ValueSphere: A Portable Widget for Quick and Easy Shading in Digital Drawings

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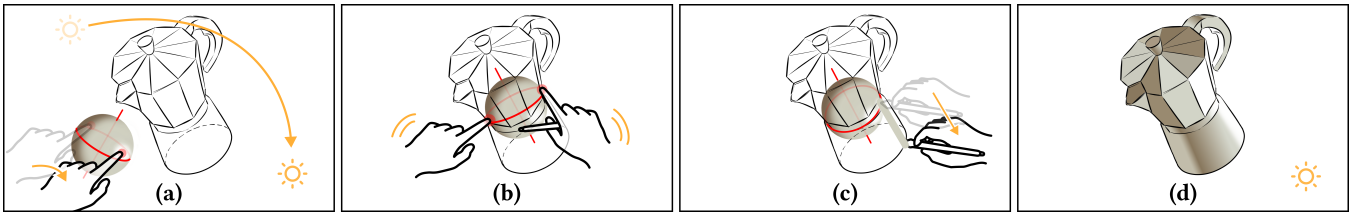

Figure 1: We propose *ValueSphere*, a novel pen and multi-touch widget designed for quick and easy shading in digital drawings. With ValueSphere, the user can (a) set the light direction, (b) relocate, resize, and rotate the widget to find correct shading values, and (c) apply them to the line sketch in order to achieve (d) plausible volumetric shading.

ABSTRACT

Marker shading is essential for communicating 3D forms in the early stages of product design. Inspired by a technique of marker shading that is widely used by designers, this study introduces *ValueSphere*, a novel widget for quick and easy shading in digital drawings. Using ValueSphere, the user can set the light direction, find accurate shading values, and apply them to the sketch through intuitive pen and multi-touch gestures. We utilized ValueSphere to shade various design sketches and showcase its usefulness.

KEYWORDS

Digital drawing; value shading; pen; multi-touch

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1 INTRODUCTION

In the early stages of product design, designers draw line sketches with pens and shade them with markers to communicate 3D forms [6]. Designers often follow three key principles during the shading process. First, they assume diffuse light from the sun as the only light source, which is simple but sufficient to create a plausible image of volumes [5]. Second, they break down the line sketch into primitives, such as spheres, cylinders, and cones [2]. Third, they use reference spheres to determine shading values for each primitive [4, 7] (Figure 2).

However, repeatedly drawing many reference spheres can be tedious and make the line sketch messy. Furthermore, designers have to start over when they want to change the light direction [1]. Thus, we propose *ValueSphere*, which helps quickly and easily shading line sketches (Figure 1). By placing the widget anywhere in the line sketch, the user can extract and apply correct shading values, which automatically update to a new light direction when the user changes it later.

2 TECHNIQUE

The ValueSphere widget features components that the user can intuitively manipulate with pen and multi-touch gestures (Figure 3). The user can first set the light direction (Figure 4). Then, the user can relocate, resize, and rotate the widget to fit it to the line sketch (Figure 5, 6). Finally, the user can extract and apply the shading value (Figure 7). At any point during shading, the user can change the light direction without starting from scratch (Figure 8).

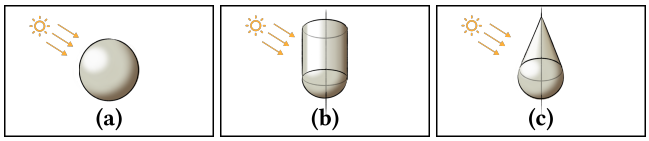

Figure 2: Shading primitives under diffuse light. (a) A sphere can be shaded with the brightest, darkest, and intermediate values, determined by the light direction and surface normals. (b) A cylinder can be shaded by extending the shading value of the sphere tangentially fitted to its cylindrical surface at its base along the parallel direction. (c) A cone can be shaded by extending the shading value of the sphere tangentially fitted to its conical surface at its base toward its vertex.

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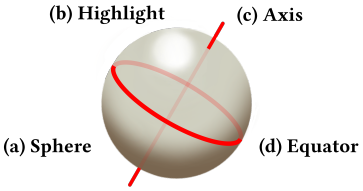

Figure 3: The ValueSphere widget consists of (a) the sphere to visualize shading values, (b) the highlight to indicate the light direction, and (c) the axis and (d) the equator to help fit the widget to the line sketch.

