Title of Project : Functional Evolution of Fiber Optic Nerve Systems with Optical Correlation Domain Technique for Structures and Materials that can Feel Pain

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Research Area : Engineering

Keyword : Measurement, fiber optic sensors, smart materials/structures, distributed sensing

【Purpose and Background of the Research】

Energetic research and development activities have been attracted on "fiber optic nerve systems," which can make buildings, bridges, airplanes, etc. as smart as being able to "feel the pain" by measuring the distribution of strain or temperature along optical fibers attached on or embedded in the materials/ structures. We have invented an optical correlation domain technique by modulating the frequency and phase of the lightwave to synthesize the optical interference, and developed various "fiber optic nerve systems" that are superior to conventional time domain techniques. Millimeter-order spatial resolution, kilohertz sampling rate, and random access-ibility, for example, have been achieved. In this project, we work on the realization of advanced sensing functions including distributed discriminative measure- ment of strain and temperature, the full-length dynamic distribu-tion measurement, etc., by exploring novel techniques to functionalize the "fiber optic nerve systems."

【Research Methods】

1. Functionalizing Brillouin optical correlation domain analysis (BOCDA) technique: high-accuracy distributed discriminative measure-ment of strain and temperature; full-length dynamic distribution measurement.
2. Functionalizing Brillouin optical correlation domain reflectometry (BOCDR) and simpli-fied BOCDA.
3. Multiplexing long-length fiber Bragg grating strain sensors.
4. Realizing smart materials/structures by implementing above techniques.

【Expected Research Achievements and Scientific Significance】

- Present for the first time in the world the high-accuracy distributed discriminative measurement of strain and temperature (see Fig. 1), and clarify the theoretical limit of the new method.
- Introduce new scheme to realize full-length dynamic distribution measurement.
- Improve the strain-resolution of BOCDR.
- Enhance the measurement speed of simplified BOCDA.
- Propose and demonstrate new scheme of multiplexing long-length FBGs by optical correlation domain technique.
- Implement above "fiber optic nerve system" techniques in carbon fiber reinforced polymer used in airplane and steel reinforced concrete to realize advanced smart materials/structures.
- Contribute to the improvement of the security of social infrastructure, and realization of a sustainable society.

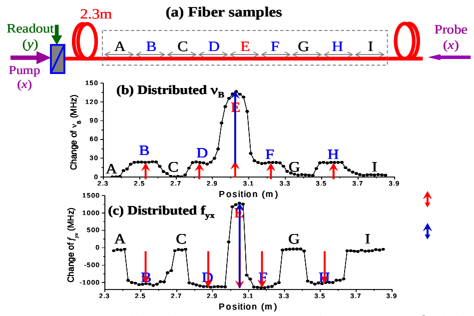

Fig. 1 Preliminary experiment of high-accuracy distributed discriminative mea-surement of strain and temperature

【Publications Relevant to the Project】

- W. Zou, Z. He and K. Hotate, "Correlation-based distributed measurement of dynamic grating spectrum generated by stimulated Brillouin scattering in a polarization-maintaining optical fiber," Opt. Lett., vol. 34, pp. 1126-1128, 2009.
- K. Hotate and K. Kajiwara, "Proposal and experimental verification of Bragg wave-length distribution measurement within a long-length FBG by synthesis of optical coherence function," Opt. Exp., vol. 16, pp. 7881- 7887, 2008.

【Term of Project】 FY 2009 - 2013

【Budget Allocation】 156,800 Thousand Yen

【Homepage Address and Other Contact Information】
http:// www.sagnac.t.u-tokyo.ac.jp/