GALAXY INTERNATIONAL INTERDISCIPLINARY RESEARCH JOURNAL (GIIRJ)
ISSN (E): 2347-6915
Vol. 10, Issue 4, April. (2022)

IDEAS FOR THE CONSTRUCTION OF CHARACTERISTIC-GRID METHODS AND THE ANALYSIS OF DIFFERENTIAL SCHEMES IN THE SPACE OF INDETERMINATE COEFFICIENTS

Raufov Azizbek Anvar o'g'li

Jonqobilov Mirjalol

ANNOTATION

This article discusses the ideas of building characteristic-grid methods and the analysis of differential schemes in the space of indeterminate coefficients.

Keywords: differential scheme, indeterminate coefficients, linear equation, characteristic-grid method.

INTRODUCTION

The basic ideas of the construction of the characteristic-grid method are shown in the example of the solution of the simple linear equation of displacement in accordance with the initial and boundary conditions:

$$\frac{\partial u}{\partial t}+c\frac{\partial u}{\partial x}=f(x,t), \qquad c=const>0. \tag{1}$$

It is known that (1) has a characteristic defined by the following characteristic equation:

$$\frac{dx}{dt}=a$$

and it becomes a simple differential equation (ODT):

$$\frac{du}{d\xi}=f(\xi).$$

Grid methods are based on the addition of a grid template to the integration area of a differential grid equation, that is, the set of grid nodes used to replace the differential analog (approximation) differential equation (in a small area). Approximation analysis usually uses the Taylor series spread of a precise solution of a differential problem in a grid. Let's look at both the grid and the characteristic class method.

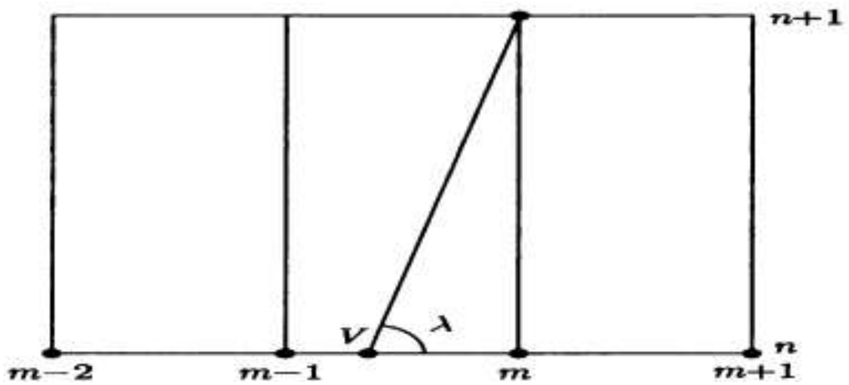

Fig. 1.

In the field of integration we include the following difference grid:

$$t^n = n\cdot\tau, x_m = m\cdot h; n = 0,1,2,3,...; m = 0,\pm1,\pm2,\pm3,...$$

(1) We denote the values of the solution by u_m^{n+1} at the nodes of the network. To proceed to the next temporary step of the grid, we use an open five-dot template (Figure 1). Value u_m^n must be calculated over time using the values in layers u and n. We transfer the characteristic from $n+1, m$ points to the intersection of λ slopes to V points with t^n layers. Then the value characteristic u_m^{n+1} is represented by u_υ^n, for example

$$u_m^{n+1} = u_\upsilon^n + \frac{\tau}{2}(f_m^{n+1} + f_\upsilon^n) + O(\tau^2). \quad (2)$$

We obtain expression (2) as an approximation of a simple differential equation by the characteristics of the trapezoidal method. To find the value of u_υ^n on the points of layer t^n, we have different differential schemes to determine u_m^{n+1} in the given template by performing this or that integration.

Space of indefinite coefficients.

