Autocollimator tutorial

The electronic autocollimator is a high precision angle measurement instrument capable of measuring angular deviations with accuracy down to fractions of an arc-second.
It can be used in numerous applications in a variety of areas. Some examples include: perform a machine alignment, measurement of slide ways, precision machines, accurate optical assemblies, alignment of optical setups and more.
Measuring with an electronic autocollimator is fast, easy, accurate, and will frequently be the most cost effective procedure.
Used extensively in workshops, tool rooms, inspection departments and quality control laboratories worldwide, these highly sensitive instruments will measure extremely small angular displacements, squareness, twist and parallelism.
Duma Optronics offers a complete line of autocollimators designed to interface and display results digitally on a computer, the interface is easy via USB2 port. Our dual-axis, digital autocollimator incorporates the latest CCD technology and optical analysis software.

Autocollimation principle

An optical schematic illustrating the basics of autocollimation is shown in Figure 1. The system has a light source followed by a projection reticle. The light source is LED (usually 670nm). After passing through the beam splitter, the light enters the objective lens where it is collimated prior to exiting the instrument. Collimation means that the projected reticle is exactly one focal length away from the main surface of the objective lens. The projected collimated light is back reflected by a mirror, or other high-quality reflective surface, and is captured by the objective lens. The returned image appears in sharp focus on the high quality CCD detector. Due to the detector high sensitivity even very faint back reflection will be captured and displayed.
Deviation of the mirror by an amount A is causing deviation on the original line of sight by an amount of 2A. Assuming the amount of deviation of the reflective surface the focal length is denoted by FL, then mirrors' deviation is to be determined from the relationship: A=X/2FL

From the equation it is apparent that measuring mirror angular deviation is independent of the distance between the instrument and the reflecting surface.

Deviations in azimuth and elevation can then be electronically determined and calculated by a computer. Furthermore the results are than clearly displayed on its screen. Resolution down to 0.01 arcsec is achievable.
<u>As a rule of thumb:</u> the higher the FL - the higher the resolution. As a result, the field of view is smaller and thus it is more difficult to acquire the reflected signal acquisition.

The electronic method offers the advantage of complete objectivity in data recording, as well as a computer interface unlike optical autocollimators which are bulkier and less accurate.
In a telescopic application, where the telescope is calibrated to infinity, the angle of movement is A=X/FL.

Applications:

Measuring the straightness of machine components

The straightness of machine components, like guide ways, or the straightness of lines of motion of machine components, can be checked with the autocollimator and a base mirror. The base mirror is moved step by step along the guide way which is to be measured.
When the mirror base is tilted, caused by unstraightness of the slideway, the angle of tilt will be measured by the autocollimator.
With this angle *a* and the known base length b, the difference in height Delta, can be calculated:
Delta = b * tan *a*
The slope of the line through the first and last point of the slideway depends on how the autocollimator has been set up.
The measuring accuracy depends on the number of measuring points along the line.

The cross-axes of the autocollimator should be parallel to the horizontal and vertical directions of the plane where the measured line is in.

Measuring flatness

Measuring the flatness of large surfaces is usually done by measuring the straightness in the relevant direction of a series of lines in the surface plane in a certain pattern. The procedure for each line is the same as for single straightness measurements. By using an extra deflection mirror, all the lines of the pattern can be measured, while the autocollimator only needs to be placed in a few different positions. By correlating the straightness results, obtained along the lines, it is possible to determine the errors of flatness of the plane, related to a reference plane.

A short list of various Applications

General applications

*Aircraft assembly jigs
*Satellite testing
*Steam and gas turbines
*Marine propulsion machinery
*Printing presses
*Air compressors
*Cranes
*Diesel engines
*Nuclear reactors
*Coal conveyors
*Shipbuilding and repair
(Civil and Military vessels)
*Rolling mills (steel, paper, sugar etc.)
*Rod and wire mills
*Extruder barrels

Optical measurement Applications

*Retro reflector Measurement
*Roof prism Measurement
*Optical assembly procedures
*Alignment of beam delivery systems
*Alignment of laser cavity
*Testing perpendicularity of laser rods in respect to its axis
*Real time measurement of angular stability of mirror elements.

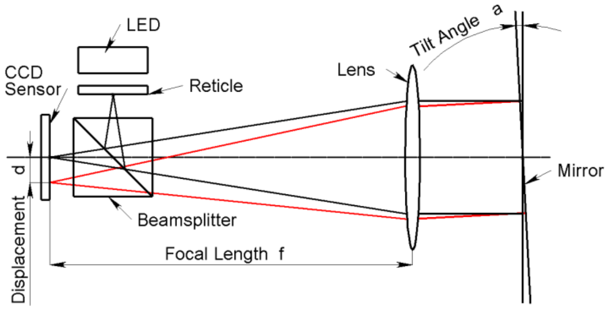

Figure 1.

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