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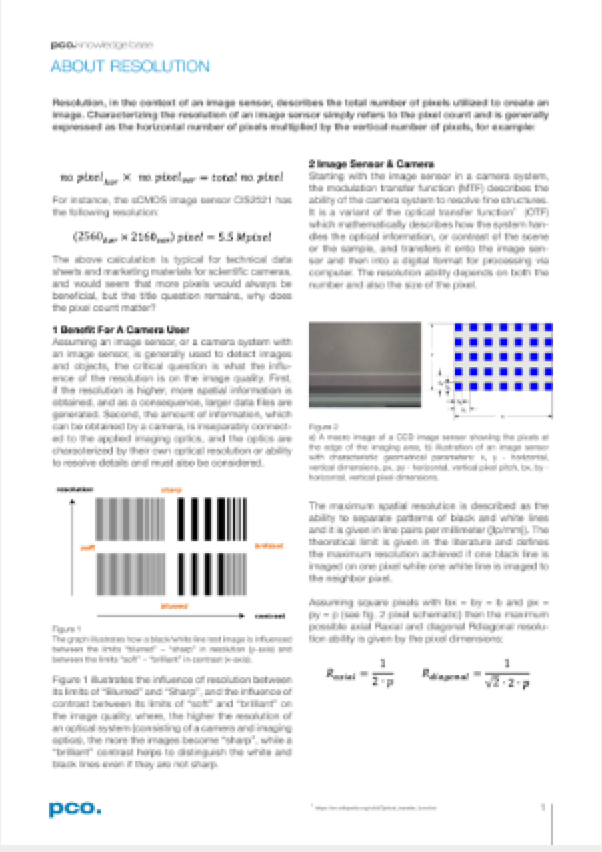
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ABOUT RESOLUTION

Resolution, in the context of an image sensor, describes the total number of pixels utilized to create an image. Characterizing the resolution of an image sensor simply refers to the pixel count and is generally expressed as the horizontal number of pixels multiplied by the vertical number of pixels, for example:

$$no\ pixel_{hor} \times no\ pixel_{ver} = total\ no\ pixel$$

For instance, the sCMOS image sensor CIS2521 has the following resolution:

$$(2560_{hor} \times 2160_{ver})\ pixel = 5.5\ Mpixel$$

The above calculation is typical for technical data sheets and marketing materials for scientific cameras, and would seem that more pixels would always be beneficial, but the title question remains, why does the pixel count matter?

1 Benefit For A Camera User

Assuming an image sensor, or a camera system with an image sensor, is generally used to detect images and objects, the critical question is what the influence of the resolution is on the image quality. First, if the resolution is higher, more spatial information is obtained, and as a consequence, larger data files are generated. Second, the amount of information, which can be obtained by a camera, is inseparably connected to the applied imaging optics, and the optics are characterized by their own optical resolution or ability to resolve details and must also be considered.

Figure 1
The graph illustrates how a black/white line test image is influenced between the limits "blurred" – "sharp" in resolution (y-axis) and between the limits "soft" – "brilliant" in contrast (x-axis).

Figure 1 illustrates the influence of resolution between its limits of "Blurred" and "Sharp", and the influence of contrast between its limits of "soft" and "brilliant" on the image quality, where, the higher the resolution of an optical system (consisting of a camera and imaging optics), the more the images become "sharp", while a "brilliant" contrast helps to distinguish the white and black lines even if they are not sharp.

2 Image Sensor & Camera

Starting with the image sensor in a camera system, the modulation transfer function (MTF) describes the ability of the camera system to resolve fine structures. It is a variant of the optical transfer function[1] (OTF) which mathematically describes how the system handles the optical information, or contrast of the scene or the sample, and transfers it onto the image sensor and then into a digital format for processing via computer. The resolution ability depends on both the number and also the size of the pixel.

Figure 2
a) A macro image of a CCD image sensor showing the pixels at the edge of the imaging area, b) illustration of an image sensor with characteristic geometrical parameters: x, y - horizontal, vertical dimensions, px, py - horizontal, vertical pixel pitch, bx, by - horizontal, vertical pixel dimensions.

The maximum spatial resolution is described as the ability to separate patterns of black and white lines and it is given in line pairs per millimeter (lp/mm). The theoretical limit is given in the literature and defines the maximum resolution achieved if one black line is imaged on one pixel while one white line is imaged to the neighbor pixel.

Assuming square pixels with bx = by = b and px = py = p (see fig. 2 pixel schematic) then the maximum possible axial Raxial and diagonal Rdiagonal resolution ability is given by the pixel dimensions:

$$R_{axial} = \frac{1}{2 \cdot p} \qquad R_{diagonal} = \frac{1}{\sqrt{2} \cdot 2 \cdot p}$$

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About Resolution

The resolution of an image sensor describes the total number of pixel which can be used to detect an image. From the standpoint of the image sensor it is sufficient to count the number and describe it usually as product of the horizontal number of pixel times the vertical number of pixel which give the total number of...

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