Light Field Background Oriented Schlieren Photography Supplemental Material

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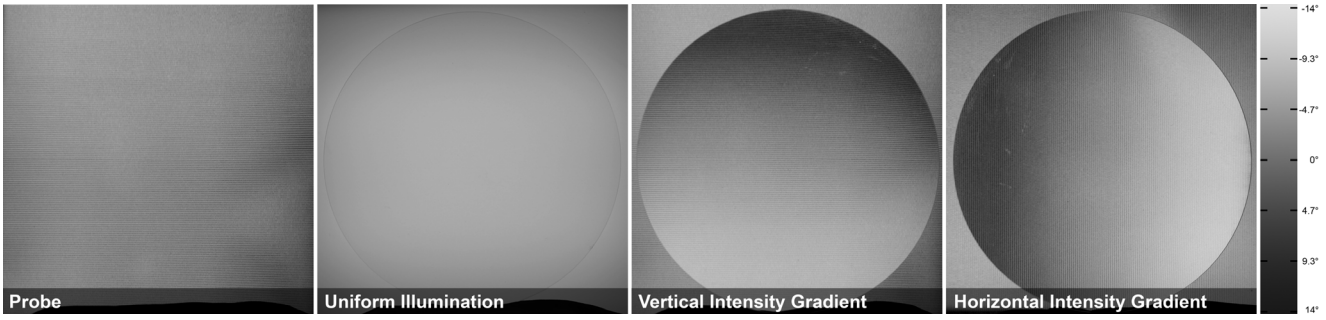

Figure 1. A lenticular light field probe encoding 1D directional light variation of the refraction created by a lens with an intensity gradient. This type of filter resembles the knife edge filter of traditional Schlieren photography in the specific direction. Left: probe encoding a horizontal intensity gradient without any object; center left: convex lens with uniform background illumination; center right: lens in front of the probe; right: lens in front of the rotated probe.

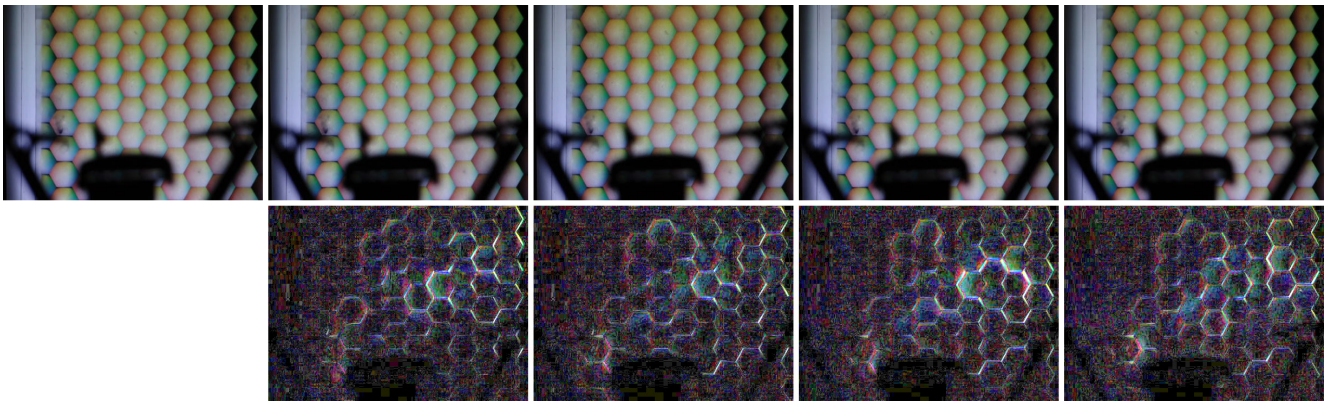

Figure 2. Multiple frames of a video sequence showing a burning camping stove in front of a probe at 30 frames per second. The probe codes refraction with a hue-saturation color wheel. Although the angular ray deflections are rather subtle in this case, contrast enhanced difference images reveal color variation due to changes in the refractive index field. For this experiment, the probe had to be placed at a distance to the stove so that it would not melt; this results in focus mismatches. The noise in the difference images is due to lossy mpeg compression; the darker boundaries between lenslets on the probe also cause artifacts.

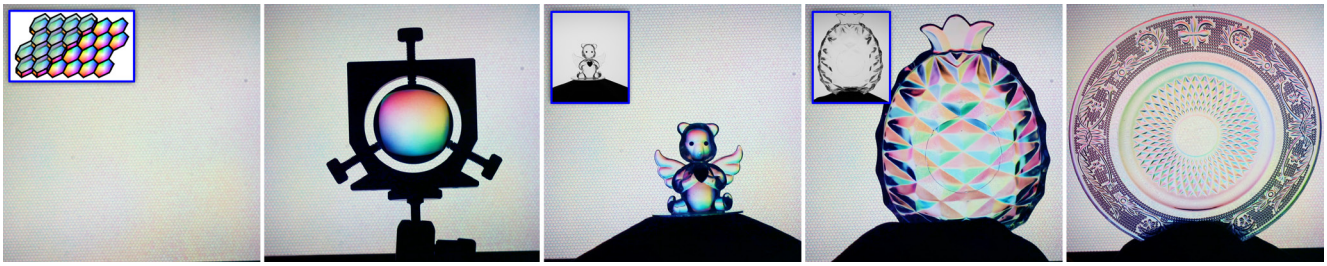

Figure 3. Additional results for refractive solids with a hue-saturation probe. The magnifications show some of the objects under uniform illumination.

