The Influence of Network Topology on the Sensitivity of Fiber Bragg Grating Sensors: Serial and Parallel Approaches

ABSTRACT

The sensing configuration of Fiber Bragg Grating (FBG) plays a crucial role in ensuring the accuracy and reliability of monitoring systems. This study presents a comparative analysis between two primary network topologies (serial and parallel) to evaluate their sensitivity towards temperature and strain variations. Simulations were conducted using OptiSystem 21.0 software, modeling three FBG sensors in each configuration. Results indicate that the parallel configuration provides a more stable signal response, uniform power distribution, and lower crosstalk compared to the serial setup. The average temperature and strain sensitivities in the parallel arrangement were 10.17 pm/°C and 1.11 pm/με, respectively, which are higher than the 8.32 pm/°C and 0.89 pm/με observed in the serial configuration. Additionally, the parallel system exhibited lower standard deviations, reflecting more consistent measurement stability. These findings confirm that the parallel FBG configuration is more suitable for multi-point sensing applications requiring high performance, signal stability, and measurement accuracy. This research offers valuable insights for engineers and researchers in selecting the most appropriate FBG network architecture for real-time monitoring in modern optical systems.

**Keywords:** Fiber Bragg Grating (FBG), Parallel and Serial Configuration, Optical Sensing Network, Sensitivity Analysis, Temperature and Strain Monitoring

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