

Resolution

Resolution vs. Imager Format

While "imager format" tells the number of pixels in the x- and y- dimensions of the sensor, resolution describes how well these pixels reproduce spatial detail in the image. This seems like a nit-picky point, but there is a difference. In the extreme, a 1Kx1K image sensor may have ½ inch of Vaseline smeared on it's surface. In this condition, it would probably not be able to resolve any meaningful spatial detail, but it would still be a 1Kx1K format imager.

A more typical comparison between imager format and resolution is shown in Figures 1 and 2. Figure 1 shows two images - both taken with a 1Kx1K imager format. These images appear to be essentially identical. However, the zoomed-in region in Figure 2 shows that the image on the right is much sharper and resolves spatial detail more faithfully than the image on the left.



Figure 1. Two seemingly identical images taken with 1Kx1K format cameras.



Figure 2. Zooming shows the difference in resolution between the two 1Kx1K cameras

There are a number of factors which influence the resolving ability of a camera:

Poor Camera Design

Sometimes, the resolution of a camera is significantly lower in the horizontal direction than in the vertical. The reason for this is that the electrical bandwidth needed in the camera to pass horizontal data is much higher (1,000x higher is common) than in the vertical direction. As a result, if the camera is not designed properly, its ability to resolve spatial detail will be reduced horizontally. This (fairly common) effect is easy to overlook in a cursory examination of camera performance unless a resolution test target is used with both horizontal and vertical test patterns.

If the mechanical housing of a camera is not carefully designed, it is possible to create a situation where the optical axis is perpendicular to the sensor's surface. In this case, the image may have good resolution in some areas of the image, and blurry, out of focus images in others.

Poor Sensor Design

Poorly designed sensors can have low resolving ability if the depletion region used to form the CCD storage well is too shallow. This occurs because red and near IR photons generate electrons outside of the CCD storage regions which drift into neighboring pixels. These drifting electrons cause blur in the final image which reduces the effective resolution of the imaging system.

Other Issues

Imager fill-factor affects the resolving ability of the camera. While it is nice to have large fill factor for sensitivity concerns, the imager actually has better resolving ability if the fill factor in the imager is low. This is a tradeoff that needs to be considered when selecting a camera architecture.