Calibration of multi-line light-sectioning

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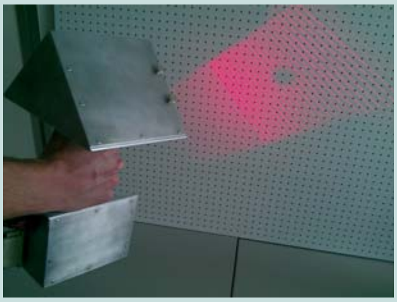

Fig. 1: *Snapshot of the novel calibration for a multi-line light-sectoning sensor (here a FlyTri sensor).*

In 2009 [1] we introduced the optical 3D sensor "**Flying Triangulation**" (FlyTri) based on **multi-line light-sectioning**. It enables a hand-guided, motion-robust measurement of complex objects without external tracking via sophisticated registration algorithms.

Besides physics and technology, it is the **calibration** which severely influences the quality of a sensor. Up to now, a **model-free** calibration was applied which displays several **weaknesses**, among others the requirement of an expensive and inflexible setup.

We present a **comfortable** and **accurate** method for the calibration of multi-line light-sectioning which only uses **one simple calibration target**. An **inexperienced user** can perform the calibration **anywhere on site**.

Sensor properties

Multi-line light-sectioning is an **extension** of the well-known **light-sectioning** principle: A multiple l**ine pattern** is projected onto the object and, as it is seen via a triangulation angle, by a camera.

Since both sensor components, **camera** and **projector,** are afflicted by **optical aberrations**, a calibration is required.

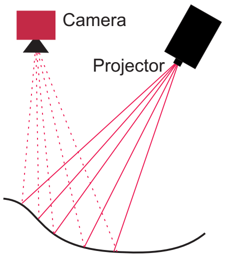

Fig. 2: *Sketch of setup.*

Discussion

The introduced calibration method is **fast** and requires only **little user interaction**.

We expect that the major error source is directly related to the **resection quality**.

So, the method should be as acurate as state-of-the-art photogrammetry.

A validation with precise calibration targets will be pursued next.

Calibration

i) Camera calibration

- common **photogrammetry** technqiues [2] with a simple target is employed
- **bundle adjustment** yields inner camera parameters and **geometry** of target

ii) Projector calibration

This novel method is an extension of the approach presented at the DGaO conference 2012 [3]. The projector calibration uses information provided by the **camera calibration**.

Basic idea:

- the **calibration target** is manually **positioned** at different positions $P_1,...,P_n$ in the measurement volume along the optical axis
- at each position P_i an **image without projected lines** is captured - yielding known (x,y,z) for each target point
- at each position P_i further an **image with projected lines** is captured - yielding known (x,y,z) along each line at the target
- from several positions $P_1,...,P_n$ the **entire volume** is calibrated via approximation

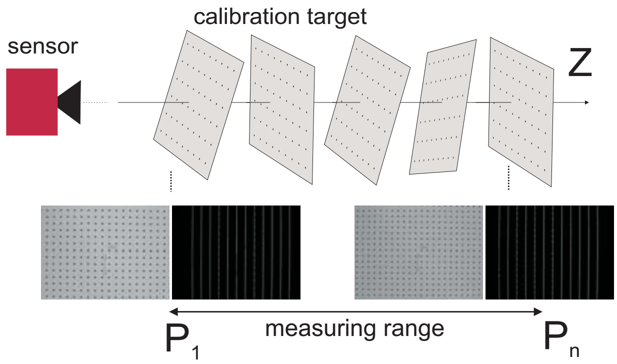

Fig. 3: *For each calibration plate position P, an image of the plate is acquired, without and with multi-line pattern projection. By resection, the positions of each observed point on the plate can be determined.*

[1] S. Ettl, O. Arold, P. Vogt, O. Hybl, Z. Yang, W. Xie, G. Häusler, "Flying Triangulation - a new optical 3D sensor enabling the acquisition of surfaces by freehand motion", DGaO-Proc., A13 (2009).
[2] Duane C. Brown, "Close-range camera calibration." Photogrammetric engineering 37.8: 855-866 (1971).
[3] M. Schöter, F. Willomitzer, O. Arold, S. Ettl, G. Häusler, "Calibration of Fyling Triangulation", DGaO-Proc., P25 (2012).