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Supplementary material for the paper "Image Palette: Brushstroke Synthesis-based Style Transfer"

paper1103

1. All large size figures in our paper

All large size figures in our paper are shown in Figure 1 - Figure 6.

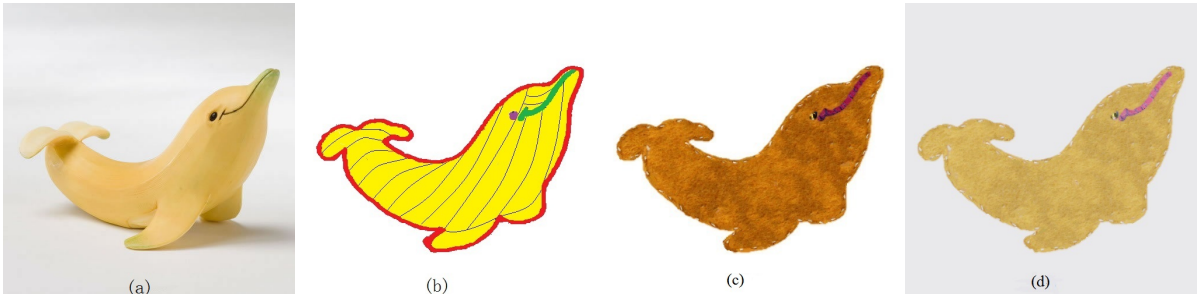


Figure 1: *Settings of strokes. (a)Target image. (b)Result of segmentation for (a) and strokes laid along the extension of the texture. (c)Results of style transfer (d)Results of color transfer*

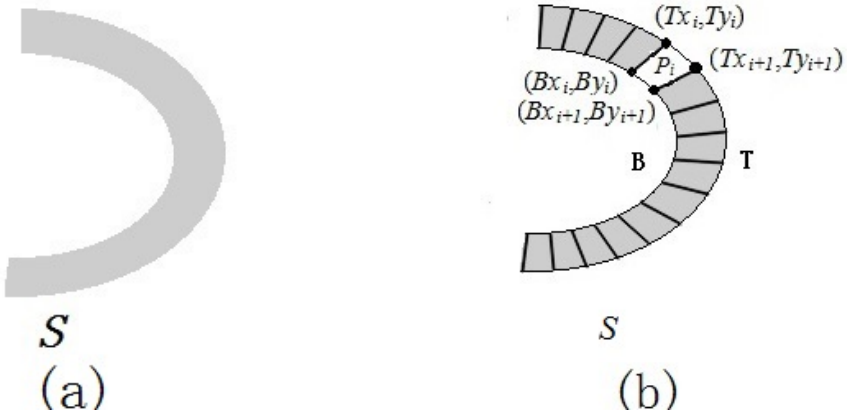


Figure 2: *Segmentation of empty strokes. (a)Empty stroke. (b)Segmentation by quadrangles.*

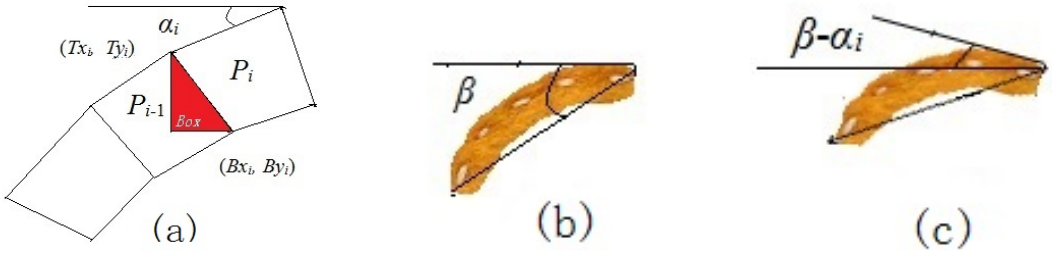


Figure 3: *Rotation of sample strokes. (a)Direction of P_i. (b)Direction of the sample stroke. (c)Rotating the sample stroke.*

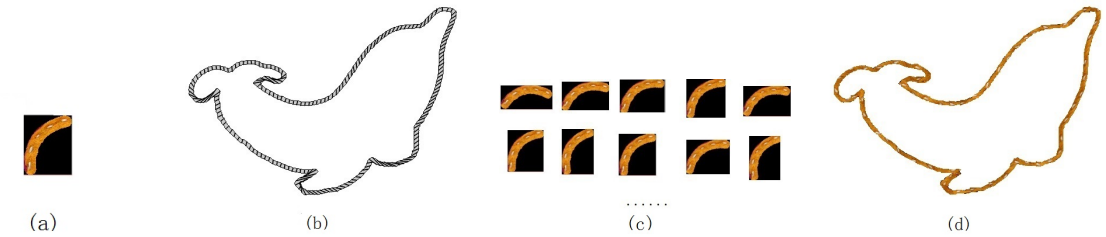


Figure 4: *Generation of strokes. (a)Sample stroke. (b)Empty stroke divided by 200 small quadrangles. (c)Rotating the sample stroke. (d)Result of synthesis.*

