Compare and contrast on varied Illuminance meters

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Abstract

Light is an important cue for visual field on human visual and psychological perception. A common device used for assess quantity of light in lighting study is an illuminance meter. The models of the device cost widely from thousand to hundred thousand Thai Baht. The meter can be different because of the model specification and accuracy. The accuracy of light measurement depends on three sets of factors: (1) accuracy of the instrument; (2) calibration of the instrument; and (3) errors in use. At a large university in north-eastern Thailand, there are various lighting instruments for study and research. Since the meters are various models and aged, they provide different measured values when reading at the same spot and time. Thus it is necessary to show the difference of the reading and suggest some variable to adjust. This study investigated the difference found from various meters.

Keywords: Illuminance meter, lux meter, light measurement

1. Introduction

A common device used for assess quantity of light in a building is an illuminance meter. The method of measuring with the meter is straight forward for assessing quantity of light in the building. At a large university in north-eastern Thailand, there are various lighting devices for learning and research in undergrad and graduate programs. A variety of models and brands were selected principally upon administrative plan annually initiated by the faculty committee. Currently, twelve light meters have been used by lighting researcher and students. Since the meters are various models and ages, they provide different light quantity values when reading at the same spot and time. Thus it is necessary to show the difference of the reading and suggest some variable to adjust. This study investigated the difference of the value read from various meters. Moreover, secondary aim of this study is to demonstrate an essential procedure in collecting light quantity to students involved in this experiment

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2. Research Methodology

The models and brands were selected for comparison comprising seven different models of light meters devices [1-3] as shown in Table 1 and Figure 1. Some of the models have more than one device and they were included for this study. The reference meter is Konica Minolta T-10A with a calibration certificate 2015/211 issued on December 4th, 2015 by Konica Minolta Sensing Singapore Pte Ltd. The accuracy range is within 2%. Other meters did not come with a calibration certificate. However, all Konica Minolta instruments were inspected with their original manufacturer inspection certificates. Table 1 also shows price ranges and device ages.

Table 1: Illuminance meters in this study

Manufacturer	Model number	Number of instruments	Measure range (lx)	Price (Thai Baht)	Age (Years)
Konica Minolta	T-10A	1	0 - 299,900	71,690	3
Konica Minolta	T-10A	1	0 - 299,900	42,800	3
Konica Minolta	T-10M	1	0 - 299,900	40,341	6
Konica Minolta	CL-500A	1	0 - 100,000	272,850	3
Extech	403125	1	0 - 200,000	8,724	8
Protros	LX-91	4	0 - 200,000	6,313	8
CEM	DT-1309	2	0 - 400,000	5,300	7
Robin	OM 210	1	0 - 20,000	2,900	7

First part of the investigation was carried in the laboratory to compare reading values from each meter with the reference values read from the standard meter. The illuminance levels in test started from 100 to 5,000 lx with 100 lx step from 100 to 1,000 lx, and with 500 lx step from 1,000 to 5,000 lx. A certified illuminance meter was used for setting illuminance on each reference illuminance. The experiments were carried out in a lighting laboratory as shown in Figure 2(a) located at the Faculty of Architecture, Khon Kaen University for the first part. The setting in the laboratory used two lamps over the desk to adjust the amount of light connecting with a dimmer. Each selected meter was placed next to the reference meter and adjusted the receptor head to the same level from the desk. Thus there were eleven pairs of light meter for each light level. The test was repeated again with different correlated colour temperature (CCT) of the lamp: 2,580 K and 3,777 K. The pair readings were then shown and compared across the devices again.

The second part was an attempt to compare the meters in the actual reading in the field survey. Moreover, reading error in use was included in the study firstly. Using the existing lighting conditions in the actual environment, students were asked to take the measurement for all the devices within five minutes for each illuminance level. Each student was assigned to one light meter and took the measurement at each light level as shown in Figure 2(b). Firstly, students were given the devices and demonstrated about the equipment setting. However they were not suggested about procedure errors in measurement. They were not aware about errors from measurement, for example, reading photocells would be affected by shade and reflectance of the person taking the measurement.

In the actual environment, measurements for each light level were made at various places. However, the level was set close to the setting in the laboratory but it was not identical. A set of illuminance levels at 100, 500, 1000, 2,000 and 3,000 lx were used for the first set. Afterward students were asked to take the measurements for the second set to repeat the illuminance reading levels as in the lighting laboratory in the first part of this work. However, in the second measurement set, students were informed about the errors in use of illuminance meters and been asked to carefully conduct the readings.

