CONTROLLING BIFURCATION IN DELAYED PREDATOR-PREY MODEL WITH FEEDBACK CONTROL IN INCOMMENSURATE FRACTIONAL ORDER

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Abstract: This paper concentrates on the bifurcation control of a fractional order predator – prey system using the feedback control strategy. Firstly, time delay is a bifurcation parameter and then state feedback controllers are apply to suitably control the Hopf bifurcation for the existing system. Periodic and Oscillatory nature of solutions for both commensurate and incommensurate order which are examined. Amazingly, it is found that cost of bifurcation control can be minimize optimally by a single controller as compared with three. Mainly, the control effects for the first feedback gain outshine the other two. At last, the numerical examples are used to validate the effectiveness of derived theoretical results.

Keywords: Predator-Prey; Fractional order; Hopf bifurcation; Feedback control; Commensurate order; Incommensurate order
MSC: 26A33, 34A08, 34K18, 37G15, 70K50.

1. Introduction

Currently, the dynamical system of Predator-Prey model have attained increasingly by many researchers. Time delay in environmental system has an important influence in dynamical behaviour. The stability theory of dynamical system diluted by delay was found [4,11]. Result of impact of particular delay can preserve concept of stability in predator – prey system [7]. Fractional order differential equations in dynamical system consists of more benefits compared with integer order due to the memory effects of various materials and processes [3,7,10,13]. With the gradual development of fractional calculus, the energetic role of Hopf bifurcation in fractional order has attained in superior level [2,4,6].

Firstly, the authors intend to dealt about the controlling bifurcation in a delayed predator–prey system with fractional incommensurate orders and also applied feedback control to the delayed fractional order chaotic systems, bifurcation as parameter [1, 8]. In [5,12], the problem based on the time delay is a bifurcation parameter and applying the hybrid tactics of control strategy for controlling bifurcation for a fractional order delayed predator-prey system and achieved the delay-induced bifurcation conditions of Hopf bifurcation.

In this paper, it seems to the problem of modeling, analysis and bifurcation control of a delayed fractional order predator–prey model stated in [14] in both commensurate and incommensurate orders by via feedback control technique. The highlights of this paper are to controlling Hopf bifurcation in a delayed predator-prey model choosing the proposed feedback gain and the stability performance of controlled model in incommensurate order can be enormously exalted.

2. Preliminaries

2.1 Fractional Order Derivative

Among Riemann-Liouville and Caputo definitions for fractional calculus, Caputo derivative with integer order are frequently used in many researchers and has understandable physical features so that we adopt this paper using the Caputo derivative concepts.

Definition 1: [9] The fractional order $q > 0$ of intergration for a function y(t) is defined as function y:(0, ∞) → R is given by

$$I_{0+}^{q} y(t) = \frac{1}{\Gamma\alpha} \int_{t_0}^{t} (t-s)^{q-1}\, y(s)ds$$

where $t_0 \leq t$ and the right hand side is pointwise defined on (0, ∞), Γ(.) is a gamma function defined as

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