

High-Frequency Fiber Bragg Grating Demodulation Methods



AI Overview

High-frequency FBG demodulation can achieve rates up to 40–120 kHz with picometer-level accuracy using microwave photonics, chromatic dispersion, and advanced signal processing algorithms.

Overview of High-Frequency FBG Demodulation

High-frequency FBG demodulators are designed to rapidly and accurately measure wavelength shifts in FBG sensors, which correspond to physical parameters like strain, temperature, or vibration. Traditional demodulation methods using tunable lasers or broadband sources with filters are limited in speed, making them unsuitable for high-frequency applications such as aero-engine testing or vibration monitoring.

Microwave Photonics and Chromatic Dispersion Approach

A widely used high-speed technique combines microwave photonics with chromatic dispersion. In this method, a broadband light source modulated with a frequency-swept microwave signal is reflected by the FBGs. The reflected signal is mixed with the original microwave to produce a beat frequency, which varies with the FBG wavelength shift. A dispersion compensation fiber (DCF) converts wavelength changes into measurable frequency changes, allowing rapid demodulation of multiple FBGs in a quasi-distributed network.

Demodulation rate: Up to 40 kHz for 105 FBGs with 0.1% reflectivity and 1 m spacing.

Accuracy: Approximately 8–10 pm.

Signal processing: Chirp-Z transform combined with Hanning window algorithms improves frequency analysis and reduces noise. Thermal drift in DCF can be compensated using a single-peak reference filter.

Algorithmic Enhancements

For high-precision demodulation, variable-step-size cross-correlation algorithms and cubic spline interpolation are used to refine wavelength determination. This approach reduces computational load while achieving picometer-level resolution over a wide bandwidth...

Article Content

Fibre Bragg Grating Wavelength Shift Demodulation with Filtering and ...

A novel approach to fibre Bragg grating spectra processing is proposed. The method is based on the use of nonlinear filtration and raising the spectrum value to the second power. A

Analytical Modeling and Generation of Versatile Optical

By utilizing a fiber Bragg grating (FBG) to remove the undesired sideband, an output signal that features a triangular-shaped waveform is finally achieved.

Fiber Bragg Gratings | SIMWORKS

Fiber Bragg Grating (FBG) is an optical filtering device formed by introducing a periodic refractive index modulation in the fiber core, widely used in optical fiber communications, fiber sensing, laser

High Resolution Demodulation of Fiber Bragg Grating via

This paper introduces a computationally efficient Logarithmic Gaussian Levenberg-Marquardt (LGLM) algorithm for FBG demodulation, which significantly enhances system stability and improves range

Demodulation of Fibre Bragg Grating Sensors by Using Cumulative

New demodulation methods are constantly being developed. Many of them have good properties, but they do not gain much polarity. This is partly due to their high complexity and partly to a small

A Tracking-Based High-Speed Demodulation Method for Fiber Bragg

In this article, a tracking-based high-speed demodulation method for FBG sensing system based on wavelength-tunable laser is proposed. The wavelength-tunable laser only scans

Everyone in the AI trade can explain a GPU, but few can explain ...

DFB (distributed feedback): a Bragg grating etched along the cavity. The product of grating coupling strength and cavity length, κL , sets single-mode yield, and quarter-wave-shifted gratings force

On the Implementation of a Micromachining Compatible MOEMS Tri

Fiber Bragg grating acceleration sensors use optical wavelength signals as a medium for information transmission to effectively eliminate the influence of electromagnetic interference between ...

Polydimethylsiloxane diaphragm-based fiber ultrasonic

This study proposes a high-frequency pneumatic system and demodulation method based on polydimethylsiloxane (PDMS) film-embedded

Xianming Liu's research works | Chongqing University and other places

Xianming Liu's 63 research works with 443 citations, including: Sapphire-silica fiber fusion splicing method based on ring-shaped laser heating

Greshnov, A. A., Lebedev, V. V., Shamrai, A. V. (2012) High-frequency ...

Greshnov, A. A., Lebedev, V. V., Shamrai, A. V. (2012) High-frequency modulation of light in diffraction by the Bragg grating with a refractive index traveling wave.

Experimental Research on Fiber Bragg Gratings High-Speed

In order to detect weak signals of high frequency with fiber Bragg gratings (FBG), the FBG demodulation system based on matched filter is established. First, the output expression and

Low-Cost FBG Interrogator Using Random Nanoparticle-Doped Fiber

The use of fiber Bragg gratings (FBGs) is widespread in a broad range of applications. However, one of the main drawbacks is the cost and practicality of FBG interrogation systems, which are generally

Demodulation Algorithm for Fiber Bragg Grating Sensors

A demodulation algorithm is vital for a fiber Bragg grating (FBG) sensing system. In this paper, a novel demodulation algorithm based on the variable-step-size method and cross-correlation algorithm is

High-Speed Demodulation of weak FBGs Based on Microwave

In this Letter, we propose a high speed quasi-distributed demodulation method based on the microwave photonics and the chromatic dispersion effect. The scheme uses broadband light source and

A bionic seal whisker Karman vortex street sensor with wet-end ...

This study introduces a novel bionic approach: a method for developing a Kármán vortex street sensor by integrating a bionic seal vibrissa structure with a fiber Bragg grating (FBG)-based vibration

Demodulation method for vibration sensors of ultra-weak fiber Bragg ...

In this paper, a novel demodulation method for vibration sensors based on ultra-weak fiber Bragg grating (FBG) using a self-referencing signal and DBN is proposed.

Multitaper FFT-Based Full-Spectrum Phase Demodulation for High ...

Conventional demodulation methods for fiber-optic Fabry-Pérot (F-P) temperature sensors are limited either by the spectral resolution of wavelength-drift approaches or by spectral

Study on Measurement Resolution Improvement Method of FBG

In the testing of Fiber Bragg Grating (FBG) vibration sensors, it was observed that the demodulation sampling rate significantly influences the acceleration measurement resolution. To investigate the

A review of technical advances in rotor temperature estimation methods ...

This involves direct temperature sensing through methods such as buried Fiber Bragg Grating-based (FBG) sensors and infrared thermal imaging, which provide high precision in

Cladding waveguide fiber Bragg grating accelerometer fabricated in ...

Abstract This paper presents a cladding waveguide fiber Bragg gratings (CWFBGs) two-dimensional (2D) vector accelerometer in a standard single-mode fiber. The cladding waveguides

A novel temperature-compensated, intensitymodulated fiber Bragg grating ...

Abstract Abstract□An intensity-modulated, fiber Bragg grating (FBG) sensor system based on radio-frequency (RF) signal measurement is presented. The RF signal is generated at a photodetector by

A miniature fiber Bragg grating-based contact force sensor with ...

To tackle the loss of tactile perception in minimally invasive surgery (MIS) and the challenge of simultaneously achieving miniaturization, high sensitivity, and lateral-force resistance in existing one

Fiber Bragg Gratings - Buyer's Guide & Suppliers

This buyer's guide for fiber Bragg gratings provides technical background, comparison of major types, selection criteria, and an overview of suppliers.

Optical Fiber Sensing Technology for Sports Monitoring:

The advancement of sports science has heightened demands for precise monitoring of athletes' technical movements, physiological status, and

Demodulation of an optical fiber MEMS pressure sensor

An approach to the interrogation of a linearly chirped fiber Bragg grating (LCFBG) sensor using a linearly frequency-modulated (or chirped) optical waveform (LFMOW) with a high resolution is ...

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