Figure 5: *Optimization synthesis based on offsets. (a)Box of strokes in the boundary. (b)Box of strokes in the area.*

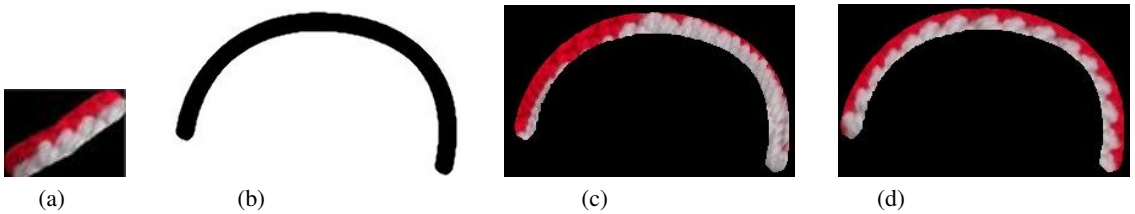


Figure 6: *Verify the method of rotating sample strokes. (a)Sample stroke. (b)Empty stroke. (c)Result without rotating sample strokes. (d)Result by the method of rotating sample strokes.*

2. Other results in our paper

Figure 7 shows a style transfer result from our method. As for the running time, our method requires relatively long time only in part of image segmentation. Other parts such as empty strokes setting and strokes transfer can be completed in a few seconds. We need to produce a result image in size of 500* 500 on average 3 to 5 minutes.

