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GLOBAL STABILITY AND EXISTENCE OF SLIDING BIFURCATIONS IN FILIPPOV TYPE PREY-PREDATOR MODEL

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Abstract. This paper is concerned with a two species Filippov predator-prey model. In the model, the predator is provided with additional food as its density goes above a threshold value. The regular, virtual and pseudo-equilibrium points as well as boundary equilibrium and tangent points of the Filippov system are obtained and analyzed. Detailed analysis for transcritical bifurcation about axial points has been carried out. Also, the existence of Hopf bifurcation about the interior point has been established. Sliding mode dynamics is discussed. The regular/virtual equilibrium, boundary equilibrium and touching bifurcations have been discussed. The coexistence of virtual and pseudo equilibria are shown numerically. Pseudo-equilibrium is shown to be Σ saddle with the help of numerical simulation.

Keywords. Filippov system; Sliding mode dynamics; Global stability; Regular/virtual equilibrium bifurcation; Boundary equilibrium bifurcation.

AMS (MOS) subject classification: 34C23, 92D25, 92D40.

1 Introduction

Mathematical models comprising of system of ordinary differential equations describe the dynamics of interacting species. Most of the dynamical systems in ecology have been modelled as system of differential equations with continuous right hand side. Filippov systems form a class of non-smooth dynamical systems described by differential equations with a discontinuous right hand side. Physical phenomena such as dry friction and impact oscillator in mechanical systems are modelled as Filippov systems. Such systems are also common in electrical systems where switching is applied [1, 3, 8]. Infact, discontinuities are designed to achieve regulation and control. Some ecologists have also investigated Filippov systems for prey predator dynamics in [6, 12, 13, 18], harvesting system in [15] and in context of Integrated Pest Management [14, 16, 17]. A Filippov type epidemic model has been discussed by Wang and Xiao in [10].