Multicore Fiber Bragg Gratings Array Shape Sensor Fabricated with an Auto-Alignment Femtosecond Laser Point-by-Point Technology

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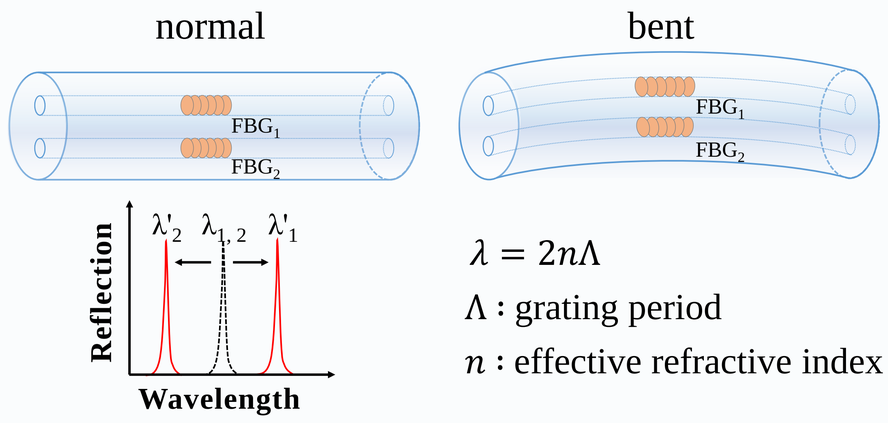
1 Introduction

Optical fiber sensors are promising for various industrial and health-care applications due to its compactness, mechanical flexibility, insensitivity to electromagnetic interference, and temperature, radiation resistance. One of such applications is a shape reconstruction using fiber Bragg grating (FBG) based multicore fiber (MCF) sensors [1, 2].

In most previous reports, the inscription of FBG is rather inefficient. It requires manually adjusting both the shape of the laser beam and the spatial distance between the fiber core and the phase mask or objectives [3, 4]. Here, we demonstrate an auto-alignment femtosecond laser point-by-point technology for fabricating FBG based MCF shape sensors and a maximum error per unit length of 4.51% in shape reconstruction is obtained.

