Improving the M_p metric for evaluation of flicker

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Abstract

Recently TLM (temporal light modulation) related measurements and calculations have regained high interest, with new regulations by European Commission and other regional regulations requiring limits for TLA (temporal light artefacts) quantities for LED lighting products. In these regulations, P_{st}^{LM} (IEC TR 61547-1-2020) for flicker and SVM (TR 63158-2018) for stroboscopic effects are commonly used. However, due to complexity of P_{st}^{LM}, attentions are paid to another metric for flicker, M_p (ASSIST vol. 11, 2015). This metric works in frequency domain and requires a much shorter measurement time (>2 sec) compared to 3 minutes for P_{st}^{LM}. M_p is already used in some commercial TLM measuring instruments. However, for some types of lamps, large variations in M_p results are found for repeated light measurements using different waveform sampling parameters.

Both simulated waveforms and measured waveforms were used to evaluate M_p. The impact of waveform duration (from 2 sec to 180 sec), sampling rates, and starting phase of the measured waveform on the M_p values were investigated.

The results show that the waveform duration and starting phase have significant impact on the M_p values when using the original formulae in the ASSIST document. The variation of calculated M_p due to these two factors was largely reduced after adding a Hann window before the FFT transform. However, applying a Hann window led to a different M_p value from the one obtained with the original formulae, since the Hann window reduces the effect of spectral leakage while enhancing the FFT spectrum peak due to the added window function. The sampling rate can also have a noticeable effect on the M_p value depending on the waveform. Further investigation into the cause of these and possible solutions is in progress to improve the metric.

Bio

Dr. Jiaye Li received her Ph. D. in engineering from Katholieke Universiteit Leuven (KU Leuven) in Belgium. Her research area is color vision: color matching, color rendering, color difference, contrast perception. She worked as a Ph. D. researcher supervised by Prof. Kevin Smet and Prof. Peter Hanselaer in the Light & Lighting Lab of KU Leuven from 2018 to 2022. She is now a Postdoc researcher at NIST, working with Dr. Yoshi Ohno on Vision Science projects in Sensor Science Division.

Dr. Yoshi Ohno received his Ph. D. in engineering from Kyoto University Japan and joined NIST in 1992. He served as a Group Leader at NIST Optical Technology Division (now Sensor Science Division) in 2003 - 2012 and is appointed a NIST Fellow since 2010. He served as CIE President for 2015-2019 term, and prior to this, Vice President-Technical and Division 2 Director since 2007. He chaired several CIE TCs and led development of CIE S 025 among other publications. His recent research focused on color quality of light sources. He led development of CIE TN 001 and ANSI C78.377 chromaticity specifications for SSL products.

Andrew Bierman received an MS in Lighting from Rensselaer Polytechnic Institute in 1992 and an MS in Electrical Engineering from Binghamton University in 2019. He worked for 27 years at the Lighting Research Center at RPI and now runs his own consulting business, Namreiba, LLC. His research focus is the application of light for vision, health, and agriculture.