Exploiting redundancy in color-polarization filter array images for dynamic range enhancement: supplemental document

This a supplemental document of the manuscript entitled "Exploiting redundancy in color-polarization filter array images for dynamic range enhancement". The main focus of this document is to give details about the statistical analysis used to justify the threshold selection, the High Dynamic Range (HDR) reference generation, and to provide the visualization of the Stokes image results for all the spectral bands.

1. STATISTICAL ANALYSIS OF DOLP DIFFERENCES BETWEEN SPECTRAL CHANNELS

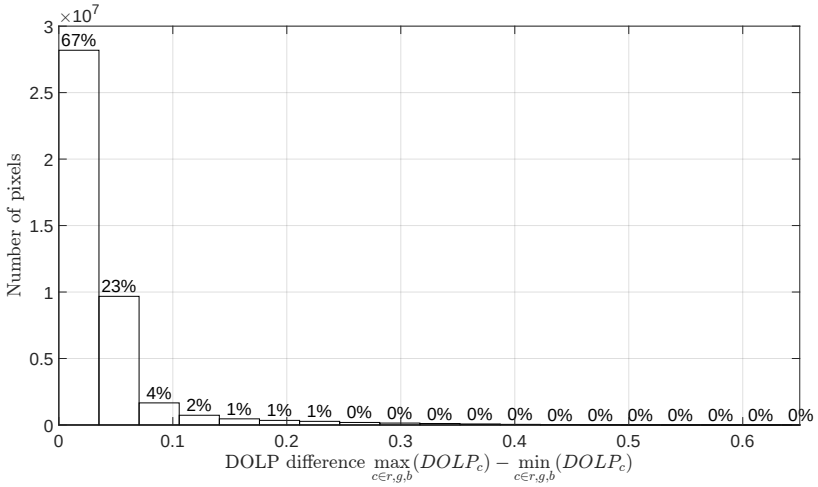


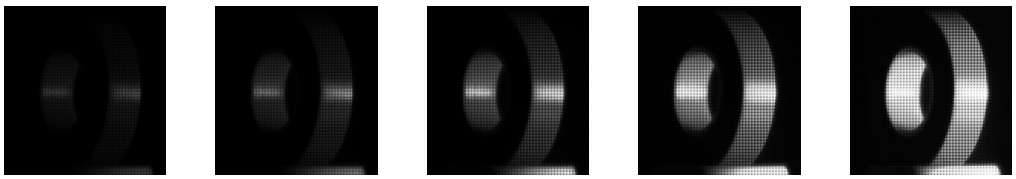
Fig. S1. Results of the statistical analysis used to justify the threshold selection (T). The degrees of polarization differences are computed by pixel, using the database of RGB-polarization images from [1]. $\approx$ 99% of observations exhibit less than 20% of $DOLP$ differences between all the spectral channels.

2. HIGH DYNAMIC RANGE REFERENCE GENERATION

The references used for the quantitative comparison shown in Table 1 in the letter are built from an exposure set of 5 images with 5 different exposure times ($\Delta t = 10$, 20, 40, 80, and $160ms$). The middle exposure is the test image ($40ms$). The raw images are shown in Figure S2. The images are fused using the "makehdr" command in Matlab, which invokes the Debevec et al. method [2] for the HDR creation. For all visual comparison with the low dynamic range images in Section 3, the HDR images are displayed on the the same range of values as low dynamic range images.

