چهارمین کنفرانس بین المللی
مطالعات نوین در علوم کامپیوتر و فناوری اطلاعات
4th International Conference
On New studies Of Computer And IT
FEBRUARY 24 ,2018
مشهد
۰۵ اسفند ماه ۱۳۹۶

Fractional steepest decent optimization method: application to image restoration problem

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Abstract

The steepest decent optimization (SDO) is one of the widely used simple and efficient optimization techniques which works based on the fact of moving in the opposite direction of the steepest ascent to reach a minimum. Although the original SDO finds some acceptable solutions for the problem, it suffers from low speed and convergence to local minima. After the introduction of fractional calculus many useful applications in science and engineering fields have been realized via non-integer-order derivatives and integrals. In this paper, a novel optimization method is proposed based on the fractional calculus and SDO algorithm. We use the memorization property of the fractional derivatives to provide a history of the past events of SDO procedure to help SDO to escape from local minima traps. An adaptive accelerator is also introduced to speed up the convergence rate of the algorithm. The proposed fractional steepest decent optimization (FSDO) is applied to the image restoration problem. In this case, the inverse of the corruption function is estimated using a linear kernel whose elements are being optimized using the introduced FSDO. Some comparative examples are provided to show the superiority of the proposed FSDO in finding the optimum restoration filters of noisy images.

Keywords: Deterministic optimization; Fractional calculus; Local optimum; Image Restoration.