Fiber Bragg Grating Demodulation Technology

Article Overview

FBG demodulation methods include cross-correlation, centroid, polynomial fitting, Hilbert transform, fast phase correlation, wavelet-based filtering, digital filtering, and neural network approaches.

Classical and Signal-Based Methods

Cross-Correlation Methods: These involve comparing the measured FBG spectrum with a reference spectrum to determine the wavelength shift. Variants include iterative cross-correlation and FFT-based cross-correlation, which improve accuracy and reduce peak-locking effects . Centroid Algorithms: The centroid method calculates the center of mass of the reflected spectrum to estimate the Bragg wavelength, providing a simple and computationally efficient approach . Polynomial Peak Tracking: Second-order or higher-order polynomial fitting is applied to the spectral peak to track wavelength shifts, often used for multiple FBGs or overlapping spectra . Hilbert Transform and Zero-Crossing: The Hilbert transform converts the resonance peak into a zero-crossing curve, which can then be analyzed to determine the wavelength shift. This method is often combined with cross-correlation for enhanced precision . Fast Phase Correlation: This method uses phase information of the spectrum to quickly and accurately determine wavelength shifts, suitable for real-time applications .

Filtering and Numerical Approaches

Wavelet Transform: Wavelet-based filtering is used to denoise the FBG spectrum before demodulation, improving measurement accuracy . Digital Filtering: Classical digital filters or matched filtering techniques can enhance the signal-to-noise ratio and extract the Bragg wavelength from noisy spectra . Karhunen-Loeve Transform (KLT): KLT is applied to represent the measured spectrum in an orthogonal basis, facilitating precise wavelength estimation . Gaussian Curve Fitting: For distorted spectra, fitting a Gaussian function to the reflection peak allows accurate determination of the Bragg wavelength . Cumulative Sum and Empirical Mode Decomposition: These preprocessing methods reduce noise influence and simplify subsequent wavelength shift calculations .

Advanced and AI-Based Methods

Artificial Neural Networks: Machine learning algorithms can model complex spectral distortions and perform demodulation with high accuracy, especially in multi-FBG systems . Dynamic Statistical Threshold Detection and Wavelet Packet Decomposition: These methods are used to minimize noise effects and improve the reliability of wavelength shift detection .

Summary

Fiber Bragg Grating Demodulation Technology

FBG demodulation methods can be broadly categorized into signal transformation techniques, numerical fitting approaches, filtering and denoising methods, and AI-based algorithms. The choice of method depends on the application requirements, including accuracy, computational complexity, noise robustness, and the number of FBGs being interrogated. Combining multiple methods, such as cross-correlation with Hilbert transform or wavelet filtering with centroid calculation, is common to enhance precision and reliability .

This paper presents a new method of demodulating the spectrum of fiber Bragg grating (FBG) based sensors by

Fibre Bragg gratings are one of the most popular sensors with a huge number of applications. Their most important

Fiber Bragg grating (FBG) array is a powerful technique for quasi-distributed sensing along the entire length of

A novel approach to fibre Bragg grating spectra processing is proposed. The method is based on the use of nonlinear

Abstract In-fiber Bragg grating filters continue to proliferate, and their applications expand with the rapid advancement of

A high-performance, low-cost demodulation system is essential for fiber-optic sensor-based measurement

Fiber Bragg grating (FBG) demodulation based on microwave photonics (MWP) would have a high resolution but the

Among them, wavelength demodulation technology is to obtain sensing information through the modulation of external

Fiber Bragg grating sensor is a new kind of sensor, which has a very broad application prospect. The main obstacle to

A three-points tracking-based high-speed fiber Bragg grating (FBG) demodulation method based on wavelength

Fiber Bragg Grating (FBG) sensors are an emerging and prominent optical sensing technology of accurately measuring

Fiber Bragg Grating Demodulation Technology

Abstract Fiber Bragg grating (FBG) sensors have emerged as advanced tools for monitoring a wide range of physical parameters in

Fiber Bragg gratings (FBGs) are widely used as sensors for temperature, strain, and

A discrimination measurement method and demodulation technique for fiber Bragg grating (FBG) sensors were

In order to detect weak signals of high frequency with fiber Bragg gratings (FBG), the FBG demodulation system

Traditional demodulation technology of optical fiber sensor has the disadvantages of low precision, slow speed and poor stability. In

Web: https://morwarreconst.co.za