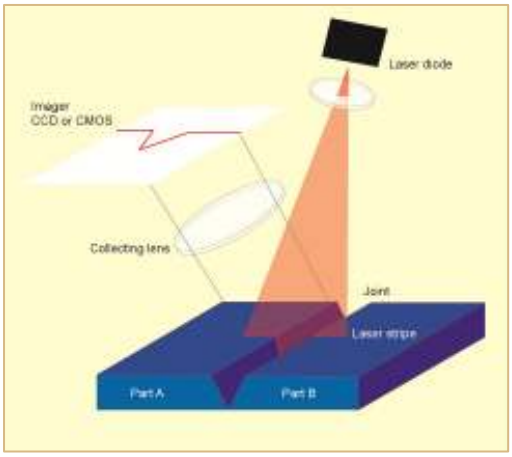
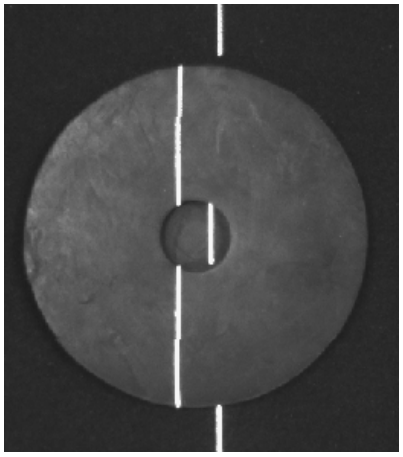
Laser Light Structures in Machine Vision Applications

Due to its high depth of focus lasers are widely used as structured light source in machine vision applications.
A pattern of light is projected on an object while a camera offset in a known distance from the pattern projector looks at the deformation of the pattern on that object. The pattern may be one dimensional (e.g. a line) or two dimensional (e.g. a grid or line stripe pattern).

Projecting such one or two dimensional patterns on an object allows for example

- Measuring by means of triangulation

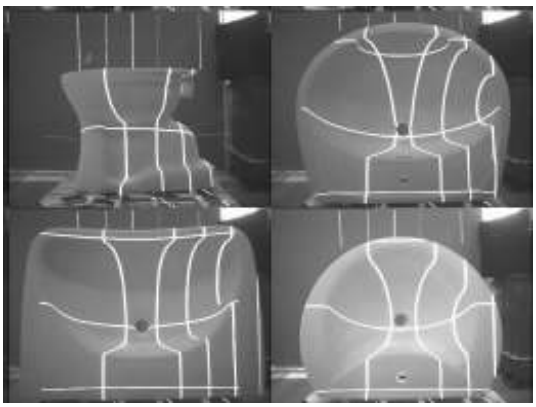




Principle of triangulation

This technique is called triangulation because the laser line, the camera and the laser form a triangle. Depending on how far away the laser strikes the surface, the laser line appears at different places in the camera's field of view.

- Location of three-dimensional characteristics in one image



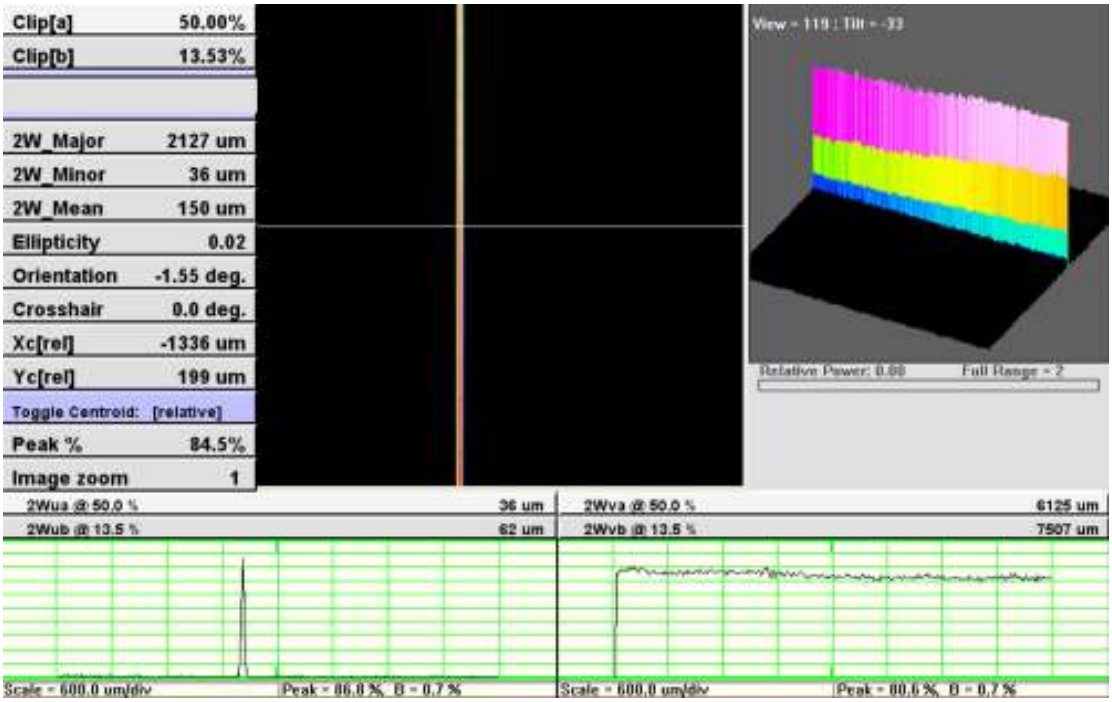
Measurement of dimensional tolerances of sanitary ware (Courtesy of GFAI, Berlin)

