



HP Photosmart Digital Cameras Real Life Technologies

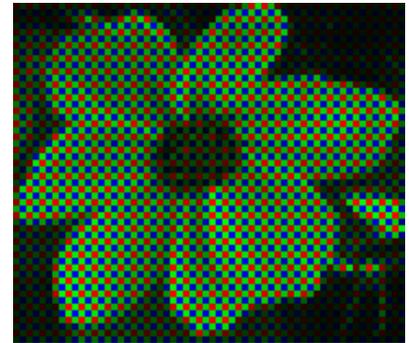
Adaptive Demosaic



What is a demosaic?

Digital cameras capture light by using an image sensor which is physically divided into light-sensitive areas called pixels. On top of each pixel is a color filter, usually red, green or blue. What this means is the camera actually captures an image where each pixel only records one color for its little piece of the scene. The filters on the sensor are placed in a checkerboard known as a mosaic or color filter array (CFA).

The image to the right, of a white flower, illustrates what is seen by the image sensor. Notice that no pixel actually sees the white of the flower – rather each pixel sees only the light passed through the color filter located on that pixel.



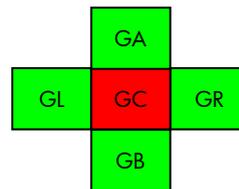
Once the mosaic image is recorded by the camera, an image processing routine called a demosaic algorithm is used to combine color and image information from neighboring pixels and create the full color image we want. The image to the left illustrates what the flower will look like after the demosaic routine is complete.



How is demosaic usually accomplished?

The precise demosaic routine used in a particular digital camera is often not revealed. Because of the critical nature the demosaic routine, the details of the routine are often a trade secret.

A very simple demosaic algorithm, illustrated to the right, averages nearby measured pixel values along horizontal or vertical directions in order to estimate missing color information. If the image is “smooth” in the horizontal direction, then the green value,



$$\text{if } |GA - GB| < |GL - GR|$$

$$\text{then } GC = (GA + GB) / 2$$

$$\text{else } GC = (GL + GR) / 2$$

GC, for the center pixel is an average of the green values to the left and right. If the image is smooth in the vertical direction, then the missing pixel is an average of the green value above and below the center pixel.

Notice that the simple demosaic method illustrated here uses a decision equation to pick either a horizontal or a vertical average for the missing green value GC. Such a method would lead to a digital camera that has excellent resolution in vertical and horizontal directions but poor resolution along diagonal image.

How does HP adaptive demosaic work?

HP adaptive demosaic is a much more complex method than illustrated here. HP adaptive demosaic uses a decision equation to pick one of 256 possible averages of the nearby measured color values. This set of averages covers all possible orientations of image edge detail. As a result, HP cameras have excellent resolution in horizontal, vertical and diagonal directions.

What does poor demosaic look like?

There are two image defects related to the demosaic routine used in a camera. One is apparent image sharpness, as discussed above. A poor demosaic routine can cause poor sharpness or uneven sharpness (the image is sharp in one direction and not another).

Another side effect of demosaic is 'colored fringes' around sharp edges. If you consider an image with a sharp edge that is only a pixel or so wide – then it is easy to see that any demosaic routine that bases a color value on a simple average of surrounding pixels may cause an inappropriate color effect at the edge. That is because a sharp edge is not the average of the two pixels on each side. Again, with HP adaptive demosaic, this is minimized because the demosaic routine can be applied *along* the edge – where the pixel values are not changing.

A final common side effect of demosaic is often called 'purple fringe.' In fact, purple fringe is the result of residual chromatic aberration in the camera lens. In essence, the camera lens does not focus red, green and blue light at the same location. Residual chromatic aberration can interact with the demosaic routine to enhance the effect of chromatic aberration.

© Copyright 2005 Hewlett-Packard Development Company, L.P. The information contained herein is subject to change without notice and is provided "as is" without warranty of any kind. The warranties for HP products and services are set forth in the express warranty statements accompanying such products and services. Nothing herein should be construed as constituting an additional warranty. HP shall not be liable for technical or editorial errors or omissions contained herein.