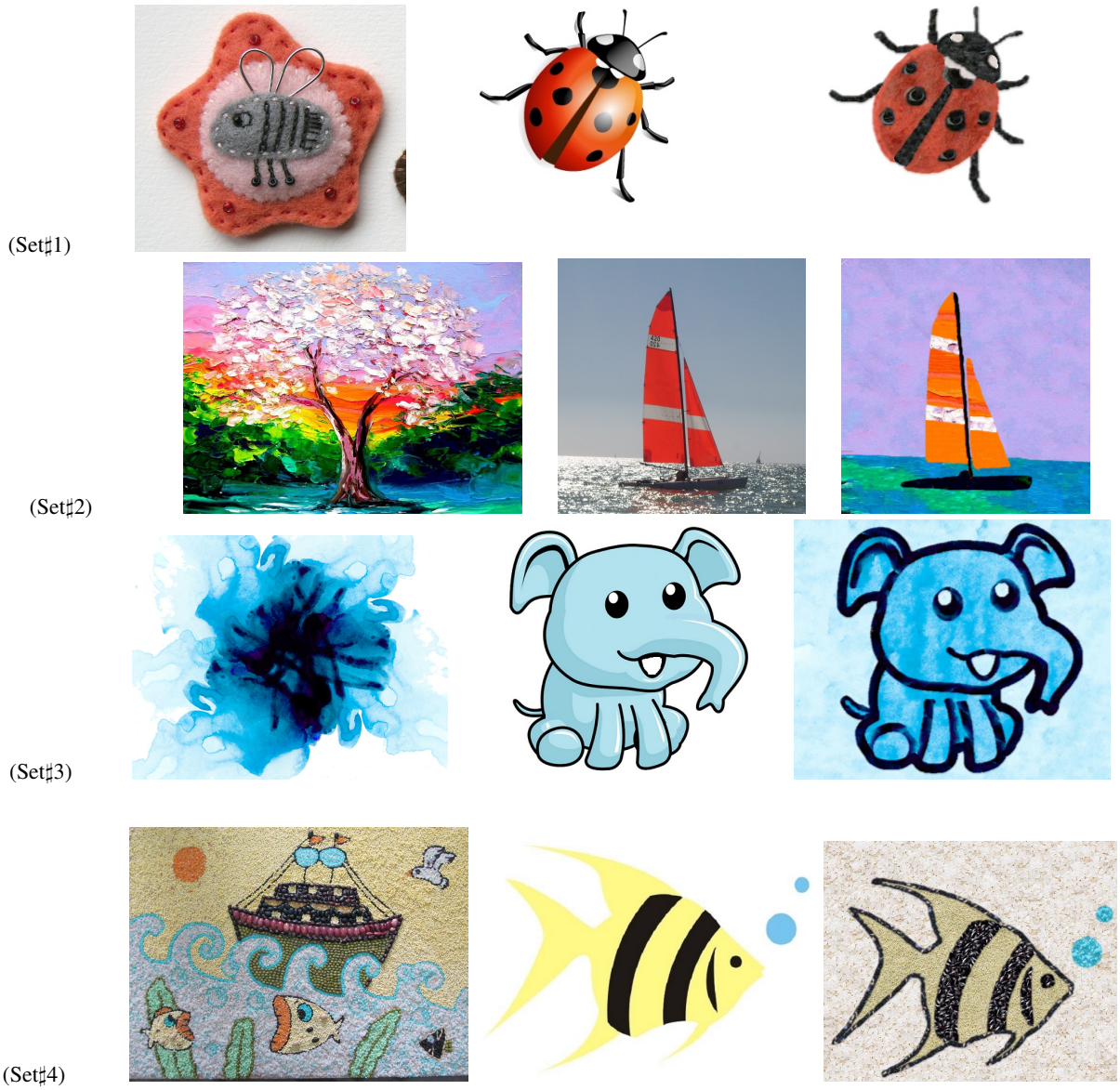


Figure 7: *Result of style transfer by our method. (a)Sample image. (b)Target image. (c)Result of style transfer from (a) to (b).*

Our method proposed in this paper can also transfer style from multiple samples as shown in Figure 8. Users can take multiple samples as a palette and select the style from different samples.

Figure 8: *Results of style transfer from multiple samples. (a)Sample images. (b)Target image. (c) Result of style transfer from (a) to (b) (Result in (1) is color transferred partially in the leaf. Result in (2) is color transferred integrally.).*

In this paper, we also carry out experiments with the same target image and sample images of different styles as shown in Figure 9 where users can take different sample images as different palettes and create a target image with a variety of styles. Experiment results show that our method can provide users with a more simple and convenient way of creating that allows users to select different sample images according to their preferences and conduct arbitrary creation.

