FORSCHUNG: VERÄNDERN

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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.

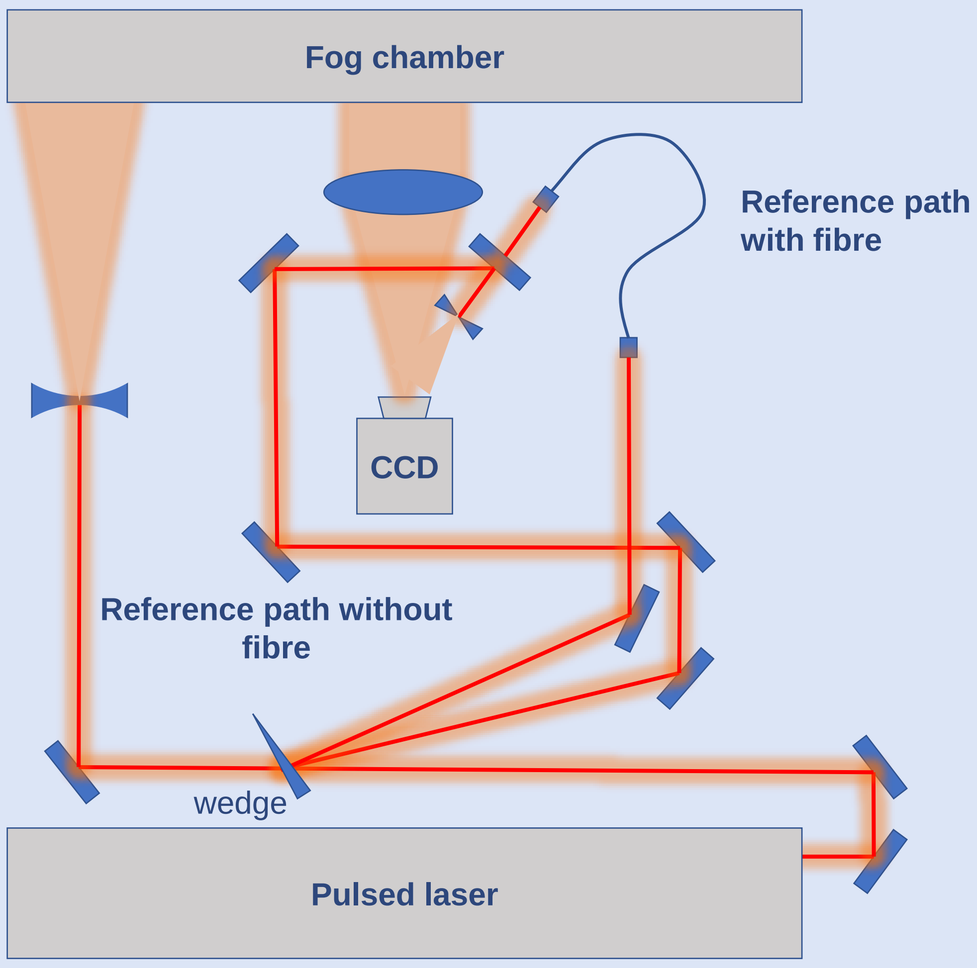
2 Systems currently in use

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.

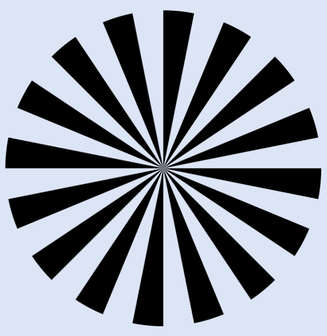
3 The novel solution

Is based on a macroscopic implementation of optical coherence tomography (OCT) known from medical technology combined with digital 2-wavelength holography. The improved depth resolution, 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 recognise them (i.e. a person is also recognised as a human being, a car as a car, etc.) and to determine the speed of the detected objects.

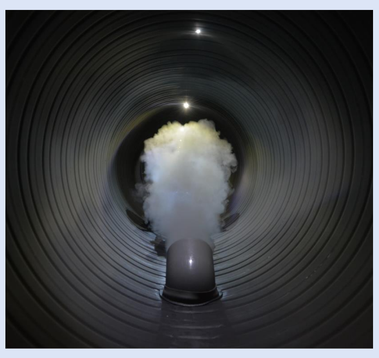
4 Experimental fundamentals



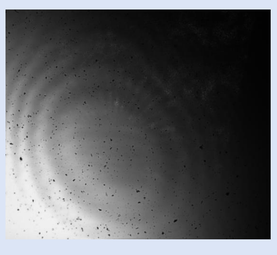
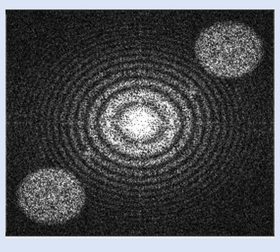
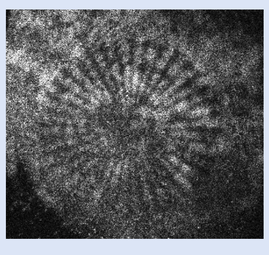
The digital holographic setup with static reference arm.



