RGB sensor based system for reduced energy consumption and safe illumination at constant chromatic yields

Luc Pockelé, Sandro De Grandi, Francesca Becherini, Arianna Vivarelli, Maria Di Tuccio e Adriana Bernardi

In the European project CETIEB an RGB sensor was developed to measure the Correlated Color Temperature (CCT) of white light. RGB sensors are silicon bases photo-sensors measuring radiation from 300 to 1100 nm matching the photonic response of the human eye. The unwanted radiation (IR and UV) needs to be filtered. RGB filters based on the colour matching functions defined by the CIE are reproducing the RGB values as if they were observed by the human eye. The selected packaged sensor TAOS TCS 3414 CS has a matrix of 16 sensors, equally distributed and grouped in 4 channels under different filter types that need to be calibrated as they do not match completely the CIE colour matching functions.
The sensor is composed of the sensor element itself, a filter eliminating the IR part of the visible light, a diffuser, the electronic interface between the sensor and the monitoring system holding the calibration and conversion functions. Such a device is much less expensive than spectrophotometers (few hundred versus thousands of €). It is integrated in a control system driving an assembly of white, red, green and blue LED's or Fluorescent light sources and capable of supplying white light at a given CCT and intensity following a control algorithm developed as part of the system. The logic is to mimic the CCT evolution of daylight during the day, known to influence the biological clock of human beings and increase their productivity.

Such a set up could also be used to maintain the illumination spectrum constant in a museum independently from external factors like the varying daylight throughout the day and seasons, the ageing of the light sources, the changes in reflectance of walls, floors, ceilings. The RGB sensor readings in a given point under a given illumination system can be correlated to the spectrum of this illumination system. This spectrum can be changed by adapting the luminance of the light sources, each having a different light spectrum. The chromatic yield of a light source is the measure of how well this light source is capable of rendering the colors of for instance a work of art, against a certain predefined standard of daylight. This yield is function of the spectrum that the light source is emitting. Indirectly, the RGB values of an illumination system, after calibration, could provide a measure of the chromatic yield and through a purpose built control algorithm keep this yield constant by adjusting the light sources of the illumination system.

Net, such a low cost light sensing and illumination control system would keep the color of the works of art observed by the visitors more constant independently from varying daylight or other factors influencing the light spectrum. In addition, by keeping the illumination level constant at adequate levels, the works of art are conserved better and energy is saved by dimming the light sources when illumination levels are sufficient.