Operating System and Applied Programming for the Multiprocessor System MBC-1000

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The developed OS allows a user to very easily and efficiently control calculations in various CMs and hardware functioning.

These characteristics are due to the original structure of the OS for MBC-1000, which functions on the basis of creating an individual copy of the router for each of the tasks being executed. The functioning of the router, due to its ease of operation and compactness, turned out to be quite reliable and as good as the best foreign analogs.

The programming system with the parallel FORTRAN and C has been developed and used. This programming system made it possible to raise the efficiency of using computational resources and to

automatize the applied program writing. The transference of the developed programming system to other hardware platforms, realizing multiprocessor systems, is its essential peculiarity.

To parallel computations the sequential programs (branches) of the initial code are loaded in different groups of computing modules, and, if their parallel execution is possible, the corresponding data dependences are established among the branches.

The skill of paralleling means to distribute the code execution to as many modules as possible, but it is desirable to arrange the message exchange alongside with calculations. These requirements being met, the actual performance of multiprocessor systems at solving tasks tends to the maximum.

Let us now turn to brief comments upon some of the problems solved.

- The problems of aerodynamics and its applications.

The mathematical set-up of the most flowing problems is to solve evolutional equations and to obtain the final flow state and the values of aerodynamic characteristics. Such a set-up is more adequate than the straightforward search of the stationary solution. In the case of the stationary solution uniqueness, the obtaining of the flow in different domains is combined with the calculation of the stationary state in other ones. While calculating the flows of complex objects, to raise the accuracy of the results the main discontinuities in the flow field are singled out, that is, the computational algorithm is adapted to the singularities of the sought-for solution. Nowadays, of special interest are the problems in which one should take into account the aerodynamic effect during the motion of a group of objects, their disconnection included. Numerical simulation for the disconnection of objects is but the only way of aerodynamic designing.

- The problems of developing the ways of energy cumulation and calculations of thermonuclear constructions. The peculiarities of paralleling the heat transfer calculation.

These problems are labor-consuming in calculations, and the following factors redouble their complexity.

First, the spatial and time heterogeneity of phenomena realizing the cumulation.

Second, the instability of the cumulation process.

Third, the risk to considerably distort the initial physical model during numerical simulation, due to approximation errors while passing from the infinte-dimensional differential description to the finite-difference one.

Fourth, the processes realizing the superdense compression with the subsequent thermonuclear transformations comprise a large totality of physical processes which are described by complicated mathematical models. This drastically aggravates the development of computational algorithms, especially their paralleling. To efficiently realize the paralleling, the construction of the discretization for the whole totality of physical processes should be implemented at the single approach with the following

structure of the computational process. At a given moment at each discretization point the sought-for magnitudes are calculated by some totality of their values at the previous moment. Such calculation patterns are called explicit. The abovesaid means that when passing over to paralleling the very techniques of creating computational algorithms should be revised. As an example let us take a new technique of calculating the heat transfer phenomena which was developed to solve the problems of gas dynamics with nonlinear heat conductibility for multiprocessor systems. Let us underline the fact that to efficiently realize parallel computations, the algorithms themselves, in some cases, should be modified. To do this is an essential and interesting problem of computer mathematics. In conclusion to this section let us emphasize that to obtain the guaranteed result is only possible via calculating each of the problems on a sequence of condensing calculation grids. This, of course, demands multiple increase of computations as compared to a single calculation.

This remark is also valid for the most of problems in which the accuracy of the results should be guaranteed.

- The problem of simulating the work of a nuclear power stations and the analysis of their reliability.

- The problem of simulating the electromagnetic radiation excitation and propagation processes.

- The problem of simulating the processes of nonlinear, nonstationary particles and radiation transfer, the interdependence with the moving environment being taken into account.

- The problem of studying the processes of structural formation of complex biological macromolecules.

- The problem of controlling and precision guiding of aircraft via trajectory parameters correction on the basis of observation of geophysical fields and orientation by the terrain peculiarities at the final section of the trajectory.

In the course of works on the present projects the authors realized that the mass parallelization systems may have much wider range of application than it had been assumed before. Besides the solution of well formalized problems (see above), they may efficiently be used to realize neural network algorithms. The development and the use of such algorithms allows the user to solve important classes of hard-to-formalize problems. Their solution is based on the principles of training by the input data sets and the totality of the results obtained.

Another essential sphere of using the mass parallelism systems is the creation, procession and storage of distributed data bases. The distributed data bases developed on the basis of transputer technologies and the integral service distributed networks (ISDN) with Gigabyte performance of data transmission make up the information resource of the state.

In future, an important problem is to integrate the computer facilities already created to regional computer centers and to arrange their work in the collective and individual mode. This will make it possible to create the computational information resource of the state.