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Applied Physics 186

Activity 6: Enhancing Color Images

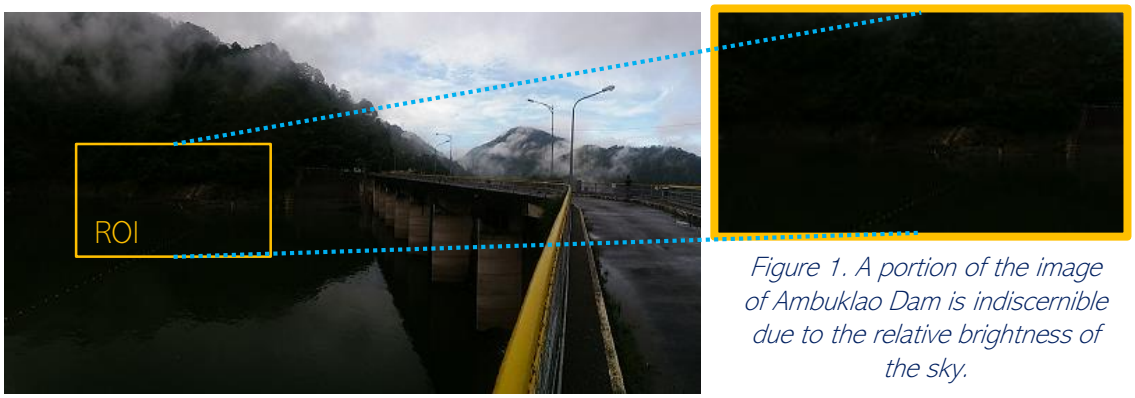

Figure 1. A portion of the image of Ambuklao Dam is indiscernible due to the relative brightness of the sky.

Figure 2. The panoramic view is dark due to the camera settings which is focused first on the sun.

Figure 3. This portrait shot used an incandescent lighting which is why the image appears to be yellowish.

In the previous activity, the goal was to carry out a single channel enhancement by histogram manipulation. Gray images were dramatically improved by the means of contrast stretching and histogram back-projection. In this report, we will dive in into improving the quality of color images using three methods namely: contrast stretching across RGB channels, gray world algorithm, and by white patch algorithm.

First-up, the images I selected to perform contrast stretching are the region of interest (ROI) in Figures 1 & 2. The presence of bright objects such as the sky and the sun overpowers the other possibly interesting subjects and colors in the image, hence, I tried performing the contrast stretching across all channels [1].

