Short-period fiber optic seismometer

Overview

This paper reviews the methods of correcting the frequency response of short-period seismometers and geophones, i.e., the multiplication of the transfer sensor functions by the transfer...

Key Takeaways

Short-period fiber optic seismometers are advanced seismic sensors that combine high-frequency detection with the sensitivity and robustness of fiber-optic technology. OverviewShort-period seismometers are designed to detect high-frequency seismic waves with periods typically less than 1 second, making them ideal for monitoring local earthquakes, volcanic activity, and small-scale seismic events. Traditional short-period seismometers use mechanical spring-mass systems with electronic feedback to achieve high sensitivity and broad frequency response.

Fiber-optic technology introduces a new approach by using optical fibers as sensing elements, which can detect minute ground motions through changes in light interference patterns.

Fiber-

Optic Implementation

A fiber-optic seismometer, similar to a fiber-optic hydrophone (FOH), typically employs an optical fiber coil wrapped around a sensitive mandrel in an interferometric configuration, such as a Michelson interferometer. Ground vibrations induce strain in the fiber, causing measurable phase shifts in the light signal. This method allows for: High sensitivity to small seismic events, comparable to traditional piezoelectric sensors.

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Wide frequency response, often covering the 5–70 Hz range suitable for short-period seismic waves. Environmental robustness, as fiber-optic sensors are lightweight, immune to electromagnetic interference, and can operate in harsh conditions without local power supply at the sensor location. Advantages Over Traditional SensorsFiber-optic short-period seismometers offer several benefits: Compact and lightweight design, facilitating deployment in dense seismic networks.

Remote sensing capability, as the optical fiber can transmit signals over long distances without significant loss. Durability and low maintenance, reducing operational costs compared to conventional electromechanical seismometers. High-resolution recordings of local seismicity, particularly useful in volcanic or submarine environments where overlapping signals complicate interpretation.

Applications

These sensors are particularly useful for: Monitoring local earthquakes with magnitudes below 4, where high-frequency body waves dominate. Volcanic activity surveillance, detecting small tremors and swarms in active volcanic regions. Critical infrastructure monitoring, such as nuclear power plants, where dense short-period seismic networks are required.

Submarine seismic monitoring, leveraging fiber-optic hydrophone designs to detect underwater seismic events. ConclusionShort-period fiber optic seismometers represent a cutting-edge integration of optical technology with traditional seismic sensing, providing high sensitivity, broad frequency response, and operational advantages in challenging environments. They are increasingly relevant for dense seismic networks, volcanic monitoring, and critical infrastructure protection, complementing conventional short-period seismometers and accelerometers.

Article Content

An illustrated guide to: Distributed and integrated fibre-optic sensing ...

The basic concept of integrated, i.e., transmission-based, fibre-optic sensing rests on the emission of a laser signal at one end of an optical fibre that is received at the other end with some

Fiber-Optic Broadband Seismometer Based on Inverted Pendulum

A fiber-optic broadband interferometric inverted pendulum seismometer (iIPS) is proposed. It is designed with a cross-spring inverted pendulum and a hybrid Michelson

(PDF) Short-Period Seismometers in Seismology

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Rapid and Temporary Deployment of Fiber-Optic ...

For the May and October field experiments, our team deployed approximately 2 km of fiber-optic cable from a spool containing 4.5 km of tight-buffered fiber, encased in a polyurethane jacket reinforced

Fiber-Seismometer Hybrid Sensing Interferometry: A New Approach to ...

In a field hybrid sensing experiment along the Qiantang River, we demonstrated how this approach improves the retrieval of coherent seismic signals, enhancing imaging techniques such as

Seismic monitoring using the telecom fiber network

We systematically analyze 1.5 years of acquisitions on a land-based telecommunication cable in comparison to co-located seismometers, with successful detection of events in a broad

Broad-band, wide-band, short period seismometer

This type of seismometer has been designed for microseismic events recording during hydraulic fracturing reservoir experiments. It uses quad geophone strings per axis, in order to maximize

Ultimate Guide to Short-Period Seismometer

Discover the significance of short-period seismometers in seismology, their applications, and how they contribute to understanding seismic activities.

On the Broadband Instrument Response of Fiber-Optic DAS Arrays

Distributed Acoustic Sensing (DAS) is a novel tool in array seismology that measures the phase of backscattered laser pulses traveling in a fiber-optic cable, and relates this measurement to

Towards a widely applicable earthquake detection algorithm for ...

Therefore, there is a need for earthquake detection algorithms that can, first, be applied for arbitrary fibre geometries; secondly, maximize the spatial sampling extent of the seismic wavefield by

Fiber optic interferometric seismometer with phase feedback control

A high sensitivity ultralow-frequency fiber optic interferometric seismometer using phase feedback control is proposed and demonstrated. The principle of sensitivity improvement using

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Researching | Design of low frequency fiber optic Fabry–Perot ...

Abstract We develop a low frequency fiber Fabry–Perot (F-P) seismometer based on transfer function analysis. The seismometer structure and demodulation system accuracy are limitations of low

New Methods to Seismic Monitoring: Laboratory Comparative Study of ...

New possibilities of vibration monitoring can be found in completely different physical approaches, where all measuring technology is currently based on sensors in the electrical domain.

Review of the Usefulness of Various Rotational Seismometers with

The review presented here shows that fibre-optic rotational seismometers are the most attractive option, since their parameters can meet all the requirements of the various areas of interest

Recent advances in earthquake monitoring I: Ongoing revolution of ...

Seismic networks have significantly improved in the last decade in terms of coverage density, data quality, and instrumental diversity. Moreover, revolutionary advances in ultra-dense

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A fiber-optic interferometric seismometer

A fiber-optic interferometric sensor has been developed which consists of a seismic mass of 520 gm supported by two rubber mandrels, each wound with a single layer of single-mode optical fiber 6.5 m

Fiber Optic 3-Component Seismometer

Abstract: An all-metal 3-component optical fiber seismometer was proposed and experimentally demonstrated. The theoretical analysis was given based on the electro-mechanical theory.

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