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Weak Convergence of Truncation Error of Differential Order Partial Derivative Equations Under Mathematical Chaos Theory

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Based on the theory that the stability of the boundary value of the differential order partial differential equation is the key factor in the stability control of the fuzzy two-degree-of-freedom control system, the weak convergence of the partial derivative truncation error is analyzed. First, by means of mixed-logic mapping, the quasi-linear differential equation of the nonlinear dynamic mixed control model is established; then, the constraint problem of the partial differential equation is analyzed using the differential equation of the eigenvalue inverse stable solution with the introduction of boundary conditions; finally, the quasi-linear equation is used with the time-delay characteristic. The function-dependent properties of differential equations traverse the solution space, and the truncation error analysis of the weak convergence and stability of the solution space is obtained. The results show that the differential order partial differential equations have weak convergence of truncation error and good convergence in a fuzzy two-degree-of-freedom control system.

Keywords: time-delay effect; quasi-linear differential equation; truncation error weak convergence problem; convergence

1. INTRODUCTION

The development and application of high-tech is inseparable from applied mathematics. With the continuous development of applied mathematics and control theory in recent years, high-tech applications are now widely used in industry and manufacturing [1]. For example, most researchers currently use time-delay linear differential equations to construct state-constrained objective functions in control systems, and apply them to control fields such as industrial control and flight guidance control [2, 3]. As a high-order differential equation, partial differential equation has great application value in the theoretical research of control systems and pattern recognition. Under the mathematical chaos theory, the differential order partial derivative equation has a certain boundary value period, and the existence and convergence of the boundary value determine the stability and time delay constraints of the control system [4]. Therefore, the research conducted in this paper on the weak convergence of the truncation error of the differential order partial derivative equation is of great significance in terms of improving the stability of the control system.

In traditional methods, the theory of equilibrium point translation is used to analyze the problem of truncation error weak convergence of differential order partial derivative equations under mathematical chaos theory [5]. By constructing a linear subspace of a quasi-linear differential equation, a linear subspace of a linear differential equation,

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a linear subspace of a linear differential equation, an edge value eigenvalue decomposition of the linear differential equation and Lyapunov-Krasovskii functional are used [6]. Reference [7] developed the stationary solution of the nonlinear autoregressive sequence and the existence analysis of its moment, provided a solution for the weak convergence value of the stable truncation error of the pseudo-linear differential equation, and applied it to the stability control of the second-order fuzzy logic system. However, this method is not suitable for the time-delay control of the weak convergence value of the truncation error when the fluctuation point of the equilibrium of the equation changes. Therefore, this paper analyzes the problem of weak convergence of truncation error of differential order partial derivative equation under the mathematical chaos theory, obtains the value of this weak convergence under mathematical chaos theory, analyzes the weak convergence and stability of the truncation error, and draws a valid conclusion.

2. THE CONSTRUCTION OF THE PRE-KNOWLEDGE MODEL AND ITS CONSTRAINT ANALYSIS

2.1 Differential Order Partial Derivative Equation Under the Theory of Mathematical Mixing

In order to analyze the aforementioned problem of weak convergence [8, 9], the boundary conditions of quasilinear differential equation with time delay effect in online subspace are analyzed. The nonlinear-coupled Levenberg-Marquardt equation is used to express the differential order partial derivative equation under mathematical chaos theory. The process is shown in equation (1).

$$\begin{cases} C_1(s) = \frac{\lambda_2 s+1}{\lambda_1 s+1}\mathrm{d}s \\ C_2(s) = \frac{\prod_{i=1}^{i=n}(T_{mi}s+1)}{K_m(\lambda_2+L_m)s}\mathrm{d}s \end{cases} \tag{1}$$

In the above formula, λ_1 and λ_2 are time constants of m-dimensional complex spaces, K_m is time delay of pure lag, L_m is open-loop transfer gain, and given a vector group $x_1, x_2, \ldots, x_n \in C^m$, the Lyapunov functional is carried out under different boundary conditions [10]. The partial derivative of the differential order partial derivative equation at the stable point of equilibrium $F(x_{k+1})$ is obtained under the mathematical mixed solution theory. As shown in equation (2).

$$g_k + A_k \Delta x_k = 0 \tag{2}$$

Definition 1 Assumes that the coupling relationship between eigenvalues and eigenvectors of differential order partial derivative equations under $g_i(\cdot)$ mathematical chaos theory of nonlinear function $\alpha, \beta \in R$, which is expressed as equation (3).

$$x_{k+1} = x_k - A_k^{-1} g_k \tag{3}$$

According to the Leibniz stability condition of the quasi-linear differential equation with time-delay effect [11], the characteristic of the input state of the $F(x)$ as the linear subspace is as equation (4).

$$F(x) = v^T(x)v(x) \tag{4}$$

Theorem 1 *If the first step of the output of the scalar ρ and the non-zero vector v is as equation (5).*

$$\nabla F(x_j) = 2\sum_{i=1}^{N} v_i(x)\frac{\partial v_i(x)}{\partial x_j} \tag{5}$$

The initial value of the differential order partial derivative equation under the theory of mathematical mixing is expressed as equation (6).

$$\begin{cases} u_n - \Delta u + |u|^4 u = 0, \\ (u, \partial_t u)|_{t=0} = (u_0, u_1) \times \dot{H}_x^{s_c-1} \end{cases} \tag{6}$$

Where u:$I \times IR^d \to IR$ is a real-valued function, the measure of fuzzy two-degree-of-freedom control system under continuous disturbance is as equation (7).

