ZoeMatrope: A System for Physical Material Design

Leo Miyashita, University of Tokyo
Kota Ishihara, PKSHA Technology Inc.
Yoshihiro Watanabe, University of Tokyo
Masatoshi Ishikawa, University of Tokyo

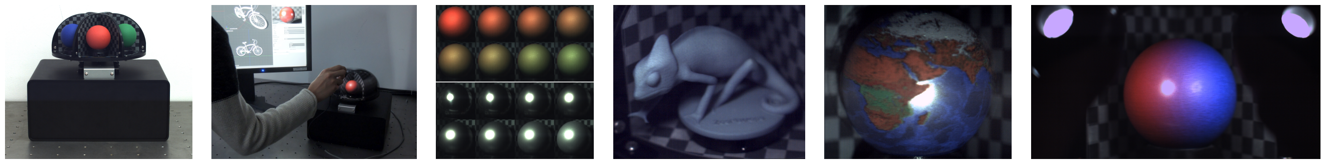


Figure 1: *The figures show, from left to right, a prototype system, a situation of physical material design, diffuse color and specular roughness animation, a chameleon-shape material display, a spatially-varying materials with a high-speed projector and an augmented material.*

Keywords: zoetrope, strobe light, thaumatrope, material display

Concepts: •**Human-centered computing** → **Systems and tools for interaction design;** •**Computing methodologies** → **Virtual reality;** •**Hardware** → **Displays and imagers;**

1 Introduction

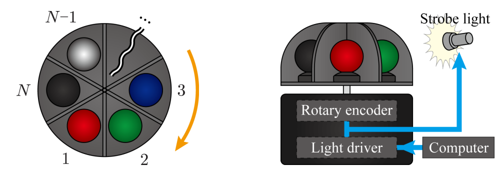
Realistic materials have recently begun to be rendered in computer graphics. The realistic presentation of materials is essential for confirming color and gloss of a product in rapid prototyping and internet shopping. In addition, it enhances various immersive experiences in art, media, and augmented reality.

However, conventional displays cannot represent realistic materials due to their limitations, including resolution, dynamic range and light field fidelity. Some research has attempted to improve these issues by using technologies such as projection mapping techniques [Raskar et al. 2001] and specialized displays [Hullin et al. 2011]; however, the results are still far behind reality, or the kinds of expressible materials are limited.

Our key approach to display a realistic material is to use real materials. To achieve a realistic material display, we computationally control afterimages and apparent motion and propose a visual material display named "ZoeMatrope", which can composite real materials like a thaumatrope and can interactively animate the materials like a zoetrope. A real object is the most realistic, and consequently, ZoeMatrope can display materials with outstanding resolution, dynamic range, and light field fidelity.

2 Principles

For example, when the user sets a red, glossy material on a 3D model on a computer, the ZoeMatrope illuminates only a red object and a glossy object among a number of objects rotating at high speed at appropriate timing as shown in Fig. 2. As a result, only these two materials are visible, and a composite material that is both red and glossy will appear in front of the user because the objects are switched at high speed without noticeable transitions and are seen in an overlaid manner by the human eye as shown in Fig. 3.



(a) Top view (b) Side view

Figure 2: *System overview.*

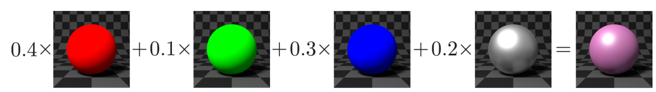


Figure 3: *A diagram of a composition. The composition weight corresponds to the quantity of light radiated onto each material.*

We propose a mathematical framework for the optimal material selection and lighting strategy for displaying a variety of realistic materials with a few real objects, and demonstrate the composition and animation of materials including diffuse, specular, transparent, translucent materials with microsecond order lighting control.

3 Applications

ZoeMatrope can use base objects of any shape and can also realize the presentation of a spatially-varying material by using a light source with a spatially-varying intensity pattern such as a projector. In addition to generally existing materials, this system can also represent augmented materials such as materials with an alpha channel. ZoeMatrope will push the frontiers of expression media by providing state-of-the-art material displaying technology.

References

HULLIN, M. B., LENSCH, H. P. A., RASKAR, R., SEIDEL, H.-P., AND IHRKE, I. 2011. Dynamic display of BRDFs. *Computer Graphics Forum 30*, 2, 475–483.

RASKAR, R., WELCH, G., LOW, K.-L., AND BANDYOPADHYAY, D. 2001. Shader lamps: Animating real objects with image-based illumination. In *Proceedings of the 12th Eurographics Workshop on Rendering Techniques*, 89–102.

SIGGRAPH '16, July 24-28, 2016, Anaheim, CA,
ISBN: 978-1-4503-4372-5/16/07
DOI: http://dx.doi.org/10.1145/2929464.2929465