

Article Overview

Fiber optic sensors, particularly plastic or polymer optical fibers, can measure angles with high sensitivity and resolution using light intensity changes caused by fiber bending or twisting.

Principles of Fiber Optic Angle Measurement

Fiber optic angle sensors operate by detecting changes in light transmission caused by bending, twisting, or macro-bending of the fiber. One common method is the Twisted Macro-Bend Coupling (TMBC), where a fiber is bent and twisted, generating a bend-loss that is coupled into a second fiber to measure the angle. This approach allows for clockwise and anticlockwise angle detection with high repeatability and stability, achieving sensitivities around 2.2 nW/° and resolutions of 0.45° across a full 0°-360° range, with repeatability errors as low as 0.4% . Another widely used approach is the light intensity-based plastic optical fiber (POF) sensor, which measures the loss of light intensity as the fiber bends or the gap between fibers changes. POF sensors are durable, flexible, and cost-effective, with system prices as low as USD 30, making them suitable for extreme environments such as underwater or areas with electromagnetic interference .

Types of Fiber Optic Sensors for Angle Measurement

- o Light Intensity Sensors: Measure changes in transmitted light due to bending or twisting. Simple, low-cost, and easy to demodulate.
- o Fiber Bragg Grating (FBG) Sensors: Detect wavelength shifts caused by strain or bending. Highly accurate but expensive (USD 20,000+), limiting widespread use.
- o Interference and Scattering Sensors: Use phase or scattering changes in light to infer angles. Typically more complex and sensitive to environmental conditions.

Applications

Fiber optic angle sensors are used in:

- o Robotics: Measuring joint angles in robot arms, including biomimetic robots, where flexibility and EMI resistance are critical .
- o Industrial Machinery: Cranes, avionics, and large civil structures where precise angle monitoring is required .
- o Extreme Environments: Underwater operations or areas with strong electromagnetic fields, where traditional electronic sensors may fail .

Advantages

Measuring Angles Using Fiber Optic Sensors

- o High sensitivity and resolution for precise angle measurement.
- o Durable and flexible, especially with plastic optical fibers.
- o Low-cost and easy to implement, particularly for light intensity-based POF sensors.
- o Stable and repeatable performance in harsh environments.

Summary

Fiber optic sensors provide a reliable, precise, and cost-effective solution for measuring angles in a variety of applications. By leveraging bending-induced light loss or wavelength shifts, these sensors can operate in environments where traditional sensors are impractical, offering high sensitivity, good repeatability, and adaptability to extreme conditions .

Here, we present a relatively new setup of two angle sensors (1-D and 2-D) for independent and simultaneous clock

Fiber optic sensors are defined as sensing devices that utilize optical fibers to convert lightwave properties into information about the

Shape-sensing optical fibers have become increasingly important in applications requiring flexible navigation, spatial

Fiber optic sensor is a new branch in fiber optics in competition with the existing communication system. This is a

The physical, technical, and functional characteristics of signal transformation in the optical system of high-precision

A fiber optic sensor operates with an optical fiber cable connected to a dedicated light source. These sensors offer great mounting

Optical fiber acoustic sensors or optical fiber hydrophones use interferometry for measurements in underwater environments [34, 38,

Few studies have addressed the quantification of crack width using distributed fiber optic sensors when the crack

Fiber-optic sensors are being widely developed because they have well-known advantages over conventional sensors

Measuring Angles Using Fiber Optic Sensors

Optical fibre sensors are an essential subset of optical fibre technology, designed specifically for sensing and

In "High-Sensitivity, Large Dynamic Range Refractive Index Measurement Using an Optical Microfiber Coupler" , a sensing

Fiber optic sensors are defined as devices that utilize optical fibers to measure a variety of stimuli, including mechanical, thermal,

A review for optical fiber bending sensors is presented. The article mainly focuses on the measurement methods of the

We present a multiplexing sensors technique using polymer optical fiber based on intensity variation for angle and

The fiber-optic angle sensor designed in this study was installed together with the high-precision MK415B Hall angle

Therefore, we have developed an angle sensor based on step-index profile plastic optical fiber (SI-POF), which is cost-effective and

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