## OMC Technical Brief - Single point optical triangulation


*Single point optical triangulation is an easy to use method of measuring distances to objects without touching them and requires little operator knowledge or supervision.*

**What does it do?**

Measure distance with accuracy from a few microns to a few millimetres, over a range of a few millimetres to tens of metres, at a rate of 100 to 60,000 times per second

**Why use this technique?**

Single point optical triangulation instruments provide distance information quickly and easily without touching the object being measured

**Typical objects measured:**

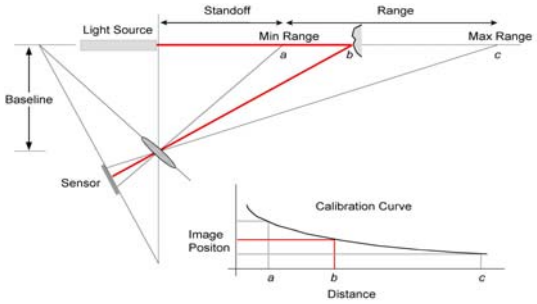
- manufactured goods
- tyre treads
- archaeological artefacts
- turbine blades
- coins
- printed circuit boards
- road surfaces
- pipes found in sewers, process industry, tunnels, and ships

**Type of information gathered:**

- size
- thickness
- depth
- opaque liquid levels
- vibration amplitude and frequency
- length
- gauging pass-fail
- robotic tool stand-off
- number of manufactured goods
- 2-D shape
- 3-D surfaces

**How does optical triangulation work?**

A single point optical triangulation system uses a laser light source, a lens and a linear light sensitive sensor. The geometry of an optical triangulation system is illustrated in figure 1.




**Geometry of Optical Triangulation**

A light source illuminates a point on an object (typically a Laser or LED), an image of this light spot is then formed on the sensor surface, as the object is moved the image moves along the sensor, by measuring the location of the light spot image the distance of the object from the instrument can be determined provided the baseline length and the angles are known

The most important component in the optical triangulation system is the sensor. There are two types. The Position Sensitive Detector (PSD) and the Charged Coupled Device (CCD) the PSD is often chosen for devices measuring over a small range providing an analogue output which is ideal for use with pass-fail applications. The CCD sensor has the advantage of better geometric stability and produces a signal well suited to providing a digital output

Some design issues for optical triangulation systems are:

- If the object is moved in equal increments then the position of the image on the sensor will not move in equal increments - the instrument is inherently non-linear
- If the object is moved over a relatively small range an approximately linear instrument can be produced.
- For a given range - if the base-line is extended the instrument will be more linear but will also become large and possibly awkward to use. If the base-



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line is shortened then a smaller instrument can be made but it may not be possible to get the accuracy required at the long range due to the increased non-linearity
- As the object is moved over the range of the instrument with a typical camera the image of the light spot will go in and out of focus. This is usually solved by positioning the sensor to comply with the Schliempflug condition - it will then be in focus over the whole range
- If an object occludes the view of the light spot, or stops the light source from illuminating the object, then measurement will not be possible
- Instability of the light source direction will cause errors which may be a problem to long range systems
- If the light source impinges on an uneven surface texture or colour measurement accuracy will be degraded
- If the configuration of an optical triangulation sensor is altered, for example, through temperature changes or shock, then the instrument will give erroneous results but the user may not be aware of this.

**Benefits:**

- low cost
- high speed measurement
- can build up information from single point to 2-D or 3-D
- better quality control
- good choice of instruments
- good selection of interfacing methods
- good protection from environment

**Disadvantages:**

- PSD sensors cannot distinguish between multiple bright spots
- Some systematic characteristics to PSD sensors
- Uses light to measure with which may not be eye safe
- Sensor can be occluded
- Some directionality issues due to handed design



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