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Distributed Acoustic Sensing Signal Model under Static Fiber Conditions

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Abstract : The research proposes a statistical model for the distributed acoustic sensor interrogation units that broadcast a laser pulse into the fiber optics, where interactions within the fiber determine the localized acoustic energy that causes light reflections known as backscatter. The backscattered signal's amplitude and phase can be calculated using explicit equations. The created model makes amplitude signal spectrum and autocorrelation predictions that are confirmed by experimental findings. Phase signal characteristics that are useful for researching optical time domain reflectometry (OTDR) system sensing applications are provided and examined, showing good agreement with the experiment. The experiment was successfully done with the use of Python coding. In this research, we can analyze the entire distributed acoustic sensing (DAS) component parts separately. This model assumes that the fiber is in a static condition, meaning that there is no external force or vibration applied to the cable, that means no external acoustic disturbances present. The backscattered signal consists of a random noise component, which is caused by the intrinsic imperfections of the fiber, and a coherent component, which is due to the laser pulse interacting with the fiber.

Keywords : distributed acoustic sensing, optical fiber devices, optical time domain reflectometry, Rayleigh scattering
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