Consultative Committee for Photometry and Radiometry (CCPR)

24th Meeting (19 - 20 September 2019)

Questionnaire on activities in radiometry and photometry

Reply from: CMS/ITRI

Delegate: Kuei-Neng Wu

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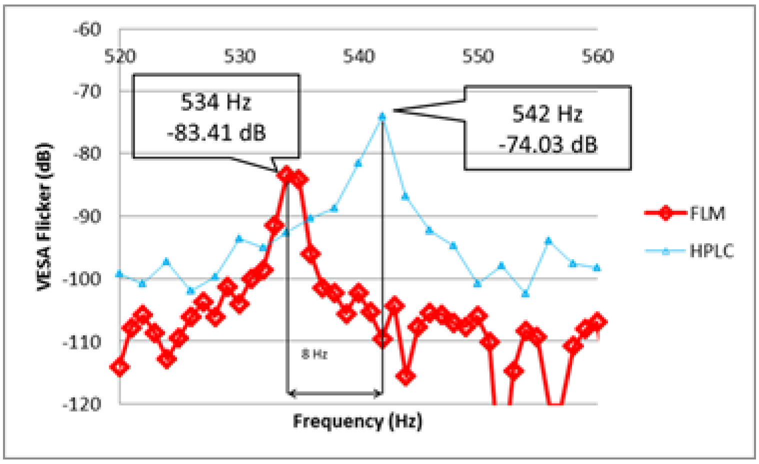
1. Summarize the progress in your laboratory in realizing top-level standards of:

   (a) broad-band radiometric quantities : none
   (b) spectral radiometric quantities : none
   (c) photometric quantities : none

2. What other work has taken place in your laboratory in scientific or technological areas relevant to the CCPR?

The Measured Method of Flicker Characteristics for Flexible Display

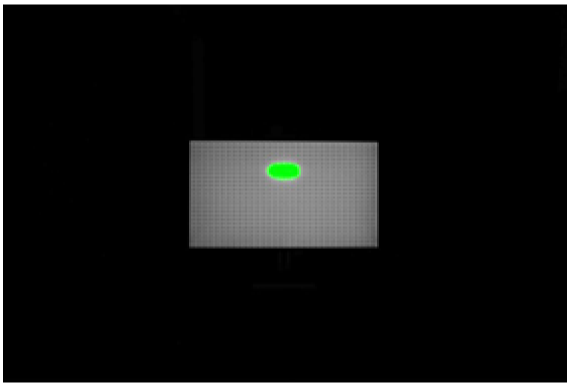
New flicker measurement methods were studied. Local Flicker and Overall Flicker are defined and measured by High Performance Linear Camera and Focused Luminance Meter, further analyze and calculate flicker frequency and VESA Flicker, the results represent the significant difference.



The difference between 2 peaks from FLM and HPLC

Investigation of Glare Metrics for Reflected Glare on Displays

This work investigates three kinds of surface treatments of displays under ambient lighting conditions. For all treatments of the experiment, the luminous distributions of displays are measured by an Imaging Luminance Measuring Device (ILMD). To evaluate the reflected glare on displays, the joint effects of display polarity and illumination condition were designed in the experiments. Total of 12 reflected glare conditions were measured, three kinds of displays, two types of display polarity contents and two ambient illumination levels. This paper reviewed the popular glare metrics and conducted an experiment to present the applicability of those metrics for predicting glare on electronic displays in indoor environments.



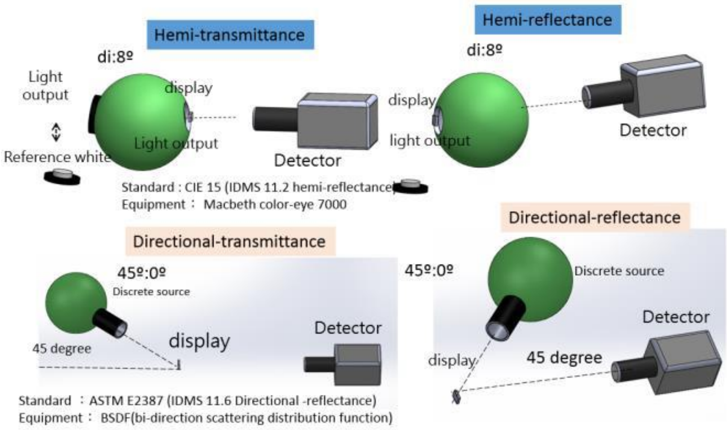
Positive Polarity, LT:300 cd/m2

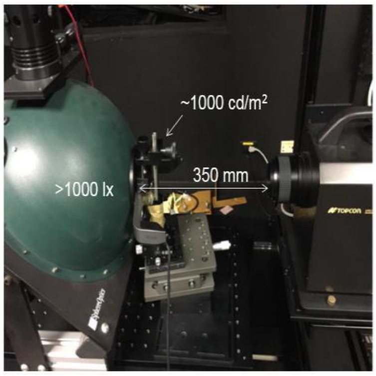
Ambient Color Volume Measurements for Augmented Reality Displays

Optical measuring methods for transparent displays were conducted to disclose that the color volume values with 0.39 % difference between IDMS method and measuring 3608 color patches without interpolation at dark room. The error of the predicted color volumes over varied illumination condition is less than 5%.