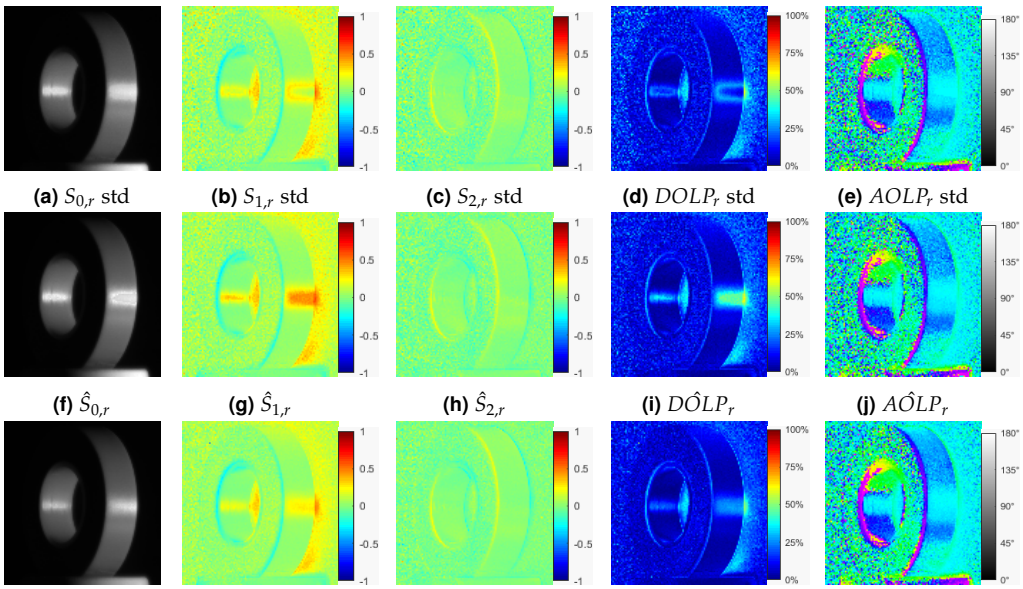
3. VISUAL COMPARISON

Figures S3, S4, and S5 show respectively the results for the spectral bands $c = r$, g, and b. Images result from the standard computation (Eq. 2 with $M = N = 1$), the proposed computation (Eq. 6 and 7), and the High Dynamic Range (HDR) reference images (Eq. 2 with $M = N = 1$ with HDR data).



(a) $\Delta t = 10ms$ **(b)** $\Delta t = 20ms$ **(c)** $\Delta t = 40ms$ **(d)** $\Delta t = 80ms$ **(e)** $\Delta t = 160ms$

Fig. S2. The 5 raw images used to generate the reference Stokes images for the quantitative comparison in Table 1 of the letter.

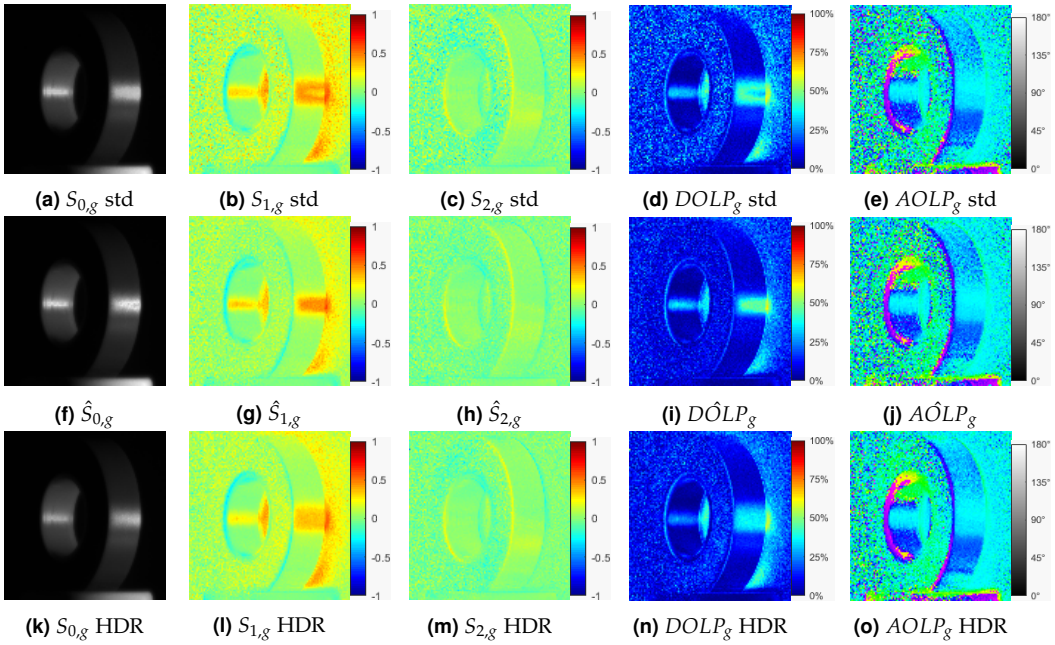


(a) $S_{0,r}$ std **(b)** $S_{1,r}$ std **(c)** $S_{2,r}$ std **(d)** $DOLP_r$ std **(e)** $AOLP_r$ std

(f) $\hat{S}_{0,r}$ **(g)** $\hat{S}_{1,r}$ **(h)** $\hat{S}_{2,r}$ **(i)** $\hat{DOLP}_r$ **(j)** $\hat{AOLP}_r$

(k) $S_{0,r}$ HDR **(l)** $S_{1,r}$ HDR **(m)** $S_{2,r}$ HDR **(n)** $DOLP_r$ HDR **(o)** $AOLP_r$ HDR

Fig. S3. Extensive visualization of the results presented in the letter, for spectral band $c = r$. First row: standard computation, second row: proposed computation, third row: High Dynamic Range (HDR) references.

