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Comment on: "Using Digital Cameras as Quasi-Spectral Radiometers to Study Complex Fenestration Systems" by N Gayeski, E Stokes, and M Andersen

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The bi-directional spectral distribution functions (BSDF) of complex fenestration systems (CFS) are particularly needed for daylighting calculations where surface point illuminance and visual detail of objects are of great importance, for thermal calculations to control solar heat gains, and for fenestration product ratings. However, measurement of CFS spectral characteristics using conventional spectral scanning goniophotometers is a laborious and expensive process. A substantial amount of data (in the order of a million points) need to be measured to cover the incident and emerging hemispheres, spectral data points (300 nm to 2500 nm), and the number of the optical properties to be measured (front/back reflectance and transmittance). Therefore, any new measurement approach to minimize the conventional data collection process with sufficient accuracy is highly encouraged. The approach of this paper using video-projection and digital cameras is one step towards achieving this goal. Cameras can collect data from the full emerging hemisphere in one measurement shot. However, the proposed quasi-spectral measurement using colour filters is still limited to a certain wavelength range, covering only the visible and a small part of the NIR spectrum (380 nm 945 nm). Finding filters and cameras to cover the remaining spectral ranges is also challenging. In addition, it would be beneficial if the authors could provide an indication of the overall accuracy of the proposed approach for real spectrally/angularly-selective CFS products.

Another approach to reduce the conventional data collection process of CFS that I would like to propose for future research consideration stems from the fact that the BSDF may be decomposed into purely geometrical and optical functions, particularly for CFS products where their micro or macro-scopic geometries do not interfere with the source wavelengths. In other words, the monochromatic BSDF at different wavelengths have similar distributions, but are different only in magnitudes. In this regard, the BSDF may be scaled so that the resulting functions are independent, or weakly-dependent of wavelength. By denoting sBDF for the scaled bi-directional distribution functions of a given optical property, the BSDF may be obtained using the following proposed relation:

$$\boldsymbol{BSDF}(\theta,\varphi,\theta_i,\varphi_i,\lambda) = \boldsymbol{P}(\theta_i,\varphi_i,\lambda)\cdot \boldsymbol{sBDF}(\theta,\varphi,\theta_i,\varphi_i)$$

where $P(\theta_i,\varphi_i,\lambda) = \sum_k\{BSDF_k.\cos\theta.\Omega_k\}$, stands for a given spectral directional-hemispherical optical property to be measured (transmittance or reflectance), and Ω_k is an elemental solid angle subtended by the sample surface along the scattering direction k. The spectral optical property (P) can be obtained using the standard measurement approach of integrating spheres, and the scaled functions (sBDF) can be obtained using a monochromatic or a non-spectral (broadband) measurement approach, without resorting to any colour filter.