MAKSIMUM BELGISI OSTIDA FUNKSIONAL PARAMETRNI O'Z ICHIGA OLGAN TENGLAMALAR SISTEMASI UCHUN BOSHLANG'ICH MASALA.

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Annotatsiya : Ushbu maqolada turlarning chiziqli bo'lmagan integro-defferensial tenglamalar sistemasi ko'rib chiqiladi

Kalit so'zlar boshlang'ich shart, integro-defferensial tenglamalar tizimi, funksional parametr, Inter jarayonini, cheklangan yopiq ko'phadlar , segment.

ИСХОДНАЯ ЗАДАЧА ДЛЯ СИСТЕМЫ УРАВНЕНИЙ, СОДЕРЖАЩАЯ ФУНКЦИОНАЛЬНЫЙ ПАРАМЕТР ПОД ЗНАКОМ МАКСИМУМА.

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Аннотация: В статье рассматривается система нелинейных интегро-дифференциальных уравнений вида.

Ключевые слова: начальное условие, система интегро-дифференциальных уравнений, функциональный параметр, интерпроцесс, ограниченные замкнутые многочлены, отрезок.

AN INITIAL PROBLEM FOR A SYSTEM OF INTEGRO-DIFFERENTIAL EQUATIONS CONTAINING A FUNCTIONAL PARAMETER UNDER THE SIGN OF THE MAXIMUM.

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Abstract: The system of non-linear integro-differential equations of species is considered in this article.
Keywords: initial condition, system of integro-differential equations, functional parameter, Inter process, limited closed polynomials, segment.

Ushbu maqolada turlarning chiziqli bo'lmagan integro-defferensial tenglamalar tizimi ko'rib chiqiladi.

$$x'(t)=F\left(t,x(t),\int_0^t K(t,\theta)\max\{x(r)\,|\,r\in[\theta-h;\theta]\}d\theta,u(t)\right),t\geq 0 \quad (1)$$

Quydagicha boshlang'ich shart berilgan

$$x(t)=\varphi(t),\quad t\in E_0\equiv[-\alpha,0] \quad (2)$$

Bu yerda $x\in X\subset R^n$ vektor holati , $u\in U\subset R^m$ funksional parameter X,U cheklangan yopiq ko'phadlar , $h=h(t,x(t),u(t))$ kechikish T vaqtiga bog'liq , kerakli $x(t)$ funksiyadan va $u(t)$ funksional parametrdan, $K(t,\theta)$ $\{0\leq\theta\leq t\leq T\}$ shu oraliqda uzluksiz $n\times n$ matrissali-funksiya, $t-h(t,x,u)\geq-\alpha_0=const$, maxsimum. Quydagi ifodani soddalashtirish uchun biz quydagi belgilashni qabul qildik.

$$\rho=\int_0^t K(t,\theta)\max\{x(r)\,|\,r\in[\theta-h;\theta]\}d\theta, h_m=h(\theta,x_m(\theta),u(\theta)),$$

$$\rho_m=\int_0^t K(t,\theta)\max\{x_m(r)\,|\,r\in[\theta-h_m;\theta]\}d\theta,\int_0^t\|K(t,\theta)\|d\theta\leq\alpha<\infty$$

Keling, nima sodir bo'lishini isbotlaylik

Teorema. Quyidagilar o'rinli bo'lsin:

1 $F(t,x,\rho)\in C([0;T]\times X\times R^n\times U)\cap B_{nd}(M)\cap Lip(L_{1/X,\rho});$ (3)

2 $t-h(t,x,u)\geq-\alpha_0=const$ (4)

Va $h(t,x,u)\in C([0;T]\times X\times U)\cap Lip(L_{2/X})$ (5)

3. $\varphi(t) \in Lip(L_3)$ (6)

Bu yerda $X = \left\{ x \in R^n \left\| x - \varphi(0) \right\| \le r \right\}, r = \max\left\{ \left\| \varphi(t) - \varphi(0) \right\| t \in E_0 \right\}.$

Keyin $\left[0; \overset{*}{t}\right], \overset{*}{t} \le T$ segmentda (2) boshlang'ich shart bilan $x(t) \in X$ funksiyaning yagona yechimi mavjud.

