FAST 3D OPTICAL-PROFILOMETER FOR THE SHAPE-ACCURACY CONTROL OF PARABOLIC-TROUGH FACETS

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VISprofile features:

**Scope:** shape-accuracy verification of parabolic-trough facets in laboratory or industry; that gives the concentration effectiveness of the specimen.

**Measures:** $x,y,z$, $\partial z/\partial x$ and $\partial z/\partial y$

VISprofile is a profilometer !!!

**Evaluates by ray tracing:** intercept-factor, $d_{\text{max}}$ of reflected radiation from the focus line, flux and incident angle distribution on receiver surface.

**Experimental setup:**

![Experimental setup](image)

View from the camera, the linear array of point light source appears imaged on the reflective panel.

Nonlinear array of point light sources

VISprofile features:

**Strengths:**

- **PROFILOMETER:** not only partial derivatives ($\partial z/\partial x$ and $\partial z/\partial y$) but also $z$ is measured. \textit{The same can not claimed by V-SHOT and FRT}
- **SIMPPLICITY:** just 3 components (linear array of point light sources, motorized linear guide rail, FireWire camera)
- **LOW-COST**
- **FAST MEASURING & DATA PROCESSING:** 3 ms/point
- **HIGH ACCURACY:** better than 20 $\mu$rad and 50 $\mu$m for arctangent of derivatives and $z$ deviation $\rightarrow$ superior than FRT instruments

**Working:**

Given $S$ and $C$, $P$ and the therein normal must fulfill

$$-\overrightarrow{SP} + \overrightarrow{PC} \propto \overrightarrow{n}$$

The normal is related to the partial derivatives

$$\overrightarrow{n} \propto \left( \frac{\partial z}{\partial x}, \frac{\partial z}{\partial y}, -1 \right)$$

The scan consists of grabbing a number of frames varying the camera abscissa, so that during the scan the observed point-source-images span the whole facet-surface, from one linear edge to the opposite one.

Let $P_0$ be a point of the facet-surface of which $z$ is known. Among its neighbor points, let us consider $P_i$ here $x_i,y_i$ are evaluated by the image itself, but $z_i$ is not known.

On the other hand, for an ideal parabolic profile, the planes tangent in $P_0$ and $P_i$ are expected to intersect each other at midway. With this criterion position and derivative in $P_i$ are uniquely evaluated.

It is reasonable to extend this criterion also along $y$, so that $z$ and the partial derivatives can be uniquely evaluated in the neighbor points of $P_0$.

The iterative application of this procedure allows to determine the shape of the whole facet-surface.