

Cubic-Spline Interpolation and Color Difference Methods for Color Filter Array Demosaicking

Matthew Golub and Koji Gardiner
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Introduction

Most modern-day CMOS and CCD digital camera sensors record color images by applying a color filter array (CFA) to the sensor such that each sensor pixel can record the intensity of either red, green or blue light. This filtering is most often done using the Bayer pattern filter, shown in Figure 1. While such filtering simplifies sensor design, it complicates full-color image reconstruction since each pixel is missing two color values. Demosaicking is the process of interpolating these missing values.

Several simple methods for demosaicking include linear, bilinear and nearest neighbor interpolation. Linear and bilinear methods take a pixel value to be the average of two or four neighboring pixels, respectively. Nearest neighbor interpolation simply takes a pixel value to be a copy of one neighboring pixel value. These methods are simple to implement, but they result in large errors, especially near edges within an image.

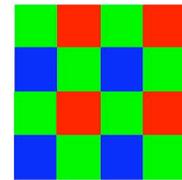


Figure 1. The Bayer CFA Pattern.

In this paper we review two recently published methods for demosaicking: cubic-spline interpolation [1] using edge orientation maps [2]; and using color difference spaces [3]. Cubic-spline interpolation fits known color values to cubic polynomials with continuous first and second-order derivatives to estimate unknown color values across a linear vector. The method uses edge orientation maps to minimize edge blurring. The color difference method estimates unknown values by assuming that differences between color channels vary little in local image regions. We implemented the methods as Matlab algorithms in order to compare their performance. Both methods show significant improvements with regard to mean-square error (MSE) and peak signal-to-noise ratio (PSNR) when compared to linear, bilinear and nearest neighbor approximations. We studied optimization within each reviewed method, and in some cases improved upon the published methods.