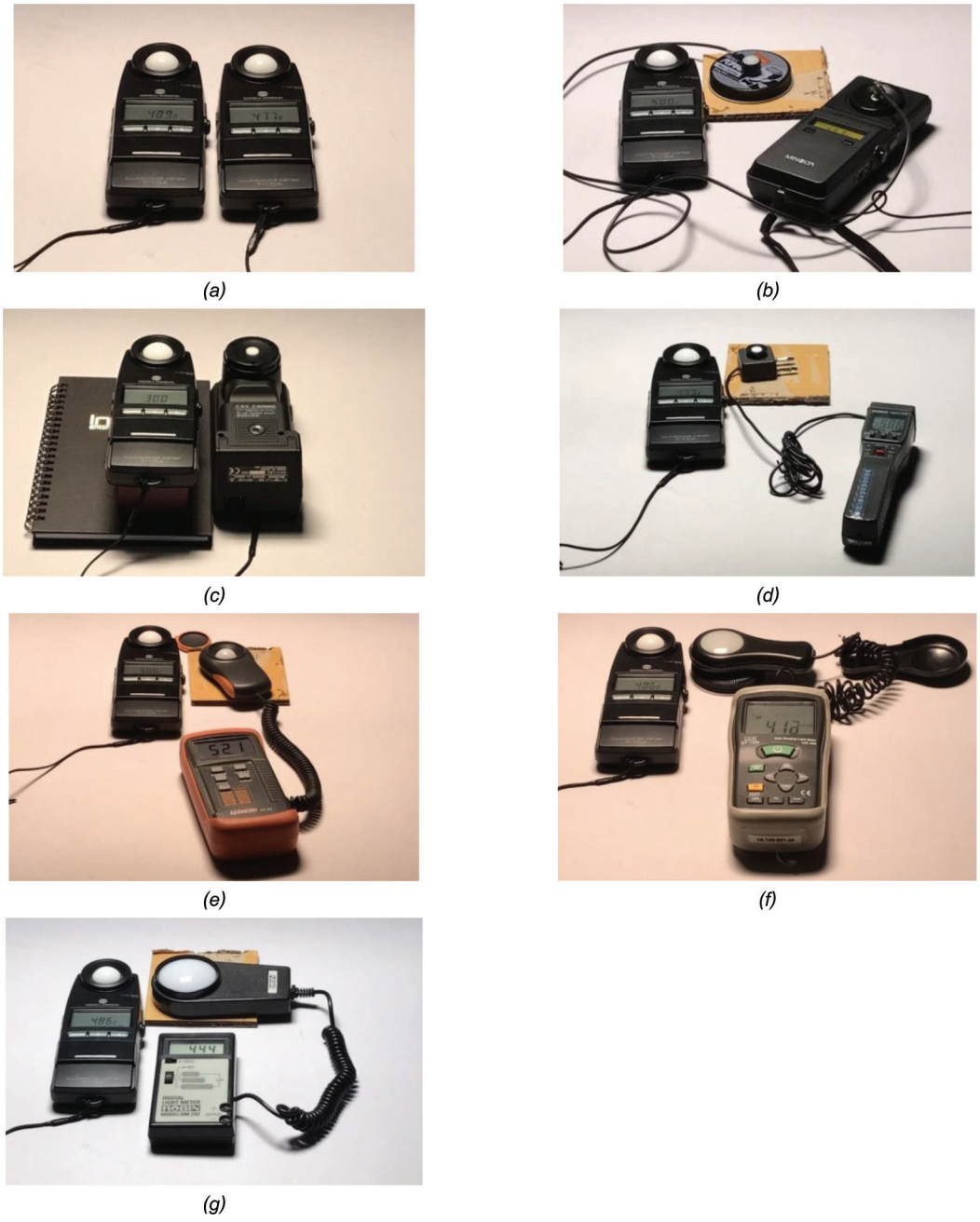

Figure 1: A reference illuminance meters (Konica Minolta T-10A) and a paired device for testing its accuracy: (a) Konica Minolta T-10A; (b) Konica Minolta T-10M; (c) Konica Minolta CL-500A; (d) Extech 403125; (e) Protros LX-91; (f)CEM DT-1309; and (g)Robin OM210.