Isbot. Biz ketma-ket yondashuvlar yordamida (1) tenglamani (2) ga aylantiramiz.

$$\left\{ \begin{array}{l} x_0(t) = \varphi(t), t \in E_0, x_0(t) = \varphi(t), t \ge 0 \\ x_{m-1}(t) = \varphi(t), t \in E_0, m = 0,1,2,... \\ x_{m-1}(t) = \varphi(t) + \int\limits_0^t F\left(\theta, x_m(\theta), \rho_m(\theta), u(\theta)\right) d\theta, t \ge 0 \end{array} \right\} \qquad (7)$$

Barcha yondashuvlar X $t \in \left[0; \overset{*}{t}\right]$ da qolishiga ishonch hosil qilish qiyin emas. Inter jarayonining farqini baholaymiz (7) da . $x_1(t) - x_0(t)$ farqi uchun (3) hisobga olinsa , biz quydagicha baholaymiz.

$$\left\| x_1(t) - x_0(t) \right\| \le \bar{M}t, \; t \in \left[0; \overset{*}{t}\right] \qquad (8)$$

Bundan tashqari farq uchun $x_2(t) - x_1(t)$ bizda bor

$$\left\| x_1(t) - x_0(t) \right\| \le L_1 \int\limits_0^t (\left\| x_1(\theta) - x_0(\theta) \right\| + \left\| \rho_1(\theta) - \rho_0(\theta) \right\|) d\theta. \qquad (9)$$

Baholash uchun $\rho_1(t) - \rho_0(t)$ biz bu farqni quydagicha yozamiz

$$\rho_1(t)-\rho_0(t)=\int_0^t K(t,\theta)(\max\{x_1(r)\,|\,r\in[\theta-h_1;\theta]\}-$$

$$-\max\{x_0(r)\,|\,r\in[\theta-h_0;\theta]\})d\theta=\int_0^t K(t,\theta)(\max\{x_1(r)\,|\,r\in[\theta-h_1;\theta]\}-$$

$$-\max\{x_0(r)\,|\,r\in[\theta-h_1;\theta]\})-(\max\{x_0(r)\,|\,r\in[\theta-h_1;\theta]\}-$$

$$-\max\{x_0(r)\,|\,r\in[\theta-h_0;\theta]\})d\theta.$$

(10)

(8) tenglikning birinchi farqi uchun (10) hisobga olinsa, quydagicha olish mumkin

$$\left\|\max\{x_1(r)\,|\,r\in[t-h_1;t]\}-\max\{x_0(r)\,|\,r\in[t-h_1;t]\}\right\|\le$$

$$\le\left\|\max\{(x_1(\tau)-x_0(r))\,|\,r\in[t-h_1;t]\}\right\|\le Mt$$

$$\max\{x_1(\tau)\,|\,\tau\in[t-h_1;t]\}=\max\{(x_1(\tau)-x_0(\tau)+x_0(\tau))\,|\,\tau\in[t-h_0;t]\}\le$$

$$\le\max\{(x_1(r)-x_0(r))\,|\,r\in[t-h_1;t]\}+\max\{x_0(r)\,|\,r\in[t-h_1;t]\}$$

$$\max\{x_1(r)\,|\,r\in[t-h_1;t]\}-\max\{x_0(r)\,|\,r\in[t-h_1;t]\}\le$$

$$\le\max\{(x_1(r)-x_0(r))\,|\,r\in[t-h_1;t]\}\le$$

$$\le\max\{(x_1(r)-x_0(r))\,|\,r\in[t-h_1;t]\}$$

$$\max\{x_0(r)\,|\,r\in[t-h_1;t]\}-\max\{x_1(r)\,|\,r\in[t-h_1;t]\}\le$$

$$\le\max\{(x_0(r)-x_1(r))\,|\,r\in[t-h_1;t]\},\quad t\ge 0$$

Xuddi shunday, biz quyidagi natijani olamiz

$$\max\{x_0(r)\,|\,r\in[t-h_1;t]\}-\max\{x_1(r)\,|\,r\in[t-h_1;t]\}\le$$

$$\le\max\{(x_0(r)-x_1(r))\,|\,r\in[t-h_1;t]\},\quad t\ge 0$$

Ushbu tengsizlikni chap va o’ng qismidan maksimum t ni olib , biz isbotlashni, istalgan tengsizlikni qo’lga kiritamiz. (4)-(6) ni hisobga olgan holda , o’ng tengsizlikdagi ikkinchi farq uchun quyidagi farqni olamiz.

