Faculty of Architecture and the Built Environment
MsC Building Technology

visual comfort prediction useing machine learning framework

P4 Reflection

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Introduction

This is a reflection on the graduation thesis with the topic: Machine learning-based assessment tool for predicting daylight and visual comfort. Multi-disciplinary optimization has demonstrated its use in assisting with design decision-making. In the design informatics discipline within the studio, it was possible to explore AI in multi-objective and multidisciplinary architectural design optimization.

Research Method and Approach

he result of the project is a machine learning model to predict visual comfort and annual daylight metrics in the early design stages. This is achieved using a research methodology consisting of five phases: The research framework phase, literature review phase, data gathering phase, data processing phase, training the machine learning model phase, and result phase. All the stages play a role in achieving the result. A background study is the first step in the research framework. The problem statement identifies the main issue that needs to be addressed, followed by the research objective to help solve the problem. A research question is formulated with various sub-questions based on this framework to define the research in steps. Literature Review provides all necessary information about the topic required to proceed further in the research. The categories into which these topics were divided are

- The state of the art of machine learning models for personal comfort
- Understanding the fundamentals of light and visual comfort
- Understanding the principles of data gathering for daylight metrics.

In the first stage of this research, the aim was to predict the visual preference of occupants based on different parameters, which included occupants subjective criteria, Occupants' feedback about their visual/privacy comfort (through questionnaires) corresponding to their location. After gathering data from the questionnaire, it turns out that the daylight and shading design criteria were the most important for the occupants. The location played a role mainly in the case that the location had any direct sunlight or view outside. As the research goal was visual comfort prediction using machine learning methods, and the dataset plays the most critical role in the machine learning models, collecting thousands of data using only questionnaires was not possible for this thesis. As a result, based on the conclusions from 50 responses gathered in two weeks in the Tu Delft library, the main question was

changed to objective criteria instead of subjective criteria to predict visual comfort.

A shoebox model was first constructed, and then two conventional solar shading models, each with their own set of variables, were applied to the area. Three main daylight metrics were chosen, such as sDA(spatial daylight autonomy), ASE(Annual sunlight exposure), and sDG(spatial disturbing glare) was simulated by ClimateStudio, which is an advanced daylighting simulation tool. The data set, which included multiple shading designs for office spaces and a database with 1000 possibilities, was used as training data for a supervised learning method. The data have been pre-proceed, and the machine learning algorithm based on the data type has been chosen for daylight features. The machine learning model was trained with simulation data to predict occupants' visual comfort with annual daylight metrics. In the end, the model's accuracy was tested to predict the visual preference of a group of occupants.

Project Relevancy

Daylighting is a major theoretical inquiry since Le Corbusier emphasized the topic's relevance as one of three critical requirements throughout the design of projects. The most sophisticated study on thermal comfort and microclimate demonstrates its effect on occupants' comfort conditions following sustainable architectural design principles. The most recent results in the physiology study a favorable long-term influence of daylight on individual well-being as it regulates the circadian rhythm. The significance of implementing optimal daylighting practices in buildings has increased interest in computational daylight simulations, which have become the most accessible method for evaluating interior lighting conditions. However, during the master thesis, I discovered that this procedure is time-consuming and costly. The study's primary objective is to investigate AI potentials to lower the time required for computational calculations and 3D model preparation. This thesis addresses the possibility of substituting a simulation engine with an algorithm for machine learning.As the literature review is built upon studies from other disciplines, such as computer science, its interpretation through Building Technology relates to contemporary discussions of AI and architecture. This means the project uses knowledge formulated from external disciplines to an alternative design strategy. Therefore the project is relevant in academic and general discussions.

Difficulty in the process and final phase

A lot of background knowledge in computer science was required for this topic, so the research and learning phase was quite long. Another challenge was the data gathering. Machine learning models require a massive amount of data to be most optimized. Gathering that amount of data with an average laptop is challenging, so a smaller dataset was gathered to train the models. In the final part of the graduation period, the spatial disturbing glare(sDG) needs to be investigated more to understand its corelation with other inputs used in the thesis.