NPR Gabor Noise for Coherent Stylization

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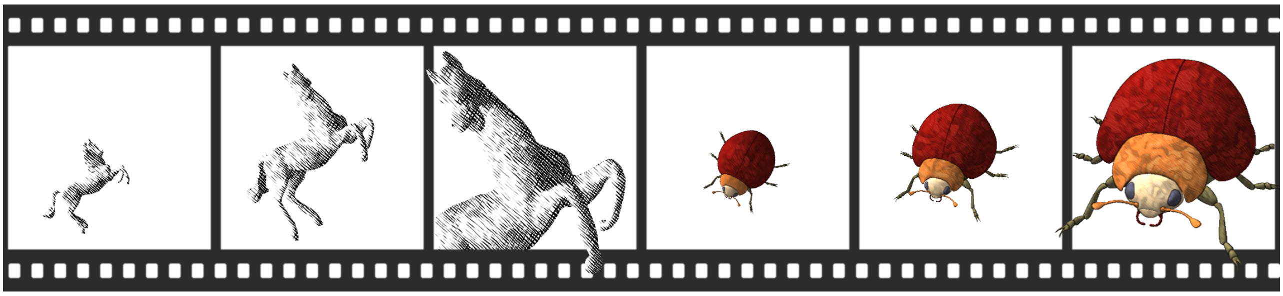


Figure 1: *We present a new noise primitive for NPR that keeps the 2D aspect of noise, conveys the 3D motion of the scene, and is temporally continuous. This allows us to use standard techniques from procedural texturing to create various styles for interactive NPR applications.*

1 Introduction

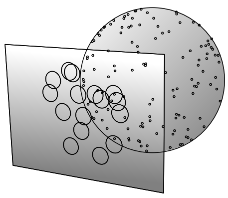
Stylized rendering algorithms, which aim at depicting 3D animated scenes with a *pattern* (i.e., watercolor pigments, strokes, paper grain, etc.), are facing the temporal coherence problem. To achieve successful temporal coherent stylization three constraints must be fulfilled: **flatness** (2D impression of the style), **coherent motion** (high correlation between the 3D motion field and the pattern motion) and **temporal continuity** (minimal changes from frame to frame). The conflicting nature of these goals implies that any solution to this problem is necessarily a compromise.

Most previous approaches can be classified into two categories, primitive-based and texture-based methods, each of them exhibiting different artifacts. We also identify a third category, many-primitive methods, establishing a connection between primitive-based methods in NPR and sparse convolution noise in procedural texturing. The dynamic canvas of Kaplan and Cohen [2005] and the interactive watercolor rendering pipeline of Bousseau et al. [2006] are the only two related methods in this category.

In this work, we propose a generalization of these approaches by introducing NPR Gabor noise which makes the connection with sparse convolution noise explicit and, thus, allows the use of standard techniques from procedural texturing to create various styles. As a many-primitive method, it features good motion coherence and a good sense of flatness.

2 Our Approach

We base our noise primitive on Gabor noise [Lagae et al. 2009] because it features a precise local spectral control. Gabor noise is a sum of randomly weighted and positioned Gabor kernels. Three kinds of Gabor noise have been proposed so far – 2D, surface and 3D Gabor noises – but none of them addresses the problem of temporal coherence for NPR. The first one is decorrelated from the 3D scene motion and the two later behave like regular texture mapping. To obtain a noise with a 2D aspect, we define the parameters (e.g., frequency and orientation) and evaluate the noise in 2D screen space. To ensure a coherent motion of the noise, we define the point distribution used by the noise on the surface of the triangle 3D model (see inset figure).



We generate this temporally coherent Poisson distribution using a pseudo-random number generator with a constant seed per triangle. In order to minimizing popping, we introduce an LOD mechanism which ensures a continuous and constant density of point distributions in 2D screen space throughout time. We express the noise as a linear interpolation between two noises using a weighting function which preserves its statistical properties. In contrast to most NPR techniques that blend between two different noises or textures, our scheme does not affect the appearance of the noise.

Finally, we process and combine multiple coherent noise layers to create styles ranging from continuous to discrete (see video). We model binary styles by thresholding a noise using a smooth step function, which produces hatches in the case of an anisotropic noise, and stipples in the case of an isotropic noise. We create color styles (painting, watercolor, ink) by compositing the noise with the scene color. Our noise primitive does not offer direct control at the stroke level. However, in contrast to most other texture-based approaches, we achieve local control by linking noise parameters to scene attributes (e.g., shading, geometric curvature).

3 Conclusion

Because any solution to the temporal coherence problem is a tradeoff between contradictory goals, its evaluation is complex. Previous approaches only relied on speculative visual inspection. However, each goal has specific artifacts which a user can observe. To evaluate them, we conducted a user study comparing six methods. It shows that motion coherence is the most important quality to preserve in the overall compromise, and that our new solution provides a good compromise between the 2D aspect of the style and 3D motion. We plan to do more user studies but also to explore objective measures to further quantify these trade-offs.

References

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