

A Mathematical Study for the Stability of Two Predator and One Prey with Infection in First Predator using Fuzzy Impulsive Control

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1. INTRODUCTION & OBJECTIVE

One of the most popular subjects in biomathematics is population dynamics. Since the impact of infectious diseases on the ecological system regulates population size, researchers have recently become more interested in the fusion of ecology and epidemiology. There are a lot of prey-predator models that have infectious infections. The dynamics of the prey-predator system with disease in the prey and predator populations were hypothesised and examined by various researchers. Additionally, numerous research studies have explored the dynamic behaviour of the predator-prey system with infection in the predator population. There are also several scholars who have studied eco-epidemic models where predator populations are infected through consuming prey, such as Anderson and May. The dynamics of a predator-prey model with disease in both prey and predator populations were proposed by Hsieh and Hsiao. Additionally, some researchers have developed eco-epidemic models with optimal control and with temporal delays.

We have witnessed rapidly growing interest in fuzzy control in recent years. This is largely sparked by the numerous successful applications fuzzy control has enjoyed. Despite the visible success, it has been made aware that many basic issues remain to be addressed. Among them, stability analysis, systematic design, and performance analysis, to name a few, are crucial to the validity and applicability of any control design methodology. However, it should be admitted that the stability of fuzzy logic controller (FLC) is still an open problem. It is important to point out that there exist many systems, like the predator-prey system, which cannot commonly endure continuous control inputs, or they have impulsive dynamical behavior due to abrupt jumps at certain instants during the evolving processes. Hence, it is necessary to extend FLC and rectify these impulsive jump phenomena in the predator-prey system. As on date a very few papers discussed about the stability of two dimensional Lotka-Volterra predator-prey system with fuzzy impulsive control.

In this paper, we have considered Lotka-Volterra predator-prey model with one prey and two predator. We also consider that only the first predator population is infected by an infectious disease, i.e., the first predator population is divided into two sub-classes: susceptible and infected. To improve the model's reality we analyze the global and asymptotic stability as of this model with the help of the T-S model, then presented the graphical solutions for the problem by considerations. Only a few articles have looked at the stability of the Lotka-Volterra predator-prey system with fuzzy impulsive control so far. So, using the T-S mathematical model and fuzzy impulsive control, the stability of the predator-prey system is examined.

2. RESULTS & HIGHLIGHTS OF IMPOINTANT POINTS

In many disciplines, including ecology, dynamics, physics, algorithms, and epidemiology, mathematical models are crucial. In this work, a predator-prey model with two predator populations and one prey population is built, but only the first predator population is infected. First, a fuzzy impulsive control-based non-linear Lotka-Volterra predator-prey model was examined. The fuzzy systems based on the T-S model are used to examine the impulsive control technique, which is found to be suitable for extremely complex non-linear systems with impulsive effects. Additionally, each local linear impulsive system is combined to create the full impulsive fuzzy system. In the meantime, numerous stability theorems demonstrate the impulsive fuzzy system's asymptotic stability and exponential stability. Finally, to illustrate the usage of impulsive fuzzy control, a numerical example of predator-prey systems with impulsive effects is shown. Simulation results show the value of the suggested method. According to the references already in existence, the current investigation covers a variety of ecological consequences and got adequate results.

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