Instrumentation and Signal Processing: Leveraging Metaheuristic Algorithms for Enhanced Performance

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Talk Abstract

Heuristic and metaheuristic optimization algorithms faced a quite significant development in the last decade and can be found in use in several science and engineering applications, like in medical science, robotics, aerospace engineering and image processing [1]. Other particular area where this sort of algorithms, along with other in the wide field of artificial intelligence, find application, is on the solar energy conversion systems [2, 3]. These are widely used because of their simplicity to implement, their converge to the global optima and their facility to be applied to various complex optimization problems where the classical methods are not efficient [4]. In instrumentation, frequently it is performed the adaptation of sine signals, from one ore two measurement channels, relying in sine fitting methods; those methods consist in the search of the sinus parameters that adapt better, under the minimum squares criteria, considering a set of data acquired with an analog-to-digital converter (ADC) [5]. When dealing with one input channel, frequently that sine wave data fitting operations are performed via the algorithm for three-parameter (known frequency) least squares, or the algorithm for four-parameter (general use) least squares [6, 5]. Regarding those methods, the former is non-iterative and assumes the need of a known frequency, whereas the later is iterative and also estimates the frequency. In what pertains to the three parameters method, the authors have developed previous studies and among them, appears the known frequency accuracy sensitivity assessment; or, how the considered frequency correctness level influences the error obtained in the fitting operations [5]. It was carried out the study of the normalized quadratic error resulting from the method application, depending on the input signal frequency, to several ADC acquired number of samples and varying other conditions; it results in real variable real functions with one global minimum, for whose the number of samples increase motivates the appearance of an increasing number of local minimums. So, the optimization operations on these functions face a challenge with increasing

complexity as the number of samples are augmented. It were applied several heuristic and metaheuristic optimization algorithms, in order to optimize those functions, varying not only the ADC number of samples, but also other conditions. There are presented case studies with several scenarios, underlining the results.

Keywords: instrumentation and measurement, sine fitting algorithm, heuristic or metaheuristic optimization algorithm.

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