Vibration Measurement Experiment Using Fiber Optic Sensing

Overview

Highly sensitive fiber optic sensor for the field of ground vibration measurement. Three orthogonal components acceleration or particle velocity measurement.

Key Takeaways

Fiber optic sensors, particularly Fabry–Perot and phase-type sensors, enable precise vibration measurement with high sensitivity, small size, and immunity to electromagnetic interference. Sensor Types and PrinciplesFabry–Perot (FP) Interferometer Sensors: These sensors detect vibration by measuring changes in the cavity length between two reflective surfaces. When a mass attached to the fiber vibrates, it alters the FP cavity length, modulating the reflected light intensity.

F

P sensors are compact, stable, and suitable for high-temperature environments up to 500 °C, with resonance frequencies typically in the range of 165 Hz and voltage sensitivities around 11. 57 mV/g (nonlinearity ~2. 06%) for small-scale setups.

Phase-

Type Fiber Optic Sensors: These sensors measure the phase change of light traveling through the fiber caused by vibrations. They offer higher accuracy than intensity-type sensors and can detect weak vibrations, such as footsteps or vehicle movement, along existing fiber optic cables.

© 2026 ENSAA OPTICAL NETWORKS - All rights reserved

Multimodal Speckle-

Polarization Sensors: Combining speckle pattern analysis and polarization interrogation allows high-fidelity waveform reconstruction over broad frequency ranges (100 Hz–40 kHz) and centimeter-scale spatial resolution, suitable for real-time monitoring of critical infrastructure.

Experimental Setup

Sensor Fabrication: For FP sensors, construct the cavity by fusing hollow silica tubes between single-mode fibers and attach a small mass to one fiber. Encapsulate the assembly in a protective shell to maintain alignment and environmental stability. Light Source and Detection: Use a coherent light source (laser or IR LED) coupled into the fiber.

The reflected or transmitted light is collected by a photodiode or photodetector, converting optical signals into electrical signals for analysis. Signal Demodulation: Light intensity or phase changes are demodulated using electronics or software (e.g., MATLAB, Arduino IDE) to extract vibration amplitude and frequency information. Data Acquisition: Synchronize multiple sensors for distributed measurements.

Multiplexing allows simultaneous monitoring of several points along a single fiber, enabling structural health monitoring or vibration localization. ApplicationsHigh-Temperature Environments: FP sensors with all-silica structures can operate in harsh conditions like turbines or pipelines. Environmental Monitoring: Phase-type sensors can detect vibrations along buried communication fibers, useful for railway, highway, or infrastructure monitoring.

Structural Health Monitoring: Distributed fiber optic accelerometers can measure dynamic responses of bridges, dams, and tunnels, and detect localized events such as cable strand breaks. Smart Infrastructure: Multimodal fiber sensors support real-time monitoring for autonomous systems, predictive maintenance, and safety applications.

Practical Considerations

Ensure proper alignment and minimal optical loss in the fiber connections. Calibrate the sensor system to relate optical signal changes to vibration amplitude. Consider environmental factors such as temperature drift, which can affect FP cavity length and phase measurements.

Use multiplexing and synchronized data acquisition for large-scale or distributed experiments. By following these principles, a fiber optic vibration measurement experiment can achieve high sensitivity, distributed monitoring capability, and robustness in challenging environments.

© 2026 ENSAA OPTICAL NETWORKS - All rights reserved

Article Content

Fiber Optic Vibration Sensors

Highly sensitive fiber optic sensor for the field of ground vibration measurement. Three orthogonal components acceleration or particle velocity measurement. Sensor encapsulated in 3D

Vibration monitoring of fiber optic current sensors based on dual ...

In this paper, we propose a modulation - demodulation method based on dual closed-loop feedback to measure the occurrence of sudden vibrations without affecting current measurement.

(PDF) Fiber Optic Vibration Sensors

A simple geometrical fiber optic vibration sensor is designed and demonstrated using fiber optic fused 2x2 coupler that utilizes the principle of reflection intensity modulation.

Enhanced Ultra-Long-Range Vibration Sensing Using an Asymmetric ...

Abstract: Ultra-long-range vibration monitoring via distributed fiber optic sensing technology is a critical advancement for modern engineering projects. However, the loss of light

Distributed Fiber-Optic Sensors for Vibration Detection

Distributed fiber-optic vibration sensors receive extensive investigation and play a significant role in the sensor panorama. Optical parameters such as light intensity, phase,

An Ameliorated Positioning Scheme for Optical Fiber Interferometer ...

Abstract: Optical fiber interferometer vibration sensors demonstrate a distinctive capability to monitor mechanical vibrations across numerous independent points using a multicore

Integrated sensing and communication in an optical fibre

A scheme of integrated sensing and communication in an optical fibre (ISAC-OF) using the same wavelength channel for simultaneous high-speed data transmission and distributed vibration...

Fiber Optic Based Distributed Mechanical Vibration Sensing

The distributed long-range sensing system, using the standard telecommunication single-mode optical fiber for the distributed sensing of mechanical vibrations, is described. Various events

© 2026 ENSAA OPTICAL NETWORKS - All rights reserved

DwyerOmega | Shop for Sensing, Monitoring and Control Solutions

Explore DwyerOmega''s comprehensive range of industrial sensing, monitoring, and control solutions from thermocouples to pressure transducers engineered for precision and reliability.

Photonics

Photonics Spectra is a global photonics resource and magazine with news, products, research, and applications covering optics, lasers, imaging, and sensing.

Fiber Optic Vibration Sensors

Three sensors presented make use of non-contact vibration measurement method with plastic fiber using distinct designs, improvement of the sensor response and advantages of one

Distributed Optical Fiber Vibration Sensors Using Light Interference ...

Recently, the optical fiber sensors have garnered widespread recognition and have been successfully deployed in various applications, such as biosensing, physical measurement, and so on. Among

Simultaneous current and vibration measurement based on

In this paper, an approach to achieve simultaneous measurement of electric current and real-time vibration is proposed with a hybrid interferometric fiber optic sensor comprised of a

Achieving precise multiparameter measurements with distributed optical ...

The development of advanced distributed optical fiber sensing systems that are capable of performing accurate and spatially resolved multiparameter measurements is of great interest to a

Distributed single fiber optic vibration sensing with high frequency ...

ABSTRACT A distributed fiber optic vibration sensing system with high frequency response and multi-points accurate location is proposed and demonstrated by combining a feedback

Vibration-Temperature Separation Using Few-Mode Forward

Long-distance distributed fiber-optic sensing can be achieved using forward transmission distributed sensing technology. However, current forward transmission methods struggle to distinguish between

Design and implementation of an optical fiber sensing based vibration ...

© 2026 ENSAA OPTICAL NETWORKS - All rights reserved

Extraction using FFT and pattern recognition through bp neural network yields the system accuracy rate of 96.7 %. The proposed interference type optical fiber technology provides a novel approach for real

Sagnac Interference-Based Contact-Type Fiber-Optic Vibration Sensor

The observation and evaluation of vibration signals is crucial for enhancing engineering quality and ensuring the safe operation of equipment. This paper proposes a fiber-optic vibration

Related Video Reference

This video was associated with the source search result. Verify technical details against current product documentation and project requirements.

Contact Us

Continue your research online:

Website: https://ensaa.es
Technical inquiry: https://ensaa.es/contact.html

This document is for preliminary research. Verify specifications against current standards, product documentation and project requirements.

© 2026 ENSAA OPTICAL NETWORKS - All rights reserved