Zero-crossing detection algorithm for arrays of optical spatial filtering velocimetry sensors

Jakobsen, Michael Linde; Pedersen, Finn; Hanson, Steen Grüner

Published in:
Optical sensors 2008

Link to article, DOI:
10.1117/12.781561

Publication date:
2008

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
This paper presents a zero-crossing detection algorithm for arrays of compact low-cost optical sensors for measuring e.g. minor fluctuations in angular velocity of rotating solid structures. The algorithm applies to signals with low signal-to-noise ratio, and delivers a “real time” output (0-1 kHz). The sensors use optical spatial-filtering velocimetry on the dynamical speckles arising from scattering off a rotating solid object with a non-specular surface. The technology measures rotation of a target, without being biased by any linear translation of the object. The calibration of the sensors is independent of the radius of the target, the wavelength of the light, and the distance to the object. No preparation of the surface, as in the case of an indexer, is necessary. Furthermore, any thermal dependency of the calibration factor is directly related to the thermal expansion and refractive-index coefficients of the optics (> 10^-5 K^-1 for glass). By cascade-coupling an array of sensors, the ensemble-averaged angular velocity is measured in “real-time”. This allows the instrumentation to significantly reduce pseudo vibrations, and to gain high performance measurement of angular velocity. The traditional zero-crossing detection is extended by 1) inserting an appropriate band-pass filter before the zero-crossing detection, 2) measuring time periods between zero-crossings and 3) doing peak searches in histograms of time-period to allow measuring at low signal-to-noise levels. The algorithm will be compared with time-resolved Fourier analysis.