

Second Edition

Optoelectronics and Photonics: Principles and Practices

S.O. Kasap
University of Saskatchewan
Canada

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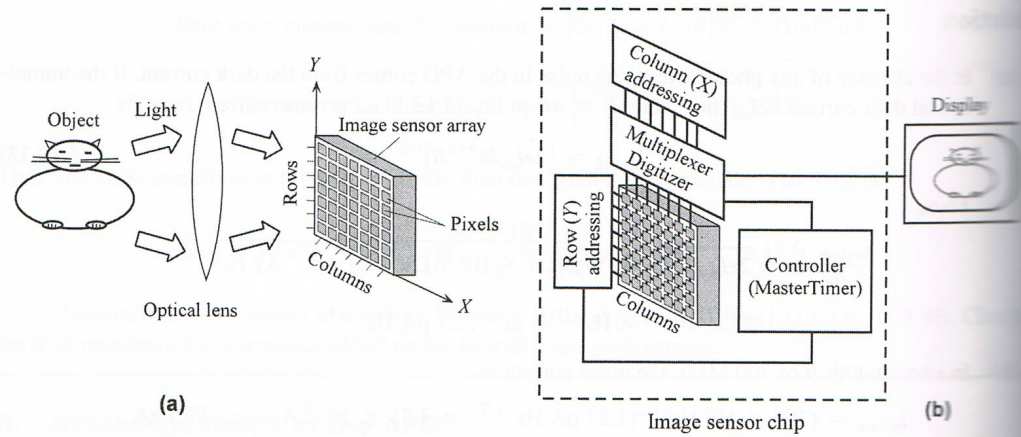


FIGURE 5.33 (a) The basic image-sensing operation using an array of photosensitive pixels. (b) The image sensor chip that incorporates the auxiliary electronics that run the sensor array (CMOS technology).

pixel (i,j) has an electrical signal (e.g., charge) proportional to $I(X,Y)$. Thus, each pixel (i,j) carries a piece of the image information, a pixel of it.

The imaging array shown in Figure 5.33 (b) is addressed from a master timer to read out the signals (charges) at the pixels and hence provide an electronically recorded image. There are two major solid state technologies: **charge-coupled device (CCD)** and **complementary metal oxide semiconductor (CMOS)** sensors, each with its own advantages and drawbacks as discussed in Sections B and C below. CMOS refers to the technology that is used to fabricate the sensor. In the CCD technology, the incident light at a pixel generates charge that is stored in the CCD pixel (called a well) at this location (and discussed below). This charge (signal) is read out by a sequential clocking mechanism, a characteristic of the CCD operation, to shift the charge to an eventual shift register for read-out. The CMOS sensor is more like the image sensor chip shown in Figure 5.33 (b). Each pixel has MOS transistors and a photodiode. The electrical signals at pixels are read out line by line. A row i is addressed by the controller, and all the pixels in this row provide their signals to the columns (data lines) $j = 1$ to M . The parallel data are multiplexed and digitized to provide a digital image. The image sensor quantizes the image because it breaks into $N \times M$ number of pixels. The pixel size imposes a resolution limit because the image is sampled by the pixels, which are of finite size.

Color rendering with image sensors can be done in three ways. The most common is to use red, green, and blue filters to separate out the colors at a point onto three different adjacent pixels.

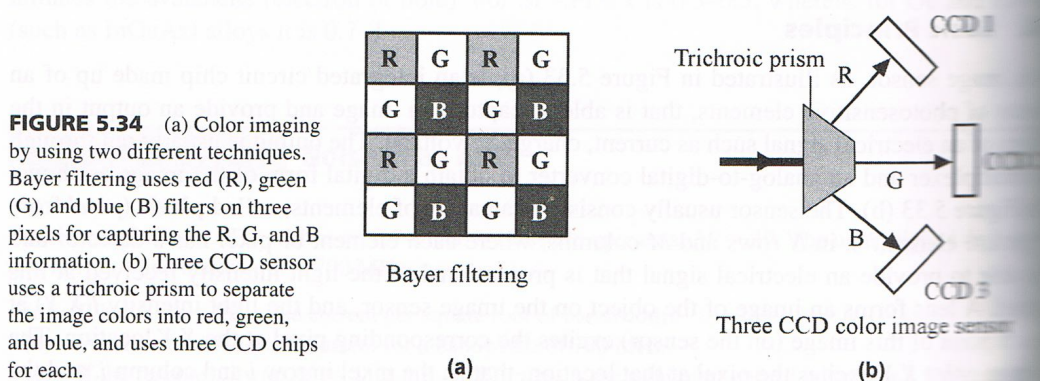


FIGURE 5.34 (a) Color imaging by using two different techniques. Bayer filtering uses red (R), green (G), and blue (B) filters on three pixels for capturing the R, G, and B information. (b) Three CCD sensor uses a trichroic prism to separate the image colors into red, green, and blue, and uses three CCD chips for each.