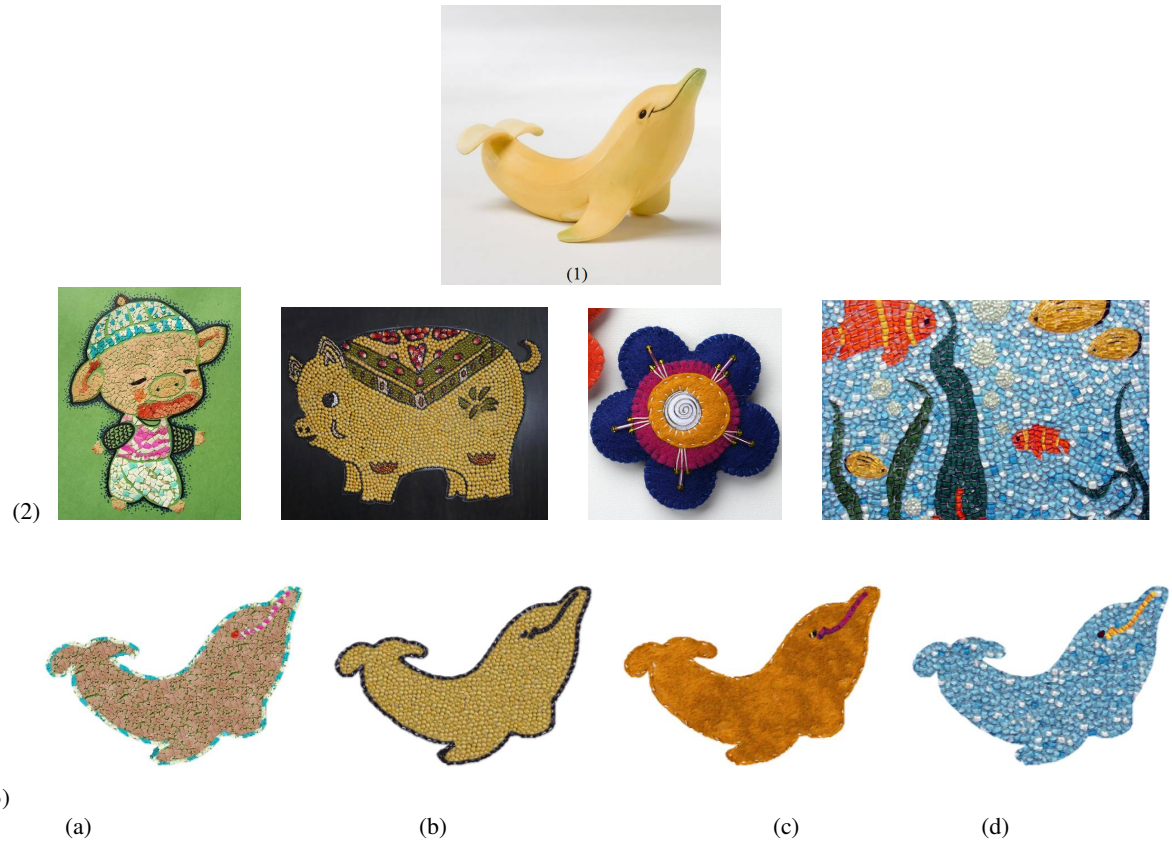
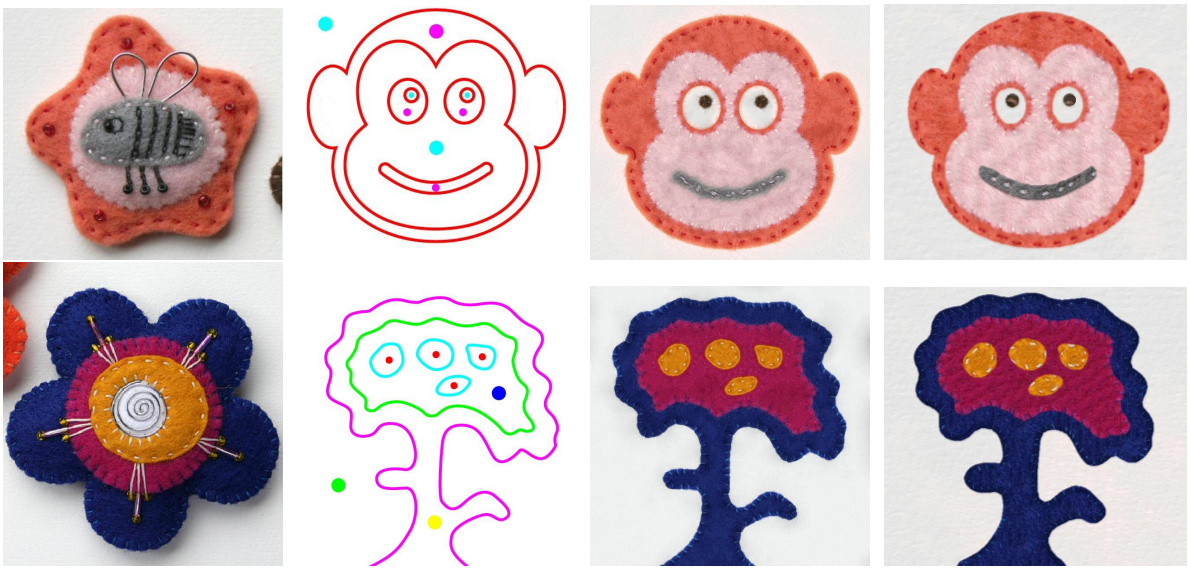


Figure 9: *Results of different stylizations with the same target image (1). (2)Sample images with different styles. (3)Results of style transfer.*

3. Comparison of results with other papers

We can also implement the corresponding content in [LFB*13]. We use the materials provided in [LFB*13] and supplementary material to do experiment. As Figure 10 shows, we use the same style samples (Figure 10 (a)) and the target image (Figure 10 (b)) to carry out experiment. Figure 10 (c) is results in the [LFB*13], and Figure 10 (d) is results of our method. It is easy to see that these two results are roughly the same except that randomness in the large area of our results is higher and integrity of texture information is better.



(a) (b) (c) (d)

Figure 10: *Comparison of results. (a)Sample image. (b)Target image. (c)Result in [LFB*13]. (d)Result by our method.*

In addition, similar to the [LFB*13], we also compare our method with the [NV02] [RLC*06] [Ash01]as Figure 11 shows. We carry out experiment with target and sample images in [LFB*13] where results in [NV02] [RLC*06] [LFB*13] [Ash01] are shown in Figure 11 (b) - Figure 11 (e). It is easy to see that our result of style transfer shown in Figure 11 (f) is better than those in other papers. The main reasons are as follows: First of all, our method of painting starts from the perspective of simulation which uses brushstrokes synthetic approach to transfer style, which is consistent with the actual painting requirements, thus achieves more realistic results. Furthermore, we add impact of computing texture features in the process of strokes transfer synthesis, therefore guarantee better smooth, continuity and randomness of strokes synthesis results.