$$\nabla F(x) = 2J^T(x)v(x) \tag{7}$$

In the time interval, when $d = 4, s_c = \frac{3}{2}$, the Jacobian matrix $A > 0$ of the weak convergence value of the truncation error of all the $J(x)$ and the differential equations is as equation (8).

$$J(x) = \begin{pmatrix} \frac{\partial v_1(x)}{\partial x_1} & \frac{\partial v_1(x)}{\partial x_2} & \cdots & \frac{\partial v_1(x)}{\partial x_n} \\ \frac{\partial v_2(x)}{\partial x_1} & \frac{\partial v_2(x)}{\partial x_2} & \cdots & \frac{\partial v_2(x)}{\partial x_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial v_N(x)}{\partial x_1} & \frac{\partial v_N(x)}{\partial x_2} & \cdots & \frac{\partial v_N(x)}{\partial x_n} \end{pmatrix} \tag{8}$$

Define the critical canonical index $s_c = \frac{d-1}{2}$. Solving the time interval and solving the weak convergence problem of truncation error of differential order partial derivative equation under mathematical chaos theory is transformed into the convergence problem of finding the critical regular index [12].

2.2 Nonlinear Dynamic Hybrid Control Model of Differential Equations

The nonlinear dynamic chaos control model of quasilinear differential equations is constructed under chaotic logistics mapping [13]. The boundary conditions with stable solutions for inverse eigenvalues of differential equations are introduced [14]. The second-order gradient $\nabla^2 F(x)$ of continuous inverse stationary differential equations is calculated with equation (9).

$$\nabla^2 F(x_{kj}) = 2J^T(x)J(x) + 2S(x) \tag{9}$$

The high-order accumulated characteristic decomposition in the time interval of the equation (1) is decomposed by using a bilateral mapping K, and the control law of the Levenberg-Marquardt constraint is as equation (10).

$$x_{k+1} = x_k - [J^T(x_k)J(x_k) + \mu_k I]^{-1} J^T(x_k)v(x_k) \tag{10}$$

When μ_k is maximum, the nonlinear dynamic chaotic control model of differential equation is stable [15]. The homogeneous equation of quasilinear differential equation with sometimes delay effect defined by $s \geq 0$, when the initial value condition is (u_0, u_1), then equation (11) exists.

$$F(x) = \sum_{q=1}^{Q} \sum_{k=1}^{m} e_{kq}^2 \tag{11}$$

Theorem 2 *The desired output vector of the first-order inertia link of the quasi-linear differential equation with the time-delay effect of the* $\frac{1}{p} = \frac{1}{q} + \frac{s}{d}, 1 < p < q < \infty, s > 0$, *and if the* $\frac{1}{p} = \frac{1}{q} + \frac{s}{d}, 1 < p < q < \infty, s > 0$, *according to the Sobolev inequality theorem in equation (12).*

$$\begin{aligned}
&|||\nabla|^{\frac{5}{4}}(|f|^4 f)||_{N_{\frac{3}{4}}} \leq |||\nabla|^{\frac{5}{4}}(|f|^4 f)||_{L_t^{\frac{20}{13}} L_x^{\frac{40}{31}}} \\
&\leq |||\nabla|^{\frac{5}{4}} f||_{L_t^4 L_x^{\frac{8}{3}}} |||f|^4||_{L_{t,x}^{\frac{5}{2}}} + ||f||_{L_{t,x}^{10}} |||\nabla|^{\frac{5}{4}} f^4||_{L_t^{\frac{20}{11}} L_x^{\frac{40}{27}}} \\
&\leq C\big[|||\nabla|^{\frac{5}{4}} f||_{L_t^4 L_x^{\frac{8}{3}}} |||f|^4||_{L_{t,x}^{\frac{5}{2}}} + ||f||_{L_{t,x}^{10}} ||f^3||_{L_{t,x}^{\frac{10}{3}}} || \\
&\quad |\nabla|^{\frac{5}{4}} f||_{L_t^4 L_x^{\frac{8}{3}}}\big] \\
&\leq C|||\nabla|^{\frac{5}{4}} f||_{L_t^4 L_x^{\frac{8}{3}}} ||f||_{L_{t,x}^{10}}^4 \\
&\leq C|||\nabla|^{\frac{5}{4}} f||_{S_{\frac{1}{4}}} ||f||_{L_{t,x}^{10}}^4
\end{aligned} \tag{12}$$

In infinite dimensional Bernoulli space, the critical threshold of the least square matrix $(u_0, u_1) \in \dot{H}_x^{s_c} \times \dot{H}_x^{s_c - 1}$ *and the higher order moment matrix* $K(Z_1 + Z_2 + Z_3)^{-1} K^T$ *of the truncation error weak convergence value of the initial value* $W Z_1^{-1} W^T$, *the equation satisfies the following continuous inverse stationary constraints.*

$$\begin{aligned}
0 &= \int_{t-\tau}^{t} \eta_1^T(t) X \eta_1(t) \mathrm{d}s - \int_{t-\tau}^{t} \eta_1^T(t) X \eta_1(t) \mathrm{d}s \\
&= \tau \eta_1^T(t) X \eta_1(t) - \int_{t-\tau}^{t} \eta_1^T(t) X \eta_1(t) \mathrm{d}s
\end{aligned} \tag{13}$$

$$\begin{aligned}
0 &= \int_{t-\sigma}^{t} \eta_2^T(t) Y \eta_2(t) \mathrm{d}s - \int_{t-\sigma}^{t} \eta_2^T(t) Y \eta_2(t) \mathrm{d}s \\
&= \sigma \eta_2^T(t) Y \eta_2(t) - \int_{t-\sigma}^{t} \eta_2^T(t) Y \eta_2(t) \mathrm{d}s
\end{aligned} \tag{14}$$

where

$$S(x) = \sum_{i=1}^{N} v_i(x) \nabla^2 v_i(x) \tag{15}$$

The solution $x_1(t), x_2(t)$ *of the quasi-linear differential equation satisfies equation (16).*

$$\lim_{t \to \infty} x_1(t) = x_1^0, \ \lim_{t \to \infty} x_2(t) = x_2^0 \tag{16}$$

