MODELING AND NANOTECHNOLOGY

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ON DIFFERENT APPRACHES TO THE MODELING OF COMPLEX OBJEXTS WITH DISTRIBUTED PARAMETERS

The most widespread methods for mathematical modeling of complex objects with distributed parameters are the methods of discretizing the mathematical model by means of space-time quantization. The representation of a mathematical model of objects with distributed parameters by systems of ordinary differential or algebraic equations allows them to be simulated on analog and digital computers. Modeling theory combines a large number of methods. The main ones are the following:

1. Discrete space - discrete time DSDT.
2. Continuous space - discrete time CSDT.
3. Discrete space - continuous time of the DSCT.
4. Continuous spaces o- continuous time CSCT.

The DSDT method is implemented in computer systems and grid RR-processors. When solving problems of field theory using computer systems, numerical methods are used, the main of which is the method of finite differences [1]. Computer systems, having practically high computational capabilities, for problems of field theory, due to their algorithmic nature, require a lot of time to solve them, which sharply increases in the transition to nonlinear problems. At the same time performance is a critical factor when we consider the many different variants of one and the same task with different starting data in order to find the optimal variant. In addition, the DSDT method with large dimensions of differential equations is characterized by the so-called nonlinear instability. Therefore, many of nonlinear time-dependent problems of field theory cannot be solved using available modern computer systems with a small number of processors.

Specialized parallel computing systems, aimed at solving partial differential equations, to which are homogeneous and digital grid, also bit-analog computing devices with fast action analog *and* precision of digital computers are currently under development. So nonlinear transient two-dimensional and three-dimensional problems of the theory of the field with time-variable and nonlinear boundary conditions, especially for bodies of complex shape, were in most cases solved using analog computers.

The method proposed by Liebman [2] for solving non-stationary problems described by equations of parabolic type on RR-grids, based on the discreteness of space and time, has become widespread for the study of heat and mass transfer processes, non-stationary filtration, hydrogeology etc. This method allows to manually make any changes in parameters models at the required times. RR-grid models with variable structure are the most versatile. They can be used to solve linear and nonlinear, stationary and non-stationary field theory problems in the most general setting. The disadvantages of the RR-grid processors include the high complexity of the computational process due to the set of parameters of the region, setting the initial and boundary conditions, measuring the results of the solution in the entire simulated region and repeating these operations after each iteration and at each time interval. In this regard, it is necessary to automate the decision process in order to increase the productivity and efficiency of grid: RR processors .

Static electric integrators SEI, based on the method DSDT, proposed by L.A. Vulis and A.T. Lukyan [3] found wide application for solution of unsteady nonlinear problems of field theory.

The CSDT method is implemented on combined models – solid environment - RR-grid. The method has disadvantages, similar to the DSDT method, and, in addition, low accuracy of the solution. So it is not widely spread.

To solve non-stationary problems, in 1936 Boykin proposed a method for modeling on RC-grids, where the solution process is discrete in space and continuous in time.

Using automated pulse width controlled conductances and capacitances as a base element of the grid processors has several advantages. It allows automating the input of initial data and changing the parameters of models in the process of solving non-linear problems of field theory in a non- iterative way. However, the cost of such processors is high.

In solving linear problems described by equations in partial derivatives of parabolic type the greatest efficiency can be achieved by the use of processors with distributed RC- parameters of implementing the **CSCT method**. The method was first implemented in the form of a computing device with a model with distributed RC-parameters. The solution using these processors is obtained in the form of a continuous function of time and space. This not only simplifies and speeds up the solution process, making it independent of the complexity of the problem being solved, but also eliminates the methodical error inherent in all other methods, caused by quantizing spatial and temporal coordinates, and also provides stability and convergence of the computational process. The main disadvantage of the RR-grid processor and processors with distributed RC-parameters is the complexity of managing their parameters in the process of solution, which limits their use in solving nonlinear problems in field theory.

References:

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