Fiber Bragg grating shape sensing

Article Overview

Fiber Bragg Grating (FBG) sensors enable precise 2D and 3D shape reconstruction by measuring strain-induced wavelength shifts along multi-core optical fibers.

Principles of FBG Shape Sensing

FBG sensors are short segments of optical fiber with periodic refractive index variations that reflect specific wavelengths of light. When the fiber bends or twists, strain alters the reflected Bragg wavelength, allowing the measurement of curvature and torsion along the fiber. By arranging multiple FBGs along a fiber or in multi-core configurations, the spatial distribution of strain can be used to reconstruct the shape of the fiber or the instrument it is embedded in .

Multi-Core Fiber Approaches

Modern shape sensing often uses multi-core fibers, such as 7-core fibers, where one central core is surrounded by six outer cores. By comparing wavelength shifts from different cores, both bending magnitude and orientation can be determined. This enables 2D and 3D shape reconstruction with high resolution and repeatability. For example, curvature resolution can reach 0.1 m?1 in 2D, and angular errors in 3D reconstruction can be as low as 1.89? .

Computational Methods

Shape reconstruction can be performed using polynomial approximations or analytic geometry. Some methods fit polynomial coefficients to known bend configurations and model curvature as a function of these coefficients, allowing real-time tip position estimation without iterative numerical solutions. This approach achieves sub-millimeter accuracy (

Fiber Bragg Grating (FBG) sensors inscribed in multi-core optical fibers have been democratized over the years and

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

SPIE conferences bring together engineers and scientists to present their latest research and to network with peers. Each year SPIE

This paper presents the development, analysis and application of a fiber Bragg grating (FBG) array for two

Fiber Bragg grating shape sensing

Abstract In order to realize the simultaneous measurement of directional torsion and vector bending, a multifunctional

Shape sensing using Fiber Bragg Grating can be applied in many fields such as medical and robotics, and the

Fiber Bragg grating-based shape sensing: a review and perspective Wu, Jingying, Li, Baixin, Li, Chenxi, Qiu, Yang, Zhang, Zejun, et al.

Shape sensing techniques based on fiber Bragg grating (FBG) sensors capture geometric information, such as

Shape sensing is of importance for the manipulation of flexible needles. In this work, a 0.6 mm diameter stylet with five

This paper presents an innovative and efficient shape-sensing approach for optical fiber Bragg grating (FBG) arrays,

In this work, we propose a novel, computationally efficient method for determining the 3D tip position of a bent multi

A new model for calculating local curvature from the wavelength shifts of Fiber Bragg Gratings (FBGs) is developed to

Here, a single-channel single-fiber shape sensing scheme is proposed based on cascaded

In this paper, we propose a novel shape-sensing method based on deep learning with a multi-core optical fiber for the

Fiber Bragg grating (FBG) shape sensing, particularly eccentric FBG (eFBG), is a promising

Tracking and controlling the shape of continuum dexterous manipulators (CDMs) in real time during nonconstant

Web: https://www.kremgroup.co.za