【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering)

Title of Project : Establishment of Scientific Basis for 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 : Sensing systems, fiber optic sensors

【Purpose and Background of the Research】

Research and development have been attracted on "Fiber Optic Nerve Systems," which can make 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 "Optical Correlation Domain Techniques" 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 techniques. A mm resolution, kHz sampling rate, and random accessibility have been achieved. Distributed discriminative measurement of strain and temperature and high speed total distribution measurement have also been demonstrated.
In this study, besides realizing the original new ideas, the scientific basis for this sensing technology shall be established.

【Research Methods】

Besides realizing the following subjects, scientific basis for the technology shall be established with also pursuing the theoretical works.
+Ultimate performance in the discriminative distributed sensing of strain and temperature.
+High speed total distributed sensing.
+High performance BOCDR systems
+Discriminative distributed sensing by S-BOCDA.
+Evolution in long-length FBG sensors.
+Evaluation of PLC circuits with BOCDA.
+Demonstrations of structures that can feel pain.

【Expected Research Achievements and Scientific Significance】

We presented, for the first time, the high-accuracy distributed discriminative measurement of strain and temperature, using the Brillouin dynamic grating (BDG). In this study, the total performance of the system is improved. Our original scheme to realize full-length dynamic distribution measurement is also optimized.
Scientific basis for the BOCDR, which utilizes spontaneous Brillouin scattering, is established with pursuing both theoretical and experimental works. The discriminative distributed measurement is also realized by a simplified BOCDA.
A new scheme of multiplexing long-length FBGs is demonstrated. Characterization method for PLC devices is also developed by BOCDA.
These "Fiber Optic Nerve Systems" are implemented into CFRP used in airplane. By realizing the advanced smart materials/structures, we shall contribute to security of social infrastructures and realization of a sustainable society.

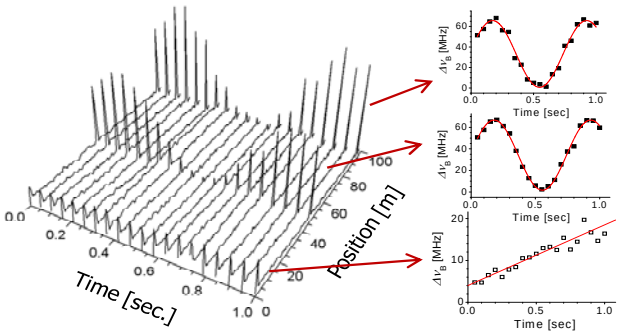

Fig. 1 High speed total distributed sensing. (20 traces/sec)

【Publications Relevant to the Project】

・K.-Y. Song, M. Kishi, Z. He and K. Hotate, "High-repetition-rate distributed Brillouin sens- or based on optical correlation-domain analysis with differential frequency modulation," Optics Letters, vol. 36, pp. 2062-2064, May 2011.
・R. K. Yamashita, W. Zou, Z. He, and K. Hotate, "Measurement range elongation based on temporal gating in Brillouin optical correlation domain distributed simultaneous sensing of strain and temperature," Photonics Technology Letters, vol.24, pp.1006-1008, 2012.

【Term of Project】 FY2013-2016

【Budget Allocation】 134, 800 Thousand Yen

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