Research on Virtual Makeup System Based on SDM

Jie LI¹,a, Ying-Liang FU²,b,* and Xiao JIA³,c

¹Dalian Maritime University No 1, Lingshui Road High-tech District, Dalian, Liaoning, China
²Dalian Maritime University No 1, Lingshui Road High-tech District, Dalian, Liaoning, China
³Unit 3, Room 802, Dibaqu High-tech District, Dalian, Liaoning, China

¹dmu_lijie@163.com, ²fuyl8125@dlmu.edu.cn, ³jiaxiao222@126.com

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Abstract. This paper presents a visual-based virtual makeup system, which uses a camera to turn a user's computer into a virtual mirror. With this system, users do not need to experience in physical store, through the computer user can pick their own designated color lipstick, and to see their lip’s color effect of lipstick in real time. The system first detects the user's face and the positions of user's lips. Based on feature point detection and alignment, the SDM¹ algorithm is used to detect the lip’s feature points in real time. It is highly accurate, fast and it can meet the real-time requirements. We set the lips as the region of interest, then smooth the edge of lips, through the gamma correction to solve the lips of the light compensation because light compensation have a big influence to my lip makeup effect, and finally to achieve lip color. The user can freely choose the lipstick color in the video to watch the effect of the using lipstick. The biggest advantage of the system compared to other existing lip systems is it’s real-time and accuracy.

Introduction

There are many varieties of lipstick on the market, how to effectively choose safe products? every woman is very concerned about the problem. In the brand counter may have trial equipment, it can be for customers to try, but because too many people try, and for a long time there is no sealed state may deteriorate, so people who’s skin is easy to allergic can not try cosmetics to avoid cross-infection.

Facing the above problems, this paper combined image processing and computer vision technology to explores a real-time lip coloring method, extracts the lips contour by using the accuracy of the SDM¹ algorithm, and corrects the influence of uneven illumination by using gamma correction. Makeup technology provide users with a makeup effect after the very intuitive virtual lip effect, so as to carry out the actual makeup of the user and personalized image packaging to provide a valuable reference. In the final, this article will be in the form of software systems.

System Framework

System Diagram

The proposed system diagram shown in Figure 1. First, call the camera read the video in real-time, and then detect the video face, using SDM¹ algorithm to implement the face for feature point alignment, the lips contour is extracted based on the feature points, adjust the system parameters to change the lips discoloration, and the final output is painting video.
Landmark Alignment

The SDM[1] algorithm avoids the problem that the Hessian matrix is not definite and the computationally large in the Newton method in the least squares method, which saves the computational complexity and detects the high accuracy of the lips. Face alignment can be framed as minimizing Eq. 1 over $\Delta x$:

$$f(x_0 + \Delta x) = \|h(d(x_0 + \Delta x) - \phi_\ast\|^2$$  \hspace{1cm} (1)

Where $\phi_\ast = h(d(x_\ast))$ represents the SIFT[2] values in the manually labeled landmarks. In the training images, $\phi_\ast$ and $\Delta x$ are known. Newton’s method creates a sequence of updates as Eq. 2

$$x_{k+1} = x_k - H^{-1}(x_k)J_f(x_k)$$  \hspace{1cm} (2)

It is unlikely that the algorithm can converge in a single update step unless $f$ is quadratic under $x$. To deal with non-quadratic functions, the SDM will generate a sequence of descent directions. So SDM using Eq. 3

$$x_k = x_{k-1} + R_{k-1}^T\phi_{k-1} + b_{k-1}$$  \hspace{1cm} (3)

SDM solves the difficult problem of $H$ and $J$, It optimizes the least squares method by calculating the product of $H$ and $J$. Fig. 2 shows the flow chart of calculating SDM:

The following is the iterative comparison graph of the two algorithms under different Hessian
matrices, it shows that the SDM algorithm has better iterative effect. Abscissa is newton step, and the ordinate is normalized error.