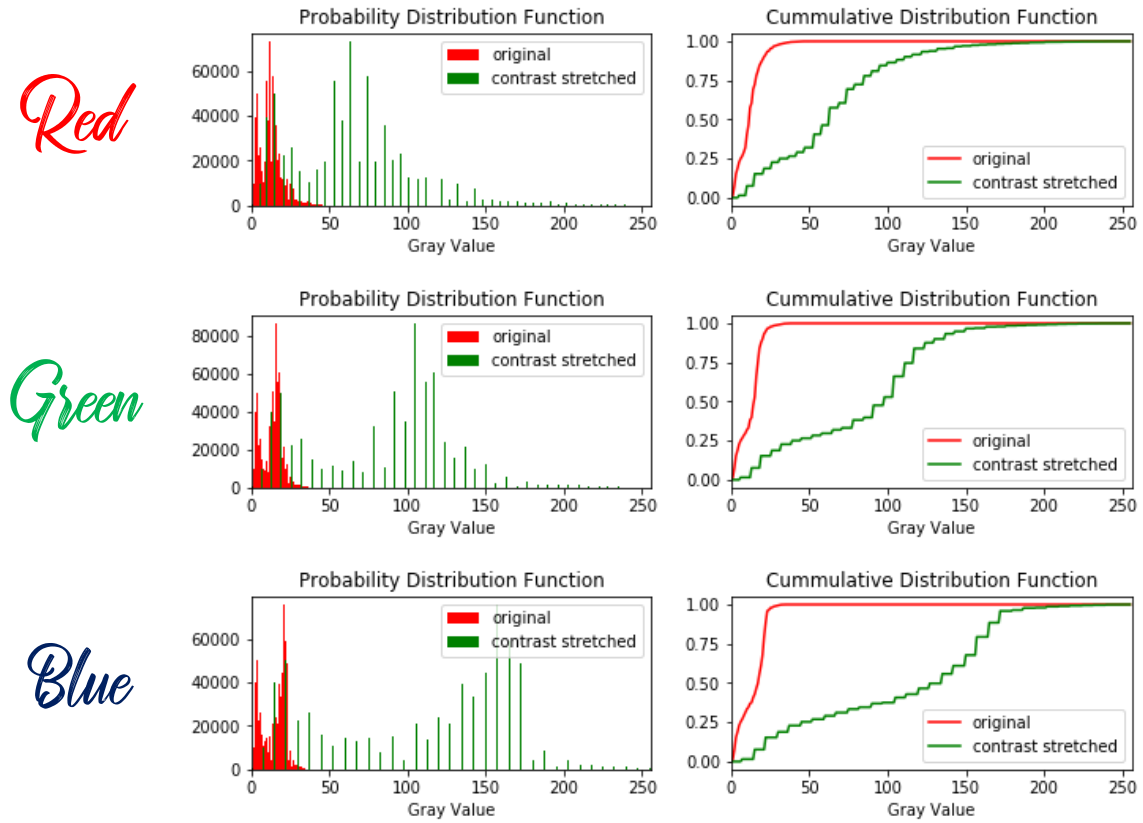

Figure 4. Statistical Properties of each image color channel was significantly altered after performing the contrast stretching algorithm on the panoramic beach photo,

Shown in Fig. 4 are the histogram manipulation plots across RGB channels for the panoramic beach image in Fig. 2. The original probability distribution function (PDF) of the image per channel is cramped on gray values less than 50, which explains its dark appearance. The corresponding cumulative distribution function (CDF) has a very steep slope at start and flatlined afterwards. I've shown in the last activity that linearly behaving CDFs were visually ideal. Hence, performing contrast stretching resulted to the green markers on the plots, which implies a well stretched PDF across all gray values, and a CDF that is steadily increasing and more linear than the original. The same process was employed on the dark portion of Ambuklao Dam in Fig. 1. The resulting contrast stretched channels were stacked to reconstruct the color images and the results are shown in Fig. 5.

For the gray world algorithm, each channel was divided on the channel's average gray value, hence the term "gray world" [1]. Since the values computed after the gray averaging were not necessarily from 0-1, I normalized the values to avoid clippings. The process is pretty straight forward and the results of the algorithm for the panoramic beach photo and a section in Ambuklao dam photo were shown in Fig. 5. Both algorithms show visually promising results. Colors were much more vibrant and appropriate to the scenery. Although the panoramic beach shot were white balanced differently by the two algorithms, the colors were still photorealistic. The ROI in the Ambuklao dam photo turned out to be covered with green trees and a cemented portion on the interface was present. Ridging details were in fact stairs towards the water shed. From completely indiscernible ROIs, the algorithms returned images which are photorealistic and discernible.

The last algorithm I used is the white patch algorithm, where we divide each chanel with the white RGB values from a known white object present in the image [1].

