How Bright Should It Be: Diffuse White in Optical See-Through Augmented Reality

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***Keywords*—Optical see-through, Augmented reality, Brightness, Diffuse white, 3D rendering, Transparency.**

Augmented reality (AR) realism has been one of the most important aspects of more immersive experiences. Realistic rendering requires the virtual images to have the correct tone and light intensity compared to the real background for seamless and visually compelling results. In this project, we focus on how bright a 3D rendered white diffusive cube should be on different background conditions including the background luminance levels, spatial variance, and luminance contrast. An interactive psychophysical experiment was used to assess the correct luminance level of the cube providing observers the ability to change the cube material reflectance and rotation.

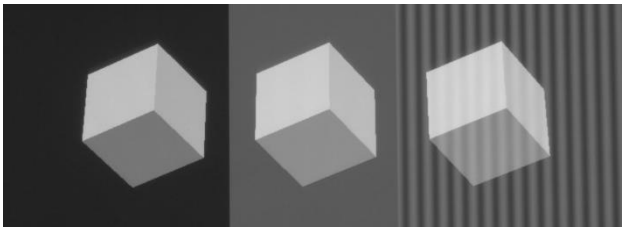

Fig. 1. Photograph of three identical cubes rendered in an OST AR against different backgrounds: dark-solid, light-solid, light-patterned (from left to right).

I. BACKGROUND

Three identical cubes are presented in optical see-through (OST) AR against different backgrounds (Fig.1). The background blending gives the identical cubes different appearances. The increased background luminance increases the overall cube brightness, but decreases the shading contrast between the cube surfaces (Fig.1 left and middle cubes). The patterned background with spatial variance gives a transparent appearance compared to a solid background with the same average luminance level, though it is not intended to be (Fig.1 right and middle cube). In addition to the background, the object rotation also affect the appearance through shading (Fig.2).

We collected response from observers on the diffuse white luminance level of a 3D rendered cube in OST AR system on various backgrounds. The cube was rendered in diffusive Lambertian material, with each side of the cube occupied 2°x2° field-of-view when facing the camera. A combination of directional and ambient light with intensity ratio of 3:1 were used. The directional light illuminated the cube from 45° above. Observers were asked to adjust the cube brightness through material albedo to be diffuse white, which was the the color of reference patches on the screen. Observers could rotate the cube to examine the effect of shading during adjustment.

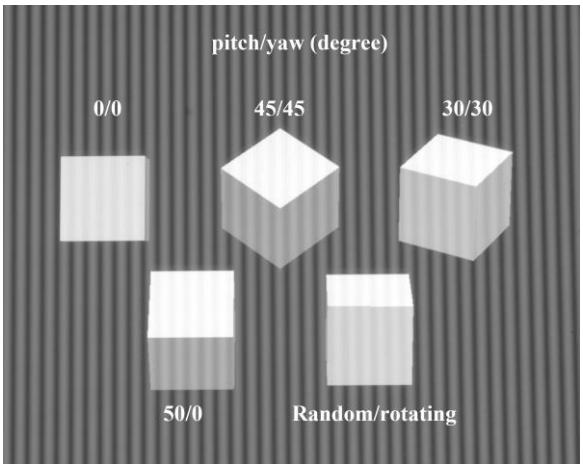

Fig. 2. The same cube gives different appearances with different rotation angles.

II. CONCLUSION

Overall higher luminance was required for the 3D cube to be perceived as diffuse white compared to flat plain patches due to the shading. The spatial average luminance over rotation angles matched well with the flat patch, indicating observers used the overall average luminance in adjustment. A solid background required higher albedo on the cube to be perceived as diffuse white compared to a patterned background with the same average luminance. Though the patterned background contrast level didn't significantly impact how bright a white diffuse cube should be, there was a trend of lower luminance on higher contrast background. Qualitative feedback also indicates that current shading models result in high contrast among surfaces on patterned backgrounds and may not be suitable for OST AR rendering. The result of this project provides insight on how to improve 3D rendering realism based on the background conditions for content makers.

III. REFERENCES

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