Machine Learning for Pressure Sensing Using Pure Silica Microstructured Optical Fiber Based Specklegram Sensor

Mohammad Istiaque Reja[a,b,c], Darcy L. Smith[a,c], Linh V. Nguyen[a,c], Heike Ebendorff-Heidepriem [a] and Stephen C. Warren-smith[a,c]

[a] Institute for Photonics and Advanced Sensing, School of Physical Sciences, The University of Adelaide, Adelaide, SA 5005, Australia, [b] Dept. of Electrical and Electronic Engineering, Chittagong University of Engineering and Technology, Chattogram 4349, Bangladesh, and [c] Future Industries Institute, University of South Australia, Mawson Lakes, SA 5095, Australia

We demonstrate the application of machine learning to improve the performance of specklegram pressure sensing using pure silica six hole microstructured optical fiber (Fig.1a). The machine learning approach overcomes the problem of traditional correlation-based techniques for specklegram sensors such as dynamic range limitation and vulnerability to environmental noise [1, 2]. Speckle images from the fiber core were collected by free space light launching using a 633 nm laser source and a camera. A sample speckle image at no applied pressure is shown in Fig. 1b. The fiber was placed in a sealed aluminium tube to apply nitrogen gas pressure. Ten sets of speckle images were recorded at different pressure levels from 0 MPa to 1.1 MPa at an interval of 0.1 MPa. A multi-layer perceptron network was trained using the first 9 sets and pressure was predicted from set 10 (Fig.1c), which gave an RMS error of 0.02 MPa. This pure silica fiber specklegram sensor will be useful for high-temperature pressure sensing applications in harsh industrial settings [3].

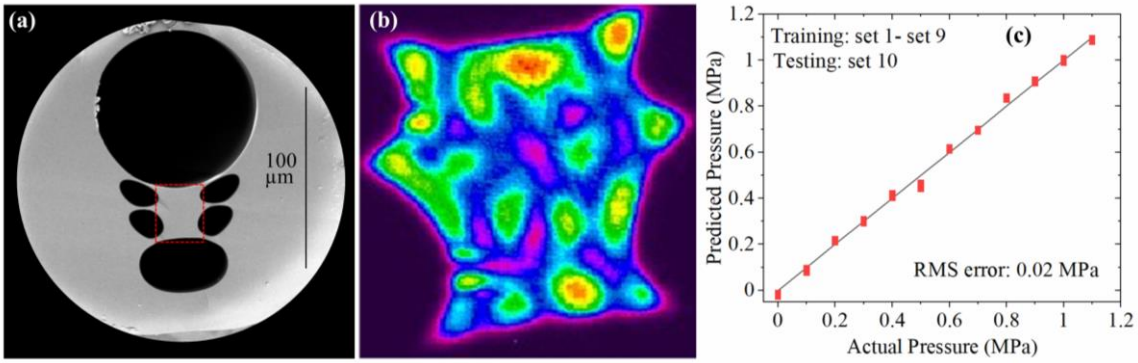

Fig.1: (a) SEM image of pressure sensing fiber. (b) Sample speckle image at no applied pressure. (c) Pressure prediction from set 10 when training was done using speckle images from set 1 to set 9.

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[2]. Nguyen, L.V., et al., *Sensing in the presence of strong noise by deep learning of dynamic multimode fiber interference.* Photonics Research, 2021. **9**(4): p. B109-B118.

[3]. Reja, M.I., et al., *Temperature-Compensated Interferometric High-Temperature Pressure Sensor Using a Pure Silica Microstructured Optical Fiber.* IEEE Transactions on Instrumentation and Measurement, 2022. **71**: p. 1-12.