The offset amplitude of the characteristic solution of the differential equation is equation (17).

$$g(x_i, y_j | \mu_k, \sigma_k^2) = \prod_{k=1}^{K} \alpha_k \frac{1}{\sqrt{2\pi\sigma_k^2}} \exp\left\{ -\frac{(x_i - \mu_k)^2}{2\sigma_k^2} \right\} \tag{17}$$

In the above formula, α_k *is the differential power,* μ_k *is the Lyapunov-Krasovskii functional parameter, the boundary condition of the inverse eigenvalue of the differential equation is introduced, and the nonlinear dynamic hybrid control model is constructed [16].*

2.3 Partial Differential Equation Constraint Problem

In the practical application of distributed control, the constraint problem of partial differential equation for $\Omega \subset R^2$ or R^3 region is as follows.

$$\begin{cases}
\min\limits_{u,f} \frac{1}{2}||u - u_*||_2^2 + \beta||f||_2^2 \\
\textit{subject to} - \nabla^2 u = f \textit{ in } \Omega \\
\textit{with } u = g \textit{ on } \partial\Omega_1 \textit{ and } \frac{\partial u}{\partial n} = g \textit{ on } \partial\Omega_2
\end{cases} \tag{18}$$

In the equation, $\partial\Omega_1$ is different from $\partial\Omega_2$, and $\partial\Omega_1 \cup \partial\Omega_2 = \partial\Omega$, $\partial\Omega_1 \cap \partial\Omega_2 \neq 0$, u_* is given. Find a u that satisfies the condition of formula (1), so that u is infinitely close to u_* below the L_2 norm.

When dealing with the optimization problem of partial differential constraint, the method of discretization followed by optimization is applied to transform the optimization problem of partial differential constraint into a set of linear equations containing a saddle point. In order to clarify the transformation steps, the weak form is used to express the process, which is shown in equation (19).

$$\begin{cases}
u \in H_g^1(\Omega) = \{u{:}u \in H^1(\Omega), \ u = g \text{ on } \partial\Omega\} \\
\int_\Omega \nabla u \cdot \nabla v = \int_\Omega vf, \ \forall v \in H_0^1(\Omega)
\end{cases} \tag{19}$$

Assume that $V_0^h \in H_0^1$ is an n-dimensional vector space, where V_0^h is represented by the test function $\{\phi_1, \ldots \phi_n\}$. In order for the boundary conditions to be true the $\phi_{n+1}, \ldots \phi_{n+\partial n}$ function is defined using the coefficient U_j to expand the set, Therefore, $\sum_{j=n+1}^{n+\partial n} U_j \phi_j$ is inserted into the boundary value as a set of vector values. If $u_h \in V_g^h \subset H_g^1(\Omega)$, then $u = (U_1 \ldots U_n)^T$ determines the value of u_h function, then equation (20) exists.

$$u_h = \sum_{j=1}^{n} U_j \phi_j + \sum_{j=n+1}^{n+\partial n} U_j \phi_j \tag{20}$$

If $V_g^h = span\{\phi_1, \ldots, \phi_{n+\partial n}\} \subset H_g^1(\Omega)$ is assumed below, then the finite-dimensional approximate formula of equation (2) can be obtained. If $u_h \in V_g^h$ is found, then equation (21) exists.

$$\int_\Omega \nabla u_h \cdot \nabla v_h = \int_\Omega v_h f, \ \forall v_h \in V_0^h \tag{21}$$

With the steps given above, the discrete value u_h of u in formula (1) is obtained. The following steps are used to find the discrete value of f, which can be obtained in the same way. The formula is as equation (22).

$$f_h = \sum_{j=1}^{n} F_j \phi_j \tag{22}$$

Under the condition that $f_h = 0$ on boundary $\partial\Omega$ is satisfied, the constrained optimization problem can be converted into equation (23).

$$\begin{cases} \min\limits_{u_h, f_h} \frac{1}{2}||u_h - u_*||_2^2 + \beta||f_h||_2^2 \\ \int_\Omega \nabla u_h \cdot \nabla v_h = \int_\Omega v_h f, \ \forall v_h \in V_0^h \end{cases} \tag{23}$$

Using the above conversion conditions, the discrete formula (1) can be rewritten as equation (24).

$$\begin{aligned} &\min_{u_h, f_h} \frac{1}{2}||u_h - u_*||_2^2 + \beta||f_h||_2^2 = \\ &\min_{u_h, f_h} \frac{1}{2}u^T Mu - u^T b + \alpha + \beta f^T Mf \end{aligned} \tag{24}$$

Where, matrix $M = \left\{\int \phi_i \phi_j\right\}_{i,j=1\ldots n}$ represents a mass matrix, $u = (U_1 \ldots U_n)^T$, $f = (F_1 \ldots F_n)^T$ and $b = \left\{\int u_* \phi_j\right\}_{i=1\ldots n}$, $\alpha = ||u_*||_2^2$. After comprehensively considering the constraint conditions, the function expression for wireless proximity to u is equation (25).

