Parallel forms of different circuit algorithms

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Actuality of the problem of developing numerical methods for solving multidimensional systems of parabolic quasilinear equations describing the processes of heat and mass exchange in various mechanisms and devices is undeniable. To date, there have been several trends in the development of computational methods with complex logical structures, which have a higher order of accuracy than traditional finite-difference methods. A number of proposals are not quite equivalent to one another but are pursuing one stereotypical goal - to reduce the problem of three-dimensional distribution of the domain of changing variables to a sequence of circuits that exclude unknown quantities in one direction (alternately in the longitudinal, transverse and vertical), which can be considered serious progress in the field of solving multidimensional spatial problems. Note that the use of implicit schemes in this case leads to systems of linear algebraic equations (SLAR) having a three-diagonal structure. Thus, the adoption of the methodological basis of the difference schemes splitting procedure; first, it provides an economical and sustainable implementation of numerical models by the method of scalar runs and secondly, it is known that the greatest effect of a parallel processor is achieved when it is used to perform matrix calculations of linear algebra. This circumstance is crucial for the application of the developed approach in multiprocessor computing systems.

These studies are aimed at highlighting the issue of constructing maximal parallel forms of algorithms for difference circuits having a three-diagonal structure. The peculiarities of parallelization by permutations, as well as the piecewise analytical method of straight lines, are revealed.

Most conventional algorithms for solving tri-diagonal equation systems (run methods, matrix decomposition to tri-diagonal form, duplication, and the like) are shown to work faster with the presence of multiple processors than one processor. The reason for this is the essential sequence of calculations of these algorithms. On the contrary, the proposed “odd-even” reduction algorithm conceals many possibilities for parallelization. It can be explained by the usage of the permutation algorithm which solves the system of equations from two ends at the same time. Therefore, it can be very promising to connect triangular systems on parallel computing systems. Note, that in this method of applying graphs to describe and investigate the general mapping of problems of computational mathematics of the algorithm developed for the architecture of parallel computing systems, makes this procedure evident.

The parallelization of three diagonal systems based on numerical-analytical sampling methods showed that there are no restrictions on the topology of grid nodes in the computational domain. And, in addition, with regard to the parallel computation of arithmetic expressions, it separates the error of the initial data from the rounding operations inherent in a real PC. This is possible due to the fact that such an approach generally eliminates the recurrent structure of the calculation of the desired solution vectors, which, as a rule, leads to the accumulation of rounding errors. In such circumstances, the parallel form of the algorithm constructed in this way is the maximum, and therefore has the minimum possible time for the implementation of the algorithm, if not on real, at least hypothetical parallel computing systems.