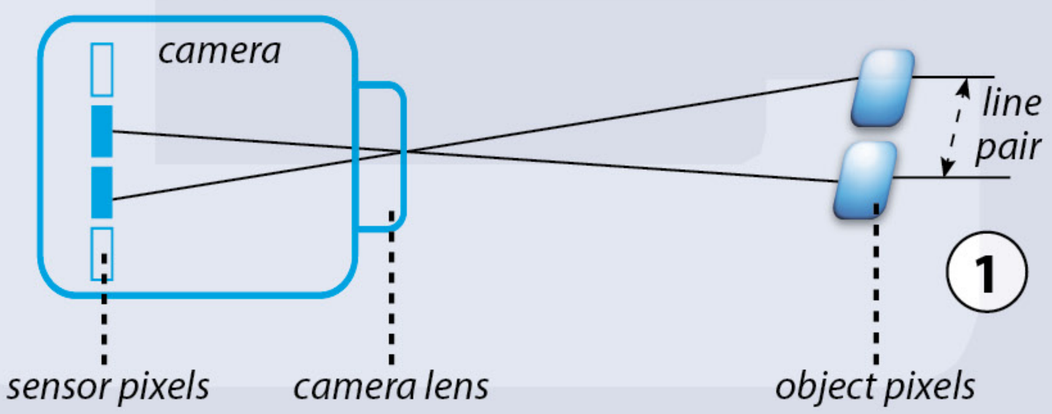
euromex®
TECHNICAL FACTS

about

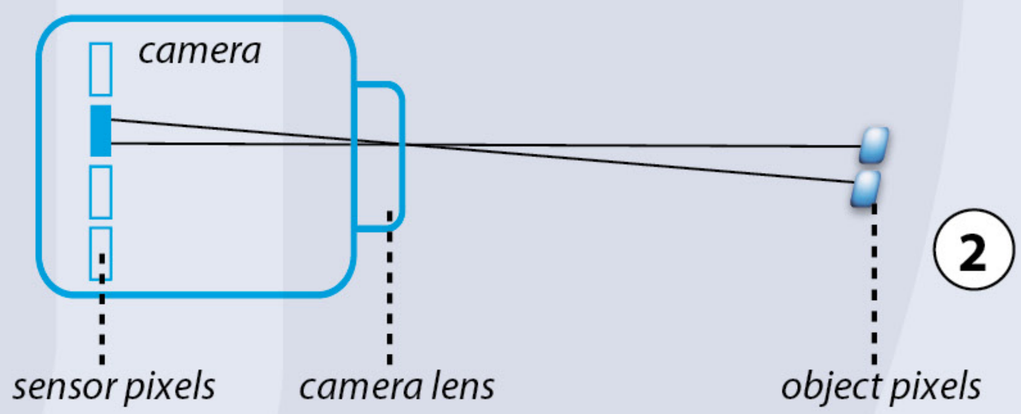
camera resolution and limits

Resolution of a camera system is the ability to reproduce object detail on screen. In practice it is depending on factors such as the good lighting of the object, the sensor pixel size and the capabilities of the optics. The smaller the object detail, the higher the required resolution

The highest frequency – expressed as line pair per mm that can be resolved – is 2 pixels or one line pair,
the so-called **Nyquist frequency**



1 *Space between objects is large enough to be detected by minimum two pixels of the camera sensor*



2 *Space between objects is too small to be detected by minimum two pixels of the camera sensor*

THE LIMITING SENSOR RESOLUTION

(image space resolution) of a camera is commonly calculated as:

$$\left(\frac{1\ \text{lp}}{2\ \text{x}\ \text{s}}\right)\ \text{x}\ \left(\frac{1000\mu\text{m}}{1\ \text{mm}}\right)$$

whereby **s** = pixel size (in µm)
and expressed as line pair per mm (Lp/mm)

The formula shows that a sensor with smaller pixels will have higher image space resolution:

Pixel size	Image Space resolution
1.67	229 LP/mm
2.2	227 LP/mm
3.45	145 LP/mm
5.5	90 LP/mm

Considering the Euromex DC.18000-Pro 2/3 inch camera which is equipped with 4921 x 3684 pixels camera on a 8.6 x 6.6 mm large sensor

THE NYQUIST IMAGE SPACE RESOLUTION

can also be calculated as 1/2 x sampling pixels/mm (Lp/mm) or:

- **Horizontal**
  4921 / 8.6 = 572 (sampling pixels) x 0.5 = 286 Lp/mm
- **Vertical**
  3684 / 6.6 = 558 (sampling pixels) x 0.5 = 279 Lp/mm

The Nyquist object space resolution or the smallest detail that could be theoreticaly resolved is then equal to:
1000 mm / (286 Lp/mm) or 3.5 µm
However, taken into account the manufacturing limitations and inevitable optical aberrations, the real image space resolution can be calculated as:
1/2 x Kell factor (approx 0.70) x sampling pixels (Lp/mm) or:

- **Horizontal**
  4921 / 8.6 = 572 (sampling pixels) x 0.35 = 200 Lp/mm
- **Vertical**
  3684 / 6.6 = 558 (sampling pixels) x 0.35 = 195 Lp/mm

or approx. 1000 mm / 200 Lp/mm or 5 µm
In comparison, the by physics diffraction limited object space resolution (smallesy detail that ever can be observerd through the eyepieces of a optical compound microscope, is around 0.20 µm