ANALYSIS OF NUMERICAL SOLUTION METHODS OF THE BURGERS EQUATION IN DISSIPATIVE MEDIA

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Abstract: In this thesis, advantages and disadvantages of methods for numerical calculation of Burgers equation are analyzed. It compares several currently common calculation methods.

Keywords: finite difference, spline, spectral, spectral-grid.

The study of the properties of the solution of the Burgers equation is important because of its applications in various fields of science and technology. This equation is used in mathematical modeling of the following practically important problems: propagation of waves in different media, theory of solitons, nonlinear acoustics, nonlinear optics, physics of plasmas, radiophysics, and electronics.

However, numerical modeling of this equation requires overcoming serious difficulties. The most important of them is that there is a thin layer in the area where the solution is considered, in which a sudden change of the solution is observed and the solution takes a state as if it has a break. In such a situation, the demand for approximation properties of numerical methods increases sharply. Although there are a number of methods for solving the Burghers equation, it is still relevant to investigate their effectiveness, accuracy, and to what extent they reflect the nature of the solution in the thin layer mentioned above.

The methods dedicated to the direct numerical solution of the Burgers equation can be divided into several groups: 1) finite difference; 2) spline; 3) spectral; 4) spectral grid.

Focusing on the research conducted in recent years, the advantages and disadvantages of these methods will be discussed.

1) The advantage of finite difference methods in the numerical solution of the Burgers equation is that the calculation algorithms have a simple appearance, but in order to provide spatial approximations in areas with a high solution gradient, there is a need to further densify the grid nodes. which, in turn, requires a sharp increase in the number of arithmetic operations, the calculation of a matrix exponent with a very large order, and a large number of iterations due to non-linearity. The decrease of the

parameters in front of the high-order derivative showed that it cannot provide a sufficient approximation.

2) The advantage of spline methods in the numerical solution of Burgers' equation is that this method has a simple algorithm and approximation, and due to its universality, it is possible to implement it on a computer, but the physical implementation of the spline method with a simple algorithm is physically simple. The method is algorithmically very complicated. In addition, it seems that spline methods are not effective enough to localize areas with a high gradient of the solution characteristic of the nature of non-linear wave processes and to adequately approximate the solution in such areas.

3) When solving Burgers' equation, the spectral method ensures a very fast approach to the solution as the number of basis functions increases, but the norm of the matrix operators that appear when approximating the spatial derivatives is very large and ill-conditioned. Poor conditioning makes it difficult to use implicit methods, and explicit methods require strict restrictions on the time integration step due to the large value of the norm of the transition operator, which in turn leads to a sharp increase in the number of arithmetic operations. will bring. In the application of this method, it is necessary to work with full-matrix algebraic systems with a very high order, which in turn leads to an increase in rounding errors in the computer calculation process, at the expense of a decrease in the parameter in front of the high-order derivative. causing it to fail to provide accuracy.

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