$$\begin{aligned} &\sum_{i=1}^{n} U_i \int_\Omega \nabla\phi_i \cdot \nabla\phi_j = \sum_{i=1}^{n} F_i \int_\Omega \phi_i \phi_j \\ &- \sum_{i=n+1}^{n+\partial n} U_i \int_\Omega \nabla\phi_i \cdot \nabla\phi_j, \ j = 1, \ldots, n \end{aligned} \tag{25}$$

or

$$Ku = Mf + d \tag{26}$$

where, matrix $K = \left\{\int \nabla\phi_i \cdot \nabla\phi_j\right\}_{i,j=1\ldots n}$ represents the stiffness matrix, and the component vectors generated by the boundary value of u_h are represented by d. By using Lagrange multiplication to calculate the constrained problem, then equation (27) exists.

$$\chi := \frac{1}{2}u^T Mu - u^T b + \alpha + \beta f^T Mf + \lambda^T (Ku - Mf - d) \tag{27}$$

where, λ stands for a vector formed by Lagrange multiplication, and linear equations of f, u and λ are obtained at the same time, then equation (28) exists.

$$AX = \begin{pmatrix} 2\beta M & 0 & -M \\ 0 & M & K^T \\ -M & K & 0 \end{pmatrix} \begin{pmatrix} f \\ u \\ \lambda \end{pmatrix} \equiv \begin{pmatrix} 0 \\ b \\ d \end{pmatrix} \equiv g \tag{28}$$

where, $M \in \mathbb{R}^{m\times m}$ represents the mass matrix, $K \in \mathbb{R}^{m\times m}$ represents the stiffness matrix, $d \in \mathbb{R}^m$ is the vector value of boundary conditions containing the discrete solution, $b \in \mathbb{R}^m$ is the discrete form of the Galerkin projection vector, β is the regular parameter, and λ is the Lagrange multiplier vector.

Due to the operation of finite element discretization, most of the coefficient matrix is the zero-block matrix, and the matrices K and M are relatively simple coefficient matrix equations, which are convenient for calculation.

3. WEAK CONVERGENCE VALUE OF TRUNCATION ERROR OF QUASILINEAR DIFFERENTIAL EQUATION AND ITS RELATED PROOF

The sampling point sequence of the boundary value solution of obtained by the partial differential equation at the initial moment is $\{X_n\}$. The initial solution vector of the partial differential equation has some fixed point X^*. The stable solution obtained with the equation (29) satisfies the constraint conditions.

$$||f||_{L^q(IR^d)} \leq C|||\nabla|^2 f||_{L^p(IR^d)} \tag{29}$$

The distribution function of the boundary value equilibrium solution vector of the partial differential equation is equation (30).

$$\begin{cases} \frac{p_H - p_L}{1-0} \times m[0,1] + m_i[p_L, \ p_H] = C_i \\ m_i[p_L, \ p_H] + m_i[0,1] = 1 \end{cases} \tag{30}$$

According to the pignistic transformation rules, the equilibrium training data set of partial differential equations generates a progressive Bochner-Riesz matrix model. As shown in equation (31).

$$\begin{aligned} m_i'[p_H, p_L] &= \omega_i \times m_i[p_H, \ p_L] \\ m_i'[0,1] &= \omega_i \times m_i[0,1] + 1 - \omega_i \end{aligned} \tag{31}$$

when $\left([p_{Hj}, \ p_{Lj}]\right) \subseteq ([p_{Hi}, \ p_{Li}])$, $\boldsymbol{w}(k) \in L_2 0, \infty)$, then equation (28) exists.

$$\boldsymbol{J} \leq \sum_{k=0}^{\infty} \left[z^T(k)z(k) - \gamma^2 \boldsymbol{w}^T(k)\boldsymbol{w}(k) + \Delta \boldsymbol{V}_k\right] \tag{32}$$

by using the Schur complementary property, then equation (33) can be obtained.

$$\boldsymbol{J} \leq \Phi_2(k)U\Phi_2^T(k) \tag{33}$$

Under zero initial conditions, the continuous functional matrix of partial differential equation is equation (34).

$$U = \begin{bmatrix} \bar{A}^T P\bar{A} - P + K^T RK + C^T C & \bar{A}^T P\bar{B} + C^T D & \bar{A}^T PF_1 + C^T F_2 \\ \bar{B}^T P\bar{A} + D^T C & \bar{B}^T P\bar{B} - R + D^T D & \bar{B}^T PF_1 + D^T F_2 \\ F_1^T P\bar{A} + F_2^T C & F_1^T P\bar{B} + F_2^T D & F_1^T PF_1 + F_2^T F_2 - \gamma^2 I \end{bmatrix} \tag{34}$$

If the inequality $\boldsymbol{U} < 0$ is true, the boundary value of the equilibrium solution is obtained, and the stability of the equilibrium solution of the partial differential equation is derived. For any $\boldsymbol{w}(k) \in L_2[0,\infty)$, $||z(k)||_2 \leq \gamma||\boldsymbol{w}(k)||_2$ is satisfied. By using the compression mapping principle, when the nonlinear term $\boldsymbol{U} < 0$ is established, the characteristic parameter H_∞ of the spatial state of the equilibrium solution satisfies the nonlinear convergence γ. By using the Schur complement property, and letting $x_{n+1} = \mu x_n(1 - x_n)$ be a set of all amplitude vector points, $\boldsymbol{U} < 0$ and matrix can be simplified as equation (35).

