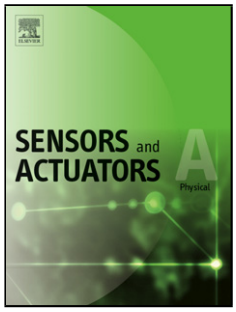

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Optical fiber low-frequency vibration sensor based on Butterfly-Shape Mach-Zehnder Interferometer

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Highlights

- **A novel and in-line fiber low-frequency vibration sensor based on Butterfly-Shape MZI is proposed and demonstrated experimentally.**
- **The sensing element is a tapered hollow-core fiber (HCF) sandwiched between two single-mode fibers (SMFs).**
- **The maximum relative error of vibration frequency is 0.27%.**
- **The proposed sensor has a negligible temperature sensitivity in the range of 30.3℃~69.5℃.**

***Abstract*—A novel and in-line fiber low-frequency vibration sensor based on Butterfly-Shape Mach-Zehnder Interferometer (BSMZI) is proposed and demonstrated experimentally. The sensing element is a tapered hollow-core fiber (HCF) sandwiched between two single-mode fibers (SMFs). The frequency measured by the Butterfly-Shape vibration sensor can well match with the applied frequency, and the presence of the higher harmonics can verify that the sensor does not distort the measured vibration signal. The maximum relative error of vibration frequency is 0.27%. The intensity of vibration signal (of the fiber sensor) is linearly proportional to the driving power of vibration platform. The vibration measurement sensitivity is 13.575 dB/w in the range of 0.1 w to 0.5 w under a constant vibration frequency of 50 Hz, and the linear fitting coefficient is 0.9556. The proposed sensor has a negligible temperature sensitivity in the range of 30.3℃~69.5℃. Because of its compact structure, easy preparation, low production cost, high frequency measurement accuracy of low-frequency vibration, and good linearity of vibration sensing, the proposed BSMZI sensor has potential application prospect in low-frequency vibration sensing field.**

***Index Terms*—Fiber sensor, Mach-Zehnder Interferometer, vibration sensor, hollow-core fiber (HCF), Butterfly-Shape.**

I. INTRODUCTION

Vibration field and vibration level measurement is a frequent measurement requirement in a number of areas. Fiber optic pressure or vibration sensors（OVS）have attracted much interest because of their unique advantages over traditional sensors such as compact size, light weight, high sensitivity, fast response, immunity to electromagnetic interference, the capability of performing remote sensing and the feasibility of multiplexing [1-7].

A number of different optical fiber vibration sensing schemes have been reported, employing a fiber Bragg grating [1, 2], reflective membrane [3], long-period fiber grating [4], distributed-feedback fiber laser [5] and Multimode interferometer [6]. C.-L. Lee et al. demonstrated a refined fiber-optic vibration sensor that is based on a pair of tapered single mode fiber that are bridged in a tiny section of a hollow core fiber (HCF). When the proposed sensor is utilized to sense acoustic vibrations, the tiny vibration sensing element is insulated and protected against the robust HCF. However, the process of preparation is relatively complicated, which is difficult for batch production [7]. O. T. Kamenev et al.