The second part was to measure light levels in the actual environment to replicate that happening in real measurement in lighting study. Using the existing lighting conditions in the actual environment, students were asked to take the measurement for all the devices within five minutes for each illuminance level. Each student was assigned to one device and took the measurement at each light level as shown in Figure 2(b). Firstly, students were given the devices and demonstrated about the equipment setting. However they were not suggested about procedure errors in measurement. They did not know how a measured value should be measured, for example, reading photocells would be affected by shade and reflectance of the person taking the measurement. In the actual environment, measurements for each light level were made at various places. However, the level was set close to the setting in the laboratory but it was not identical. A set of illuminance levels at 100, 500, 1000, 2,000 and 3,000 lx were used for the first step. Afterward students were asked to take the measurements for the second set to repeat the illuminance reading values as in the lighting laboratory in the first part of this work. However for the second step, students were informed about the errors in use of illuminance meters.

(a) *(b)*

Figure 2: Experiment settings: (a) test setting in the lighting laboratory and (b) field measurement in actual environment

3. Research Results

The light meters have similar configurations and portable for use in lighting field survey and scale model test. The meters have two physically types: detachable receptor head and fixed receptor head. A receptor head size is varied from 10 to 40 mm. The devices are varied in measurement ranges from 0 lx to 299,900 lx. The broad measuring range of models has been divided into a step of smaller ranges in some models and automatically range switch. The most expensive device can measure some other factors in lighting for example correlated colour temperature and spectrum wavelengths of the source. However, for quantitative lighting study, it is enough for recording the illuminance values for evaluation.

Figures 3 and 4 illustrate the different of the measured values from different devices under warm and cool white light from the laboratory experiments. The results show wider value differences when reference illuminance above 1,000 lx. The inaccuracy difference is highest at the 5,000 lx test level. It is 1,400 lx different in a laboratory setting. Under the cooler light, the discrepancy is lessening than the results under the warm light as shown in Figure 4. The uncertainty in a reading [4] is a combination of the three sets of factors: intrinsic accuracy of the instruments; (2) the calibration of the instrument; and (3) errors in use. For the measurement in the laboratory, the third set of the factors was carefully controlled. So the discrepancy of the results could be from the first two sets.

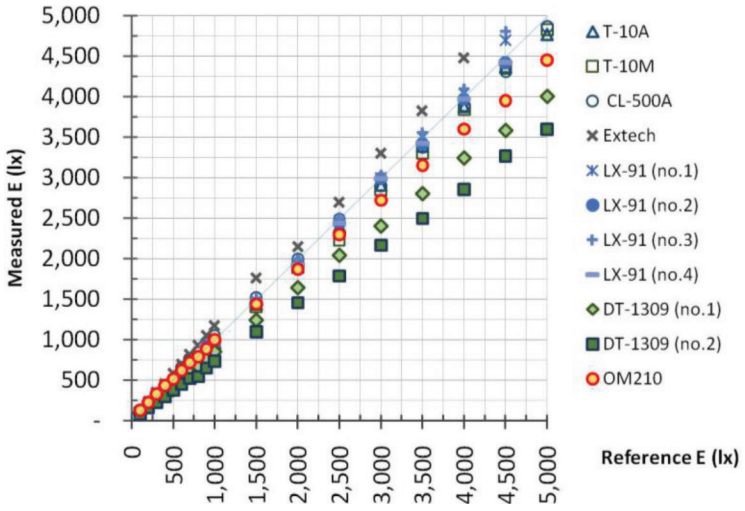

Figure 3: Measured illuminance under CCT at 2,580 K

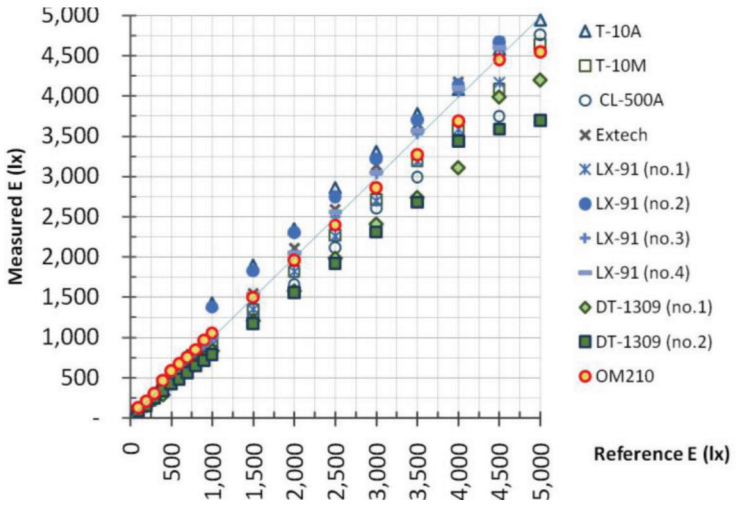

Figure 4: Measured illuminance under CCT at 3,777 K

Figures 5 and 6 show the results of the measurements in the actual environment. It is seen that the errors are lessen when students were carefully on taking the light measurements. However, at higher illuminance, the discrepancy is very large. Figure 7 shows all the results of the second step with a similarly pattern when taking measurement in the field work. However they are more diverse that might cause from human and environment during the measurements. Light falling on the receptor was partly blocked by the person taking the reading. Moreover, extra light might fall on the sensor variedly from the shirt with different colours. It should be noted that in the field measurement, the cost of the device is not related to the result accuracy.