$$\begin{bmatrix} -\boldsymbol{P}^{-1} & \bar{\boldsymbol{A}} & \bar{\boldsymbol{B}} & \boldsymbol{F}_1 & 0 \\ \bar{\boldsymbol{A}}^T & -\boldsymbol{P} + \boldsymbol{K}^T \boldsymbol{RK} & 0 & 0 & \boldsymbol{C}^T \\ \bar{\boldsymbol{B}}^T & 0 & -\boldsymbol{R} & 0 & \boldsymbol{D}^T \\ \boldsymbol{F}_1^T & 0 & 0 & -\gamma^2 \boldsymbol{I} & \boldsymbol{F}_2^T \\ 0 & \boldsymbol{C} & \boldsymbol{D} & \boldsymbol{F}_2 & -\boldsymbol{I} \end{bmatrix} < 0 \tag{35}$$

The boundary existence and global convergence of partial differential equations under linear search are analyzed, and lemma can be used to obtain.

$$\begin{bmatrix} -\boldsymbol{P}^{-1}+\varepsilon\boldsymbol{G}\boldsymbol{G}^{T} & textbftextit A & \boldsymbol{B} & \boldsymbol{F}_1 & 0 \\ \boldsymbol{A}^{T} & -\boldsymbol{P}+\boldsymbol{K}^{T}\boldsymbol{R}\boldsymbol{K}+\varepsilon^{-1}(\boldsymbol{A}_1^{T}\boldsymbol{A}_1) & \varepsilon^{-1}(\boldsymbol{A}_1^{T}\boldsymbol{B}_1) & 0 & \boldsymbol{C}^{T} \\ \boldsymbol{B}^{T} & \varepsilon^{-1}\boldsymbol{B}_1^{T}\boldsymbol{A}_1 & -\boldsymbol{R}-\varepsilon^{-1}(\boldsymbol{B}_1^{T}\boldsymbol{B}_1) & 0 & \boldsymbol{D}^{T} \\ \boldsymbol{F}_1^{T} & 0 & 0 & -\gamma^{2}\boldsymbol{I}\boldsymbol{F}_2^{T} & \\ 0 & \boldsymbol{C} & \boldsymbol{D} & \boldsymbol{F}_2 & -\boldsymbol{I} \end{bmatrix} < 0 \tag{36}$$

By using the Schur complement property, the global regular asymptotic periodic solution satisfies the LESLIE-GOWER transformation. As shown in equation (37).

$$\begin{bmatrix} -\boldsymbol{P}^{-1}+\varepsilon\boldsymbol{G}\boldsymbol{G}^{T} & \boldsymbol{A} & \boldsymbol{F}_1 & \boldsymbol{B}\boldsymbol{R}^{-1}\boldsymbol{D}^{T} & \boldsymbol{B}\boldsymbol{R}^{-1}\boldsymbol{B}_1^{T} & 0 \\ \boldsymbol{A}^{T} & -\boldsymbol{P} & 0 & \boldsymbol{C}^{T} & \boldsymbol{A}_1^{T} & \boldsymbol{K}^{T} \\ \boldsymbol{F}_1^{T} & 0 & -\gamma^{2}\boldsymbol{I} & \boldsymbol{F}_2^{T} & 0 & 0 \\ \boldsymbol{D}\boldsymbol{R}^{-1}\boldsymbol{B}^{T} & \boldsymbol{C} & \boldsymbol{F}_2 & -\boldsymbol{I}+\boldsymbol{D}\boldsymbol{R}^{-1}\boldsymbol{D}^{T} & \boldsymbol{D}\boldsymbol{R}^{-1}\boldsymbol{B}_1^{T} & 0 \\ \boldsymbol{B}_1\boldsymbol{R}^{-1}\boldsymbol{B}^{T} & \boldsymbol{A}_1 & 0 & \boldsymbol{B}_1\boldsymbol{R}^{-1}\boldsymbol{D}^{T} & -\varepsilon\boldsymbol{I}+\boldsymbol{B}_1\boldsymbol{R}^{-1}\boldsymbol{B}_1^{T} & 0 \\ 0 & \boldsymbol{K} & 0 & 0 & 0 & -\boldsymbol{R}^{-1} \end{bmatrix} < 0 \tag{37}$$

The delay differential equation is treated by the generalized strong vector quasi-equilibrium, which is also multiplied by the matrix. As shown in equation (38).

$$\begin{bmatrix} \boldsymbol{I} & 0 & 0 & 0 & 0 & 0 \\ 0 & \boldsymbol{P}^{-1} & 0 & 0 & 0 & 0 \\ 0 & 0 & \boldsymbol{I} & 0 & 0 & 0 \\ 0 & 0 & 0 & \boldsymbol{I} & 0 & 0 \\ 0 & 0 & 0 & 0 & \boldsymbol{I} & 0 \\ 0 & 0 & 0 & 0 & 0 & \boldsymbol{I} \end{bmatrix} \tag{38}$$

The auxiliary matrix is applied to solve the equation to determine the coefficient c_k. Let $\boldsymbol{P}^{-1} = \boldsymbol{Q}$, $\boldsymbol{R}^{-1} = \boldsymbol{S}$, $\boldsymbol{M} = \boldsymbol{K}\boldsymbol{P}^{-1}$, $\Psi_2(d_2(t))$ be the Bernoulli Spaces of partial differential equations $L(Z_2+Z_3)^{-1}L^T$ and $M^T(Z_2+Z_3)^{-1}M^T$ on the global regular region $d_2(t)(0 \le d_2(t) \le h_2)$, and only if:

$$\begin{aligned} \Psi(h_1,h_2) &= \Psi + h_1K(Z_1+Z_2+Z_3)^{-1}K^T \\ &\quad + h_2M(Z_2+Z_3)^{-1}M^T < 0, \end{aligned} \tag{39}$$

$$\begin{aligned} NEG_C^M(d) &= \cup\{E_i|g(d|E_i) \\ &= \min(g(d_1|E_i),\cdots,g(d_m|E_i)) \\ &< 0,\ 0,\ E_i \in E\} \end{aligned} \tag{40}$$

$$BND_C^M(d) = \cup\{E_i|g(d|E_i) = 0,\ E_i \in E\} \tag{41}$$

$$\begin{aligned} \Psi(0,0) &= \Psi + h_1WZ_1^{-1}W^T + h_1L(Z_2+Z_3)^{-1}L^T \\ &\quad + h_2L(Z_2+Z_3)^{-1}L^T < 0. \end{aligned} \tag{42}$$

