As digital cameras and software become mainstream, so does the consideration of HDR imaging in lighting practice, pointing away from using workplane illuminance as a sole determining metric for design.

Until a few years ago, measuring luminance distributions was prohibitively expensive for most applications, requiring sophisticated equipment and effort. Since then, HDR digital photography has emerged as an inexpensive and easy-to-use technique for producing luminance maps that are accurate enough for many lighting applications. Figure 2 shows a luminance map of a room illuminated by two tubular daylighting devices. Luminance mapping allows, for example, the quantitative characterization of glare from these devices, something that would be impossible to do using illuminance measurements.

Several systems exist today to produce luminance maps using HDR photography. Photolux [Dumortier 2005] is a commercially available system that uses the Nikon Coolpix 5400 camera and a fisheye lens (calibration coefficients can be obtained for other lenses for a fee). The software runs on the Windows operating system. Photosphere [Ward 2002] runs on MacOS and is a free system with which any camera and lens can be used, although it requires some.
equipment calibration procedures. It supports many standard HDR image formats, as well as performing some image enhancement. HDR images also can be generated online using WebHDR.¹

Given the dynamic nature of daylight in daylighting applications, however, it becomes important to acquire luminance data over time. This can be done with a high-end, single-lens-reflex digital camera and a computer program that controls the camera and stores the data [Lee 2007]. For time-lapse luminance mapping to be widely accessible and gain wider use, simpler and less expensive equipment will be required. In the course of the authors’ research at the California Lighting Technology Center, a particularly simple, versatile and inexpensive solution has been identified that requires a point-and-shoot digital camera, free software and, in most cases, a tripod.

**SIMPLE SYSTEM**

The system presented here includes:

- Canon point-and-shoot digital camera (Ixus or PowerShot series)
- Memory card and card reader
- Tripod (for most uses)
- Canon Hack Development Kit software and script for automated time-lapse photography
- Photosphere software

Canon Hack Development Kit (CHDK)² is free software that allows many models of Canon point-and-shoot digital cameras to perform

![Figure 1: Fisheye images of side-lighted office for occupant facing away from window (left) and occupant facing the window (right).](image1)

![Figure 2: Luminance map obtained by high-dynamic-range photography.](image2)

![Figure 3: Time-lapse luminance mapping workflow.](image3)
HDR imaging requires the sequential acquisition of images of varying exposures. Time-lapse HDR imaging involves performing that procedure at regular intervals. A simple script was developed for that purpose and can be viewed at http://citc.ucdavis.edu/images_downloads/ubasic-script.pdf. It was tested using CHDK and a Canon PowerShot S90.

The image acquisition portion of the system is depicted in Figure 4 at the California Lighting Technology Center’s Daylighting Lab. The configuration shown includes a luminance meter used to confirm the accuracy of the results—this would not normally be required in a field application.

FIELD TEST

A test of this system was conducted by monitoring the luminance of an office window and its adjacent areas from 9:41 a.m. to 2:23 p.m. September 16, 2010. The images taken by the camera at the end of this period were processed using Photosphere into a series of time-lapse luminance maps, four of which are shown in Figure 5.

The capability for generating luminance maps using HDR software, such as Photolux, Photosphere or WebHDR, has been available for a few years already, and the necessary equipment, software and information are becoming more readily available. As the use of luminance maps through HDR imaging increases, lighting design is entering a new era of significant improvement through designing and evaluating luminous environments based on what the eye sees rather than how much light arrives at surfaces.
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REFERENCES