Test object Siemens star r=8 cm

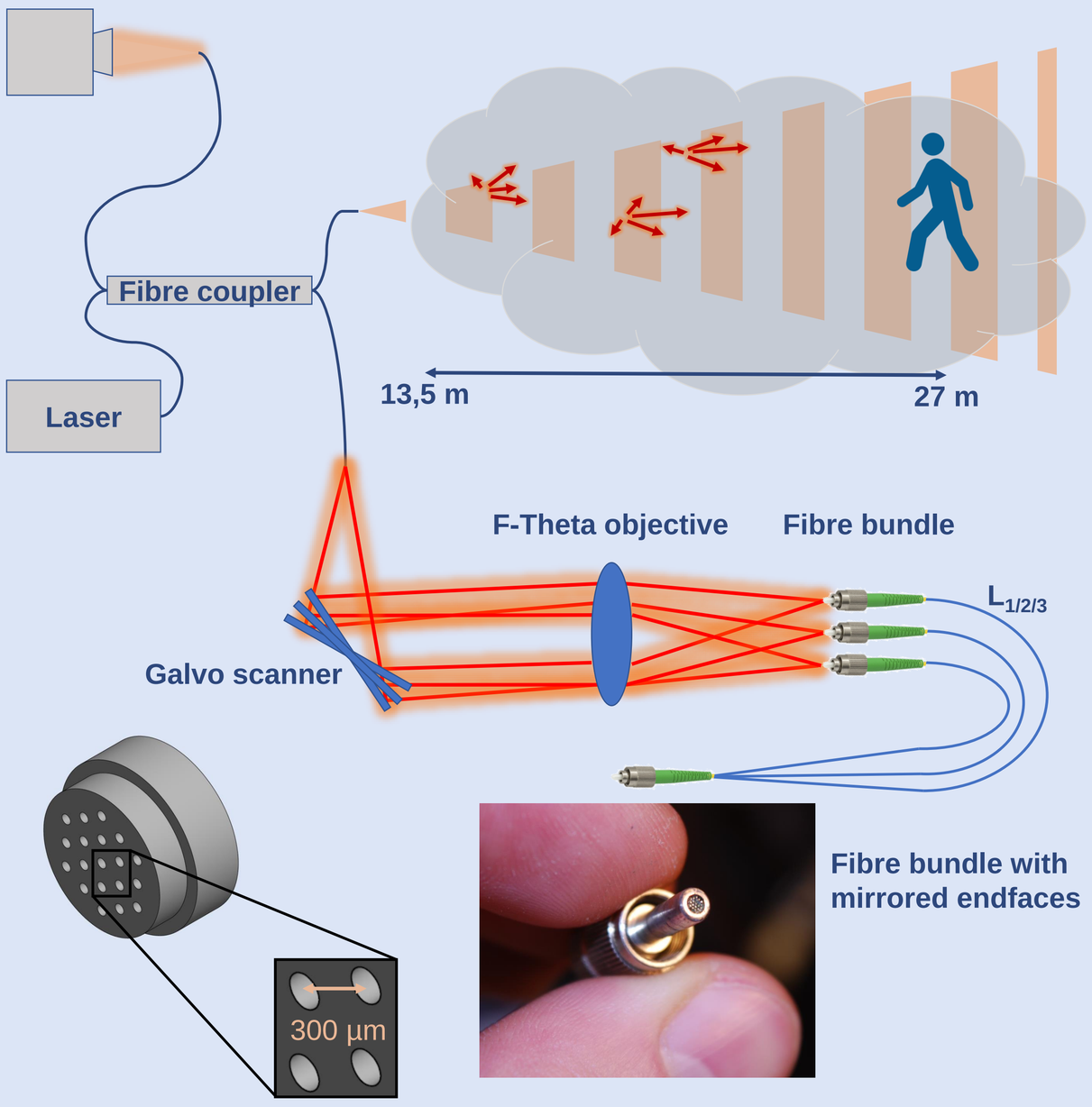


Camera image obtained from a distance of 17 m

a)  b)  c) 

a) Obtained digital hologramm. b) 2D Fouriertransform. c) Numerical reconstructed image. In comparison to the camera image the Siemens star can be recognised

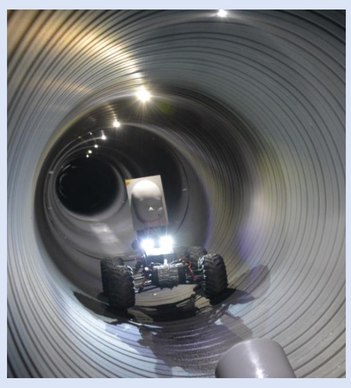
5 The dynamic reference arm



Fibre bundle adapter printed with a 2-photon-polymerization printer

6 Conclusion and outlook

- A digital holographic setup, which is capable of retrieving the shape information of a test object in a highly scattering medium has been created.
- A dynamic reference arm with 19 fibres of different lengths, able to scan distances from 13,5 m to 27 m, was constructed.
- Next steps:
  - Combine the digital holographic setup with the dynamic reference arm
  - Static and dynamic test of the system in the fog chamber
  - Integration of the 2-wavelength method to the system
  - Improve evaluation with available simulations of the scattering properties of fog and clouds
- Final goals of the project
  - Checking the laser safety requirements for tests on public roads
  - Test of the vehicle-mounted system



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