Thousands of Fiber Grating Sensor Array Based on Draw Tower: A New Platform for Fiber-optic Sensing

Optical fiber sensing technology has attracted considerable attention because of its high sensitivity, anti-electromagnetic interference and distributed measurement. It has been widely used in health monitoring of large-scale structures. Rayleigh scattering and Brillouin scattering as sensing methods have shown reliable means for distributed sensing. However, in the sensing systems of Rayleigh scattering and Brillouin scattering, sensing dynamic and spatial resolution are limited by the system signal to noise ratio (SNR), which is limited by the low intrinsic backscattering coefficient of the fiber. Fiber Bragg grating (FBG) arrays have been employed as attractive sensing methods for various measurands such as temperature, strain and vibration, because of the high SNR and huge multiplexing capacity of the systems. Wavelength-division multiplexing (WDM) and Time-division multiplexing (TMD) are two major multiplexing techniques for the expansion of the sensor network capacity. For the WDM method, the maximum number of FBGs is restricted by the ratio of the source spectral width over the dynamic wavelength range of an individual FBG sensor. The TDM method utilizes different time delays between reflected pulses to distinguish sensors even with an identical wavelength and to relieve the spectral bandwidth issue. However, the multiplexing capacity is seriously limited by signal crosstalk and shadow effect among the FBG arrays.

In this talk, a FBG array with three kinds of central wavelengths is used for a wide range of temperature measurements. Using the TDM + WDM method, the multiplexing number of FBGs in a fiber is increased, therefore spatial resolution and sensing distance will be improved. In addition, a broadband FBG array with 1000 ultra-weak FBGs in an equal separation of 5 m using Michelson interferometer of Φ-OTDR is proposed for vibration measurement. By matching the arm lengths of the Michelson interferometer and detecting the interference signals between two adjacent weak FBGs, the system can achieve high sensitivity distributed vibration measurement.