An Efficient Method to Determine Strain Profiles on FBGs by Using Differential Evolution and GPU

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II. METHODOLOGY

The DE algorithm is used to determine mechanical deformation profile applied to an FBG sensor. The profile determination is performed by using the magnitude of the FBG reflection spectrum that can be easily obtained with interrogation methods [1]. This experimentally obtained light spectrum (magnitude only, no phase information) is referenced here as target spectrum, and contains enough information about the perturbation in the sensor structure.

The proposed method maintains a population of candidate solutions, where each individual of this population corresponds to one deformation profile. This population is iteratively improved by using DE until a suitable deformation profile is found, whose reflection spectrum matches the target spectrum. This evolutionary process is guided by the fitness evaluation of each individual, that is computed as the error between the target spectrum and the one simulated from the candidate solution. The transfer matrix method was used to simulate the reflection spectrum of each individual.

Among the steps of the proposed evolutionary process, the fitness evaluation is the one which takes more time due to the computational cost of the transfer matrix method. Computing the reflectance of an FBG from its parameters by using the transfer matrix method requires, for each evaluated wavelength, a series of matrix multiplications and, eventually, solving algebraic equations to produce the simulation parameters. To reduce the required computation time, a GPU with capacity of running multiple parallel processes was employed. In this way, fitness evaluation of each individual can occur in parallel taking advantage of the easy parallelization feature of the DE method. Further, the reflectance spectrum computed