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A MIXING PROBLEM FOR A QUASI LINEAR EQUATION WITH PARTICULAR DERIVATIVES WITH SOME LATE ARGUMENT

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A B S T R A C T	K E Y W O R D S
In the work, the solutions of the mixed problem set for the quasi – linear partial differential equation with some delayed arguments were studied, and algorithm for finding its numerical solutions was solved by the finite difference method.	mixed problem, delayed argument, quasi linear, numerical solutions, algorithm, finite diffence method, transporent and non revealing schemes, driving.

Introduction

In the work, the solutions of the mixed problem set for the quasi – linear partial differential equation with some delayed arguments were studied, and algorithm for finding its numerical solutions was solved by the finite differince method.

НЕКОТОРЫЕ СМЕШАННАЯ ЗАДАЧА ДЛЯ КВАЗИЛИНЕЙНОГО УРАВНЕНИЯ С ЧАСТНЫМИ ПРОИЗВОДНЫМ С ЗАПАЗДЫВАЮЩИМ АРГУМЕНТОМ

Abstract

В данной работе решается смешанная задача для квазилинейного дифференциального уравнения с запаздывающим аргументом, задача решается методом конечных разностей. Составляется алгоритм численного решения

In the article, the quasi – linear equation of the hyperbolic type with delayed argument $Q=\{\tau\le t\le T, 0\le x\le l, 0\le y\le m\}$ in the area

$$\frac{\partial^2 u}{\partial t^2}=a^2\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)+b^2\left(\frac{\partial^2 u(t-\tau,x,y)}{\partial x^2}+\frac{\partial^2 u(t-\tau,x,y)}{\partial y^2}\right)+$$

$$+f(t,x,y,u(t,x,y),u(t-\tau,x,y),u_t(t,x,y),u_t(t-\tau,x,y)) \qquad (1)$$

$(t,x)\epsilon E=\{0\le t\le \tau, 0\le x\le l, 0\le y\le m\}$ start when

$$\left.\begin{aligned} u(t,x,y)&=\varphi(t,x,y)\\ u_t(t,x,y)&=\varphi'_t(t,x,y)\end{aligned}\right\} \qquad (2)$$

Gwin the initial internal conditions when the tsist

$$\tau\le t\le T$$

$$\left.\begin{aligned} u(t,0,y)&=0\\ u(t,l,y)&=0\end{aligned}\right\}\ 0\le y\le m \qquad \left.\begin{aligned} u(t,x,0)&=0\\ u(t,x,m)&=0\end{aligned}\right\}\ 0\le x\le l \qquad (3)$$

The problem of finding a satisfactory solution of homogeneous boundary conditions by the finite this overael this issue of the existence and uniqueness of generalized solutions was discussed by the author in we introduce the notation for. Q Lets' mesh the area $t_k=k\tau,\ x_i=i\Delta, y_j=jh$ that, the grid function $u(t_k,x_i,y_i)=u_{ij}^k$ Lits' enter the designations.

$$i=0,1,2,\dots,N, j=0,1,2,\dots,P, k=0,1,2,\dots,M,$$

$$M\tau=T,\ N\Delta=l\ , Ph=m$$

(2) from the initial conditions (t,x,y)ϵE when($k=0$ va $k=1$ da)

$$u_{ij}^0=\varphi(0,x_i,y_j) \qquad \frac{u_{ij}^1-u_{ij}^0}{\tau}\approx\varphi'_t(\tau,x_i,y_j) \qquad (4)$$

$$u_{ij}^1\approx U_{ij}^0+\tau\varphi'_t(\tau,i\Delta,jh)=\varphi(0,i\Delta,jh)+\tau\varphi'_t(\tau,i\Delta,jh) \qquad (5)$$

(3) from the boundary conditions

$$u_{0j}^k=0\ ,\quad u_{Nj}^k=0\ ,\quad u_{i0}^k=0\ ,\quad u_{ip}^k=0 \qquad (6)$$

We will have values. The values of *u(t,x,y)* are given on the sides and base of the sphere Q. Using the above, we find the numerical values of $u(t,x,y)$ at the internal nodes of the field Q.

We may use the follaving non – disclosure schemes without general permussion:

$$\frac{u_{ij}^{k+1}-2u_{ij}^k+u_{ij}^{k-1}}{\tau^2}=a^2\left(\frac{u_{i+1,j}^{k+1}-2u_{ij}^{k+1}+u_{i-1,j}^{k+1}}{\Delta^2}+\frac{u_{i,j+1}^k-2u_{ij}^k+u_{i,j-1}^k}{h^2}\right)+$$

$$+b^2\left(\frac{u_{i+1,j}^k-2u_{ij}^k+u_{i-1,j}^k}{\Delta^2}+\frac{u_{i,j+1}^k-2u_{ij}^k+u_{i,j-1}^k}{h^2}\right)+f_{ij}^k \qquad (7)$$

or

$$\frac{u_{ij}^{k+1}-2u_{ij}^k+u_{ij}^{k-1}}{\tau^2}=a^2\left(\frac{u_{i+1,j}^k-2u_{ij}^k+u_{i-1,j}^k}{\Delta^2}+\frac{u_{i,j+1}^{k+1}-2u_{ij}^{k+1}+u_{i,j-1}^{k+1}}{h^2}\right)+$$

$$+b^2\left(\frac{u_{i+1,j}^k-2u_{ij}^k+u_{i-1,j}^k}{\Delta^2}+\frac{u_{i,j+1}^k-2u_{ij}^k+u_{i,j-1}^k}{h^2}\right)+f_{ij}^k \qquad (7_1)$$

comes out. Here

$$f_{ij}^k=f(k\tau,i\Delta,jh,u(k\tau,i\Delta,jh),u((k-1)\tau,i\Delta,jh),(u(k\tau,i\Delta,jh)-u((k-1)\tau,i\Delta,jh))/$$

$$\tau,\left(u((k-1)\tau,i\Delta,jh)-u((k-2)\tau,i\Delta,jh)\right)/\tau))$$

$\tau\le t\le 2\tau$ if we have, we will select the driving mode for the above undisclosed circuit.

