Existence of Positive Periodic Solutions for Nonautonomous Delay Differential Equations Based on Multiple Integral Approximation

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Abstract: This paper mainly discusses the existence of positive periodic solutions of hysteretic differential equations approximated by multiple integrals. Delay differential equations play an important role in the modeling of stochastic phenomena, which cannot be replaced by traditional deterministic models. Under some conditions, the trivial solution of the state-dependent time-delay system is exponentially stable if and only if the zero solution of the corresponding linear system is exponentially stable. The asymptotic behavior of solutions of delay differential equations is appropriate in different ranges. A sufficient condition for the existence of a positive periodic solution is studied. The existence of multi-periodic positive solutions for a class of non-autonomous delay differential equations is studied. When general results are applied to several kinds of bio-mathematical models with time-delay, they have high parallelism, high nonlinearity and good fault tolerance. It is of great theoretical and practical significance to study its development process and problems.

1. Introduction

Periodic phenomena are ubiquitous in nature, and these periodic phenomena usually lead people to study the existence of periodic solutions of functional differential equations. Especially in some ecological models, because of the need of practical significance, people are often required to discuss the existence of positive periodic solutions [1]. Many scholars have used Krasnoselsiki's cone fixed point theorem to study the existence of positive solutions for two-point boundary value problems of second-order and higher-order ordinary differential equations. However, few works have been done to study the existence of periodic solutions of delay differential equations by using this fixed point theorem as a tool [2]. The stability of functional differential equations with perturbation terms has been an important subject in the field of differential equations for many years. Some earlier research results are mostly for autonomous equations, which are limited to the discussion of their local asymptotic properties. The biggest advantage of the new stochastic multiple integral approximation lies in its simple form and low computational complexity. Naturally, we want to know the feasibility of applying this approximation to traditional methods [3]. The stability and vibration of trivial solutions of autonomous delay differential equations have become the focus of many scholars, and the method of judging the roots of the characteristic equations is widely used. How to approximate a general function with a simple function under certain conditions, that is, to find an approximate expression of the function. The mathematical branch formed by the research of such problems is the function approximation theory. The simple function used is called the approximation tool; the method of constructing the approximate expression of the function according to the partial information of the function is called the algorithm [4].

The approximation and conformal properties of generalized operators are studied. Generally speaking, the operator constructs a multiple integral approximation operator by using the function value at a finite number of points of the function, which is only suitable for the multiple integral approximation of continuous functions [5]. In most practical cases, time delay has an effect on the density constraint effect. That is to say, the population growth rate at a certain time is not only related to the population density at that time, but also to the population density at a certain time before that and at all times in the past, so the density constraint term is more complex [6]. Delayed

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differential equations are also ubiquitous in ecological models and have special significance. Delayed differential equations are the most direct reflection, so it is of great significance to discuss the positive periodic solutions of delayed differential equations. The remarkable advantage of this scheme is its lower computational complexity and intuitive and clear multiple integral approximation form [7]. The idea of combining the re-integral approximation format with the splitting step is applied to the traditional Milstein method. The global attraction of zero solution is a very meaningful topic. It avoids the traditional ideas and creates a new way to establish the relationship between the solution and its linearization equation. The sufficient condition for the global solution of zero solution in the case where the linear part is the periodic coefficient and the asymptotic periodic coefficient is obtained. There are sufficient conditions for the positive solution of the period, and then applied to these equations with actual background, and they get quite simple and sufficient conditions for the existence of positive periodic solutions [8].

2. Materials and Methods

The zero solution of delay differential equation is a global attractor. Its basic idea is to estimate the basic solution by traditional eigenvalue distribution and to establish the relationship between the solution and its linearization equation by means of constant variation formula. This method is invalid in the case that the linear part is non-autonomous. Sufficient and necessary conditions for asymptotic mean square stability of numerical methods. One is stability analysis under multidimensional coefficient, the other is stability analysis under one-dimensional coefficient. The basic theorem and eigenvalue theory of unconditional stability give the sufficient conditions for the unconditional stability of the system, which indicates that the time lag is harmless time lag, and the time lag is used as the parameter. The existence condition and branch of the system 叩 branch are obtained by using branch theory. The model equilibrium state stability condition at the value. Considering the influence of the mutation on the population, the simultaneous approximation of the operator is simply that the operator's derivative is also close to the derivative of the approximated function as the operator approximates the approximated function.

Delay differential equations are naturally generalized on the basis of ordinary differential equations, differential-difference equations and differential equations with delay variables. Because the solution mapping of the equation is considered in infinite dimensional space, there are many differences in properties compared with ordinary differential equations. Under the assumption that the nonlinear activation function is bounded, continuous differentiable and the derivative of the activation function is positive bounded, the sufficient conditions for the existence of equilibrium point and its global exponential stability are established. Operators are not only simple in calculation, but also have many good properties, such as endpoint interpolation, conformal preservation and simultaneous multiple integral approximation. The existence and oscillation of positive solutions for non-autonomous linear delay differential equations, and some good comparison results. The generalized characteristic equations are used to study the existence, asymptotic behavior and stability of solutions of second-order or higher-order differential equations. result. The new re-integral approximation is similar in form to the proposed re-integration approximation. Subtle differences are caused by the characteristics of the often delayed delay differential equation itself. As such, the approximation form has a simple form and is easy to understand.