A 0.46 inch silicon-based transparent display was investigated. The see-through display had 1280×720×RGB pixels and could display 8 bits for each color channel. The measurements for hemi-transmittance and hemi-reflectance are at diffuse di:8°geometry. And the measurements for directional transmittance and directional reflectance are at 45°:0° geometry.

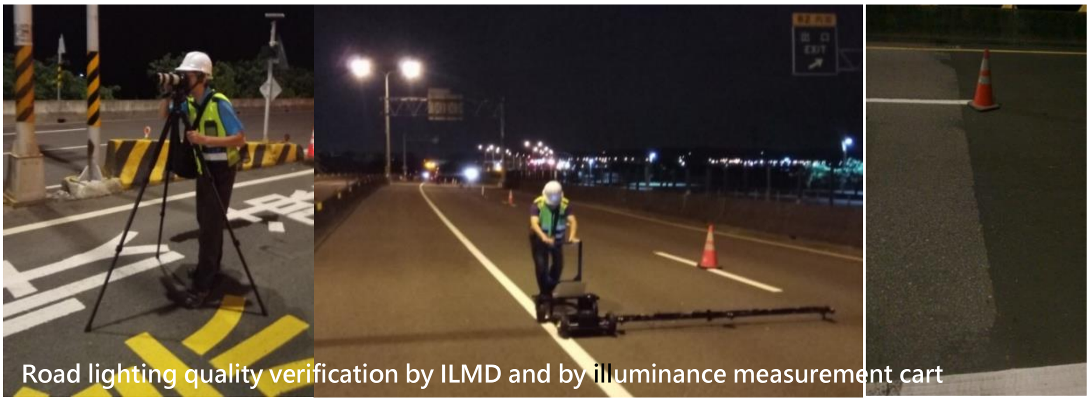
The experiments were performed through three stages. The first step was to calculate color volume. An automatic measuring system was used to measure the testing color patches one-by-one on the transparent display. The system automatically controlled the color patches measured by the spectroradiometer (0.1° measurement area), and integrated the measured spectrum to analyze color volume based on the IDMS method. The second stage, we developed a color volume prediction model for ambient illumination conditions. This work integrated the fundamental concepts of color volume calculation, measurement and optical geometry based on IEC and IDMS. The third step was to verify the color volume prediction model. The color volume prediction model was significant for evaluating the transparent display.



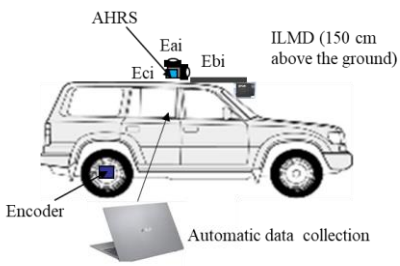


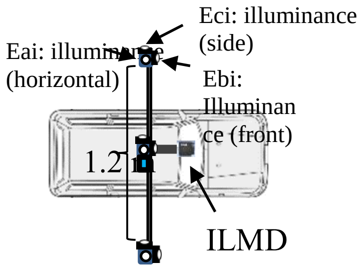
Evaluation of LED Road Lighting

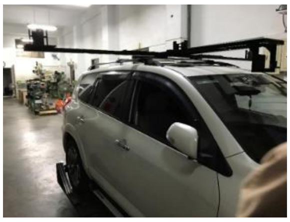
A 4 km high way was selected for LED lighting demonstration. 82 LED luminaires provided by 6 manufacturers were installed and studied. Comparison with 250 W HPS with LED lamp (< 150W) were made. The optical property was measured every 1000 hours for totally 6000 hours.


Road lighting quality verification by ILMD and by illuminance measurement cart

A Smart Lighting Measurement Car was built to obtain simultaneous data while driving. Information includes, Horizontal illuminance, Vertical illuminance, Imaging luminance (of the ground) and Luminance (of the lamps).



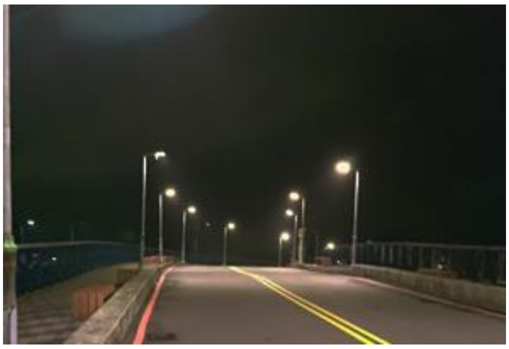




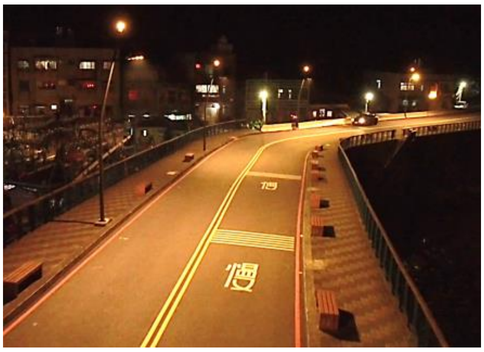
Smart Lighting Demo Site

In this project, a small fish port in Taiwan was converted to a smart lighting site. The street lighting was upgraded to smart lighting in the demonstration areas including

