# Mathematically correcting over- and underexposure in photographs

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Almost anyone with a camera or smartphone is sure to have noticed that taking pictures in bright conditions, such as a sunny day, can cause a loss of highlight details (or overexposure) in bright regions and a loss of shadow details (or underexposure) in dark regions. A paper published last November in the SIAM Journal on Imaging Science attempts to overcome these photography woes.

In digital photography, "exposure" controls how much light reaches the image sensor and the lightness of the photograph is determined by the amount of light shown. There is a physical limit on the lightness contrast, or separation between the darkest and brightest areas of an image that a camera can capture (called the dynamic range). An outdoor scene with bright or harsh lighting conditions has a much higher dynamic range than the capacity of a regular image sensor—this results in loss of highlight and shadow details.

In their paper aptly titled "Recovering Over-/Underexposed Regions in Photographs," authors Likun Hou, Hui Ji, and Zuowei Shen present a new wavelet frame-based approach for correcting pixels that are affected by over- and underexposure in photographs. Generic color image restoration techniques like image inpainting and contrast enhancement are not optimized to correct over- and underexposure in digital photography. Hence, the authors use color image restoration methods specifically designed for overexposure correction, which simultaneously correct over- and underexposed regions.

The problem of over-/underexposure is broken down and resolved as three sub-problems: the first is an inpainting problem which recovers the lightness value of over-/underexposed pixels, which are clipped to fit the dynamic range. The second problem deals with adjusting the lightness of the whole image to fit the range while revealing more image details of the darker regions. Third, missing chromatic details of overexposed pixels are recovered from information provided by neighboring well-exposed pixels.

**More information:** Recovering Over-/Underexposed Regions in Photographs, *SIAM Journal on Imaging Sciences*, 6(4), 2213-2235. epubs.siam.org/doi/abs/10.1137/120888302

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