Fig. 3 Two method’s comparison when $H(x)=x^3$

Fig. 4 Two method’s comparison when $H(x)=\text{ERF}(x)$

The Fig. 3 and Fig. 4 shows SDM converges with the same number of iteration as Newton method, but each iteration is faster. Moreover, SDM is more robust against bad initializations and ill-conditions.

There’s many methods for face alignment, such as Active Appearance model[2], Morphable models[3], Eigentracking[4], they build an object appearance and shape representation by computing Principal Component Analysis (PCA) on a set of manually labeled data. Constrained Local Models (CLM) [5] model this prior similarly as AAM assuming all faces lie in a linear subspace expanded by PCA bases. Saragih et al.[6] proposed a non-parametric representation to model the posterior likelihood and the resulting optimization method is reminiscent of mean-shift. In [7], the shape prior was modeled non-parametrically from training data. Now we compared SDM with AAM if the face have a block under LFPW datasets[8], we can found SDM more suitable for us, their effect as Fig. 5:

Fig. 5 Different between SDM and AAM if there is a block

Green is SDM and red is AAM. This shows that if there is a block, SDM effect is stronger than SDM.so this is the reason we choose SDM.

SDM algorithm have a good alignment effect when people smile, conversation and other non-exaggerated expression, the effect of their different expressions as Fig. 6:
Contour Extraction And Smoothing Filter

Firstly, the edge detection of the image is realized by the morphological gradient edge detection operator, and the direction information of the edge is taken into account in the process, so that the main edge of the image can be better tracked. Finally, the contour information of the object is extracted by rolling expansion. The direction control condition factor is introduced in the process of moving the structural elements, which reduces the computational redundancy. The experimental results show that the method can realize edge detection and contour extraction with high precision.

For the 20 feature points of the lip detection, the green line is connected into the communication area, it can be regarded as a preliminary outline as shown in Fig. 7, by using Gaussian filtering, the image area is blurred and smooth, smooth contour edge looks more natural.

Gamma Correction

In image processing, illumination is always an important factor affecting image quality. In order to effectively weaken the influence of illumination on the image quality, a reasonable Gamma value change curve is constructed by the method of superposition of nonlinear function, which makes the Gamma correction[9] method fully adapt to the actual situation of illumination change in the image and effectively prevent the situation image is distorted using gamma correction. Experiments show that the method has good performance in improving the image illumination condition and improving the image quality. In the light compensation, histogram equalization[10] is also an important method to solve the uneven illumination. The Fig. 8 and Fig. 9 shows the results of gamma correction and histogram equalization. It can be seen that the effect of Gamma correction is more uniform than that of histogram equalization. So this paper uses the Gamma correction method.

\[
dst = src[I] \ast \alpha + src^{2}[I] \ast \beta + \gamma,
\]

(4)

We can adjust the alpha and beta values in Eq. 4, the lip contours is changed to be translucent, and ultimately achieve image fusion.

Summary
In this paper, this system has many advantages, for example, the video-based virtual makeup technology is real-time compared with the traditional 2D virtual lip technology, users can observe the using effect of user’s different angles, and maintain lip shape stability in the smiling state. Due to the limitations of feature point detection, users in the performance of exaggerated expression, the effect will be unsatisfactory. This is our next step to optimize the direction. The final make-up effect is as Fig. 10:

![Fig. 10 Left And Right Direction lip Make-up effect](image)

By using our system, users only need to click the keyboard toggle button to change the color of lipstick, we provide more than 10 colors for the user to select, later will increase. The system is to meet the needs of consumers in the selection of cosmetics on the Internet, this system make the purchase more convenient.

When our system deal with complex expressions, there will be cosmetic effect of the situation. The reason is that the accuracy of the facial feature point detection is changed with the change of the face angle. Our next step is to optimize the accuracy of the feature point detection and improve the usability of the system.

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