

ABSTRACT

Validating RADIANCE Program as Design and Evaluation Tools for the Luminous Environment

Yang, Hye-Ihn

Directed by Prof. Song, Kyoo Dong

Department of Architectural Engineering

Graduate School, Hanyang University

The prediction of illuminances from daylight and artificial lighting has long been an important issue in the field of architecture. Architects traditionally have used scale models or various computer programs as tools for predicting the available illuminance in a building and for visualizing the overall lighting quality of the environment. The program requires accurate modeling of the geometric and photometric properties of a designed environments.

RADIANCE is a program to aid lighting designers and architects by predicting the lighting levels and appearance of a space prior to construction of a building. The modeling of geometric property is usually conducted by commercially available CAD softwares. However, RADIANCE itself provides such a tool, too. The modeling of photometric properties includes material color, texture and/or transmittance, daylight availability, and luminous intensity distribution of artificial light sources. The simulation itself uses backward ray-tracing technique to compute radiance values, which are typically arranged to form a photographic quality image.

The purpose of this study is to validate RADIANCE program as lighting design and evaluation tools at the early stages of architectural design process. To achieve the purpose, an actual architectural space under daylighting condition and artificial lighting condition were photographed, measured and simulated.

This study consists of a total of six chapters, and each chapter can be summarized as follows:

In Chapter 1, the background, the objective, the scope and the method of the study are described.

In Chapter 2, theories related to the lighting design and evaluation methods are reviewed. The theories include Monte Carlo method and ray-tracing technique, radiosity and other lighting simulation program.

In Chapter 3, Introduction, algorithms, flowchart, and modules of RADIANCE Program are described.

In Chapter 4, The accuracy of the computer model is validated through measurements inside a physical scale model and a real room for daylighting.

In Chapter 5, The accuracy of the computer model is validated through measurements to interior of a real room and exterior of a actual construction for artificial lighting.

In Chapter 6, the conclusions of the study are stated.

The results can be summarized as follows :

- [1] For daylighting condition, the RADIANCE program showed relative error of less than 5 percent for both illuminance and luminance values.
- [2] For artificial lighting condition the relative error of RADIANCE showed less than 5 percent for illuminance and less than 7 percent for luminance values.
- [3] For outdoor lighting about 5 percent of relative error was observed.
- [4] For all cases, the RADIANCE program produced photo-realistic images which can be need to impressive design evaluation tools during the early stages of building design process.