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Geoscientific Instrumentation Methods and Data Systems Discussions

Interactive comment on "Research and Application of an Inner Thrust Measurement System for Rock and Soil Masses based On OFDR" *by* Yimin Liu et al.

Anonymous Referee #2

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The paper by Liu and Co-authors is about a quasi distributed system to measure "stress." First of all, I found the motivation not adequate: the Authors start by claiming that FBGs show low spatial resolution, low measurement accuracy, and non-distributed measurements, but the proposed solution can be compared to FBGs in term of accuracy, accuracy. About the distributed feature, neither the proposed solution is distributed. Then they claim generally that "the sensing fiber contains may pressure-sensing points in series", which is meaningless, without a proper context. About the SOTA: OTDR has been proposed in some marginal applications for distributed monitoring, but it is not feasible for monitoring for the reasons also enlisted by the Authors. Talking about BOTDR, compared to other techniques, such as BOTDA/BOFDA

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Discussion paper

or OFDR, it is well known that it does not provide high accuracy. About the capability of achieving simultaneous measurement of strain and temperature over the same fiber, to my knowledge, it has been demonstrated in BOTDA schemes, but it requires a complex setup to measure both the Brillouin shift and power spectrum (supported by Rayleigh measurement). Alternatively, special fibers (LEAF) should be used. Most typically, in BOTDR systems, one collects the shift, and it is not possible to distinguish among the temperature and strain effect. Then, the Authors claim that "Optical frequency domain reflection (OFDR) presents the advantages of quasi-distributed monitoring..." but it is not the case: OFDR is normally used as a distributed sensing system, despite the fact that the Authors used it as a quasi distributed system. The Authors ultimately designed a transducer that induces pressure-dependant losses and measure it using an OFDR. But, in my opinion, this is a reductive way to use a powerful tool such as an OFDR. Typically, an OFDR is used to measure the Rayleigh spectral shift induced by the strain and gives the best performance when used in such a way. When used as an intensity-based system, it is affected by large uncertainties.

About the cubic spline interpolation, it is a well known approach, introduced, for example in: Yüksel K., Wuilpart M., Mégret P. Analysis and suppression of nonlinear frequency modulation in an optical frequency-domain reflectometer. Opt. Express. 2009;17:5845–5851. doi: 10.1364/OE.17.005845. Vergnole S., Lévesque D., Lamouche G. Experimental validation of an optimized signal processing method to handle non-linearity in swept-source optical coherence tomography. Opt. Express. 2010;18:10446–10461. doi: 10.1364/OE.18.010446. Song J., Li W., Lu P., Xu Y., Chen L., Bao X. Long-Range High Spatial Resolution Distributed Temperature and Strain Sensing Based on Optical Frequency-Domain Reflectometry. IEEE Photonics J. 2014;6:6801408. doi: 10.1109/JPHOT.2014.2320742. Kim D.Y., Ji Y.L., Ahn T.J. Suppression of nonlinear frequency sweep in an optical frequency-domain reflectometer by use of Hilbert transformation. Appl. Opt. 2005;44:7630–7634.

The Authors should explain where is the novelty.

To conclude, I found the use of the OFDR technique to probe intensity-based sensors, not so indicated for this application, as the main feature of the technique cannot be exploited. The Authors claim that their system achieves a spatial resolution of 20 cm in a 500 m testing fiber. Still, I do not think that they will exploit such resolution in practice (it would mean having 2500 sensors). Given the requirements and experimental tests, in my opinion, a well-designed system made of arrays of FBG load cells may provide better performance at a lower cost.

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