Holographic optical element for laser time-of-flight flow sensor

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Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Dam-Hansen, C., Kitchen, S.
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VCSEL array for compact time-of-flight sensor

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Organisations: Risø National Laboratory for Sustainable Energy
Contributors: Jakobsen, M., Osten, S., Kitchen, S., Dam-Hansen, C., Hanson, S. G.
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Holographic common-path interferometer for angular displacement measurements with spatial phase stepping and extended measurement range

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Optical Sensors Based on Dedicated Diffractive Optical Elements

This thesis deals with the development of optical sensors based on laser diodes and dedicated diffractive optical elements. The thesis is divided into two parts. The first part of the thesis deals with development of interferometrically based displacement sensors intended for use in pressure transducers. For the purpose of probing the deflection of the diaphragm in a pressure transducer, a novel common-path interferometer has been developed. The central part of the common-path interferometer is a multi-functional holographic optical element (HOE) that handles function like beam splitting and focusing of the light. The HOE works as both transmitter and receiver in the common-path setup. This means that the stability is inherent in the HOE and the system is self-aligning, which makes the sensor very robust. There has also been devised a new technique to extend the unambiguous measurement range of differential displacements. This
technique is based on probing three points on the object surface simultaneously and utilises the quadrature phase signals that are automatically provided by the specially designed HOE. During the project, there has also been developed a new tool for conceiving new types of common-path interferometers by placing a specially designed HOE in the Fourier plane of a 4-f setup. The surface structure for the Fourier filter can be calculated by Fourier transforming the desired impulse response function of the system. Thereby, the system can be designed to probe a specific type of surface displacement.

The second part of the project deals with development of optical flow sensor systems. Firstly, a new beam splitter system based on two linear gratings has been devised. The beam splitter is intended for use in laser Doppler anemometry systems, where the fringe spacing in the measurement volume is directly proportional to the wavelength of the light source. This is compensated by the beam splitter system by letting the closing angle of the two probe beams be wavelength dependent. Secondly, a new laser time-of-flight sensor has been developed. The sensor is intended for in-situ calibration of other types of flow sensors, which are permanently installed in large flow installations. The system is designed so that the transmitter and receiver functions are implemented in a single HOE plane. This makes the LTV sensor self-aligning and robust. The multi-functional HOE is additionally designed so that the LTV sensor to a first degree is wavelength independent. All the diffractive structures are implemented as surface relief structures in photoresist. These structures have the advantage that they can be replicated using for instance injection moulding. Thereby one can mass-produce the structures at low cost, which makes it possible to manufacture a cheap optical sensor.

Quasi-achromatic laser Doppler anemometry systems based on a diffractive beam splitter

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VCSEL array for compact time-of-flight sensor

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Compact optically based systems for linear and angular displacement sensing

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Contributors: Hanson, S. G., Jakobsen, M., Kitchen, S., Osten, S.
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Diffractive beam splitter for use in laser doppler anemometry systems based on laser diodes

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Enlargement of the dynamic range for interferometric displacement measurements (poster)

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Holographic common-path interferometer for measuring tilt or vibrations utilising a spatial heterodyne principle

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Contributors: Kitchen, S., Dam-Hansen, C.
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Holographic common-path interferometer with extended measurement range for differential displacement measurements

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Holographic laser time-of-flight velocimeter

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Impulse response function for common-path interferometers

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Fourier plane filters and common path interferometry in vibrometers and electronic speckle interferometers

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Contributors: Kitchen, S., Hanson, S. G., Hansen, R.
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Introduction of the impulse response function in common-path interferometers with Fourier plane filters

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Optical displacement sensor based on common-path interferometry for industrial purposes

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Optical displacement sensor based on common-path interferometry for industrial purposes

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Projects:

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