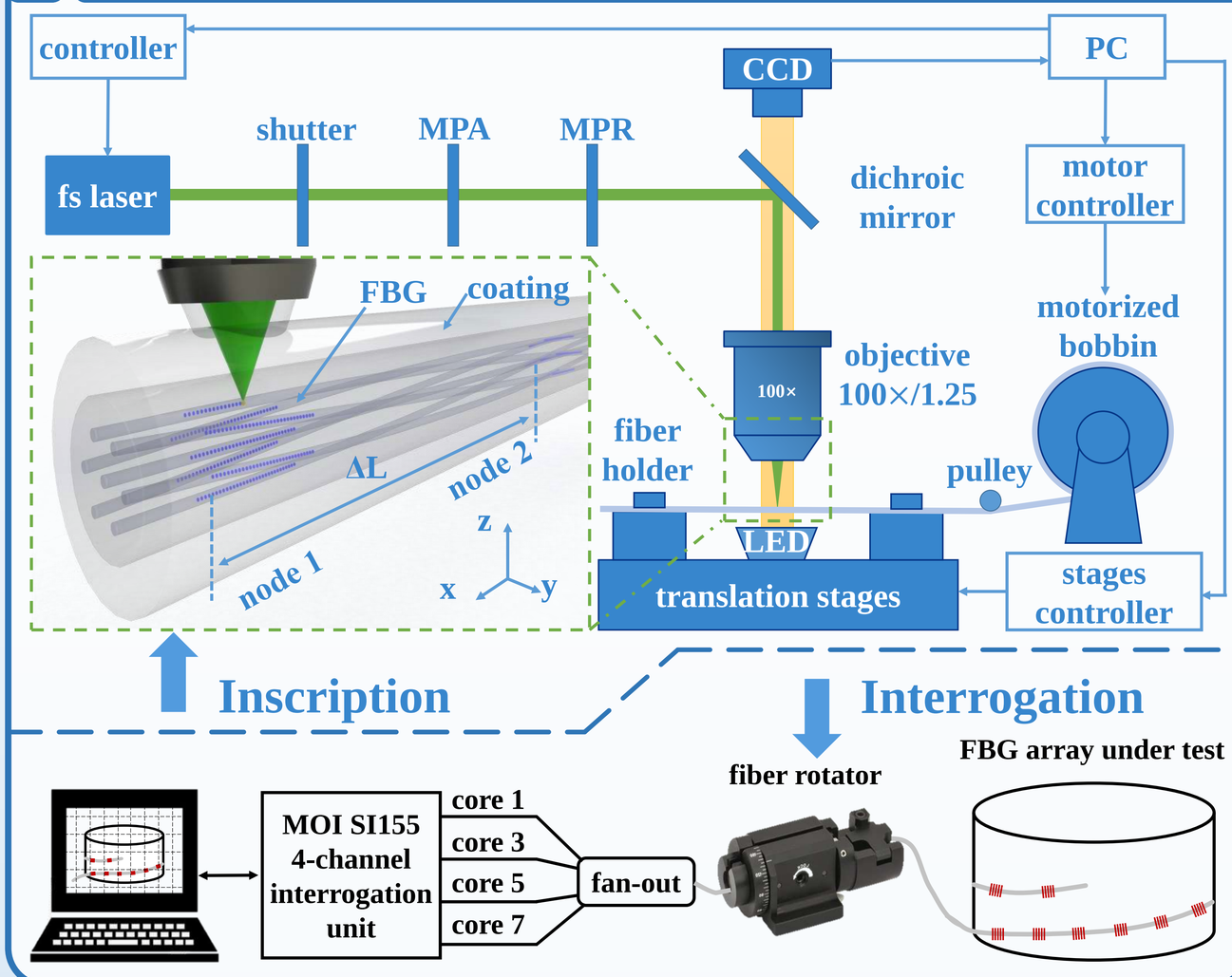


$\lambda = 2n\Lambda$

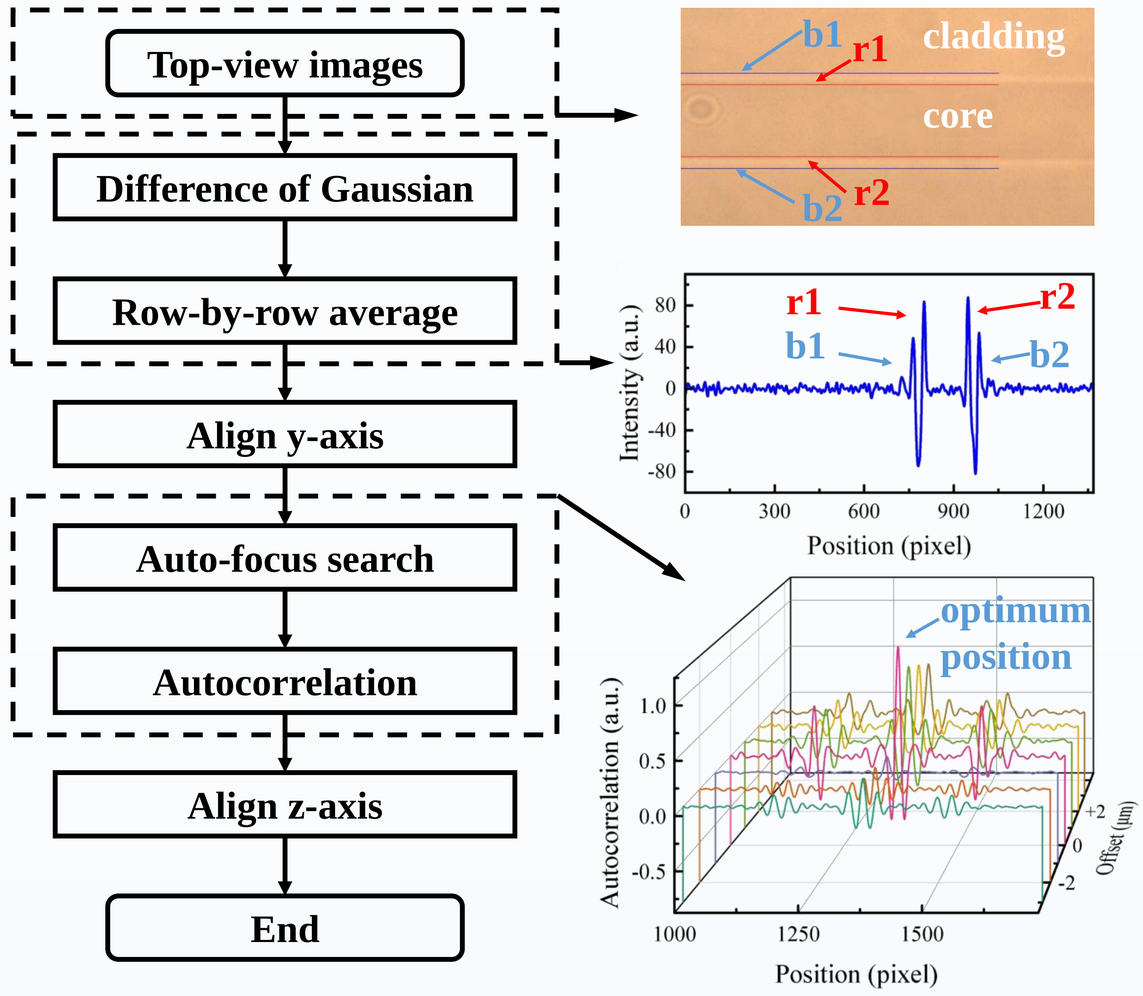
Λ : grating period

n : effective refractive index

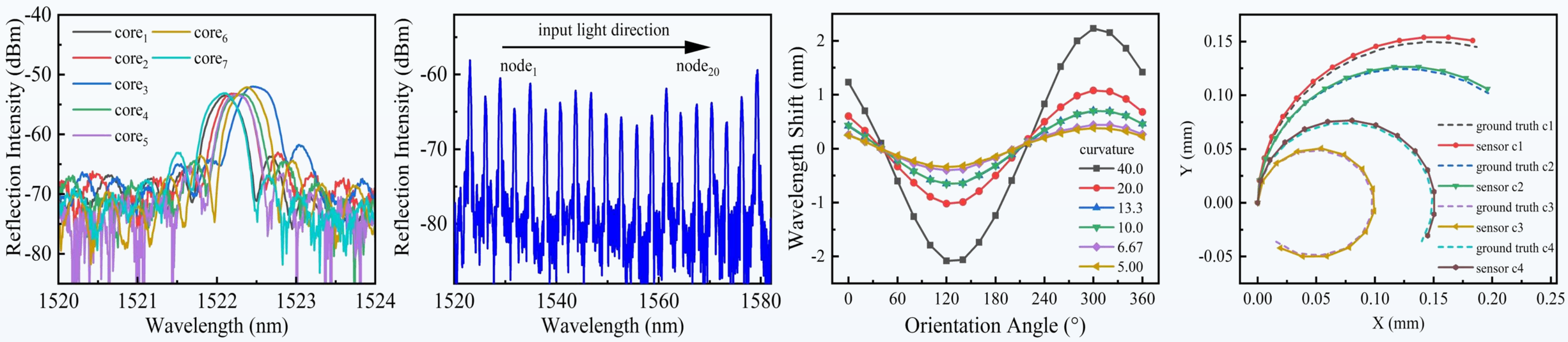
2 Experimental Setup



3 Fabrication Method



4 Bend Measurements and Shape Reconstruction



MC-FBG array： 140 FBGs in 20 nodes

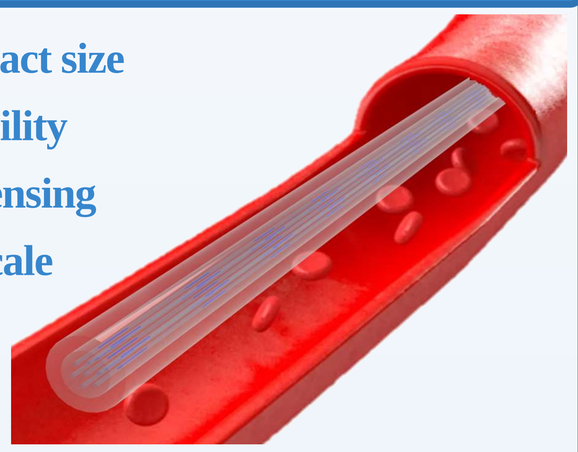
Bend sensitivity : 55.49 pm/m^{-1}

Error per unit length ≤ 4.51%

5 Conclusion & perspective

- **All-fiber design → Electromagnetic interference free & compact size**
- **Femtosecond laser direct writing → High temperature durability**
- **Wavelength interrogation → High resolution & high-speed sensing**
- **Auto-alignment method → Automatic preparation & large scale**

Moreover, we shows several promising applications with this platform for intelligent artificial limb, micro-robotic surgical robot and space robotic manipulators.



Scheme of micro-robotic surgical system

6 References & funding

1. Hou et al, Opt. Express. 26, 23770-23781, (2018).
2. Dostovalov et al , Opt. Express. 24, 16232-16237, (2016).
3. Bronnikov et al , Opt. Express. 27, 38421-38434, (2019).
4. Bao et al, , Opt. Express. 28, 26461-26469, (2020).

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