別紙５（論文博士）

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Abstract
論文内容の要旨（博士）

Title of Thesis 博士学位論文名	A Study of Adaptation Luminance for Mesopic Photometry (薄明視測光のための順応輝度の研究)

(Approx. 800 words)
(要旨　1,200 字程度)

To measure light and lighting, current practice always uses the spectral luminous efficiency function, $V(\lambda)$, which represents the visual perception by light at equal power for each wavelength. However, the $V(\lambda)$ was developed only based on the sensitivity of the central field of view that adapts to higher light levels. It is known that the peripheral field of view shifts its spectral sensitivity to shorter wavelengths in darker light levels, called the mesopic range. Current lighting practice is not optimized for the light levels.

The recommended system for mesopic photometry published by the Commission Internationale de l'Éclairage (CIE) provides the spectral luminous efficiency function, $V_{mes;m}(\lambda)$, the shape of which changes depending on the adaptation luminance in the mesopic range. The system could open the door to more energy-efficient lighting. According to an estimate in this study, 10% to 40% energy saving could be possible. However, lack of methods to determine the adaptation luminance for particular lit scenes prevents the system being implemented.

This study aims to propose an adaptation field definition, where the average luminance sufficiently correlates to the adaptation luminance, for the mesopic photometry system implementation. The first question is whether the peripheral adaptation depends only on the local luminance or on the global average luminance in the field of view. A series of vision experiment revealed that the local luminance is the dominant factor even for the mesopic and peripheral adaptation. However, the surrounding luminance also slightly affects the adaptation and its impact may be significant when high-luminance sources exist in lit scenes.

Further vision experiments were conducted to characterize the surrounding luminance effect. According to the experiments, it can be considered as the veiling luminance caused by stray light in eyes. However, existing veiling luminance models do not agree with the experimental results. This study proposes a new model that is suitable to predict the peripheral veiling luminance in the mesopic range.

This study also proposes a method to simulate the adaptation luminance from

the luminance distribution, by taking both the surrounding luminance effect and the eye movements into account. The simulation results show good agreement with the empirical data acquired in this study. By applying the simulation method to real road luminance distributions, adaptation field candidates were tested. According to the analysis, the adaptation field can be defined as the design area of the lighting (i.e. road surface) for typical road lighting. Limitations of this proposal are also discussed.

For rigorous field photometric measurements with the mesopic photometry system, special luminance meters that are not widely available at present are needed. To avoid use of such instruments, this study proposes simplified measurement methods. Since road surface spectral reflectance variations cause some errors with the proposed methods, the error was analyzed with real road surface spectral reflectance data. The analysis shows that a proposed method with a correction can measure the mesopic quantities accurately enough only with conventional instruments and source spectral power distribution data.

The proposed adaptation field definition and the field measurement method enable the mesopic photometry implementation to typical road lighting. These allow more energy-efficient lighting design for the applications. For more general adaptation field definitions, further field luminance distribution examples are needed. However, once such data is available, the methodology established in this study could give comprehensive solutions.