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A modal-based approach for modelling the cantilever FBG accelerometer with the presence of tip mass and its sensitivity analysis

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ABSTRACT

The modal-based approach for modelling cantilever-type FBG accelerometer (FBG-MM), which has been recently published, does not include the presence of tip mass and sensitivity study since it mainly focusses on the feasibility of the Euler-Bernoulli model onto a cantilever FBG accelerometer. The adaptability of tip mass into the modal model of the cantilever FBG accelerometer, namely FBG-MMTP, is presented in this manuscript, which can precisely predict the response and sensitivity of the accelerometer. The newly presented model is compared to the experimental results for different sizes of tip mass and the range of excitation frequencies less than its resonant frequency. Within the transmission range, there is an excellent agreement between the time response of wavelength shift calculated using FBG-MMTP and the experimental results. The sensitivity obtained from both FBG-MMTP and experimental results is roughly comparable, with around 25% discrepancies, which are thought to be due to imprecision in the physical dimension of tip mass and beam, as well as measurement errors.

1. Introduction

FBG sensors (FBGs) were first widely employed in the telecommunication industry for dense wavelength division demultiplexing, minimal power loss, and quicker data transfer speed when compared to basic cable. Additionally, expanding the use of FBGs in the construction of transducers is facilitated by the material's immunity to electromagnetic fields, low cost, resistance to high temperatures, corrosion, lightweight, low noise, and adaptability to harsh environmental conditions. These qualities make it ideal for structure health monitoring and seismic activities, notably for the measurement of a wide variety of physical parameters, including displacement, acceleration, pressure, strain, temperature, and angle. Examples include temperature measurement in medical applications and the FBG-Mach-Zender interferometer temperature sensor, the 2-D strain measurement system based on the Michelson interferometer, pressure measurement with sensitivity control techniques using microbend fibre grating and the simultaneous pressure and temperature FBG sensor, sensitivity-controlled voltage sensor, temperature and vibration insensitive fibre-optic current sensor, displacement sensor based on Gaussian beam interference, fibre-optic acoustic multiplex sensors, magnetic field sensors based on an extrinsic Fabry-Perot interferometer, and various acceleration applications and developments. However, this measurement principally pertains to the FBGs' capacity to respond to strain and temperature [1]. With regards to acceleration, there have been numerous studies on the

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