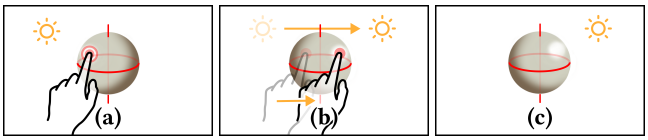

Figure 4: The user can (a) touch the highlight with one finger, and (b) drag along the surface of the sphere (c) to change the light direction.

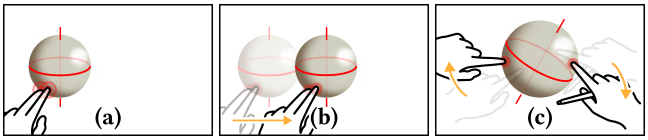

Figure 5: The user can (a) touch the widget and drag (b) with two fingers of one hand to relocate, or (c) with one finger of each hand to simultaneously relocate, resize, and rotate it.

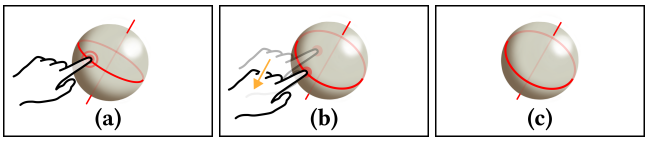

Figure 6: The user can (a) touch the equator with one finger and (b) drag in the orthogonal direction (c) to tilt it.

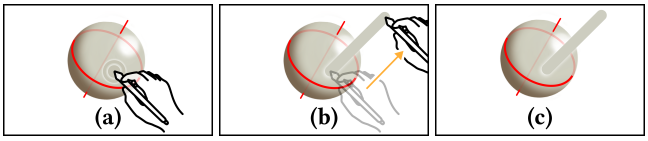

Figure 7: The user can (a) tap the sphere with the pen to extract the shading value and (b) draw (c) to apply it.

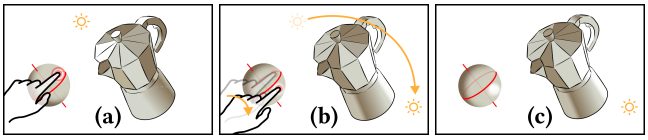

Figure 8: At any time the user can (a) touch and drag the highlight (b) to change the light direction (c) with the shading values automatically revised in accordance.

3 SHOWCASE

To showcase the usefulness of ValueSphere, we prototyped the widget in the Unity 3D game engine and utilized it to shade various line sketches, while measuring the times taken (Figure 9).

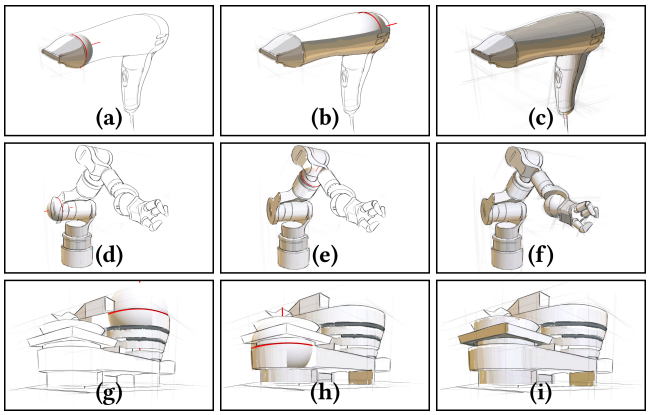

Figure 9: One of the authors used ValueSphere to shade the line sketches of (a-c) a hair dryer (time taken: 3 min), (d-f) a robot arm (time taken: 8 min), and (g-i) a modernist building (time taken: 7 min).

4 CONCLUSION & FUTURE WORK

In this study, we propose a novel shading widget called ValueSphere that the user can carry anywhere on the canvas to easily find and quickly apply accurate shading values to the line sketch. In future work, we will enable customization of material properties (e.g. color, reflectivity, and translucency), light sources (e.g. type, intensity, and number), and scene reflections [3], and evaluate the technique's usability and effectiveness with student and professional designers.

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