Dynamic Fur on Mobile using Textured Offset Surfaces

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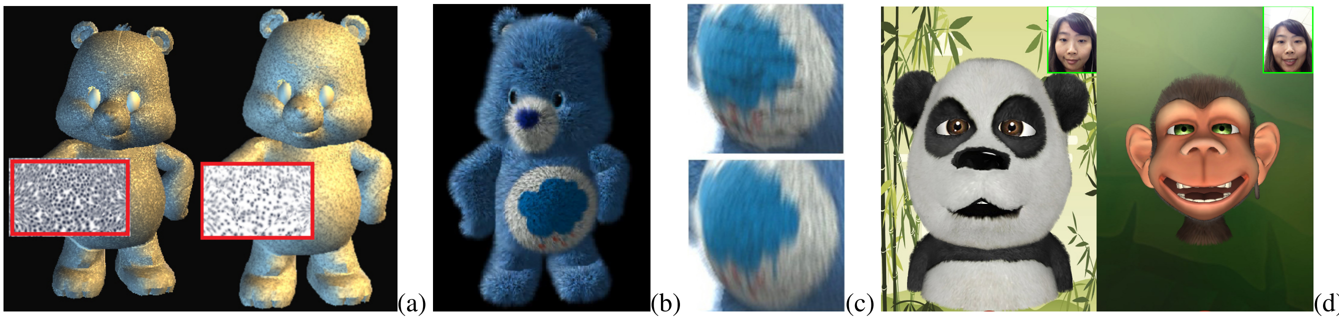

Figure 1: (a) Textured offset surfaces with scattering density details (Left: inner layer; Right: outer layer). (b) Illuminated furry surface. (c) Comparison of fur animation results (Upper: previous work; Bottom: proposed work). (d) Dynamic fur results on mobile.

1 Method Overview

Fur simulation is crucial in many graphic applications since it can greatly enhance the realistic visual effect of virtual objects, e.g. animal avatars. However, due to its high computational cost of massive fur strands processing and motion complexity, dynamic fur is regarded as a challenging task, especially on the mobile platforms with low computing power. In order to support real-time fur rendering in mobile applications, we propose a novel method called textured offset surfaces (TOS). In particular, the furry surface is represented by a set of offset surfaces, as shown in Figure 1(a). The offset surfaces are shifted outwards from the original mesh. Each offset surface is textured with scattering density (red rectangles in Figure 1(a)) to implicitly represent the fur geometry, whose value can be changed by texture warping to simulate the fur animation. In order to achieve high quality anisotropic illumination result, as shown in Figure 1(b), Kajiya/Banks lighting model is employed in the rendering phase.

The proposed method is derived from classic shell texture methods [Lengyel et al. 2001] [Yang et al. 2008], but outperforms existing methods in the following aspects.

• **High speed performance.** Since the proposed offset surface is mapped with texture for the whole surface, it can share the same texture coordinates with original mesh. In this way, only single VBO (Vertex Buffer Object) of mesh vertices is sufficient for rendering multiple TOS, by efficiently performing the offset operations in vertex shader for GPU acceleration. Compared with [Lengyel et al. 2001], our method achieves more than 4 times rendering speed, as shown in Table 1.

• **High visual quality with flexible interactions.** In order to simulate fur animation, texture warping is performed on TOS, and the displacement $u(x, y)$ is calculated by $u(x, y) = \mathbf{F}_i(x, y)u^e$, where $u^e = (u_x^T, u_y^T)^T$ contains the basis displacement vector. $\mathbf{F}$ is the force vector field and can be calculated by physical model, and i means the ith offset surface. Owing to the scalable texture warping method, we achieve much better visual quality than [Yang et al. 2008], whose work deforms the shell texture volume units but may cause overlapping error and result in intersection artifacts, as shown in Figure 1(c). Furthermore, our method is suitable for various user interactions, such as combing, wind blowing, and facial driven fur animation with vibration, as shown in the accompanied video.

• **Mobile-friendly implementation.** On one hand, the scattering density texture of TOS is compressed effectively by separating images with different lossy ratios. We achieve less than 3 MB storage for TOS with 16 layers, which is nearly 18 times smaller than the classic DTC (DirectX Texture Compression) method. On the other hand, our method uses very small video memory of GPU since we make good use of the shared VBOs.

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2 Results and Conclusion

Table 1: Comparison of frame rates (fps) on mobile platforms.

Model	Monkey/6k	Panda/7k	Bear/8k	Bunny/10k
Ref[1,2]	24fps/IP5	20fps/IP5	19fps/IP5	14fps/IP5
Ours	98fps/IP5	86fps/IP5	84fps/IP5	67fps/IP5
Ours	27fps/S3	21fps/S3	19fps/S3	16fps/S3

Table 1 shows the performance of proposed method with different avatar models of 16-layer TOS (1024x1024 resolution for each layer) on iPhone 5(IP5) and Samsung Galaxy S3(S3). The experimental results demonstrate that our method can achieve high speed performance on both high-end and low-end mobile devices. Besides, convincing visual results are obtained by the proposed method, as shown in Figure 1(d), and the accompanied video.

In conclusion, our method outperforms the existing techniques in both visual quality and fur simulation speed. Furthermore, the proposed fur simulation technology and the demonstrated user interactions will benefit many potential mobile applications in the future.

References

LENGYEL, J., PRAUN, E., FINKELSTEIN, A., AND HOPPE, H. 2001. Real-time fur over arbitrary surfaces. *In ACM 2001 Symposium on Interactive 3D Graphics*, 227–232.

YANG, G., SUN, H., WU, E., AND WANG, L. 2008. Interactive fur shaping and rendering using nonuniform-layered textures. *IEEE Computer Graphics and Applications 28*, 85–93.