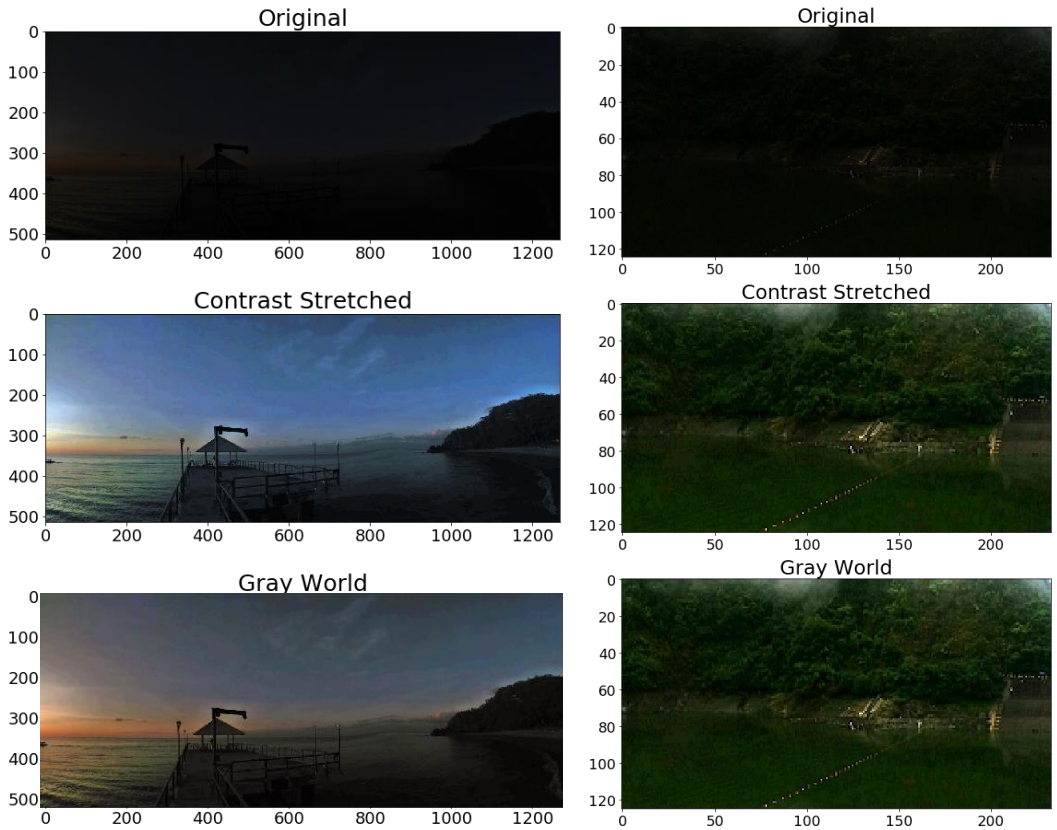

Figure 5. Contrast stretching and gray world algortihms were performed on the indiscernible ROIs of a beach photo and the portion of Ambuklao Dam and the results returned a qualitatively realistic color story of the image.

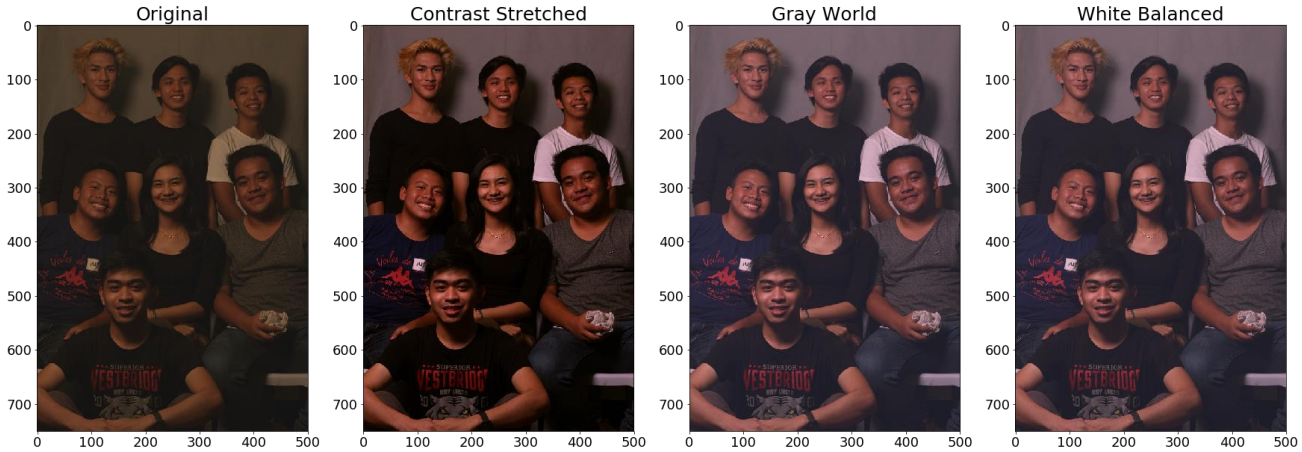

Figure 6. Comparison of the images recovered by various white balancing algorithms on the portrait shot which has an innate yellowish tint due to the incandescent lighting.

Since there was no white object on the scene for the first two images, I added the portrait shot in Fig. 3 such that I can implement the white patch algorithm. In this image, I used the white shirt of my friend as the white object. The white patch algorithm results, in comparison with the two other algorithms, were shown all in Fig. 6. Each algorithm brings a different "flavor" to image, and I guess subjectivity/preference shall be the basis as to which algorithm performed the best.

Self Evaluation:

I'd give myself a **10/10** in this activity. I got the results on the first try since I've been doing this in my image processing research. The only drawback in this activity is not having a quantitative measure as to how correct our white balanced image is. Nevertheless, the fact that an indiscernible image was brought back to (colorful) life is quite awesome.