We write the difference scheme as follows:

$$u_m^{n+1} = \sum_{k=-2}^{1} \alpha_k \cdot u_{m+k}^n , \quad (3)$$

here we look for the coefficients of the approximation of the α_k coefficients by spreading the u_m^{n+1}, u_{m+k}^n to the Taylor series around (t^n, x_m) point. By leaving two coefficients blank (for example, α_{-2}, α_0), we obtain a $O(\tau + h)$-order approximation condition:

$$\alpha_{-1} = \frac{1}{2}(1 + \sigma - 3\cdot\alpha_{-2} - \alpha_0),$$

$$\alpha_1 = \frac{1}{2}(1 - \sigma + \alpha_{-2} - \alpha_0).$$

We take empty coefficients as starting points for coordinates in linear space with Euclidean metrics. Each point in this space corresponds to a differential scheme with first-order approximation. You can also define multiple $O(\tau + h^2)$-order schemes

$$\alpha_0 = 1 - \sigma + 3\cdot\alpha_{-2} \quad (4)$$

and in this template a single third-order approximation scheme can be defined in $O(\tau + h^3)$ order:

$$\alpha_{-2} = \frac{\sigma\cdot(\sigma - 1)}{6}. \quad (5)$$

The remaining coefficients are found using (4) and (5).

(α_{-2},α_0) we enter the space of the coefficients. Then there is an arbitrary point in this space $O(\tau+h)$ is an orderly approximation differential scheme. (4) separates many schemes of order $O(\tau+h^2)$ in direct space (Fig. 2) because it contains a single point of approximation $O(\tau+h^3)$. There must also be a $O(\tau^2+h^2)$-order approximation point.

We record a number of chimes, for example, we apply the indeterminate coefficients of the spectral sign (Neumann background) to the differential scheme $\sigma=0.5$. (3). In the space of indefinite coefficients, a curve is formed that defines the stability limit of the differential circuits.

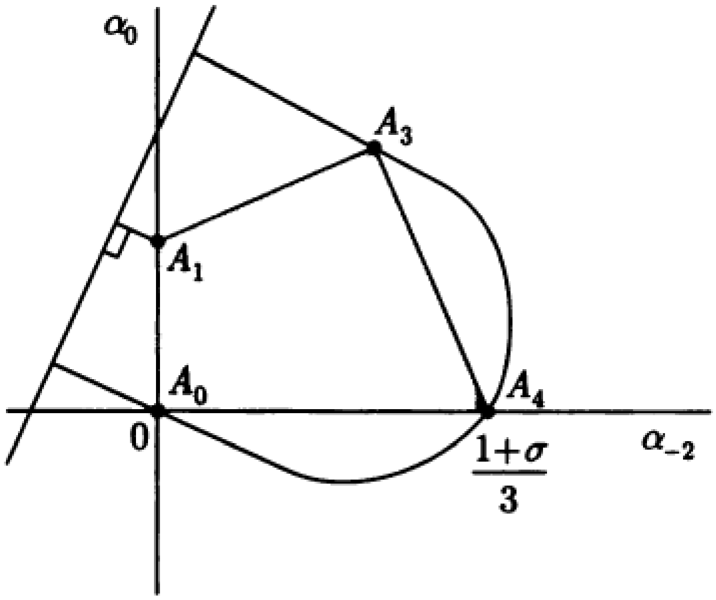

Fig 2.

For first-order schemes, we write the first differential approximation:

$$u'_t+au'_x=\frac{h^2}{\tau}(1-\sigma^2-\alpha_0+3\alpha_{-1})u''_{xx}.$$

You can specify many schemes, such as $\alpha_\mu \geq 0$ this is a dashed polygon in monotone schemes (Figure 2). Monotonous schemes include schemes with less approximation error. Given a polygonal σ point, it lies in the nearest second-order approximation diagrams.

Let's end the example with the linear equation of the displacement model:

$$u'_t+cu'_x=0.$$

The selected template displays an arbitrary differential scheme as follows:

$$u_m^{n+1}=\sum_{\mu\in III}\alpha_\mu u_{m+\mu}^n.$$

Many positive approximation schemes do not intersect with many first-order approximation schemes according to S. K. Godunov's theorem.

REFERENCES

1. Mathematical Analysis Part 1 T. Azlarov, H. Mansurov
2. Kakharboyevich A. S., Turgunboyevna C. L. CONCEPTS OF STABLE MOVEMENT OF LIQUID FLOW // Sovremennye nauchnye resheniya aktualnykh problem. - 2022. - №. January.
3. Malikov Z. M. and dr. CHISLENNOE ISSLEDOVANIE TECHENIYA V PLOSKOM VNEZAPNO RASShIRYaYushchEMSYa KANALE NA OSNOVE DVUXJIDKOSTNOY MODELI TURBULENTNOSTI I MODELI UILKOKSA // Problems mashinovedeniya. - 2021. - C. 204-211.
4. www.ziyonet.uz
5. www.kitob.uz