Contribution ID: **29** Type: **Sectional reports**

The grid-characteristic method for applied dynamic problems

Thursday, 8 July 2021 17:15 (15 minutes)

Due to the rapid development of high-performance computing systems, more and more complex and time-consuming computer simulations can be carried out. It opens new opportunities for scientists and engineers. A standard situation for scientific groups now is to have an own in-house research software, significantly optimized and adopted for a very narrow scientific problem. The main disadvantage of this approach is the necessity to support a lot of computer programs. It leads to the code duplication and non-effective use of researchers'time. To overcome it, a uniform approach may be used in connection with the modular structure of the in-house software.

In the current work, the numerical solution of dynamic linear hyperbolic systems is considered. They describe wave problems and are widely used in earth seismicity simulations, seismic survey processes, non-destructive testing of composites, etc. The grid-characteristic method on structured meshes can be successfully applied to this class of problems. However, for a general hyperbolic system the numerical calculation or storage of transformation matrices is necessary. To overcome this drawback, they can be analytically precalculated and incorporated (as separate functions) in the solver source code. The second challenge is the dependence of the matrix spectrum on the medium rheology. It prevents the usage of a single mesh for the whole computational domain. The procedure of explicit contact correction can eliminate this challenge.

The described uniform approach was successfully applied to simulate:

- seismic wave propagation in porous fluid-saturated media;
- seismic processes in ice;
- dynamic behavior of thawed zones;
- dynamic loading of fractured media;
- dynamic processes in complex elastic geological models;
- acoustic diagnostic of the heterogeneity of the damaged zone;
- elastic wave propagation in vertically transversely isotropic and general anisotropic media.

To achieve enough computational speed on large grids the general framework designed by Khokhlov N.I. at MIPT was used. It is parallelized with OpenMP, MPI and GPGPU technologies with a good scalability up to thousands of cores.

Summary

The unified computational approach, applicable for media with the wide range of rheologies, was implemented and successfully used for solving industrial problems. To carry out numerical experiments for reasonable time the research software with multi-core/multi-processors parallelization was used.

Primary author: Dr GOLUBEV, Vasily (Moscow Institute of Physics and Technology)

Presenter: Dr GOLUBEV, Vasily (Moscow Institute of Physics and Technology)

Session Classification: HPC

Track Classification: 5. High Performance Computing