

Evaluation of a space brightness based on the border luminance of color appearance mode

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It is very important for architectural design to assess a space brightness quantitatively. While in the Japanese Industrial Standards, JIS, appropriate illumination levels for typical situations are recommended in terms of 'horizontal illuminance', it's reported that a subjective brightness does not always match the horizontal illuminance. Therefore a new evaluation method of space brightness is required for lighting design instead of horizontal illuminance.

The objectives of this study are to establish a new measurement method to evaluate a space brightness based on a recognition of illumination intensity and to examine determining factors for the recognition. To evaluate a recognition of illumination intensity, a phenomenon of color appearance mode change was employed. The color appearance modes are divided into three categories according to its appearance; object color mode, unnatural object color mode, and light source color mode. As an object's luminance exceeds the recognition of illumination intensity, the appearance of its surface should change from object color mode to unnatural object color mode. The term of the 'border luminance' was defined as the transition luminance between object color mode and unnatural object color mode. In the study, determinants of border luminance and the correspondence between border luminance and space brightness were examined through several psychophysical experiments.

From the results, three important findings were obtained. Firstly, the logarithm of border luminance agrees with perception of space brightness. Therefore the border luminance enables us to assess the space brightness immeasurable by the horizontal illuminance. Secondly, the border luminance is determined according to the luminance distribution of object-color-mode object. If the luminance distribution of entire scene changes in the same way, the border luminance follows the luminance distribution. Thirdly, the additivity law holds for the border luminance. This rule is very useful for practical lighting design. For example, the border luminance of a room illuminated by two or more lights can be estimated from the border luminances under each single light. To conclude, measurement of the border luminance is recommended as the best method to evaluate a space brightness.