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

This paper presents a zero-crossing detection algorithm for arrays of compact low-cost optical sensors based on spatial filtering for measuring fluctuations in angular velocity of rotating solid structures. The algorithm is applicable for signals with moderate signal-to-noise ratios, 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 the instantaneous angular velocity 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 is needed in the case of an indexer, is necessary here.

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 will reduce the influence of pseudo-vibrations arising from repeating the same measurement error for each revolution of the target, 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 the histograms of time-periods facilitating measurement at low signal-to-noise levels. This algorithm will be compared with time-resolved Fourier analysis.

General information
State: Published
Organisations: Optical Sensor Technology, Department of Photonics Engineering
Contributors: Jakobsen, M. L., Pedersen, F., Hanson, S. G.
Publication date: 2008

Host publication information
Title of host publication: Optical sensors 2008
Volume: 7003
Place of publication: Bellingham
Publisher: SPIE - International Society for Optical Engineering
Editors: Berghmans, F., Mignani, A., Cutolo, A., Meyrueis, P., Pearsall, T.
ISBN (Print): 978-0-8194-7201-4
Electronic versions:
2008_75.pdf
DOIs:
10.1117/12.781561
Source: orbit
Source-ID: 223213
Research output: Research - peer-review » Article in proceedings – Annual report year: 2008