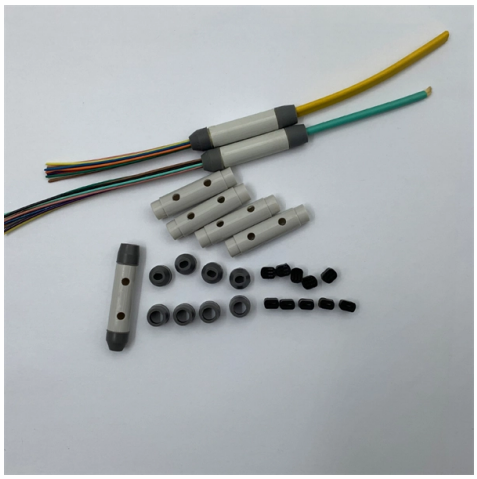
Optical Degradation Correction Splitter



Overview

In this paper, we propose a method for designing and optimizing spectrum-splitting filters which considers the wavefront aberration and transmittance of the multi-modal optical imaging system.

Key Takeaways

Optical degradation in splitters can be corrected through a combination of hardware optimization, environmental management, and computational aberration correction techniques.

Causes of Optical Degradation in Splitters

Fiber optic splitters, such as Planar Lightwave Circuit (PLC) and Fused Biconical Taper (FBT) types, distribute optical power from one input to multiple outputs. Over time, their performance can degrade due to mechanical stress, environmental exposure, and micro-bending at fiber attachment points. Common manifestations include output imbalance, elevated insertion loss, and gradual power drift across branches.

PL

C splitters are sensitive to precision alignment, while FBT splitters are more affected by fiber bending and thermal expansion. Temperature cycling and adhesive aging can cause micro-displacement, reducing optical coupling efficiency and causing branch imbalance.

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Hardware-

Based Correction Approaches

To mitigate degradation, splitters can be designed with strain relief mechanisms to reduce tension on internal fiber joints. Optimized packaging and adhesive selection help minimize thermal expansion mismatch. Additionally, wavefront aberration analysis can guide the design of coatings and filters to reduce phase and polarization aberrations, improving transmission and reducing amplitude and phase distortions.

Computational Aberration Correction

Recent advances in Computational Aberration Correction (CAC) provide software-based solutions.

CA

C models, often powered by deep learning, can correct residual optical aberrations post-capture. Techniques like Domain Adaptive CAC (DACAC) and Quantized Domain-Mixing Representation (QDMR) allow models to adapt to real-world optical degradation by learning from unpaired real-world data, effectively reducing artifacts and improving image quality. Non-blind methods, such as frequency self-adaptive networks, restore spatially varying aberrations by operating in the Fourier domain and fine-tuning models for manufacturing deviations, enabling rapid adaptation to mass-produced devices.

Practical Applications

Correcting optical degradation is critical in telecommunications, multi-spectral imaging, remote sensing, and biomedical imaging, where splitter performance directly affects signal quality and imaging accuracy. Combining hardware optimization with computational correction ensures long-term stability and high fidelity in optical systems. By integrating these approaches, optical splitters can maintain balanced output, low insertion loss, and consistent performance, even under environmental stress or aging conditions.

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Relying on paired synthetic data, existing learning-based Computational Aberration Correction (CAC) methods are confronted with the intricate and multifaceted synthetic-to-real domain

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Optical degradation correction of manufacturing-perturbed glass-plastic hybrid lens systems via a joint hardware-software optimization framework Jingwen Zhou, Bingkun Chen, Jiapu Yan, Zheng Ren,

Neural Invertible Variable-degree Optical Aberrations Correction

Optical aberrations of optical systems cause significant degradation of imaging quality. Aberration correction by sophisticated lens designs and special glass materials generally incurs high

Optical degradation correction network architecture. The UNet-based ...

Optical degradation correction network architecture. The UNet-based network architecture is shown in (a), and the layer configurations are illustrated with different colored blocks on the bottom.

The Ways of Reducing the Degradation of Optical Signals

This paper is to analyze the impact of optical signal degradation on the quality of optical fiber communication systems, and enhance the way of reducing the signal degradation mechanism.

Non-blind optical degradation correction via frequency self-adaptive ...

The official implementation of the paper "Non-blind optical degradation correction via frequency self-adaptive and finetune tactics" (OSA OE 2022) - TanGeeGo/FSANet

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Optical degradation correction of manufacturing-perturbed glass

Overall, our framework establishes a new paradigm for optical degradation correction in glass-plastic hybrid lens systems by synergizing the front-end lens assembly process with the back-end

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