Validating Perception of Hyperspectral Textures in Virtual Reality Systems

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Virtual Reality (VR) environments are increasingly offering higher quality content. They use different computing techniques to improve the final user experience. In this work, we create different light sources and introduce ***hyperspectral textures*** for the object reflectance to boost the **VR environment's quality.** In addition, we perform a quantitative study to demonstrate that hyperspectral textures improve the final quality of the content in virtual reality systems.

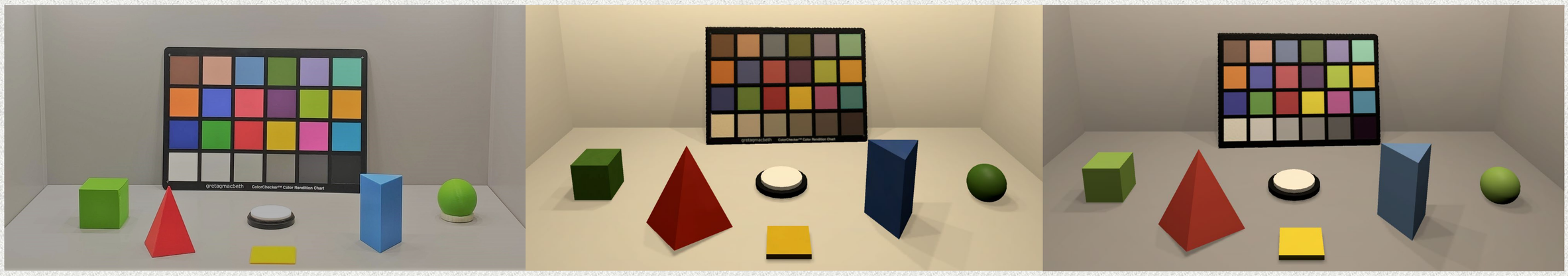


Figure 1: *The quantitative experimental environment. Left: Scenario on a real light booth and real several objects created with a 3D printer; Center: Virtual environment with 3D scanned objects and RGB textures under D50 illuminant; Right: Virtual environment with 3D scanned objects and hyperspectral textures under D50 illuminant.*

1. Calibration of Head Mounted Display

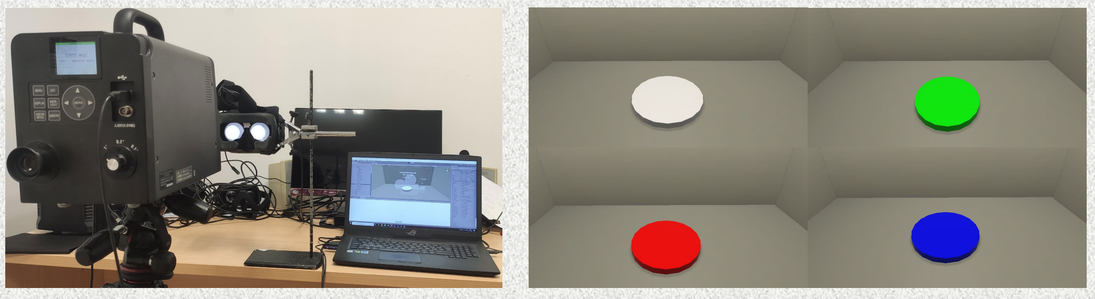


Figure 2: *Left: Set up of calibration of the Head Mounted Display. Right: Different examples of color values used for color calibration.*

$$R' = R^{\gamma} \quad G' = G^{\gamma} \quad B' = B^{\gamma}$$

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} X_{R'max} & X_{G'max} & X_{B'max} \\ Y_{R'max} & Y_{G'max} & Y_{B'max} \\ Z_{R'max} & Z_{B'max} & X_{B'max} \end{pmatrix} * \begin{pmatrix} R' \\ G' \\ B' \end{pmatrix}$$