Ping-Lang bridge and the operation area of the fish port. A central management system was built to monitor the environmental conditions and apply dimming.
Light poles and light fixture were modeled to match the street lighting standards, based on the distribution of illuminance and luminance, threshold increment (TI) and dimming levels. The traffic flow sensor and weather sensors were also integrated to the central management system. The dimming control algorithms adjust light intensity according to traffic flow and weather condition. These parameters have different influences and are criterial for dimming control settings. Therefore, we apply the fuzzy algorithm to determine the optimized settings of street lighting.
Typically, the fisherman have to process the fish products and prepare equipment in the operation area. The minimum illuminance for the operation area is 100 lx. Also, the higher colour rendering index of lighting is necessary for fisherman to recognize the freshness of fish products. The lighting level of each docking area can be controlled individually to consume electricity more efficiently. If the fishing boat leaves, the lighting is dimming at default condition. In contrast, the fisherman working near the boat, the lighting is turn on at the operation condition.



Old street lighting on Ping-Lang bridge



Remodeled smart lighting

3. What work in PR has been/will be terminated in your laboratory, if any, in the past /future few years? Please provide the name of the institution if it has been/will be substituted by a DI or accredited laboratory.

   none

4. What are present, new or emerging needs of users of your services that are not being supported sufficiently by current CCPR activities or initiatives? In the light of this information please suggest desirable changes in the future working program of the CCPR.

   The application of developing micro-LEDs may get huge growth in the near future. The related parameter or quantity need to be verified, especially during the manufacture processes. However, because of micro-LEDs' tiny size, conventional measurement methods might not be suitable.

   For example, the optical power of a single micro-LED chip could be too low to measure, especially with grey scale condition.

The near field absorption due to the mount is expected to be huge; no solution to overcome such effect yet.
And it is not practical (too time consuming) to measure ~10^8 micro-LED chips in a 4" wafer one by one, while the characteristics of single chip is important to know.

5. What priorities do you suggest for new research and development programmes at NMIs in the area of Photometry and Radiometry?

   Total spectral radiant flux and radiant power for UV LED. Wavelength range is from 250 nm to 300 nm.

6. Are there any research projects where you might be looking for collaborators from other NMIs or are there studies that might be suitable for collaboration or coordination between NMIs?

   DUV/EUV metrology; few photon metrology; flexible integrated optics/photonics

7. Have you got any other information to place before the CCPR in advance of its next meeting?

   none

8. Bibliography of radiometry and photometry papers of your laboratory since the last CCPR (September 2016)?

[1] Shau-Wei Hsu, Tsung-Ying Chung and Jung-Mei Hsu, Characterizations of Modulation Transfer Function and Noise Power Spectrum of Tablet Display, the 24th congress of the international commission for optics, (2017).
[2] Shau-Wei HsuShao-Tang HungCheng-Hsien Chen, MEASUREMENTS OF REFLECTION PROPERTIES OF A WET LED-LIGHTED ROAD, CIE 2017 Midterm Meetings and Conference on Smarter Lighting for Better Life (2018).
[3] Chao-Hua WenShao-Tang HungWen-Chun Liu, Investigation of Glare Metrics for Reflected Glare on Displays, CIE 2018 (2018).
[4] Shau-Wei HsuCheng-Hsien ChenShao-Tang Hung, VISIBILITY OF ROAD MARKINGS ON A LED-LIGHTED FOGGY ROAD, CIE 2018 (2018).
[5] Cheng Hsien ChenShau-Wei HsuShao-Tang Hung, CONTRAST RATIO STUDIES OF A LED-FLASHED TRAFFIC SIGN AT A FOGGY ROAD, CIE 2018 (2018).
[6] Shao-Tang Hung, Chih-Hsuan Sun, Chao-Hua Wen, Bao-Jen Pong, Ambient Color Volume Measurements for Augmented Reality Displays, 2019 The Society for Information Display, vol. 50 p 534, (2019).
[7] Chao-Hua Wen, Shao-Tang Hung, Kai-Chieh Chang, Zong-Huei Tsai, Cheng-Hsien Chen, GLARE ASSESSMENT FOR LOW-REFLECTION DISPLAY DEVICES, Proceedings of the 29th Quadrennial Session of the CIE (2019)
[8] Shau-Wei HsuCheng-Hsien CgenShao-Tang HungTsung-Ying Chung, ROAD LIGHTING MEASUREMENTS BY AN EQUIPPED VEHICLE, Conference: Proceedings of the 29th Quadrennial Session of the CIE (2019)