The partial derivative of the solution vector of the equilibrium solution vector of the partial differential equation is set as 0, and the following is obtained.

$$\begin{aligned} &\frac{\partial L}{\partial R} = 0 \to \sum_i \alpha_i = 1 \\ &\frac{\partial L}{\partial o} = 0 \to \mathrm{o} = \frac{\sum_i \alpha_i x_i}{\sum_i \alpha_i} = \sum_i \alpha_i x_i \\ &\frac{\partial L}{\partial \xi_i} = 0 \to \mathrm{A} - \alpha_i - \gamma_i = 0 \end{aligned} \tag{43}$$

The distribution characteristic function was applied to carry out the adaptive lyapunov exponential functional of partial differential equation in Cauchy kernel, and the stability objective function of the equilibrium solution was obtained with equation (44).

$$\begin{aligned} &\max \sum_{i=1}^{n} \alpha_i K(x_1,x_i) - \sum_{i=1}^{n}\sum_{j=1}^{n} \alpha_i\alpha_j K(x_i,x_j) \\ &s.t{:}\sum_{i=1}^{n}\alpha_i = 1 \qquad 0 \le \alpha_i \le A \end{aligned} \tag{44}$$

It can be seen that when there is a stable solution to partial differential equations under double boundary conditions exists. The proof of stability is explained below.

It is proved that: the random measure foot of the stable solution of partial differential equation at the equilibrium point. As shown in equation (45).

$$\begin{aligned} |Tu(t)| &= \left|\int_0^1 G(t,s)f(s,u(s),\ D_{0+}^{\beta}u(s))\mathrm{d}s\right| \\ &\le \int_0^1 |G(t,s)a(s)|ds + M\int_0^1 |G(t,s)|\mathrm{d}s \\ &\le k + \left(\int_0^1 \frac{(1-s)^{\alpha-1}}{\Gamma(\alpha)}ds + \frac{1}{\Gamma(\alpha)}\int_0^t (t-s)^{\alpha-1}\mathrm{d}s\right) \\ &\le k + \frac{M(t^{\alpha}+1)}{\alpha\Gamma(\alpha)} \\ &\le k + \frac{2M}{\Gamma(\alpha+1)} \end{aligned} \tag{45}$$

In the quadrant of the discrete stochastic process, the covariance matrix of the partial differential equation is $(x_1, x_2 \ge 0)$, and the Lyapunov functional is adopted. Let the Yapunov functional confidence of $D_{0+}^{\beta}u(s)$ and $G(t,s)$ be equation (46) and equation (47).

$$\sum_{i=0}^{F}\binom{n}{i}p_L^{n-i}(1-p_L)^i = \frac{1}{2}(1-C) \tag{46}$$

$$\sum_{i=F}^{N}\binom{n}{i}p_H^{n-i}(1-p_H)^i = \frac{1}{2}(1-C) \tag{47}$$

The triple solitary wave solution of boundary region BND_C^M is equation (48).

$$POS_C^M(d) = \{E_i|g(d|E_i) > 0, E_i \in E\} \tag{48}$$

$$NEG_C^M(d) = \{E_i|g(d|E_i) < 0,\ E_i \in E\} \tag{49}$$

$$BND_C^M(d) = \{E_i|g(d|E_i) = 0,\ E_i \in E\} \tag{50}$$

To obtain the stable periodic points in equilibrium partial differential equations with stable solutions, we use equation (51) and equation (52).

$$G(C[\Delta + \kappa(\Delta)]) + CT = 0 \tag{51}$$

$$\begin{aligned} &\lim_{x\to\infty} E[\sup|X(t)-y(t)|^p] < \lim_{x\to\infty} G^{-1} \\ &\quad \times (G(c[\Delta+\kappa(\Delta)]) + CT) = 0 \end{aligned} \tag{52}$$

According to the Cauchy convergence condition, it is proved that the equilibrium interpretation of a class of partial differential equations with a homogeneous solution is asymptotically stable, thereby proving the proposition.

3.1 Weakly Convergent Value of Truncation Error of Quasilinear Differential Equation and its Proof

The differential boundary $\nabla^2 F(x)$ of the differential order partial derivative equation under the theory of mathematical mixing can be approximated as equation (53).

$$[\nabla^2 F(x)]_{kj} \cong 2J^T(x)J(x) \tag{53}$$

The iterative formulas of discrete differential boundary solution vectors W and Z at the equilibrium point $P_0(x_1^0,\ x_2^0)$ of the equation are equation (54) and equation (55).

$$\mathrm{W}_{ji}(k+1) = w_{ji}(k) - \alpha\frac{\partial F}{\partial w_{ji}} \tag{54}$$

$$z_{kj}(k+1) = z_{kj}(k) - \alpha\frac{\partial F}{\partial z_{kj}} \tag{55}$$

The Jacob matrix for constructing the characteristic space of weak convergence value of truncation error can be written as equation (56).

