Data Driven In-betweening for Hand Drawn Rotating Face

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1. Introduction

In anime production, some key-frames are drawn by artist precisely and then a great number of in-betweening frames are drawn by assistants' hands. However, it is seriously time-consuming and skilled work to draw many characters especially including face rotation. In this paper, we propose an automatic in-betweening technique for rotating face of hand drawn character only from a front image and a diagonal image (Fig.1). Baxter [2009] represented generating in-betweening using image morphing technique. However, their approach doesn't consider reflecting the artist's style and touch. Accordingly, we represent reflecting style and touch using morphing technique trained by his own database and introduced especially to generate a rotational in-betweening faces. This database contains center of gravity of each part (right eye, left eye, nose, mouth, eyebrow) and the contours on the facial image.

2. Database Construction

Each artist has a style and touch and we focused on the center of gravity of facial parts which are reflecting artist's style. Accordingly, we construct the database that has facial features like angle of the face θ, artist's label i, center of gravity of each part (right eye, left eye, nose, mouth, eyebrow) $\vec{G}_{i,j,\theta}$ (j: parts index) calculated by hand plotted points (Fig.2) and feature points on facial contour $\vec{F}_{i,\theta,k}$(k: points index). $g_{i,j,\theta}$ represents orthogonal projection.

$$g_{i,j,\theta} = \frac{(\vec{G}_{i,j,\theta} - \vec{F}_{i,\theta,m}) \cdot (\vec{F}_{i,\theta,l} - \vec{F}_{i,\theta,m})}{\left|\vec{F}_{i,\theta,l} - \vec{F}_{i,\theta,m}\right|^2} \qquad (l,m) = \begin{cases} (0,6) & eye, eyebrow \\ (1,5) & nose \\ (2,4) & mouth \end{cases} \qquad (1)$$

$$\alpha_{i,j,\theta} = \frac{g_{i,j,\theta} - g_{i,j,\min}}{g_{i,j,\max} - g_{i,j,\min}} \qquad (2)$$

Our system calculate blend ratios $\alpha_{i,j}(\theta)$ which is interpolated by $\alpha_{i,j,\theta}$ using cubic spline interpolation.

3. Morphing Method

Feature points $\vec{P}_{i,j,k}$ (i: input image index, j: parts index, k: points index) are warped by Eq.3. The number of feature points is 98.

$$\vec{P}_{morph,j,k}(\theta) = \alpha_{1,j}(\theta)\vec{P}_{1,j,k} + (1-\alpha_{1,j}(\theta))\vec{P}_{2,j,k} \qquad (3).$$

The morphed texture is generated by mixing front image and diagonal using alpha-blending.

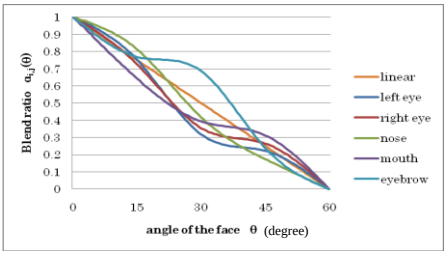

Fig.1 Blend ratio for each angle of the face

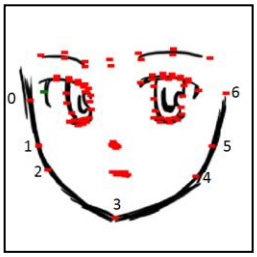

Fig.2 Hand plotted points

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(a)Diagonal (b) Outputs (c) Front
Fig.3 Closed-test

Fig.4 images used for database

(a) Diagonal (b) Outputs (c) Front
Fig.5 Open-test

Fig.6 Target hand drawn images

4. Test results

We perform closed-test using key images shown in Fig.3(a),(c) and $\alpha_{i,j}(\theta)$(Fig.4). Fig.3(b) shows generated in-betweening images. This test represents that in-betweening can be generated by only two textures we input. Subsequently, we perform open-test by using Fig.5(a),(c) as input images and we get Fig.5(b) as a result.

5. Conclusion

We perform both closed-test and open-test. Closed-test shows that generated in-betweening images in Fig.3(b) are similar to target images in Fig.4. As a result, in between image can be gene by only two hand drawn textures. Subsequently, open-test shows that generated in-betweening images in Fig.5(b) are similar to target images in Fig.6. This results shows that our system can generate in-betweening image of another character drawn by same artist. And the in-betweening reflects artist's style and touch in the database. This system can handle various facial images and interpolate in-between.

Reference

William Baxter et al., "Compatible Embedding for 2D Shape Animation", IEEE Transactions Visualization and Computer Graphics, vol. 15, Issue 5, p867-879, 2009.