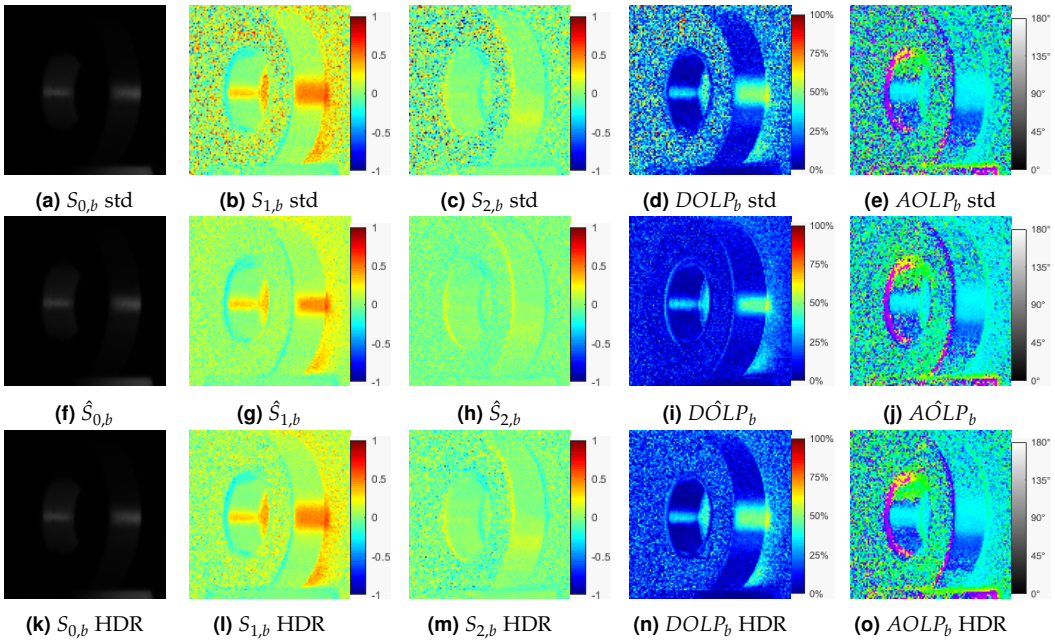


(a) $S_{0,g}$ std **(b)** $S_{1,g}$ std **(c)** $S_{2,g}$ std **(d)** $DOLP_g$ std **(e)** $AOLP_g$ std

(f) $\hat{S}_{0,g}$ **(g)** $\hat{S}_{1,g}$ **(h)** $\hat{S}_{2,g}$ **(i)** $D\hat{O}LP_g$ **(j)** $A\hat{O}LP_g$

(k) $S_{0,g}$ HDR **(l)** $S_{1,g}$ HDR **(m)** $S_{2,g}$ HDR **(n)** $DOLP_g$ HDR **(o)** $AOLP_g$ HDR

Fig. S4. Extensive visualization of the results presented in the letter, for spectral band $c = g$. First row: standard computation, second row: proposed computation, third row: High Dynamic Range (HDR) references.



(a) $S_{0,b}$ std **(b)** $S_{1,b}$ std **(c)** $S_{2,b}$ std **(d)** $DOLP_b$ std **(e)** $AOLP_b$ std

(f) $\hat{S}_{0,b}$ **(g)** $\hat{S}_{1,b}$ **(h)** $\hat{S}_{2,b}$ **(i)** $D\hat{O}LP_b$ **(j)** $A\hat{O}LP_b$

(k) $S_{0,b}$ HDR **(l)** $S_{1,b}$ HDR **(m)** $S_{2,b}$ HDR **(n)** $DOLP_b$ HDR **(o)** $AOLP_b$ HDR

Fig. S5. Extensive visualization of the results presented in the letter, for spectral band $c = b$. First row: standard computation, second row: proposed computation, third row: High Dynamic Range (HDR) references.

REFERENCES

1. S. Qiu, Q. Fu, C. Wang, and W. Heidrich, "Polarization Demosaicking for Monochrome and Color Polarization Focal Plane Arrays," in *Vision, Modeling and Visualization*, H.-J. Schulz, M. Teschner, and M. Wimmer, eds. (The Eurographics Association, 2019), pp. 117–124.
2. P. E. Debevec and J. Malik, "Recovering high dynamic range radiance maps from photographs," in *Proceedings of the 24th Annual Conference on Computer Graphics and Interactive Techniques*, (ACM Press/Addison-Wesley Publishing Co., New York, NY, USA, 1997), SIGGRAPH '97, pp. 369–378.