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DETERMINING PERSONAL LIGHT EXPOSURE AND OCCUPANT’S VIEWING DIRECTION BY USING THE NON-OBTRUSIVE LOCATION-BOUND-ESTIMATIONS (LBE) METHOD

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Abstract

1. Motivation, specific objective

Every individual is different suggesting that every individual responds differently to light. This is the main reason why measuring at the individual level is essential when investigating light effects individually. Personal lighting conditions can be determined using person-bound measurements (e.g., activity watches, light loggers) or via location-bound measurements. A novel practical method (Location-Bound Estimations, i.e. LBE) was developed to estimate personal lighting conditions based on reference measurements. However, these estimations are just based on the reference locations and on the desk location of the office worker inside the office. The actual position of the office worker and its viewing direction is still not included in the LBE method. The aim of the current study is to investigate the differences in light exposure based on different viewing directions (i.e., towards the window, parallel to the window) and the gain in accuracy of the LBE when incorporating the occupant’s viewing direction into this method.

2. Methods

A workplace within a larger office landscape was simulated under laboratory conditions. A virtual window emitted light in five different correlated colour temperatures (CCT, i.e. 6000 K, 6500 K, 7500 K, 8500 K, and 9000 K) and was placed closer (i.e., 1.0 m) and further away (i.e., 2.4 m) from the simulated occupant’s viewing point. In addition, a dimmable TL office light (providing a horizontal illuminance of 300 or 500 lx at the viewing point) was placed at different locations 1.45 m above the viewing point (i.e., 0 m, +1.5 m, -1.5 m where a negative distance means a location in between the viewing point and the virtual window). These four different aspects (i.e., virtual window – CCT and distance, tubular fluorescent light – illuminance and position) resulted into 65 different office configurations for which the influence of viewing direction on light exposure was investigated. At the position of the simulated viewing point, horizontal illuminance, vertical illuminance, CCT, and general colour rendering index (CRI) were measured. In addition, light spectrum was measured in 16 different office configurations.

The spectral data was analysed using the irradiance toolbox. The five different α-opic values (i.e., cyanopic, melanopic, rohodopic, chloropic, erythropic) were obtained. All absolute measured data and the α-opic values were transformed into relative data meaning that the highest effective radiant exposure (for a specific office configuration) counts as 100% (for example at the viewing direction of 0°) and the effective radiant exposures at the other viewing directions were expressed as percentages of this maximum 100% value. Differences between the five α-opic values and differences between the 65 office configurations were investigated, all regarding the different viewing directions.

In addition to that, light measurements were performed in an office room including daylight. These measurements were to validate the findings from the simulated office experiment. Similar to the other experiments, the measurements were carried out for different viewing directions. Four fibers were used to measure light exposure at four viewing directions simultaneously. The viewing directions investigated were straight to the window, parallel to the window (both sides) and facing straight away from the window.

Finally, the office room including daylight was simulated to extend the research. The aim for the simulation study was to investigate the differences in light exposures for all different viewing directions and all positions inside the office environment. These simulation results will ensure a better understanding of the measurements in the real office environment. The secondary aim was to
potentially identify the optimal office configuration regarding light exposure and its influence on human health.

Combining the results of the laboratory study, field study and the simulation study will result in certain weighing factors per different viewing direction. These factors can be added to the original non-obtrusive LBE method in order to increase its accuracy.

3. Results

The data analysis of this experiment is still in progress. It is expected that weighing factors can be determined for each viewing direction and that these factors can be included in the LBE method in order to increase its accuracy.

The results will be presented at the CIE workshop in August 2018 in Copenhagen.