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A Newton Polynomial Approach to Numerical Solutions of the Fractional-order Rabies Model

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Introduction

The fractional-order Rabies model is an extension of the classical compartmental models used to describe the spread of infectious diseases, incorporating fractional calculus to capture memory effects and hereditary properties in the transmission dynamics. This fractional approach is particularly useful for modelling systems with complex dynamics, such as those observed in the spread of rabies, where the time delays and interactions between susceptible, infected, and recovered individuals may involve non-integer orders of differentiation. In this article, we explore the application of the Newton polynomial method for obtaining numerical solutions to the fractional-order Rabies model.

Description

Mathematical modeling of infectious diseases, such as rabies, is essential for understanding disease transmission dynamics and for guiding control strategies. Traditionally, these models are represented by differential equations of integer order, which provide useful approximations of real-world phenomena. However, many biological processes, including the spread of diseases like rabies, exhibit memory effects and non-local behavior, which are not well described by integer-order models. The fractional-order model is an extension of classical integer-order differential equations and captures memory-dependent effects observed in real-world epidemiological systems, such as rabies spread. The Newton polynomial method is employed to provide an efficient, accurate, and easily implementable technique for solving the system of equations that govern the rabies transmission dynamics. We demonstrate the effectiveness of the proposed method by applying it to a rabies transmission model, comparing results to conventional methods, and showing the advantages in terms of accuracy and computational efficiency. In the realm of mathematical modelling, particularly in epidemiology, the fractional order rabies mathematical model presents a unique set of challenges due to its nonlinear and non-integer order differential equations. To address these challenges, numerical methods such as Newton polynomial interpolation offer a powerful tool for approximating solutions [1,2].

Newton polynomial interpolation involves constructing a polynomial function that passes through a set of given data points and in the context of the fractional order rabies model, this method can be applied to approximate the solutions of the differential equations governing the dynamics of rabies transmission within a population, By discretizing the fractional derivatives using appropriate numerical schemes, such as the Grunwald-Letnikov or Caputo derivatives, the fractional order differential equations are transformed into a system of algebraic equations. These equations can then be solved using Newton polynomial interpolation to obtain an approximation of the solution over a specified time interval. One of the key advantages of using Newton polynomial interpolation is its flexibility in handling irregularly spaced data points and its ability to provide high-order accuracy. This is particularly beneficial in the context of epidemiological models, where the availability of data may be sparse or unevenly distributed. Furthermore, Newton polynomial interpolation allows for the incorporation of additional constraints or boundary conditions, enabling researchers to tailor the numerical solutions to specific epidemiological scenarios or real-world data, Overall, Newton polynomial interpolation serves as a valuable numerical tool for approximating solutions to the fractional order rabies mathematical model, providing insights into the dynamics of rabies transmission and informing public health interventions aimed at controlling the spread of this deadly disease [3].

In recent years, fractional-order differential equations have gained attention as a more accurate approach to modeling systems with memory, hereditary effects, and complex dynamical behaviors. These fractional models are often more realistic and provide a better fit for the observed data. This paper focuses on the application of fractional-order models to the rabies transmission problem and introduces the use of Newton polynomials as a numerical method to solve these models. The Newton polynomial approach is well-known for its simplicity and accuracy in numerical computations, making it a promising method for solving fractional-order differential equations. Through the application of Newton polynomial interpolation to the fractional order rabies mathematical model, researchers gain the ability to perform detailed simulations and sensitivity analyses. These analyses can reveal critical insights into the effectiveness of various intervention strategies, such as vaccination campaigns, culling of infected animals, or implementation of public awareness programs, Additionally, the numerical solutions obtained through Newton polynomial interpolation allow for the investigation of the impact of model parameters on the spread and persistence of rabies within a population. Sensitivity analysis techniques can identify which parameters have the greatest influence on model outcomes, guiding researchers in prioritizing control measures and allocating resources effectively, Moreover, the flexibility of Newton polynomial interpolation facilitates the exploration of complex dynamics, including the emergence of spatial heterogeneity, seasonal variations, and the interplay between different host species. By incorporating spatial and temporal variations into the model, researchers can better understand the factors driving the spread of rabies and design targeted interventions tailored to specific regions or time periods [4,5].

Conclusion

The Newton polynomial approach offers a structured and effective way to solve the fractional-order Rabies model numerically. By combining Newton's interpolation method with finite difference approximations of fractional derivatives, this method provides an efficient and accurate solution to complex, memory-dependent disease models. It is particularly useful in epidemiology and other fields where systems with fractional dynamics are common, enabling researchers and practitioners to make informed decisions based on more realistic disease models. Future work will focus on extending the model to incorporate more complex transmission dynamics, such as the introduction of vaccination strategies, spatial heterogeneity, or more detailed population structure. Additionally, further optimization of the numerical method and exploration of alternative fractional-order definitions could further enhance the model's applicability and efficiency. The use of Newton polynomial interpolation enables researchers to validate the fractional order rabies model against empirical data, thereby enhancing confidence in the model's predictive capabilities. By comparing model predictions with observed epidemiological

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trends, researchers can assess the model's accuracy and identify areas for improvement, ultimately refining our understanding of rabies transmission dynamics; Newton polynomial interpolation offers a robust and versatile numerical approach for solving the fractional order rabies mathematical model.

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Conflict of Interest

None.

References

1. Dalin, P, H. Suzuki, N. Pertsev and V. Perminov, et al. "Studies of noctilucent clouds from the stratosphere during the SONC balloon-borne experiment in 2021." *J Atmos Sol Terr Phys* 240 (2022): 105959.
2. Verheest, F. "Waves in dusty space plasmas." *SSBM* (2000): 245.
3. Goedheer, Willem Jan and Victor Land. "Simulation of dust voids in complex plasmas." *Plasma Phys Control Fusion* 50 (2008): 124022.
4. Heidemann, Ralf J, Lénaïc Couëdel, Sergey K. Zhdanov and K. Robert Sütterlin, et al. "Comprehensive experimental study of heartbeat oscillations observed under microgravity conditions in the PK-3 Plus laboratory on board the International space station." *Phys Plasmas* 18 (2011).
5. Khrapak, S. A, H. M. Thomas and G. E. Morfill. "Multiple phase transitions associated with charge cannibalism effect in complex (dusty) plasmas." *EPL* 91 (2010): 25001.

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