Homework 1: EE569

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Problem 1: Image Demosaicing and Histogram Manipulation

Abstract

Demosaicing is the process of translating the color filter array of primary colors into a color image that contains the R, G, B values at each pixel. The task is to apply bilinear demosaicing to the image of the cat. The next task is to perform Malvar-He-Cutler(MHC) demosaicing on the same image. The last part of the problem is to use two histogram equalization techniques on an image of roses.

Approach

For the first part, the given image was split into R, G, B color channels assuming the 'grbg' filter. Each color channel array was padded symmetrically and then for each of the R, G, B locations, the other 2 channel values were estimated. The 3 estimated channels were put together and the colored image of the cat was obtained. For the MHC demosaicing, the same operations were carried out with the exception of the estimation. The estimated channels produced another colored image. The first histogram equalization method applied was transfer function based. This method involved finding the CDF of the number of pixels for each intensity value. The transfer function, histogram was plotted, and the resulting image produced. The second histogram equalization method applied was the cumulative-probability-based/bucket filling method. All pixels were evenly spread into 256 buckets with 625 pixels in each one. The histogram and the final image were obtained. Both methods were applied to three images of roses – dark, bright and mix.

Results

A few images are reported below. The rest can be viewed by running the corresponding MATLAB codes.

Fig: Colored image from 1(a)

Fig: Colored image from 1(b)

Fig: Equalized image from 1(c)

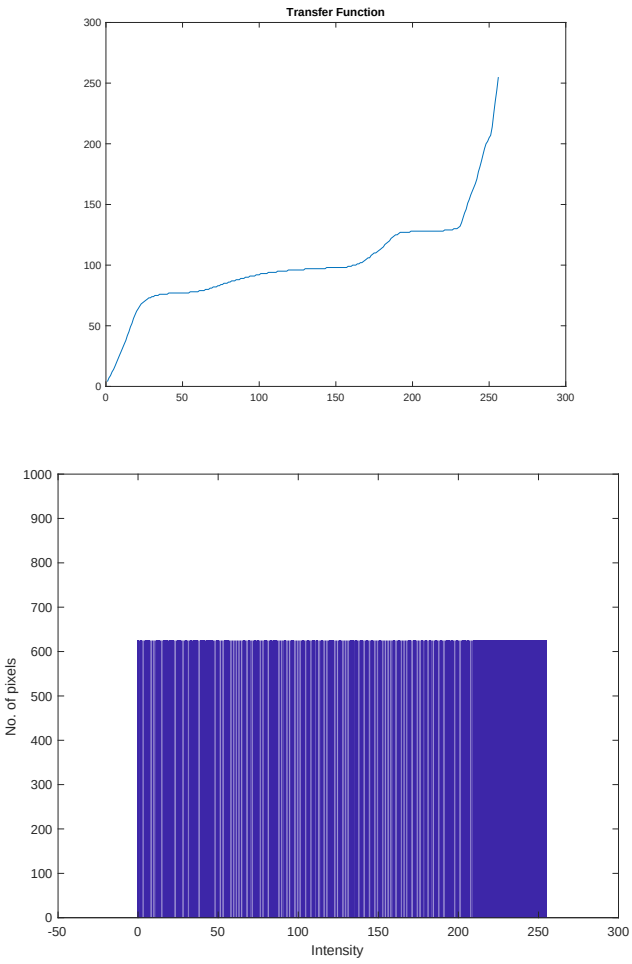

Fig: Histogram after bucket-filling equalization

Discussion

The MHC image has a lot less blue than the bilinear demosaiced image. The histogram equalization methods provided good contrast to the images. Both methods gave similar results.

Problem 2: Image Denoising

Abstract

Removing different types of noise from an image is of utmost importance. A number of different noises were seen in this problem and dealt with using different denoising techniques.

Approach

For the first part, a linear filter was used to denoise the image of peppers. This was when uniform noise was present. A uniform linear filter(averaging) was used as well as a Gaussian linear filter(weighted). The mean squared error and peak signal to noise ration with respect to the original image was calculated for both cases. A bilateral filter was also used on the image to preserve the edges in it. Given a color image with both impulse and uniform noise applied to all three color channels. First the averaging filter was used on each channel and then the median filter was used on the same. The resulting image was a combination of both and was therefore denoised. For the last part, an image with shot noise was given. The Anscombe root transformation was applied to each pixel value. Then the denoising Gaussian weighted filter was used. Finally, each pixel value was inverted and transformed back to obtain the denoised image.

Results

A few images are reported below. The rest can be viewed by running the corresponding MATLAB codes.

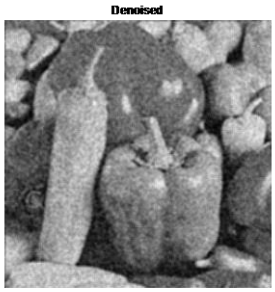

Fig: Uniform filter

Denoised - After Averaging Filter

Denoised - After Averaging and Median Filter

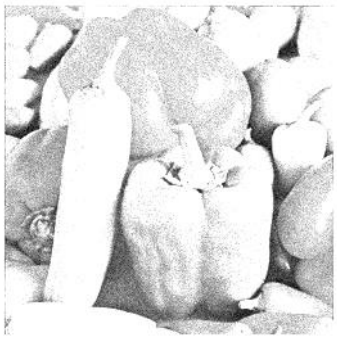

Fig: Anscombe root transformation

Discussion

The type of embedded noise in 7(b) is uniform noise. For uniform filter, MSE = 0.0033 and PSNR = 72.9543. For Gaussian filter, MSE = 0.0027 and PSNR = 73.7659. Hence we can say both performed similarly. One should perform filtering on individual color channels separately for both noise types. Averaging and median filters were used. They can be cascaded but one cannot expect the exact same result as the matrix intensities would have changed. It would not be commutative.