2. Simulation of Light Sources

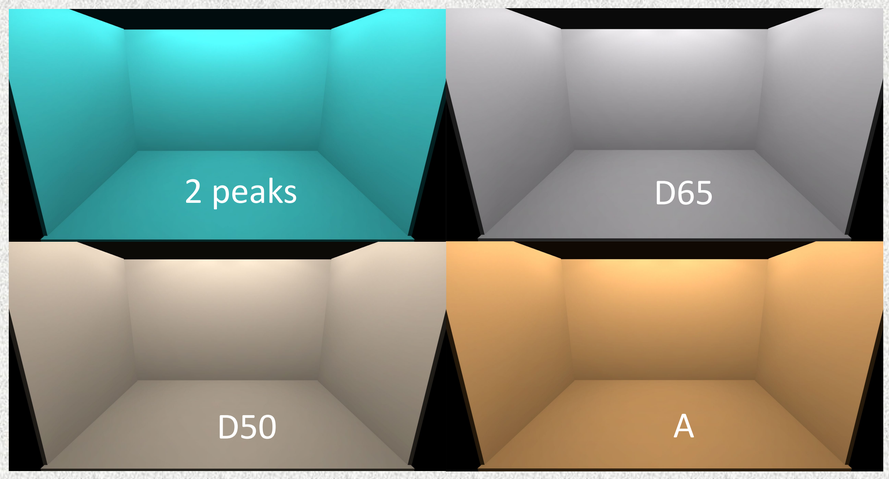


Figure 3: *Representation of different light sources in virtual reality.*

3. Introducing Hyperspectral Textures

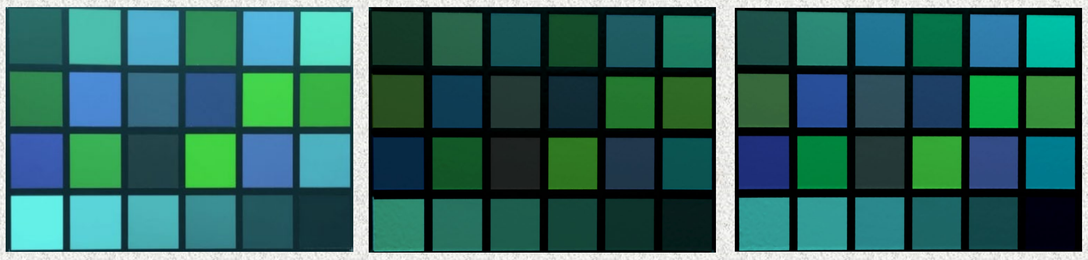


Figure 4: *Left: Real ColorChecker. Center: Virtual ColorChecker without hyperspectral texture. Right: Virtual ColorChecker with hyperspectral textures. All of them represented under 2 peaks lighting (blue and green)*

4. Observers Validation

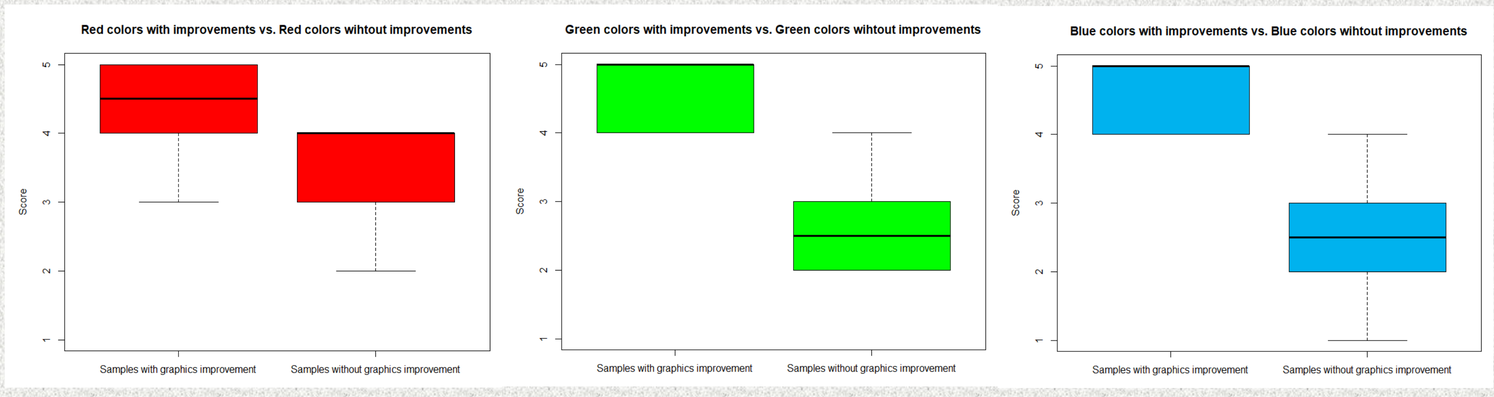
x 5 users

Real Scene **VS** Virtual scene **without** hyperspectral textures

Real Scene **VS** Virtual scene **with** hyperspectral textures

x 4 light sources

5. Results



Color	With graphics improvements		Without graphics improvements	
	Average	Standard Desviation	Average	Standard Desviation
Red	4.46	0.58	3.51	0.53
Green	4.65	0.48	2.53	0.56
Blue	4.71	0.45	2.48	0.59

Figure 5: *Scores obtained for each RGB channel from 0 (not similar) to 5 (equal similarities) for the virtual scenario with and without graphic enhancements.*

Acknowledgments

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