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Detection of Structured laser beam centroid and its use for alignment

A Structured Laser Beam (SLB) is a pseudo-non-diffractive optical beam. Its transverse profile is similar to a Bessel Beam (BB), hence its bright central core is surrounded by concentric circles. SLB can propagate with very low divergence over long distances. Propagation over 200 m has been tested with a divergence under 0.01 mrad. Therefore, the central core can still fit onto the camera chip and its centroid position can be accurately detected, which is not the case for well-known Gaussian beams (GB). These properties make the SLB a promising candidate for long-distance alignment applications because it could be used as a reference line.
The alignment accuracy is affected by the algorithms for centroid detection. In this work, different algorithms for centroid position detection are evaluated and compared on simulated data, namely the best fitting of a well parameterized Bessel function and different alternations of the center of gravity methods. In addition to simulations, real data are obtained during experiments using a high-precision motorized stage to induce a known translation of a sensor resulting in misalignment. This misalignment is compared with the misalignment detected by an SLB sensor. Therefore, the potential of SLB for long-distance alignment is explored.

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