Figure 11: *Comparison of results from different approaches. (a) Sample image. Result of (b)Image Analogies [HJO*01], (c) Painting with Texture [RLC*06], (d) Synthesizing Natural Textures [Ash01], (e)Painting by Feature [LFB*13], (f) our approach.*

4. User evaluation

In general, the quality of transfer can be measured from the human's visual perception and is difficult to evaluate quantitatively. Therefore we conduct a survey to investigate users' satisfaction with style transfer results. We investigate a total of 40 users and divide them into Group A, B with 20 users in each group (Group A and B each contains 10 males and 10 females). Users in Group A are non-professionals and do not understand rules of painting, while users in Group B are professionals with good understanding of painting rules. This helps us to evaluate the effectiveness of our approach from different angles.

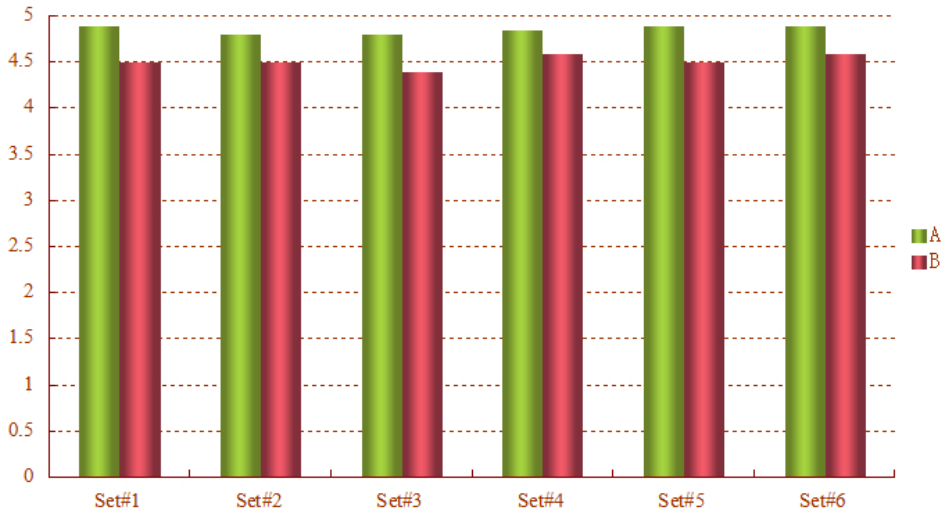


Figure 12: *Settings of strokes. (a)Target image. (b)Result of segmentation for (a) and strokes laid along the extension of the texture. (c)Results of style transfer (d)Results of color transfer*

We give out 6 sets of different style transfer results (4 sets in Figure 7 and 2 sets in Figure 8) in our user survey. We select oil painting, toner painting, embroidery, and other style samples and a variety of different target images to conduct style transfer experiment. We again select 10 users randomly from each group. We let them score on visual satisfaction of style transfer results(5 points represents satisfaction, while 0 points represents dissatisfaction). Investigation results are shown in Figure 12. The scores of Group A are slightly higher than those of Group B because professional users' requirement for painting results is higher than non-professional users'. Average scores on style transfer results from Group A and B are both more than 4.4. This also proves that using our method can produce personalized results of various artistic styles which meet users' visual perception.

References

[Ash01] ASHIKHMIN M.: Synthesizing natural textures. In *Proceedings of the 2001 Symposium on Interactive 3D Graphics* (New York, NY, USA, 2001), I3D '01, ACM, pp. 217–226. 7

[HJO*01] HERTZMANN A., JACOBS C. E., OLIVER N., CURLESS B., SALESIN D. H.: Image analogies. In *Proceedings of the 28th Annual Conference on Computer Graphics and Interactive Techniques* (New York, NY, USA, 2001), SIGGRAPH '01, ACM, pp. 327–340. 7

[LFB*13] LUKÁČ M., FIŠER J., BAZIN J.-C., JAMRIŠKA O., SORKINE-HORNUNG A., SÝKORA D.: Painting by feature: Texture boundaries for example-based image creation. *ACM Trans. Graph. 32*, 4 (July 2013), 116:1–116:8. 6, 7

[NV02] NEHAB D., VELHO L.: Multiscale moment-based painterly rendering. In *Proceedings of the 15th Brazilian Symposium on Computer Graphics and Image Processing* (Washington, DC, USA, 2002), SIBGRAPI '02, IEEE Computer Society, pp. 244–251. 7

[RLC*06] RITTER L., LI W., CURLESS B., AGRAWALA M., SALESIN D.: Painting with texture. In *Proceedings of the 17th Eurographics Conference on Rendering Techniques* (Aire-la-Ville, Switzerland, Switzerland, 2006), EGSR'06, Eurographics Association, pp. 371–376. 7