

Method and hardware for single-shot simultaneous AE and HDR imaging

CSIC and the University of Seville have developed a sensing method for simultaneous realization of auto-exposure (AE) and high dynamic range (HDR) during image capture. Hardware implementation based on pixel array circuitry that automatically adjusts its response to the ambient illumination and fits the radiance map of the scene into the available signal range. Linear sensor response for low levels of light intensity and non-linear sensing response for high levels of light intensity – “low” and “high” relative to the ambient illumination. No extra time apart from the photo-integration interval needed to generate a HDR image. Arbitrary radiance maps can be accommodated into the available signal range. Asynchronous operation of the proposed circuitry once the pixels are reset, requiring no external control.

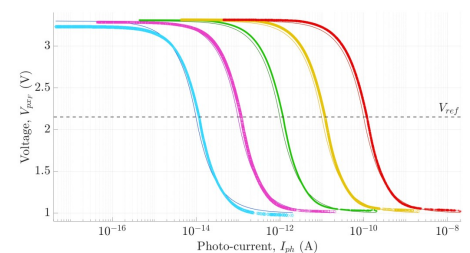
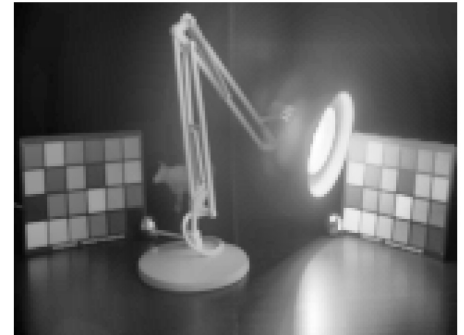
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Asynchronous pixel operation for automatic light adaptation to extreme illumination conditions

Image sensors are expected to adapt to the ambient illumination and properly encode the wide dynamic range of real-world scenes, both of which (ambient illumination and dynamic range) are unknown in advance.

The standard adaptation approach in commercial image sensors implies: I) Iteratively searching for a suitable exposure setting according to prescribed aspects of the scene (for example, the average illumination) using AE techniques, which may cause flickering in scenes undergoing abrupt lighting changes; and II) capturing several images with different exposure times to compose a HDR image using the well-known technique of exposure bracketing, which may generate motion artifacts. The complete process prolongs the image formation, which may lead to missing critical information and delays decision making.

The presented method concurrently merges AE and HDR. AE is accomplished on-the-fly during the image capture with no external control. HDR is achieved from a single capture, in contrast to exposure bracketing. The resulting AE HDR image is immediately ready after the photo-integration interval for analog-to-digital conversion and further processing.



High-dynamic-range scene (top); response of the proposed circuitry for different ambient illuminations of the above scene (bottom).

Main innovations and advantages

- First imaging technique that integrates AE and HDR asynchronously in a single shot keeping a linear pixel response.
- Simple and rapid image formation process, requiring neither external control nor assumptions about the illumination conditions of the scene.
- Saving of memory and computational system resources: no composition of multiple images required.
- Suitable for application scenarios demanding prompt decision making: navigation of robots and drones, security, surveillance...

Patent Status

Spanish Patent Application

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