Nonlinear Dynamics and Systems Theory, **25** (1) (2025) 91–100

Efficient Descent Direction of a Conjugate Gradient Algorithm for Nonlinear Optimization

Mohamed Lamine Ouaoua * and Samia Khelladi

Laboratory of Fundamental and Numerical Mathematics,
Department of Mathematics, Faculty of Sciences,
Setif 1 University-Ferhat Abbas, 19000, Algeria.

Received: February 21, 2024; Revised: January 9, 2025

Abstract: We propose an efficient variant of the conjugate gradient method for nonlinear optimization based on a new parameter β_k. We show that the new search direction fills the sufficient descent condition and we prove the global convergence of the corresponding algorithm using the strong Wolfe inexact line search. The established numerical results show that the new algorithm is more efficient in comparison with the standard Fletcher-Reeves method in terms of either the iteration number or CPU time.

Keywords: *unconstrained optimization; conjugate gradient method; descent direction; inexact line search; global convergence.*

Mathematics Subject Classification (2020): 65K05, 90C26, 90C30, 93A30.

1 Introduction

Consider the following unconstrained nonlinear optimization problem:

$$\begin{cases} \min\ f(x), \\ x \in \mathbb{R}^n, \end{cases} \tag{1}$$

where $f : \mathbb{R}^n \longrightarrow \mathbb{R}$ is a continuously differentiable function.

Conjugate gradient methods are efficient to solve unconstrained optimization problem (1), especially for large scale problems. These methods generate the following sequence:

$$x_{k+1} = x_k + \alpha_k d_k, \tag{2}$$

* Corresponding author: mailto:mohamedlamine.ouaoua@univ-setif.dz