Under the assumption that the nonlinear activation function is bounded and monotonically increasing, sufficient conditions for the existence, uniqueness and global stability of the equilibrium point are obtained by using matrix analysis techniques and function methods. On the one hand, the operator can be used for integrable functions. On the other hand, because the average value is used to replace the value of function at discrete points, the performance of the operator's multiple integral approximation is studied for continuous functions. Under the assumption that the non-linear activation function increases monotonously, the sufficient conditions for global asymptotic stability of equilibrium point are obtained by using matrix analysis techniques and function methods. In practical applications, when the coefficient matrix is used. When the order is higher, it is difficult to calculate the stability matrix. However, state-dependent time-delay models are not frequently used in these applications because the required numerical models, such as linearization techniques, have only recently developed. The linearization stability describing the relationship between the equilibrium stability of a differential equation of a nonlinear function and the stability of a zero solution of a corresponding linear equation. The formula converts it exactly to an expression with a step size. However, for random re-integration, we can't directly convert it into an expression with step size, and the new random re-integral approximation method is very necessary.

3. Result Analysis and Discussion

A new approximation scheme is proposed for stochastic delay multiple integrals of differential equations with constant delay. The remarkable advantage of this scheme is its low computational complexity and intuitive and clear form of double integral approximation. Sufficient conditions for the existence, uniqueness and global stability of equilibrium point are established. Under the assumption that the activation function is bounded and satisfied, by constructing appropriate functions, delay differential equation is an important branch of functional differential equation developed in recent years, and many problems in mechanics, physics, ecology, biology and economics can only be described by delay differential equation. The sufficient conditions for the existence, uniqueness and global exponential stability of equilibrium points and the existence of periodic solutions are established. The worst framework emphasizes the approximation error of the function class in terms of the worst elements used by the approximation tools and methods. The averaging framework emphasizes the approximation error of most of the elements of the approximation tools and methods used in the function class that equips the probability measure.

Now we consider the following forms of delay differential equations with one-dimensional coefficients:

$$\mu_{s,d} = \frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}\left|W_{s,d}(m,n)\right| \tag{1}$$

Assuming that the analytical solution of equation (1) is stable, we consider applying it to equation M (W). According to the formula:

$$M(w) = \frac{w}{D}R_{ON} + (1-\frac{w}{D})R_{OFF} \tag{2}$$

According to the case of the lemma for the one-dimensional coefficient Ws, the stability matrix m,n becomes a real number, and its value is:

$$\sigma_{s,d} = \left[\frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}\left|\left|W_{s,d}(m,n)\right| - \mu_{s,d}\right|^{2}\right]^{1/2} \tag{3}$$

The numerical method is asymptotically mean squared VD stable, according to the formula:

$$v_D = \eta\frac{u_D R_{ON}}{D}i(t) \tag{4}$$

The role of the law of value in economics is also caused by the time lag between production and consumption; if the time lag is too long, the system controlled by the feedback loop will cause a large oscillation. In order to reflect nature more truly, time delay is often a factor that should not be neglected in the ecosystem. Some local or large-scale properties of solutions of differential equations usually change with some parameters in the equation, resulting in bifurcation phenomenon. The bifurcation belongs to one of these problems. In nature, the density change of biological population is extremely complex. By constructing appropriate functions, using matrix theory and topological degree method, matrix norm and matrix measure knowledge, the equilibrium point is obtained. Existence, uniqueness, global asymptotic and global exponential stability. The convergence order is the same. This indicates that the error between our new re-integral approximation proposed for random delay re-integration and the real value of the original stochastic delay re-integration is small enough that the strong convergence order of the overall new numerical format remains unchanged.

The existence of positive periodic solutions. Obviously, some special forms, such as the single-factor Logistic model, depend on the formula:

$$v_D = \frac{dw}{dt} \tag{5}$$

By using it, the necessary and sufficient conditions for the existence of positive solutions and some results of oscillation are obtained:

$$M(q) = R_0 - \eta \frac{\Delta Rq}{Q_0} \tag{6}$$

According to the characteristic equation, the derivation of the two ends with respect to the real delay t is obtained as follows:

$$M(t) = u(t)/i(t) = R_0 \sqrt{1 - 2\eta \Delta R \Phi(t)/Q_0 R_0^2} \tag{7}$$

Among them, U and I are normal numbers, especially when the relative growth rate is high:

$$M(t) = u/i = R_0 \sqrt{1 - 2\eta \Delta RUt/Q_0 R_0^2} \tag{8}$$

The importance of stability can be imagined, as small as a specific control system, as large as a social system, financial system, ecosystem is always operating under various occasional or continuous disturbances. After suffering from this kind of interference. For the properties of such equations, such as the existence, uniqueness, stability and properties of periodic systems, the development of mathematical theory and the need of practical application are considered. It mainly concentrates on the autonomous parameters including instantaneous consistent network parameters and input stimuli. In addition, there are some difficulties in mathematical processing. On this basis, some analytical techniques related to the median theorem are added, and the average error estimate of the operator's simultaneous reintegration approximation in the reintegration space is obtained. The sufficient conditions for the asymptotic mean square stability of the numerical method are given in the form of theorem. Here we mainly consider how the selection of each parameter in the numerical method affects the stability of the mean square.

4. Conclusion

In this paper, we study the existence of positive periodic solutions of nonautonomous delay differential equations based on multiple integral approximation. Delay differential equation is an important branch of modern mathematics. It is closely related to differential equation, functional analysis, computational mathematics, potential theory and stochastic analysis. The necessary and sufficient conditions for the mean square stability are given. For the case of one-dimensional coefficients, the influence of the selection of coefficients on the mean square stability of numerical methods is discussed, and the sufficient conditions for the mean square asymptotic stability in different cases are given. Under the averaging framework, the operator has exactly the same approximation and simultaneous approximation performance as the operator. The conclusions show that under the average framework, the existence of the almost identical approximation and simultaneous approximation between the operators yields the existence, uniqueness and global exponential stability of the almost periodic solutions with variable coefficients.

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