Baden-
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Forschungsergebnisse

Optische 3D-Sensorsysteme für mobile Anwendungen

der Baden-Württemberg Stiftung gGmbH

FORSCHUNGSTAG 2022

A compact and cost efficient optical 3D distance measurement sensor for mobile applications

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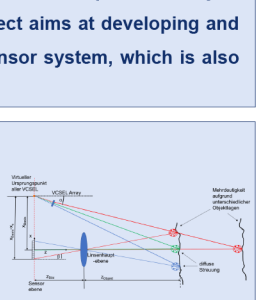
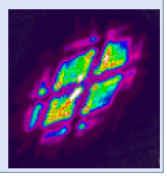
Motivation

Service robots of the future for people in need of assistance will require a variety of sensors to register the environment. Therefore, the project aims at developing and evaluating a robust, simple and thus inexpensive 3D sensor system, which is also scalable with respect to the measurement range.

Innovation

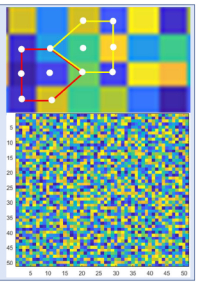
Since many established sensors require a texture or pattern on the objects to capture the 3D environment, the planned triangulation sensor system should generate and evaluate optical markings on the objects. To overcome the possible ambiguity of the markings, it was planned to provide each marker with a unique feature. This concept promises to allow an extremely robust mechanical realization and an arbitrarily repeatable software-based calibration with simple calibration bodies.





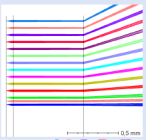
Marker Coding

A 45×49 Vertical Cavity Surface Emitting Laser (VCSEL) array is used for pattern projection. Each VCSEL beam is forming an ellipse with defined axis angle. The angle pattern is designed that it is unique for each ellipse and its six neighbours. Forming is done be a microlense array produced with 2-photon lithography

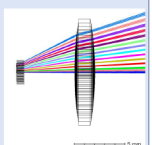


Optic Design

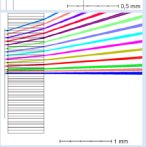
Left surface forms the ellipse, right surface tilts the beam



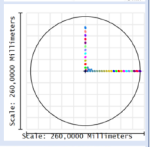
Beam path



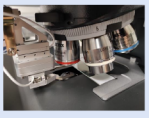
Forming and tilting the beam combined in the left suface



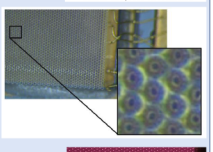
Beam pattern in a distance of 1 m



Mounting the lens array with sub µm accuracy

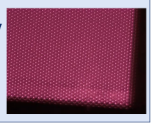


Microlenses with obvious asperic shape



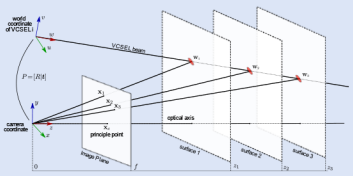
Printed lens array on the VCSEL array

Test of the VCSEL array with lens array



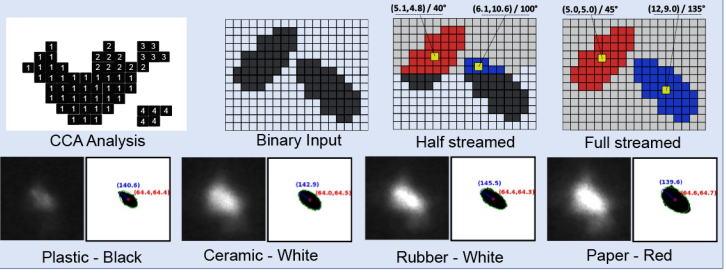
Laser Spot Profiling and Distance Measurement

System Parameters Estimation and Depth Resolving



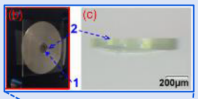
Simultaneously Laser Spot Profiling and Distance Estimation

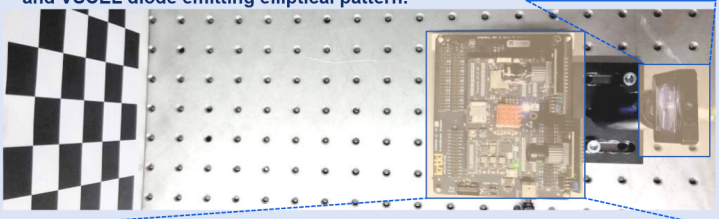
Fast connected component analysis (CCA) for COG + ROT Estimation



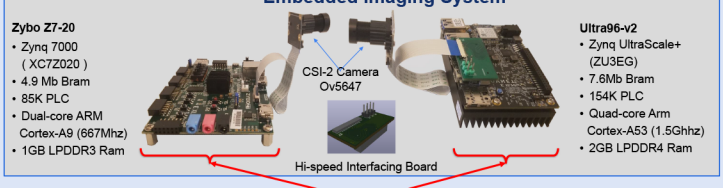
System Setup

- Imaging system assembling FPGA board and embedded CMOS sensor.
- Laser Illuminator assembling micro-lens array and VSCEL diode emitting elliptical pattern.

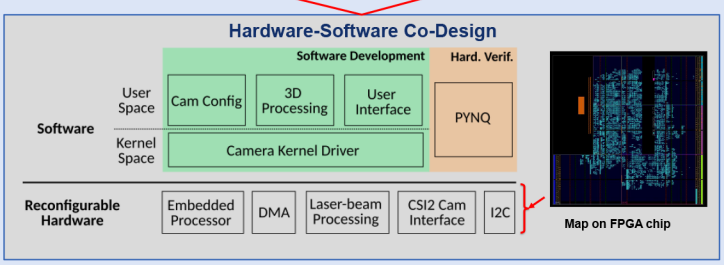




Embedded Imaging System



Hardware-Software Co-Design



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