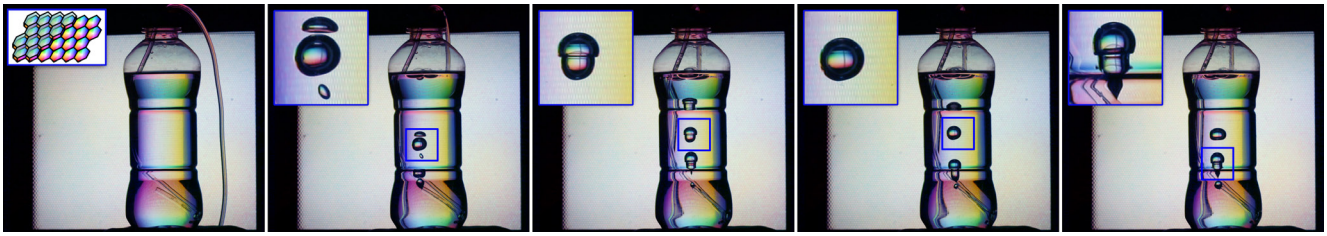

Figure 4. An angular hue-saturation probe behind a bottle filled with clear corn starch. Light rays are refracted by the bottle, its content, and rising air bubbles.

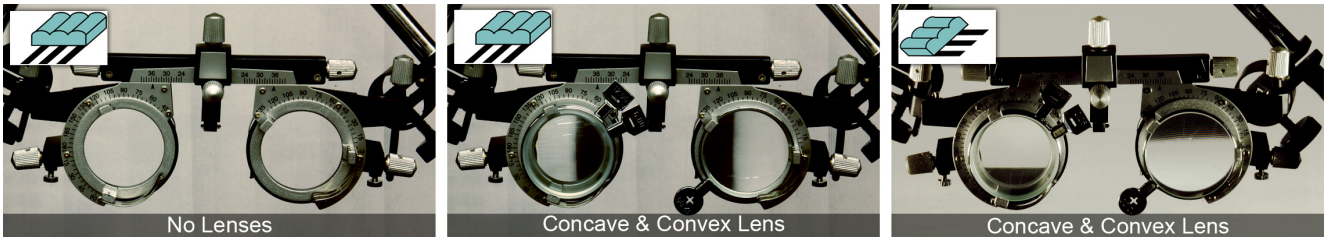

Figure 5. A concave and a convex lens in front of hard 1D cutoff filters. The lenticular-based probe without any lenses is shown on the left; a horizontally and a vertically aligned probe with the lenses is seen in the center and on the right, respectively.

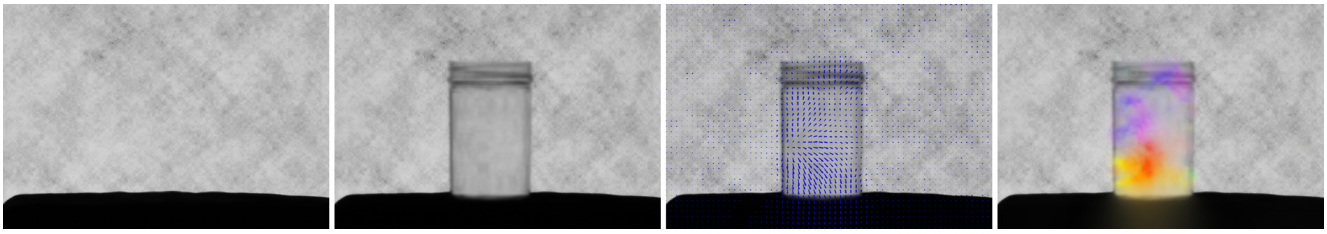

Figure 6. Background oriented Schlieren photography of a glass of water. From left: the diffuse wavelet noise background, a glass of water added to the scene, estimated optical flow vectors, color coded optical flow vectors. The color coding scheme matches that of our color probes: refraction angle are coded in hue and magnitudes in saturation. We used a Horn-Schuck implementation of optical flow, which is considered the most rebust algorithm for this purpose [1].

References

[1] B. Atcheson, W. Heidrich, and I. Ihrke. An Evaluation of Optical Flow Algorithms for Background Oriented Schlieren Imaging. *Experiments in Fluids*, 46(3):467–476, 2009. 2