

Fuzzy fractional pantograph stochastic differential equations: Existence, uniqueness and averaging principle

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Abstract

Fuzzy fractional pantograph stochastic differential equations (FFPSDEs) is investigated here. The initial objective is to show the existence and uniqueness of solutions using Banach fixed point theorem. The second objective is discussing averaging principle of FFPSDEs, precisely, we will prove that the solutions of FFPSDEs can be approximated in the sense of mean square by the solutions of averaged fuzzy fractional stochastic system.

Keywords: fuzzy fractional pantograph stochastic differential equations, Banach fixed point, averaging principle
2020 MSC: 34A07, 34A08, 35K05, 26A33, 35R60

1 Introduction

Pantograph equations are a sort of delay differential equation that may be encountered in physics, medicine, biology, and other domains. The word pantograph come from the work of Taylor and Ockendon [28]. Many academics have recently explored pantograph differential equations (PDEs) of fractional order, for example, we recommend the reader to [3, 14, 15, 17, 18, 20]. Furthermore, multiple writers have demonstrated the existence and uniqueness of solutions for various fractional pantograph differential equations (FPDEs) with distinct fractional derivatives, for example see [2, 13, 19, 32, 33]. Recently, PDEs have also been extended to pantograph stochastic differential equations (PSDEs), see [27, 24], in this context, Priyadharsini et al [30], extended PSDEs to fuzzy setting, they proposed a new type of equation namely fuzzy fractional stochastic pantograph differential equations (FFSPDEs). On the other hand, the notion of averaging principle has a long history. It's a great way to look at the qualitative properties of a dynamical system. Then, the study of this method for stochastic differential equations (SDEs) has received a lot of attention as theory has progressed [4, 13, 16, 22, 25, 29, 34]. Arrhrabi et al [5] initiated the study of averaging principle of fuzzy SDEs, also, Arrhrabi et al [6, 7, 8, 9, 10, 11, 12] studied the existence and stability of solutions for fuzzy fractional SDEs (FFSDEs) with Brownian motions, existence and uniqueness results of FFSDEs with impulsive and Fuzzy fractional boundary value problem and other types of FFDEs. To our knowledge, no publication has looked at the averaging principle of fuzzy fractional PSDEs, instead, numerous studies have looked at the averaging principle of fractional PSDEs in a crisp case. To close this gap, we will investigate the existence, uniqueness, and averaging principle of

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