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An automated (day)light admission system based on a generic office model: from the simulation workflow to preliminary results

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Automated daylight admission systems can adjust to varying lighting conditions and hence decrease the use of electrical lighting while improving user comfort. Several studies have shown in fact that manual control of shading systems often result in inadequate lighting conditions, as users tend to unregularly change the blind position throughout the day.

Among the reasons limiting the deployment of these systems, the unreliability in lighting level predictions and the difficulties in design and installation, linked notably to photosensors choice and calibration, are often cited in the literature. These systems typically require illuminance (and possibly luminance) sensors to be installed either indoors or outdoors. When only outdoors, simulation-based methods require a detailed geometric and photometric model of the space. Either way, both strategies often result in an excessive burden and cost for their commissioning in most buildings.

We present here a prototype of a data-driven (day)light admission system requiring only few geometric user inputs and weather data, hence easing its deployment. The system evaluates indoor illuminances in an office room equipped with external horizontal blinds, including sun and sky contributions, as well as the one from the luminaires.

The procedurally-generated geometrical 3D model of the scene includes a simple shoe-box model of the room and a simplified skyline, generated by retrieving terrain height data from an open API.

The daylight model is trained on RADIANCE-based simulations. Over 15'000 solar radiation measurements at a 15-minute resolution are used to model sky conditions for 3 representative orientations of the case-study building. We use the Perez All-weather sky model with diffuse and direct radiation monitored from a weather station installed on the building rooftop. Simulations of illuminance conditions for two virtual sensor points, corresponding to the best and worst desk locations within the room, are run using BSDF data for the fenestration system and 6 blind positions. The results of the simulations are used to train and test a Random Forest model, using a standard 70-30% split between the two sets.

The electric light model, based on previous work, predicts the illuminance contribution of electric lighting on the work-plane depending on the dimming status (0-100%) of the luminaires.

Both model are deployed on a RaspberryPi retrieving live data from the weather station via MQTT, and controlling the luminaires and blinds via KNX. Depending on the location of their desk, each user is assigned to the closest daylight and electric light virtual sensor. A user interface programmed in Node-RED allows the user to set their preferred illuminance range, while the automated control (which can be overridden) maximizes the use of daylight to stay within the range.

While the predictions are still to be compared with measurements, preliminary work shows an accuracy of 76% in the test set compared to the physically-simulated results, where predictions are scored differently depending whether they are within useful illuminance range or not. Future work includes training the model on a larger variety of room and window sizes to generalize it for all offices within the case-study building.

Keyword 1

lighting control system

Keyword 2

predictive model

Keyword 3

surrogate model

Keyword 4

Keyword 5

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