$$\left\|\max\left\{x_0(r)\mid r\in\left[t-h_1;t\right]\right\}-\max\left\{x_0(r)\mid r\in\left[t-h_0;t\right]\right\}\right\|\leq$$

$$\leq L_3\left\|h(t,x_1(t),u(t))-h(t,x_0(t),u(t))\right\|\leq$$

$$\bar{M}L_2\left\|x_1(t)-x_0(t)\right\|\leq\bar{M}^2L_2t,\bar{M}=\max\left\{M,L_3\right\}$$

$$\left\|\rho_1(t)-\rho_0(t)\right\|\leq\bar{M}\alpha(1+ML_2)t$$

Shuning uchun

$$\left\|\rho_1(t)-\rho_0(t)\right\|\leq\bar{M}\alpha(1+ML_2)t$$

Keyin (9) quyidagicha yoziladi:

$$\left\|x_2(t)-x_1(t)\right\|\leq L_1\int_0^t\bar{M}\left[1+\alpha\left(1+ML_2\right)\right]\theta d\theta=L_1\bar{M}\left[1+\alpha\left(1+ML_2\right)\right]\frac{t^2}{2!}$$

$$\left\|x_3(t)-x_2(t)\right\|\leq L_1\int_0^t\left(\left\|x_2(\theta)-x_1(\theta)\right\|+\rho_2(\theta)-\rho_1(\theta)\right)d\theta\leq$$

$$\leq L_1\left[1+\alpha\left(1+\left\|x_1'(\theta)\right\|\right)L_2\right]\int_0^t L_1\bar{M}\left[1+\alpha\left(1+\bar{M}L_2\right)\right]\frac{\theta}{2!}d\theta=$$

$$=L_1^2\bar{M}\left[1+\alpha\left(1+\bar{M}L_2\right)\right]^2\frac{t^3}{3!}$$

$x_3(t)-x_2(t)$ farqni quydagicha olamiz

$$\left\|x_3(t)-x_2(t)\right\|\leq L_1\int_0^t\left(\left\|x_2(\theta)-x_1(\theta)\right\|+\rho_2(\theta)-\rho_1(\theta)\right)d\theta\leq$$

$$\leq L_1\int_0^t(\left\|x_2(\theta)-x_1(\theta)\right\|+\int_0^\theta\left\|K(\theta,\xi)\right\|$$

$$[\left\|\max\left\{x_2(r)\mid r\in\left[\xi-h_2,\xi\right]\right\}-\max\left\{x_1(r)\mid r\in\left[\xi-h_2,\xi\right]\right\}\right\|+$$

$$+\left\|\max\left\{x_1(r)\mid r\in\left[\xi-h_2,\xi\right]\right\}-\max\left\{x_1(r)\mid r\in\left[\xi-h_1,\xi\right]\right\}\right\|]d\xi)d\theta\leq$$

$$=L_1^2\bar{M}\left[1+\alpha\left(1+\bar{M}L_2\right)\right]^2\frac{t^3}{3!}$$

Demak, ushbu baholashlardan $m \to \infty$ da $\|z(t) - x_m(t)\| \to 0$ manashu $\left[0;\overset{*}{t}\right]$ segmentdagi t da teng ravishda ko'rinadi. Shundan kelib chiqadiki, $\{x_m(t)\}$ ketma-ketligini talab qiladigan (1) tenglamaning yechimi $\left[0;\overset{*}{t}\right]$ segmentida yagona.
Teorema isbotlandi.

Adabiyotlar

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