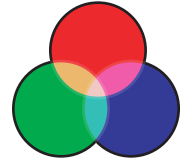


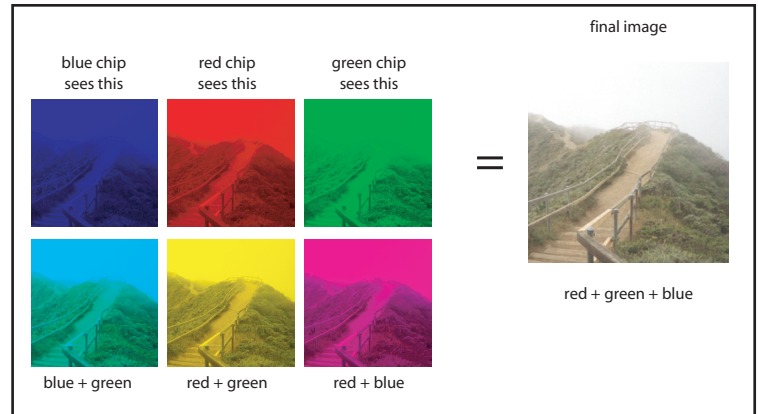
How digital cameras see the world

Where film cameras have film to record the light coming in through the lens, digital cameras and all camcorders use a light-sensitive "charge-coupled device," or CCD.

As you may know, from the light colours red, green and blue, all other colours of light can be made. A CCD is a grid of little light-sensitive spots, called photosites. Each photosite, however, only measures intensity of light, not colour, so there are several ways cameras can work.

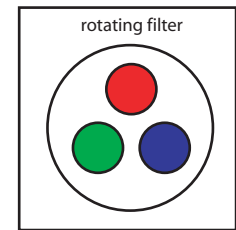


Professional or high-end "prosumer" (pricey) camcorders have 3 CCDs, one for each colour of light. When light from an object comes in the lens, a prism-like device splits it up for the 3 CCDs. The camera then combines it to produce one high-quality final image. In this idyllic snapshot of California, you can see how this works, as well as how some intermediate combinations would look.



But CCDs are expensive, so for most of us, cameras usually have 1 CCD, and work a little differently.

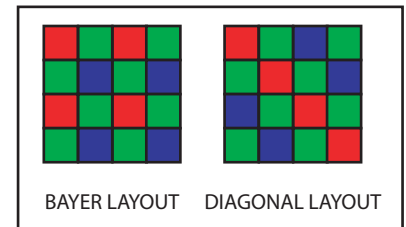
An intermediate method is this: there is 1 CCD, but a filter rotates in front of it, exposing the CCD to one colour at a time, meaning you get 3 images, red, green and blue, which are stored in the camera's memory and combined into one image. This is just as good as a 3 CCD camera, but it means that the camera musn't move during the shot, and thus isn't really useful in camcorders or for much of anything not using a tripod.



Finally, the method used in nearly all consumer (affordable) cameras and camcorders is perhaps the most complex.

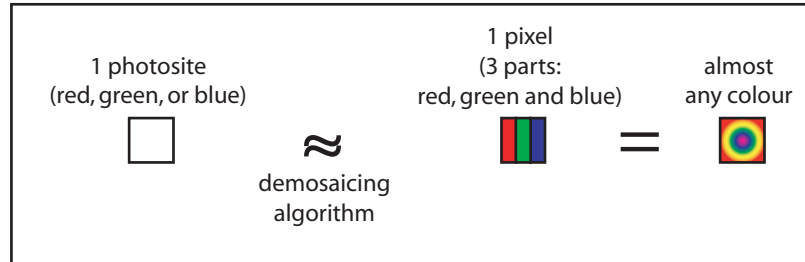
These cameras all have 1 CCD, and a good camcorder might be advertised as having a "680,000 pixel CCD." A digital still camera might be many times higher. But if you read the fine print you might see that your 680,000 pixel CCD actually has more like "410,000 effective pixels." This is because while your CCD does indeed have 680,000 photosites, this isn't quite the same as 680,000 pixels.

Like the CCDs in professional cameras, the photosites measure only intensity of light, not colour, so a red, green or blue filter is placed over each photosite. In order to make an image which "looks right," there are twice as many green sites as red or blue. They are typically arranged in one of two layouts, both shown here.

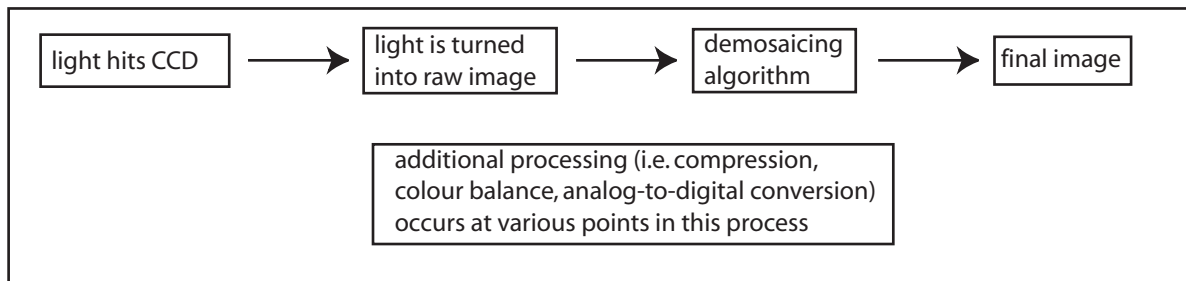


Each photosite corresponds to a pixel of the final image. But photosites are sensitive to only one colour, pixels (in your computer or TV screen) have 3 parts to determine their colour: red, green and blue. Sound familiar? Take a close look at your computer screen (a magnifying glass helps) and you'll see what I mean.

So a pixel gets its initial value from its photosite. This is a stage called a raw or mosaic image, and while it's recognizable, it's rather rough and not very nice looking. What happens next is "de-mosaicing," and the process uses a mathematical algorithm to produce the final image. These algorithms are proprietary, and differ depending on the CCD and the manufacturer. What they do is interpolate what the colour of the pixel should be based on its photosite, and the 8 photosites surrounding it. This process produces the final, nice-looking image, but it also cuts down the resolution, usually by about 1/3. So you can see that the CCD resolution may sound fantastic, but isn't quite what they say.



So, to simplify, here's a flowchart of what happens in the typical digital camera:



There are several other methods in use, although most cameras and camcorders you might encounter use one of the above three methods.

In some scientific camera systems, the CCD actually moves. The CCD may move over 15 times, in very small increments, and takes a series of images. By the use of more complicated algorithms, this means that they do not have the loss of resolution with common demosaicing algorithms. In other systems, the CCD can actually move the length of the whole CCD, giving you a much larger image. Instead of getting say, a 680,000 pixel image, the CCD moves over, and you end up with 1 million pixels or more.

So you can see that cameras and camcorders are a lot more complex than they appear. When comparing them, it's important to consider what you will be using them for and how much quality you really need for the price.