A high performance approach for parallel computing of fibre Bragg grating strain profiles using graphics processing units

L.H. Negri, H.S. Lopes, M. Muller and J.L. Fabris*

Graduate Program in Electrical and Computer Engineering,
Federal University of Technology – Paraná, Brazil
Email: lucashnegri@gmail.com
Email: hslopes@utfpr.edu.br
Email: mmuller@utfpr.edu.br
Email: fabris@utfpr.edu.br
*Corresponding author

A.S. Paterno

Department of Electrical Engineering,
Santa Catarina State University, Brazil
Email: aleksander.paterno@udesc.br

Abstract: This work proposes an efficient approach to recover the mechanical strain profile applied on fibre Bragg grating sensors. The proposed method is based on differential evolution and uses only the sensor reflectivity, without requiring phase information. The method has been shown to be highly parallelisable, with the fitness evaluation procedure implemented on graphical processing units. Experiments were performed to evaluate the performance of the method on three distinct graphic processing units (GPU), under a series of increasing loads. An enhancement up to three orders of magnitude in performance was obtained in respect to other evolutionary method proposed in the literature for the same purpose. Furthermore, it was observed that, for smaller problem sizes, the GPU clock rate was more significant than the number of cores of the GPU.

Keywords: graphical processing unit; GPU; differential evolution; performance evaluation; sensors; parallel computing; computational intelligence; fibre Bragg grating; FBG; optical fibre; sensing.


Biographical notes: L.H. Negri is currently working towards his PhD in Electrical Engineering and Industrial Informatics at the Federal University of Technology – Paraná. His interests include machine learning, computational intelligence, and fibre optic sensors.

H.S. Lopes is a Titular Professor at the Federal University of Technology Paraná, in Curitiba, Brazil. He holds a PhD and MSc in Electrical and Biomedical Engineering. His current research interests are bioinformatics, evolutionary computation, deep learning and high-performance computing.

M. Muller received her BSc in Physics from Federal University of Paraná in 1985, MSc from the Fluminense Federal University in 1989 and PhD from the University of São Paulo in 1994. She is currently a Full Professor at Federal University of Technology in Brazil. Her current main research area is photonics, with special interest in optical fibre grating-based sensors.

J.L. Fabris received his BSc in Physics from the Federal University of Paraná in 1986, MSc from the Fluminense Federal University in 1989 and PhD from the University of São Paulo in 1994. He is currently a Full Professor at Federal University of Technology in Brazil. His current main research area is photonics, with special interest in optical fibre grating-based sensors and spectroscopy.