Remote Sensing Project.

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1 Introduction

This project tackles the concept of demosaicing: reconstructing a full RGB image from a sensor that capture only one color channel per pixel. these sensors generally have two types of filters that enables them to capture the intensity of one wavelength at every pixel, the filters are presented in the Figure 1:

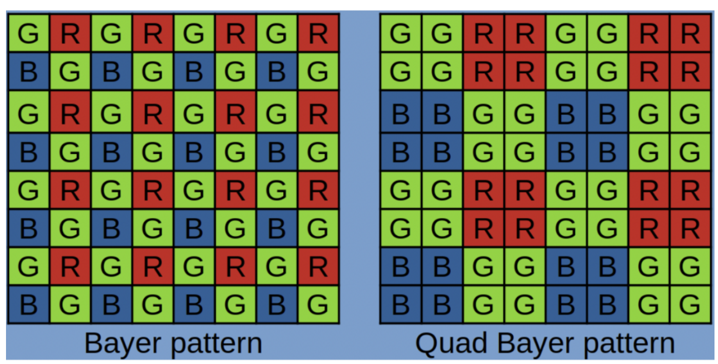


Figure 1: Bayer and Quad-Bayer Patterns.

The aim of this project is to use the information of the intensity of a color at one pixel as well as the surrounding pixels to generate a new RGB image as shown in Figure 2.

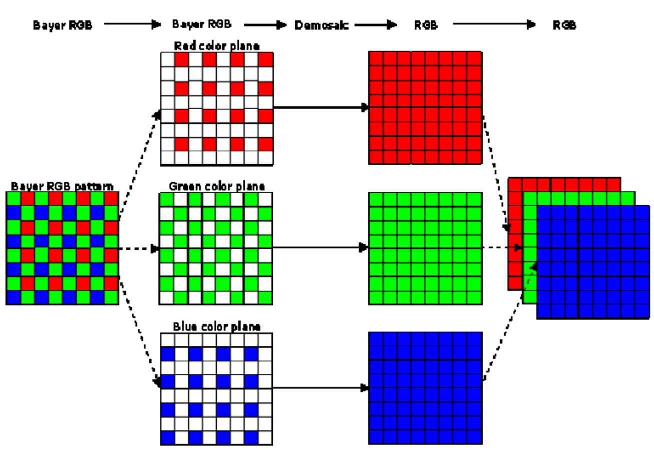


Figure 2: Demosaicing Procedure.

2 Hamilton-Adams Algorithm:

The method I chose to conduct this project is the Hamilton-Adams Algorithm. In this method we start by interpolating the Green Channel horizontally or vertically at each pixel depending on the green first derivatives and the red and blue second derivatives as described below.

1. Calculate horizontal gradient
   $\Delta H = |G_4 - G_6| + |R_5 - R_3 + R_5 - R_7|$

2. Calculate vertical gradient
   $\Delta V = |G_2 - G_8| + |R_5 - R_1 + R_5 - R_9|$

3. If $\Delta H > \Delta V$,
   $$G_5 = \frac{(G_2 + G_8)}{2} + \frac{(R_5 - R_1 + R_5 - R_9)}{4}$$
   Else if $\Delta H < \Delta V$,
   $$G_5 = \frac{(G_4 + G_6)}{2} + \frac{(R_5 - R_3 + R_5 - R_7)}{4}$$
   Else
   $$G_5 = \frac{(G_2 + G_8 + G_4 + G_6)}{4} + \frac{(R_5 - R_1 + R_5 - R_9 + R_5 - R_3 + R_5 - R_7)}{8}$$

The subindex of the Red (R), Blue (B) and Green (G) channels correspond to the pixels shown in Figure 3:

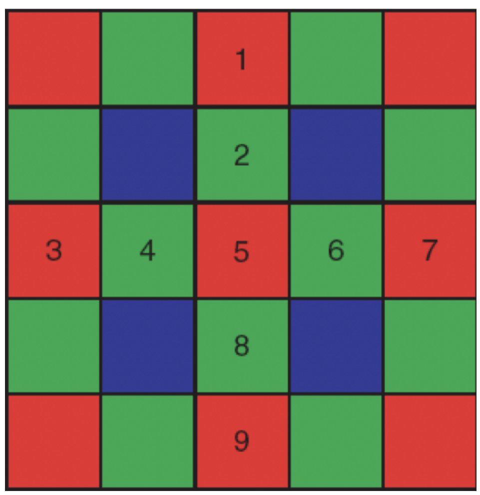


Figure 3: Filter pattern in Hamilton-Adams algorithm.

The red and blue channels are interpolated taking into account the already filled green channel. A bilinear interpolation is applied to the differences R-G and B-G

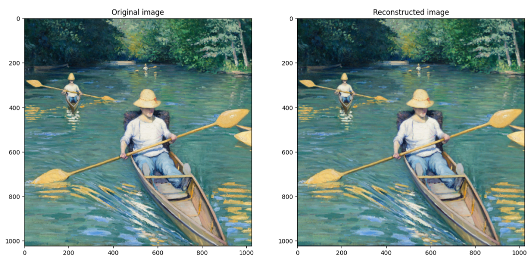
3 Results:

The Algorithm provides quite satisfying results as we can see in the figure 4 But when zooming to look more into details, we can see some artefacts and some irregularities and this is due to intgerpolation being simplistic.

In comaparaison to the naive interpolation we don't see much improvement and a slight decrease overall: -3% in SSIM.

(a) Image1: PSNR: 32.14, SSIM: 0.9302

(b) Image 2: PSNR: 26.78, SSIM: 0.8458



(c) Image 3: PSNR: 29.29, SSIM: 0.8928

(d) Image 4: PSNR: 26.69, SSIM: 0.8051

Figure 4: The output images using HA vs the original image.

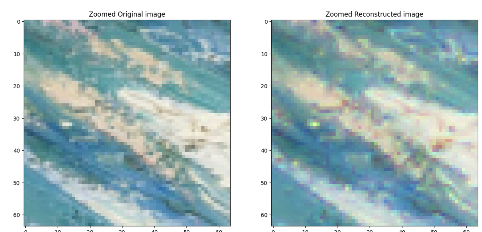


Figure 5: Zoomed picture.

4 Conclusion

This algorithm provided satisfying results but it didn't really handle the quad-Bayer CFA. As improvements it would've been good to handle the case of the quad-bayer CFA and also use more sophosticated interpolation especially for the Red and Blue channels.

5 References

https://www.ipol.im/pub/art/2011/bcms-ssdd/article.pdf
https://www.ece.lsu.edu/ipl/papers/IEEE_SPM2005.pdf