

The -filter is one of nonlinear filters, which is defined by following equations.

$$y(n) = x(n) + \sum_{i=\ \ N}^{N} a_i F(x(n+i) \quad x(n)) \qquad (1)$$

$$F(x) = \begin{cases} x & \leq x \leq \\ 0 & other \end{cases} \qquad (2)$$

where, $x(n)$, $y(n)$ are input and output signals, a_i are filter coefficients whose summation becomes 1, $2N+1$ is corresponding to the filter window size. By using this filter in the image processing, noise in the image is removed with preserving edges.

2.2 -filter bank

The filter bank [5] for face image make up system is composed of the above filters(Fig.1). The filter bank divides input signals into some components(Fig.2). In this figure, $_1$, $_2$, and $_3$ are the parameters used in the filter E_1, E_2 and E_3 respectively , and f_1 and f_2 are correspoinding to the window sizes used in the filter E_0 and E_1. In the divided components, the signal y_3 which has middle frequecy and small amplitude and y_4 which has high frequeny and middle amplitude mainly contain spots and wrinkles respectively. By eliminating these two components and combining remaining components, the clean face image is obtained without wrinkles and spots.

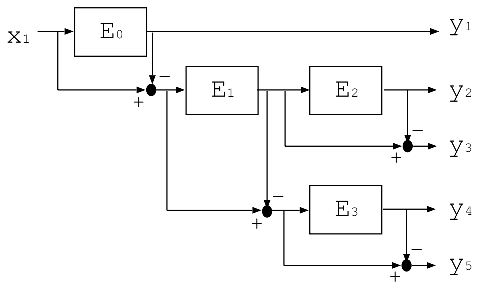

Figure 1: -filter bank

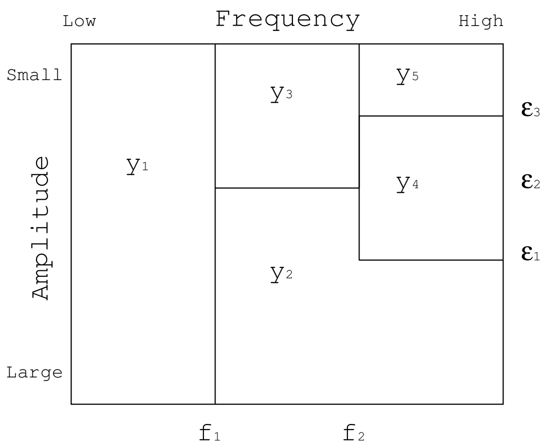

Figure 2: Separated Components

2.3 Examples

The result image where wrinkles and spots are eliminated from the original image shown in Fig.3 by the filter bank mentioned above is shown in Fig.4. The result image shows that the spot beneath the eye in the original image clearly disappears. Fig.5,6 show extracted components y_3, y_4 respectively.

2.4 Difficulty in traditional method

The effectiveness of face image make up system using -filter is obvious from the above example. However, there is the difficulty to put in practice because the filter bank has many parameters to be optimized for achieving best performance. These parameters are N_1, N_2, $_1$, $_2$ and $_3$. The parameter N_1 and $_2$ are corresponding to spot regions, and N_1, $_1$ and $_3$ are corresponding to wrinkle regions respectively. In the above example, these parameters are manually optimized. However, it is not easy for users who are not familiar with -filter to optimize those. In order to overcome this point, we have proposed the automatic parameter optimization as mentioned in following section.

Figure 3: Face image 1.

Figure 4: Simulation result 1(Manual).

3 Proposed method

In order to solve the parameter optimization problem in the traditional method, we propose new method for automatic parameter optimization. Our proposed method is composed of two parts. As the first part, we propose the parameter optimization corresponding to spot regions and the second part is the method for wrinkle regions.

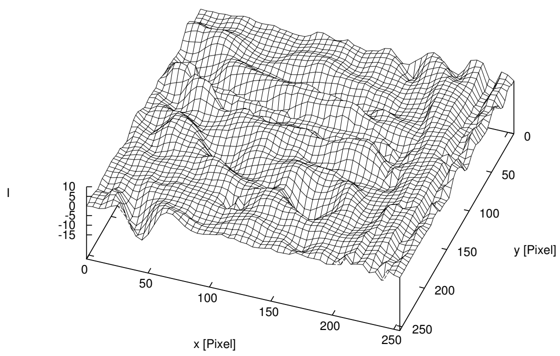

Figure 5: Component y3.