Grids, line stripe patterns or dot matrices allow determining three-dimensional characteristics of an object in one image. The finer the pattern the more accurate is the information. Often used for quick quality control.

Compared to conventional light sources laser light has some extraordinary features which makes it an ideal source for structured light applications.
Structured light applications allow to quantify an object (dimensions, shape, volume) while incident light is often just verifies the presence of an object.

Making use of specific laser characteristics

▶ Emission out of one point allows focussing into very fine lines



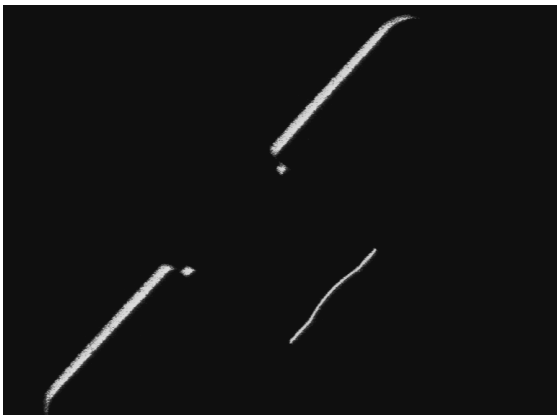
Example of a 36 µm line (FWHM, f=130 mm) with homogeneous light distribution

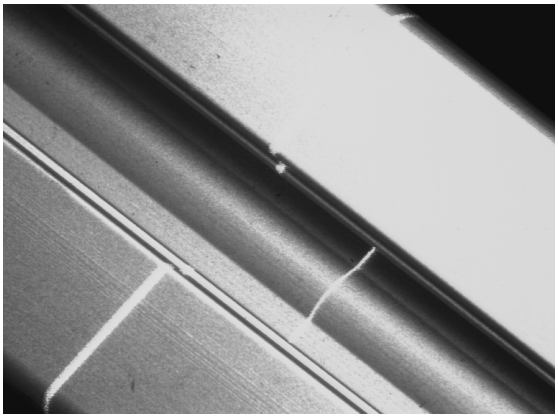
Very fine lines are used for example in AOI systems in printed circuit board inspection.

▶ Laser light is <u>monochromatic</u>
This allows the use of band filters. As result you see only the laser light.

▶ Diode lasers send out linear <u>polarised</u> light.
Disturbing reflections can be removed by polarisation filters.

Glue seam inspection





With red filter

without red filter

▶ Laser light has a <u>high light density</u>

Single measuring lines use typically laser powers ranging from 5 to 100 mW. Line stripe patterns or especially dot matrices may require – depending on the application – much higher power.
Example:
Imagine a 40 x 50 dot matrix is required to characterise an object of 800 x 800 mm. The ambient light is bright and you need an intensity of 0.5 mW in each dot to have a sufficient contrast under any ambient light situations. The necessary power is in this case 40 x 50 x 0.5 mW = 1 000 mW or 1 W. Such light intensities are only possible using a laser in combination with a glass Diffractive Optical Element (DOE) as – different from conventional light sources using masks – almost all light goes into the DOE.

Practical aspects of laser controls

Using a laser in a machine vision application requires typically remote on and off, Adjustment of focus and optimum brightness.
For synchronisation with the pixel read-out of the camera high modulation frequencies are required.
All these controls as well as various optical patterns are available in ***Z-LASER*** 's Machine Vision series ZV. This series can be used up to 100 mW and wavelengths in the red and infrared region.

For other wavelengths (e.g. 405 nm or 532nm) and/or higher power it is strongly recommended to use active temperature controlled lasers of the ZQ series.
Red diode lasers are available up to 1.5 Watt.

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