$$J(x) = \begin{pmatrix} \frac{\partial e_{11}}{\partial w_{11}} & \frac{\partial e_{11}}{\partial w_{12}} & \cdots & \frac{\partial e_{11}}{\partial z_{mt}} \\ \frac{\partial e_{21}}{\partial w_{11}} & \frac{\partial e_{21}}{\partial w_{12}} & \cdots & \frac{\partial e_{21}}{\partial z_{mt}} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial e_{mQ}}{\partial w_{11}} & \frac{\partial e_{mQ}}{\partial w_{12}} & \cdots & \frac{\partial e_{mQ}}{\partial z_{mt}} \end{pmatrix} \tag{56}$$

Theorem 3 *Under the anti-periodic boundary condition, the constraint control is realized by the bounded condition $w \in (a_1, a_N]$, and the differential boundary condition of the differential order partial derivative equation under the theory of the mathematical mixed solution is equation (57).*

$$\frac{\partial e_{dq}}{\partial z_{kj}} = \frac{-\partial Y_{dq}}{\partial z_{kj}} = -\frac{\partial g(o_{dq})}{\partial z_{kj}} = -g'(o_{dq})\frac{\partial\left(\sum_{j=1}^{t} z_{dj}a_{jq}\right)}{\partial z_{kj}} \tag{57}$$

$$\frac{\partial e_{dq}}{\partial w_{ji}} = \frac{-\partial Y_{dq}}{\partial w_{ji}} = -\,g'(o_{dq})\frac{\partial o_{dq}}{\partial w_{ji}} = -\,z_{dj}x_{iq}g'(o_{dq})f'(net_{jq}) \tag{58}$$

The characteristic solution space of the quasi-linear differential equation is subjected to the characteristic solution space traversal of the quasi-linear differential equation by adopting the time-delay correlation degree characteristic functional, and the scale $S_i(i = 1, 2, \cdots, L)$ of the weak convergence value of the cut-off error of the quasi-linear differential equation meets the following conditions.

(1) $S_i \cap S_j = \varphi,\ \forall i \neq j$;

(2) $\cup_{i=1}^{L} S_i = V - v_s$;

(3) *All solution vector sequences in S_k are monotone increments*

Lemma 1 Let $f(x)$ be a continuous function, the sequence of solution vectors of differential equations satisfies the Hausdorff discreteness condition, and the continuous solution vector G of the boundary value of differential equations is obtained.

$$f(x) = \begin{cases} f(x),\ x \in Levf \\ a,\ x \in Levf \end{cases} \tag{59}$$

$$G(x) \begin{cases} \partial f(x),\ x \in Levf \\ a,\ x \in Levf \\ \partial C(x) \end{cases} \tag{60}$$

Then it is shown that $f(x)$ is a stable convex function of quasilinear differential equation, and $f(x)$ is a strictly convex function [17]. When $b > a$, mathematical chaos theory, the upper and lower boundary of the boundary value $Lev_a f$ of differential order partial derivative equation can be obtained.

$$Lev_a f \subset \{x|f(x) < b\} \tag{61}$$

When the $\exists x,\ p > 0,\ u > 0$ condition is established, there are:

$$u(t) = w(t)(u_0,\ u_1) + \int_0^t \frac{\sin((t-t')|\nabla|)}{|\nabla|}F(u(t'))dt' \tag{62}$$

Let $f(x)$ be a continuous function in the real number field, and satisfy the $||f||_{L_t^q L_x^r(I\times IR^d)} = \left(\int_I \left(\int |f(t,x)|^r dx\right)^{q/r} dt\right)^{1/q}$, then:

$$\frac{1}{r} + \frac{1}{r'} = 1,\ \frac{1}{q} + \frac{1}{q'} = 1 \tag{63}$$

For the map F of the set of $R \rightarrow P(R)$, there are equation (64).

$$R_\beta X = U\{E \in U/R|c(E, X) \leq 1\beta\} \tag{64}$$

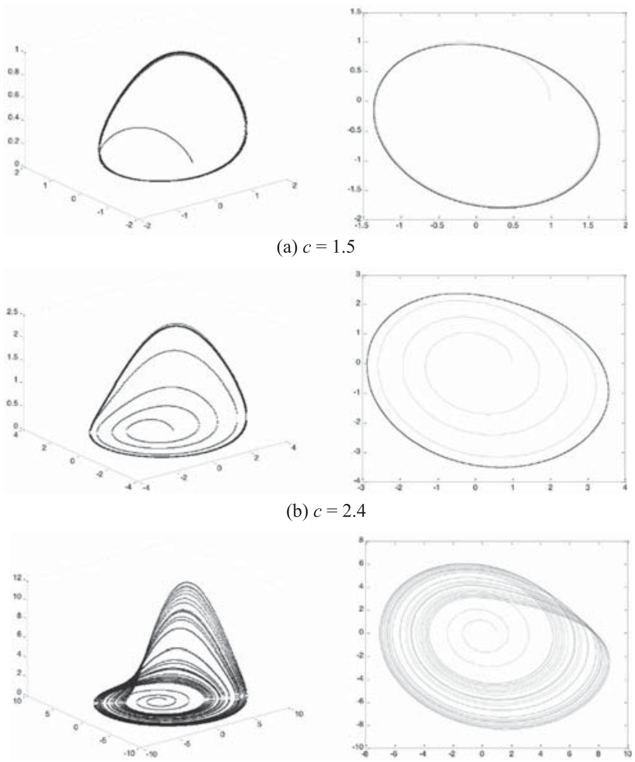
$$\begin{cases} a(H_{ac}) = 1 - \frac{H_{ac}}{\max(H_{ac})+l} \\ \max(H_{ac}) = \log_2 k \end{cases} \tag{65}$$

