Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **31 (2024)** 209-225

EXISTENCE AND UNIQUENESS OF SOLUTIONS TO FRACTIONAL INTEGRO-DIFFERENTIAL EQUATIONS VIA THE DEFORMABLE DERIVATIVE

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Abstract. In this paper, we establish sufficient conditions for the existence and uniqueness of solutions for a class of initial value problems for integro-differential equations involving the deformable fractional derivative. We achieve our results using classical fixed point theorems such as the Krasnoselskii's fixed point theorem and the Weissinger's fixed point theorem. We provide an example to illustrate our abstract results.

AMS (MOS) subject classification: 26A33; 26D10; 47H10.
Keywords and Phrases: Deformable fractional derivative, Integro differential equations, Krasnoselskii's fixed point theorem, Weissinger's fixed point theorem, mild solution.

1 Introduction

Fractional integro-differential equations have been an important tool to describe many problems and processes in different fields of science. In fact, fractional models are more realistic than the classical models. Fractional integro-differential equations appear in many fields such as physics, economics, image processing, blood flow phenomena, aerodynamics, and so on. For more details about fractional integro-differential equations and their applications, we provide the following references [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 21, 22, 23, 27, 29].

Zulfeqarr, et al. [30] introduced the new concept of deformable derivative using the limit approach as in the usual derivative. They called it "deformable" as its intrinsic property of continuously deforming function to derivative. This derivative is linearly related to the usual derivative. The deformable derivative can be viewed as a derivative of the fractional order.

Recently, Meraj and Pandey [26] used this concept to study the existence and uniqueness of solutions to the Cauchy problem

$$D^{\alpha}x(t) = Ax(t) + f(t, x(t)),\ t \in (0, T],$$