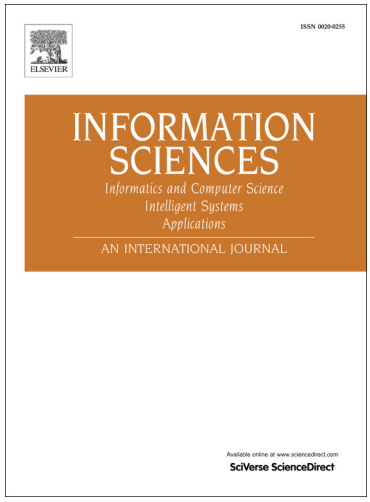

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On Periodic Solutions to First Order Linear Fuzzy Differential Equations under Differential Inclusions' Approach

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Abstract

In this work, we study some properties of the solutions to first order linear fuzzy differential equations under differential inclusions' approach. We show that the differential inclusions' approach generally adapts better to some properties of the solutions to ordinary differential equations. Sufficient conditions for the solutions under this approach to be periodic and bounded are presented. We also give some examples to show the applicability of these results.

Keywords: First order fuzzy differential equation, Differential inclusion, Periodic solution, Bounded solution.

1 Introduction

In the study of fuzzy differential equations, there are many different approaches, varying from the use of Hukuhara derivative to several generalizations of this concept or alternative points of view.

Some essential results on fuzzy differential equations under the Hukuhara derivative are included in [14, 17, 21, 26]. Besides, in the literature, it has been highlighted one important shortcoming of Hukuhara-differentiable fuzzy functions for the modeling of periodic problems, originated in the nondecreasing character of the diameter of its level sets with respect to the time variable. This problem, among other inconveniences, makes this approach less adequate [21] for displaying in this context some interesting properties showed by the solutions to ordinary differential equations and, in consequence, establishes the requirement for the development of new techniques.

The concept of generalized differentiability [6] prevents from the above-mentioned difficulty, allowing a larger set of differentiable fuzzy functions and different possibilities for the diameter of their level sets. See also the related works [1, 7, 8, 11, 18, 19, 22]. In many circumstances, in order to obtain a well-defined fuzzy solution in the interval of study from the point of view of generalized differentiability, it is interesting to introduce switching points at the instants where the branches of the solution meet, see [22, 32].

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