Then

$$ind(P) = \left\{ \begin{matrix} (x, y) \in U^2|a(x) = a(y) \\ \forall a \in P \end{matrix} \right\} \tag{66}$$

Because $f(x)$ is a stable pseudorandom convex function, the eigen solution space of the quasilinear differential equations is traversed by using the time-delay correlation degree characteristic functional, and it is found that any stable point in the solution vector space is an extreme point. From this, the stable truncation error weak convergence value is obtained with equation (67).

$$f^o(x, v) = \lim_{x\rightarrow\infty} \sup(f(y+tv) - f(y))/t \tag{67}$$



(a) $c = 1.5$

(b) $c = 2.4$

(c) $c = 5.0$

Figure 1 Weak convergence test results of truncation error of differential order partial derivative equation under mathematical chaos theory.

Where $f^o(x, v)$ is the derivative of the continuous function $f(x)$ in the real field in the direction x of the v. When satisfied equation (68).

$$(g - x)^T (x_0 - x) > 0 \tag{68}$$

Then F has a pseudorandom boundary value vector at $B(x, u)$. Through the above steps, the weak convergence value of truncation error of differential order partial derivative equation under mathematical chaos theory is obtained, and the weak convergence and stability of truncation error are analyzed on this basis.

$$\eta(x_2 - x_0) < 0,\ \forall \eta \in \partial f(x) \tag{69}$$

If the $||f||_{L_t^q L_x^r (I \times IR^d)} = (\int_I (\int_{IR} |f(t,x)|^r dx)^{q/r} dt)^{1/q}$, for the appropriate a, b has $\Phi(B) \subset B$, the convergence value of the weak convergence of the truncation error is equation (70).

$$\begin{aligned} ||\Phi(u)||_{L_{t,x}^{10}} &\leq ||w(t)(u_0, u_1)||_{L_{t,x}^{10}} \\ &+ \left\| \int_0^t \frac{\sin((t-s)|\nabla|)}{|\nabla|} (|u(s)|^4 u(s)) ds \right\|_{L_{t,x}^{10}} \\ &\leq \eta + |||\nabla|^{\frac{5}{4}} (|u|^4 u)||_{N_{\frac{3}{4}}} \\ &\leq \eta + C|||\nabla|^{\frac{5}{4}} u||_{S_{\frac{1}{4}}} ||u||_{L_{t,x}^{10}}^4 \\ &\leq \eta + Ca^4 b \end{aligned} \tag{70}$$

It is proved that the weak convergence value of the differential order partial derivative equation of the differential order partial derivative equation has stability and the asymptotic convergence, and the proposition's validity is proved by selecting the appropriate a to make the $C(a^4 + 2a^3 b) < 1$.

4. TEST AND TEST ANALYSIS

In this paper, by using the method of numerical calculation with c as the control parameter, the weak convergence analysis of the cut-off error of the differential order partial derivative equation under the theory of mathematical mixing is carried out, and the periodic variation of the periodic trace of the Rossler system with the change of the parameter is observed. In the numerical simulation experiment, a hyperchaotic Rossler system is established; its mathematical model is

$$\frac{dy}{dt} = By + G(y) + u(x) + U(t) \tag{71}$$

Among them, $y = (y_1, Y_2, y_3, y_4)^T$; $B = \begin{pmatrix} -a_1 & a_1 & 0 & 1 \\ d_1 & c_1 & 0 & 0 \\ 0 & 0 & -b_1 & 0 \\ 0 & 0 & 0 & r \end{pmatrix}$; $G(y) = \begin{pmatrix} 0 \\ -y_1 y_3 \\ y_1 y_2 \\ y_2 y_3 \end{pmatrix}$; $u(x) + U(t)$ is the tracking controller, and $u(x)$ is the compensator. The compensator equation is $u(x) = \frac{dx}{dt} - Ax - F(x)$. During the experiment, the parameters $(a, b, c, d) = (0.25, 3, 0.5, 0.5)$ and $J(a_1, b_2, c_1, r) = (35, 3, 12.7, 0.5)$ were selected, and the initial values were set to $[x_1(0), x_2(0), x_3(0), x_4(0)] = (3, -4, 2, 2)$ and $[x_1(0), x_2(0), x_3(0), x_4(0)] = (-15, 5, 9, 3)$. Based on this, the test was carried out. The simulation results of the convergence of the differential order partial derivatives are shown in Figure 1. The left and right graphs in the figure represent the 3D and 2D phase trajectories, respectively.

The study reported in this paper found that, with the proposed method, the stability of differential order partial derivative analysis is better and the convergence is strong.

5. CONCLUSIONS

In this paper, the problem of the weak convergence of the truncation error of the partial derivative of the differential order is analyzed. The nonlinear dynamic hybrid control model of the quasi-linear differential equation is constructed by means of mixed-logistic mapping, and the boundary condition of the stable solution of the inverse characteristic value of the differential equation is introduced. The characteristic solution space of the quasi-linear differential equation is subjected to the characteristic solution space traversal of the quasi-linear differential equation using the time-delay correlation degree characteristic functional. In this paper, the weak convergence value of the cut-off error of the differential order partial derivative equation is obtained by applying the theory of mathematical mixing, and the weak convergence and stability analysis of the truncation error are carried out. It is concluded that the differential order partial derivative equation in the mathematical mixed-degree-of-freedom system has the weak convergence of the truncation error, and has better convergence in the control of the fuzzy two-degree-of-freedom control system.

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