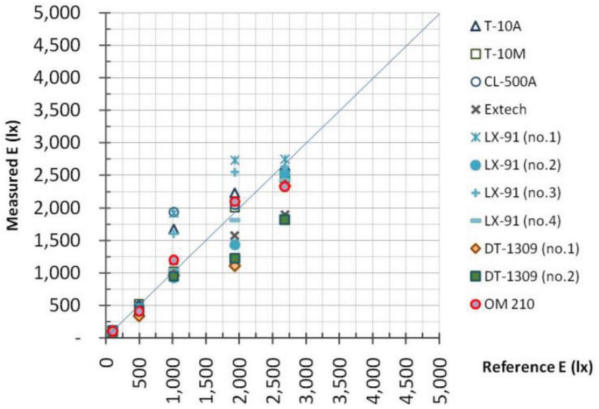

Figure 5: First measured illuminance in field study *with potential errors in use*

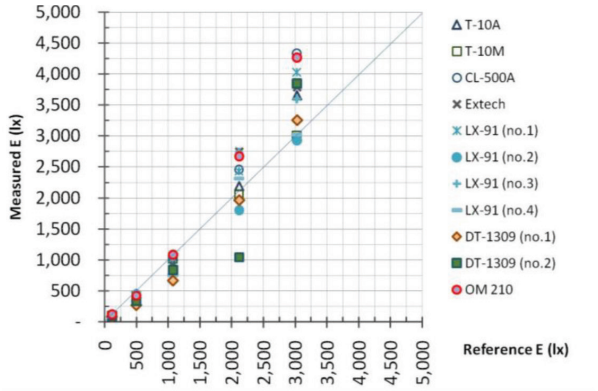

Figure 6: Second measured illuminance in field study *with careful readings*

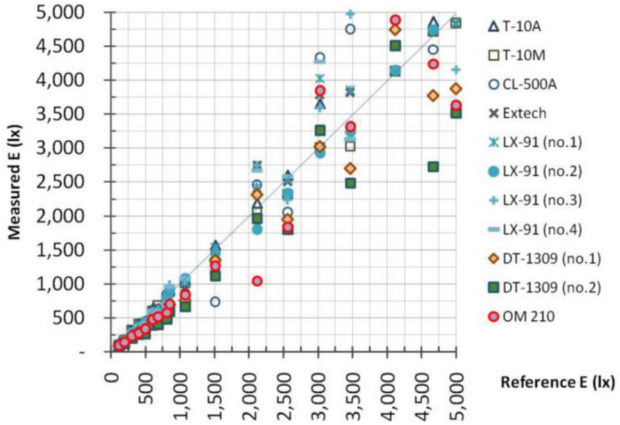

Figure 7: Measured illuminance in field study

4. Conclusion and Discussion

The price of the light meters in this study is not related to the results of the two parts. Cheaper meter can take the reading closer to the reference meter than the results from some expensive instruments for example, Robin OM210 and Konica Minolta CI-500A. Moreover, same model meters show similarity of the measurement, particularly Protros LX-91 meter. This meter also gives close results compared with expensive meters. Determination of illuminance in an interior space is a key stage in lighting studies and illuminance meter is an important tool as an initial assessing method. The measurement method can be applied to assess lighting qualitatively such as contrast and glare possibility. Thus, accuracy of the tool is important to judge lighting levels for interiors spaces. This study shows the contrast of values obtained by different models and different devices. It is shown that price of the meter is not the main factor for accuracy. A calibration of the tool is needed before taking a field survey involving measurement, especially when taking the measurement at the environment above 1,000 lx.

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6. References

[1] Konica Minota. (2018, 1 May). https://sensing.konicaminolta.us/products/.

[2] Ponpe Instruments. (2018). Light Meter. Available: https://www.ponpe.com/เครื่องวัดแสง

[3] Extech. (2018). Extech 403125 Light Probe Meter. Available: http://www.testequipmentdepot.com/extech/lightmeters/403125.htm

[4] P. R. Tregenza and D. Loe, The Design of Lighting, 2nd Edition ed. Oxon: Routledge, 2014.