Baden-Württemberg Stiftung
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Forschungsergebnisse

Optische 3D-Sensorsysteme für mobile Anwendungen

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Real-time 3D optical data acquisition in difficult visibility conditions for road traffic applications

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1 Motivation

Modern driver assistance systems, and in particular autonomous driving, require the 3D recording of the prevailing traffic situation in real-time under different weather and visibility conditions. In particular, extreme conditions such as fog, heavy rain or snowfall can severely impair or even obscure the visibility of people or objects such as cars or road signs.

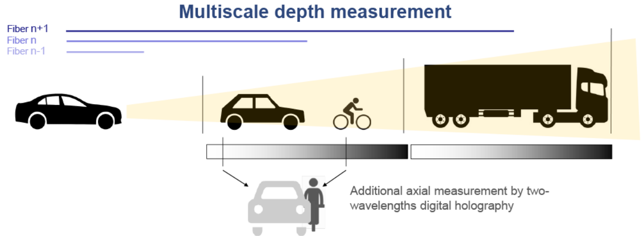
2 Systems currently in use

Radar equipment and cameras are mainly used for 3D detection. Radar units are very reliable but do not offer the necessary resolution for details like arms and legs, which makes object recognition more difficult. Cameras for the visible spectral range, on the other hand, provide the necessary details but require a machine adaptive software that can translate 2D images into 3D understanding. Beyond that, the strong scattering of visible light in fog, rain or snow reduces the contrast significantly, which, in the worst case, completely prevents the object to be recognized.

3 The novel solution

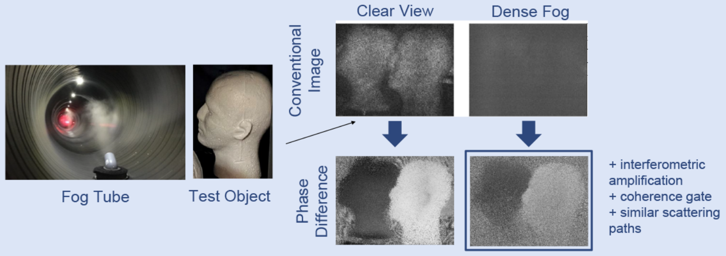
Is based on a macroscopic implementation of time domain optical coherence tomography (OCT) known from medical technology combined with digital two-wavelengths holography. The multi-scale depth measurement, in combination with appropriate post-acquisition processing software, enables not only to detect objects at a distance of up to 100 m despite poor visibility conditions but also to recognize them (i.e. a person is also recognized as a human being, a car as a car, etc.) and to determine the speed of the detected objects.

Multiscale depth measurement

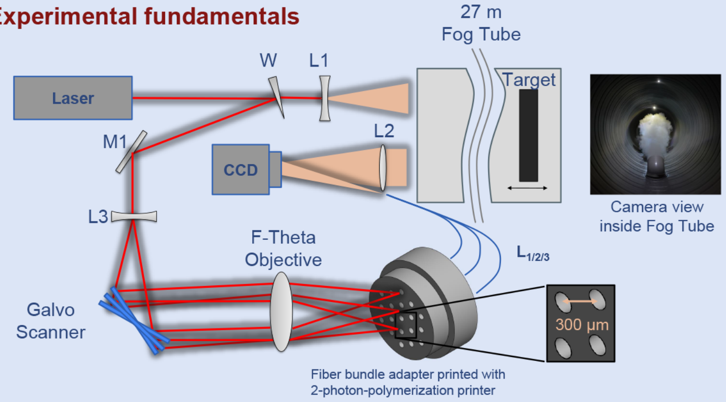


5 Experimental Results

- Compared to conventional imaging, the digital holographic measurement requires 20x less laser illumination power for the same imaging range. With the holographic shape measurement, the spatial relation of different objects in a „scene“ covered in dense fog can be retrieved.

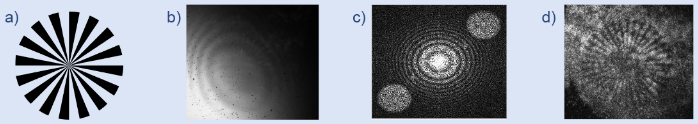


4 Experimental fundamentals



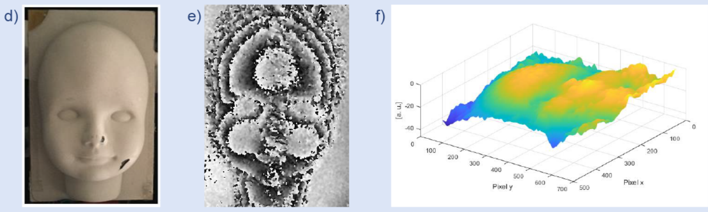
The digital holographic setup with dynamic reference arm.

Digital holographic reconstruction



a) Test object Siemens star r=8 cm. b) Obtained digital hologramm. c) 2D Fouriertransform. d) Numerical reconstructed image. In comparison to the camera image the Siemens star can be recognised

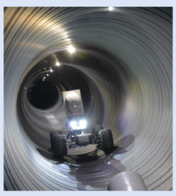
Two-wavelengths digital holographic shape measurement



d) Test object. e) Phase image of two holograms with different wavelengths. f) Unwrapped phase map.

6 Conclusion and outlook

- A digital holographic setup, which is capable of retrieving the distance and shape information of objects in a highly scattering medium with temporally changing location of the scattering particles has been created.
- A kHz high speed dynamic reference arm, where the light can sequentially be launched into 19 different fibers of different lengths, was constructed and successfully implemented over a length ranging from 13.5 m to 27 m
- The next steps will focus on the generation of a miniaturized, environmentally robust system using mass production scalable manufacturing techniques of the different opto-mechanical and elctro-optical devices
- The system will be implemented in driving vehicle to highlight its advantage compared to the state of the art techniques



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