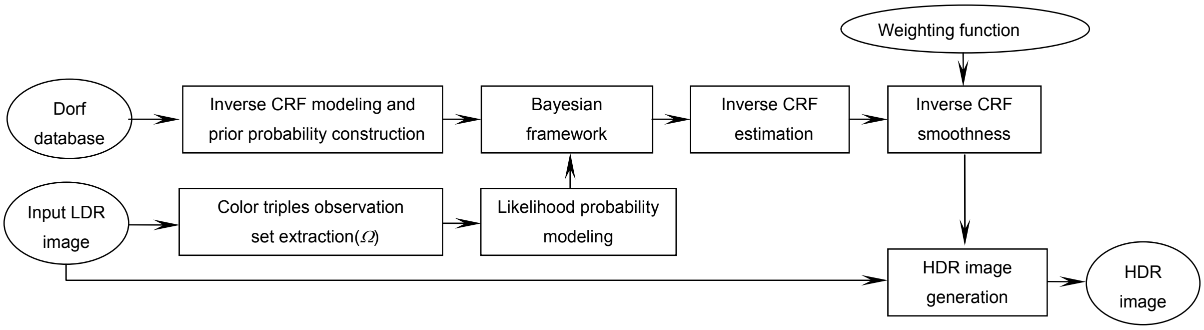
DOI: 10.3969/j.issn.1003-501X.2017.06.002

Generating HDR radiance maps from single LDR image

Xiaofen Li and Yongqing Huo*

School of Communications and Information Engineering, University of Electronic Science and Technology of China, Chengdu 611731, China



The flowchart of the proposed method.

Abstract: We propose a method for generating high dynamic range (HDR) radiance maps from a single low dynamic range (LDR) image and its camera response function (CRF). Most single-image based HDR image generation methods expand dynamic range only from bright areas which reduces details visible in shaded areas and induces artifacts at the edge of bright areas. This inspires us to exploit an approach expanding dynamic range both from highlight region and shaded region. The proposed method achieves this goal by performing inverse CRF on image intensity to recover the image irradiance which is taken as HDR image. The method first constructs inverse CRF model and computes its optimal solution, and then selects a weighting function and multiplies it by the optimal solution to make the inverse CRF smooth near the maximum and minimum pixel values, and finally conducts the smooth inverse CRF on the input LDR image to produce HDR image.

The proposed algorithm generates HDR image from single LDR image depending on inverse CRF reconstruction. The main steps include: inverse CRF estimation, inverse CRF smoothness, and HDR image generation. For inverse CRF estimation, the approach first models and then estimates inverse CRF based on the database established by Grossberg. The inverse CRF is reconstructed using the edge pixels in the LDR image based on the Grossberg's DoRF database and EMoR database, and the prior probability is empirically modeled as a Gaussian mixture model. Then, a Bayesian framework is formed by combining the likelihood function with the prior model. Finally, the optimal inverse CRF is obtained by maximizing the posteriori probability (MAP). For inverse CRF smoothness, because the inverse CRF function typically has a steep slope near the minimal and maximal pixels, it is less smooth and non-monotonic near these extremes. To solve this problem, we introduce a weighting function to make the function more smooth and reduce the effect of the pixels near the minimal and maximal in HDR image construction. The considerable choices of weighting function are rectangular function, triangular function and Gaussian function. For HDR image generation, we can easily conduct the inverse CRF on the input LDR image to generate HDR image.

Unlike most existing methods, the proposed method expands image from both high and low luminance regions. Thus, the algorithm can avoid the artifacts and detail loss in dark area which results from extending image only from bright region. Extensive experimental results show that the approach induces less contrast distortion and produces high visual quality HDR image. The significance and novelty of the method include the smoothness function used in the estimation of inverse CRF and the utilization of the inverse CRF in HDR image generation. These novelties realize expanding image both from bright and dark regions while guarantee the quality of generated HDR image.

Keywords: high dynamic range (HDR) image; low dynamic range (LDR) image; camera response function (CRF); image quality metric

Citation: Li Xiaofen, Huo Yongqing. Generating HDR radiance maps from single LDR image[J]. *Opto-Electronic Engineering*, 2017, **44**(6): 577–586.

See page 577 for full paper.