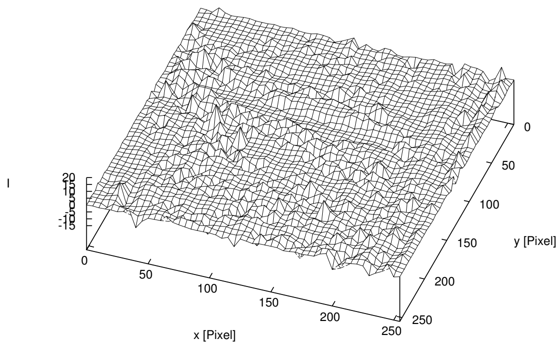

Figure 6: Component y4.

3.1 Spot region

Spot regions, for example shown in Fig.3, are approximated by ellipses defined by the equation 3.

$$E = \sum_{x\ y \in S_1} (I(x\ y) \quad (a(x \quad x_1)^2 \qquad (3)$$
$$+ b(x \quad x_1)(y \quad y_1) + c(y \quad y_1)^2 + d))^2$$

where $I(x\ y)$ denotes the intensity of face image at point (x,y), a,b,c,d denote ellipse parameters, the region S_1 denotes spot respectively. As result of this approximation, the parameter N_1 and $_2$ are determined as the diameter of the ellipse and the intensity difference between the center and the edge of ellipse. In this method, the approximate position of the ellipse is required for efficient fitting. Therefore, users need to select the spots which should be cleaned up. This additional procedure is cumbersome for users. However, the completele automation in the face image make up is impractical because the spots which shoud be cleaned up are variant depending on the users and their situations. This is also applicable in the next wrinkle elimination.

Table 1: Filter parameters.

Sim No.	N_1	N_2	$_1$	$_2$	$_3$
1(Manual)	31	7	25	20	7
1(Auto)	50	10	14	26	7
2	42	6	6	23	3

3.2 Wrinkle region

As the second part of our proposed method, the parameters N_2, $_1$, $_3$ corresponding to wrinkles are determined. Wrinkles are approximated by line segments which are determined by users' giving start and end points. Along the approximated line segment, the face image has the valley of intensity which is the wrinkle. Along this line segment, image intensities are accumulated and the averages of intensities on the opposite side of the valley are used to reduce noise influence, and the accumulated intensity histogram becomes the monotonically increasing function from the bottom of intensity to the outer side. For example, the intensity histogram of the wrinkle beneath the left eye in the face image 1 (Fig.3) is shown in Fig.7. By using the intensity difference between the first peak and bottom in the above function, and the width of valley, $_1$ and N_2 are determined respectively. Finally, $_3$ is set at the half of $_1$ empirically.

4 Simulation

In order to confirm effectiveness of our proposed method, the method is applied to sample face images shown in Fig.3,9. Result images are shown in Fig.8,10 and optimized parameters are shown in Table 1. Simulation results show effectiveness of our proposed method. In order to remove remaining spots in Fig.10, finer segmentation in frequency domain is needed to eliminate signal components which include only spots by adding more -filters to the filter bank.

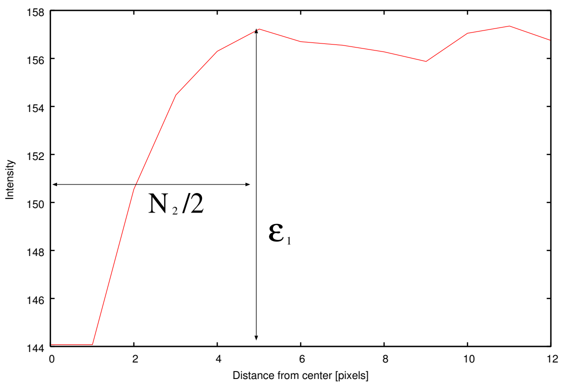

Figure 7: Intensity histogram.

Figure 8: Simulation result 1.

Figure 9: Face image 2.

Figure 10: Simulation result 2.

5 Conclusions

We have proposed the face image make up system using -filter and their parameters optimization. Simulation results show the effectiveness of our proposed method. As the future work, we consider about finer segmentation of input face images in frequency domain for strict spots and wrinkles elimination.

References

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