Simplified configuration of fiber-optic Brillouin observation using tunable reflectivity mirror

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1. Background and purpose

- **Optical fiber sensors**
  Increasing demand for “health monitoring” of civil infrastructures for human safety
  
  Features of optical fibers, such as small diameter, light weight, high flexibility, and resistance to electromagnetic interference

- **Distributed strain and temperature sensing based on Brillouin scattering**
  Ability to measure magnitude and position of strain and/or temperature change along sensing fiber

  BFS linearly depends on applied strain and temperature
  

- **BOCDR**
  
  + Frequency downshift
  - Incident light spectrum
  
  Powershift (BFS)
  
  Frequency spectrum

BFS linearly depends on applied strain and temperature

- **Purpose**
  Development of Brillouin observation system that eliminates the independent reference light path and installs a TRM at the open end of the sensing fiber to control the power of the Fresnel reflected light, and thus maximize the SNR of the BGS.

2. Experiments

- **Experimental setup for observing BGS**
  
  **Standard setup**
  
  **Simplified setup with TRM**

  Length of sensing fiber : ~ 5 m
  Injected optical power : ~ 20 dBm
  Conditions:
  ① Observation of BGS when the reflectivity is between −7 dB to −17 dB.
  ② Investigation of reflectivity dependence of BGS height when reflectivity is between −2 dB to −20 dB.

- **Experimental result**
  ① Observed BGS dependence on mirror reflectivity
  ② Height of BGS change in varying the reflectivity

  Reflectivity is defined as power difference between incident and reflected light on sensing fiber

  BGS around 10.83 GHz clearly changed depending on reflectivity

  SNR reached maximum of 1.8 dB when reflectivity was -9 dB

  Fresnel reflection at open end of silica SMF is about -14 dBm, and SNR at this time is about ~ 1.0 dB

3. Conclusion

We developed a simplified Brillouin observation system that eliminates the need for an independent reference path by incorporating a tunable reflectivity mirror at the open end of the sensing fiber.

At a reflectivity of -9 dBm the SNR was approximately double that of the -14 dB Fresnel reflection.