Global Illumination for 2D Artworks with Vector Field Rendering

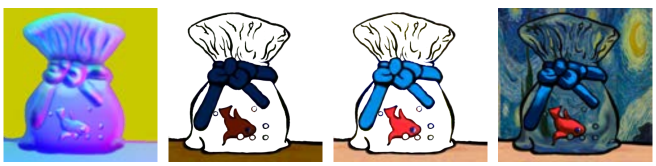
Youyou Wang
Computer Science Department
Texas A&M University

Ozgur Gonen
Architecture Department
Texas A&M University

Ergun Akleman
Visualization Department
Texas A&M University

(1) Original Image (2) Normal Map (3) S image (4) I_0 Image (5) I_1 Image (6) Rendering

Figure 1: *An example of the applications of 2D global illumination: improving of an artwork. (1) An artist's original drawing; (2) a normal map created from the original drawing; (3) a shading parameter image, S that provides the combined effect of our shading, shadow and ambient occlusion computations; (4) and (5) Two control images provided by the artist; (6) The rendered image created by interpolating the two images* I_0 *and* I_1 *as* $(1-S)I_0 + SI_1$*. The final image is more volumetric looking than the original drawing because of subtle effects provided by shadow and ambient occlusion although there is no true 3D shape.*



Normal Map I_0 Image I_1 Image Rendering

Figure 2: *An example of non-photo-realistic compositing with reflection, glossy reflection, refraction and translucence combined with Fresnel. The diffuse control images* I_0 *and* I_1 *and the normal map were freely hand-painted by an artist. The white regions in diffuse control images are transparent and, therefore, allow refraction and reflection.*

Despite the potential power of normal maps as shape representations for 2D artists, only a few groups investigated the potential use of normal maps as mock-3D shapes, or shape maps. All these methods, such as Lumo [Johnston 2002] or Crosshade [Shao et al. 2012], focused on "modeling" of these "normal/shape" maps. To render these mock-3D shapes, only basic 3D rendering methods are employed. The global rendering effects such as shadow, ambient occlusion, reflection and refractions has never been included.

The problem of inclusion of global rendering effects comes from the fact that normal maps are just vector fields, which may not not necessarily be conservative. Therefore, they do not necessarily correspond to any meaningful geometry and can represent impossible shapes. This can be considered as an advantage for 2D artists such as painters or illustrators, who wants to experiment with unusual shapes such as impossible or incoherent shapes. To unleash the true power of normal maps for 2D artists, there is a need for a new rendering framework that is designed to provide artists to control results while providing consistent global rendering effects.

In this work, we demonstrate that 3D shapes can be reconstructed even from non-conservative vector fields with simple image processing operations such as line integral convolutions in real-time using frame buffer. Using these temporarily constructed 3D shapes, we can obtain qualitatively convincing global illumination effects during interactive rendering of normal maps. This approach allows us to use vector fields that may not necessarily correspond to any 3D shape, but that can still help to compute a 3D appearance.

We provide a rendering framework that allows 2D artists to create 3D-looking stylized depictions with complete visual control. This rendering framework is compatible with existing 2D image manipulation systems and it can be included without a major change. With our approach, artists can intuitively control the results by providing and manipulating images. Final images are created in (1) a diffuse rendering process that interpolates two shader control images using a shader parameter image (see Figure 1) and then (2) a compositing process that interpolates the transparent regions of the diffuse image with deformed background and environment maps blended using Fresnel (see Figure 2).

References

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Shao, C., Bousseau, A., Sheffer, A., and Singh, K. 2012. Crossshade: shading concept sketches using cross-section curves. *ACM Trans. Graph. 31*, 4, 45:1–45:11.

SIGGRAPH 2014, August 10 – 14, 2014, Vancouver, British Columbia, Canada.

ACM 978-1-4503-2958-3/14/08