



# ПРИБОРЫ И ТЕХНИКА ЭКСПЕРИМЕНТА

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## Enhancing the Temperature-Measurement Efficiency in the Brillouin Optical Time-Domain Reflectometry (BOTDR) Fiber Sensor with the K-nearest Neighbor (K-NN) Algorithm



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## Abstract

The authors propose to use the K-nearest neighbor (K-NN) algorithm to process the probe signals from the previously proposed Brillouin optical time-domain reflectometry (BOTDR) fiber sensor called the differential cross-spectrum BOTDR (DCS-BOTDR), which features a high spatial resolution. Widening of the Brillouin gain spectrum (BGS) when the pulse duration TL is set shorter than the phonon lifetime (~10 ns) is a key problem associated with the DCS-BOTDR. Although the spectrum distortion is reduced also, deterioration in the Brillouin frequency shift (BFS) resolution is observed, which is caused by the broadening of the Brillouin spectrum. On the other hand, while the TL duration exceeding the steady state of the Brillouin signal narrows the spectrum, sidelobes are produced within the steady-state range, which result in the deterioration of the BFS resolution. This limitation is observed only in the DCS-BOTDR, although it is capable of measuring with a high spatial resolution. The experimental data obtained for a fiber with a length of ~400 m and with optimized TL duration in the temperature range of 40–80°C were used in our model to extract the Brillouin temperature coefficient CT. Ideal BGSs were then constructed in the training phase by simulation with different linewidths of 50–70 MHz in order to train the K-NN model with due account for the linewidth variation caused by the difference in the conditions between the training and testing phases. The model was thereby made flexible for various fiber conditions. Experimental data for the sensing of a ~3.6-km-long fiber with TL = 60 ns were used in the testing phase to obtain the temperature distribution. By employing K-NN, the accuracy in determining the temperature for TL = 60 ns has been improved to approximately 2.77°C. Therefore, the K-NN model can be an excellent alternative tool for processing BGSs measured by the DCS-BOTDR and obtaining the temperature distribution along the fiber.

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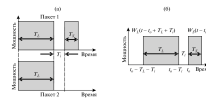
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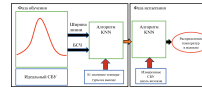
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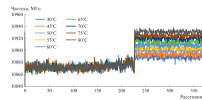
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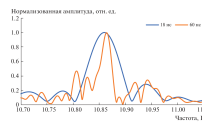
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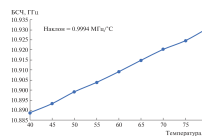
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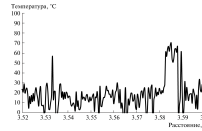
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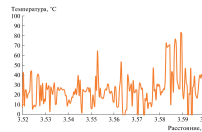
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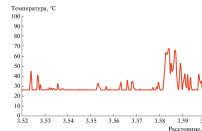
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