(7) in scheme $k=1$ $\qquad u_{ij}^2-2u_{ij}^1+u_{ij}^0=$

$$=\frac{a^2\tau^2}{\Delta^2}\left(u_{i+1,j}^2-2u_{ij}^2+u_{i-1,j}^2\right)+\frac{a^2\tau^2}{h^2}\left(u_{i,j+1}^1-2u_{ij}^1+u_{i,j-1}^1\right)+\frac{b^2\tau^2}{\Delta^2}\left(u_{i+1,j}^1-2u_{i,j}^1+u_{i-1,j}^1\right)+\frac{b^2\tau^2}{h^2}\left(u_{i,j+1}^1-2u_{i,j}^1+u_{i,j-1}^1\right)+\tau^2 f_{ij}^1 \quad (8)$$

Then the differential equation looks like this:

$$a_{ij}^1 u_{i-1,j}^2+b_{ij}^1 u_{i,j}^2+c_{ij}^1 u_{i+1,j}^2=F_{i,j}^1 \quad (9)$$

Here, $a_{ij,}^1\ b_{ij}^1, c_{ij}^1, F_{ij}^1$-Coefficients are fixed numbers resulting from the expression (8) from (9) as je 1

$$a_{i1}^1 u_{i-1,1}^2+b_{i1}^1 u_{i,1}^2+c_{i1}^1 u_{i+1,1}^2=F_{i,1}^1 \quad (10)$$

We use the driving method to solve this differencial equation:

at i=1 $$a_{11}^1 u_{01}^2+b_{11}^1 u_{11}^2+c_{11}^1 u_{21}^2=F_{11}^1 \quad (11_1)$$

from this u_{11}^2 , u_{21}^2 we express it linearly

$$u_{11}^2=L_{11}^1 u_{21}^2+K_{11}^1 \quad (12_1)$$

we will have patience, in this

$$L_{11}^1=-\frac{c_{11}^1}{b_{11}^1} \quad , \quad K_{11}^1=\frac{F_{11}^1}{b_{11}^1} \quad (13_1)$$

in $i=2$, (10) from

$$a_{21}^1 u_{11}^2+b_{21}^1 u_{21}^2+c_{21}^1 u_{31}^2=F_{21}^1 \quad (11_2)$$

(12_1) if we use

$$a_{21}^1(L_{11}^1 u_{21}^2+K_{11}^1)+b_{21}^1 u_{21}^2+c_{21}^1 U_{31}^2=F_{21}^1$$

Now u_{21}^2 ni u_{31}^2 letus linearey express u by us

$$u_{21}^2=L_{21}^1 u_{31}^2+K_{21}^1 \quad (12_2)$$

Is formed, in which,

$$L_{21}^1=-\frac{c_{21}^1}{a_{21}^1 L_{11}^1+b_{21}^1} \quad , \quad K_{21}^1=\frac{F_{21}^1-a_{21}^1 K_{11}^1}{a_{21}^1 L_{11}^1+b_{21}^1} \quad (13_2)$$

etc when i=*n-1*

$$a_{N-1,1}^1 u_{N-2,1}^2+b_{N-1,1}^1 u_{N-1,1}^2+c_{N-1,1}^1 u_{N1}^2=F_{N-1,1}^1 \quad (11_{N-1})$$

$$a_{N-1,1}^1(L_{N-2,1}^1 u_{N-1,1}^2+K_{N-2,1}^1)+b_{N-1,1}^1 u_{N-1,1}^2+c_{N-1,1}^1 u_{N1}^2=F_{N-1,1}^1$$

from this.

$$u_{N-1,1}^2=L_{N-1,1}^1 u_{N1}^2+K_{N-1,1}^1 \quad (12_{N-1})$$

$$L_{N-1,1}^1=-\frac{c_{N-1,1}^1}{a_{N-1,1}^1 L_{N-2,1}^1+b_{N-1,1}^1}, \quad K_{N-1,1}^1=\frac{F_{N-1,1}^1-a_{N-1,1}^1 K_{N-2,1}^1}{a_{N-1,1}^1 L_{N-2,1}^1+b_{N-1,1}^1} \quad (13_{N-1})$$

Driving coefficient - L_{i1}^1, K_{i1}^1 is found in the correct way from the formula (13_i) in ascending order. This, when j – 1, the process is terminated. Them when it is 2, the above process is continued and U, S are found , etc. They are found in the first layer.

$2\tau\leq t\leq 3\tau$ when, we apply the above (7) driving method to the undisclosed scheme. When $k=2$ all the above processes are repeated and u_{ij}^3 is found in the second layer, and so on. It is calculated u_{ij}^k.It can be calculated using the differential scheme (7_1) above u_{ij}^k.

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