INSTITUTE OF COMPUTATIONAL MATHEMATICS
AND MATHEMATICAL GEOPHYSICS
SIBERIAN BRANCH OF RUSSIAN ACADEMY OF SCIENCES

International conference
ADVANCED MATHEMATICS, COMPUTATIONS AND APPLICATIONS – 2014

ABSTRACTS

June 8-11, 2014
Akademgorodok, Novosibirsk, Russia

Section 4. MATHEMATICAL GEOPHYSICS

Fast parallel method for computing of 3D creeping flows on GPU with CUDA, modeling the salt diapirism

T.V Abramov., B.V. Lunev (Invited talk)

We propose an algorithm and program implementation rate of 3-D creeping flows uniformly viscous Newtonian fluid with variable density under the action of gravity. The high efficiency of the algorithm is due to the using of the Green's function for the problem of the halfspace with a free surface. This makes it possible to significantly reduce the number of operations and effectively organize parallel computations. Computing acceleration in this case is proportionally to peak perfomance of parallel computing hardware, not to the throughput of memory, as for difference methods. It makes the algorithm especially suitable for GPU with CUDA. The paper presents calculations of the 3-D fluid flows with piecewise-homogeneous density distribution, modeling the processes of salt diapirism, the study of which is of considerable practical interest in connection with the search for hydrocarbon deposits.

Solving oil extraction problems using MapReduce Hadoop and MPI

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We have designed an experiment to gain data on working implementations of three iterative Hadoop solutions for an oil extraction problem: single stand Hadoop, Hadoop-MPI combination, and Hadoop-MPI that uses memory-mapped files for data management. ×

Oil extraction problem is defined as follows. Consider hypercube of porous elastic anisotropic medium $\Omega = [0, T] \times K\{0 \le x \le 1, 0 \le y \le 1, 0 \le z \le 1\}$. Let (1) describe the fluid flow in W with initial condition (2) and boundary condition (3).

$$\frac{\partial P}{\partial t} = \frac{\partial}{\partial x}(\phi(x,y,z)\frac{\partial P}{\partial x}) + \frac{\partial}{\partial y}(\phi(x,y,z)\frac{\partial P}{\partial y}) + \frac{\partial}{\partial z}(\phi(x,y,z)\frac{\partial P}{\partial z}) + f(x,y,z) \quad (1)$$

$$P(0, x, y, z) = \varphi(0, x, y, z) \quad (2)$$

$$\left.\frac{\partial P}{\partial n}\right|_{\Gamma} = 0 \quad (3)$$

Here, G is the surface area of Ω. In (1) solution function $P(t, x, y, z)$ is the reservoir pressure at point (x, y, z) at time t; $\varphi(t, x, y, z)$ is the diffusivity coefficient of reservoir; $f(t, x, y, z)$ is density of the sources, deposit of wells. We used implicit numerical Jacobi method to solve the problem de-fined in (1)−(3).

Hadoop implementation of hybrid iteration technology results in design and implementation of novel control mechanism for iterations of MapReduce Jobs; initialization module for the first iteration step; and, specialized class for updating data on each step of iteration.

Rock formation objects recognition and visualization software tools development using micro-seismic monitoring data

K.S. Alsynbaev, D.N. Gapeev, G.N. Erokhin, A.V. Kozlov

To analyze the results of micro-seismic monitoring, it is necessary to structure and visualize data obtained as a result of micro-seismic records processing. These data contain micro-seismic activity hypocenters that form clusters, which are indicators of heterogeneities and areas of fractures in rocks. The obtained processing results are represented by multidimensional pixel arrays of a volume up to several million elements. Interpretation of the data requires involvement of algorithmic and ergonomic issues. Rock formation objects recognition and visualization software tools using micro-seismic monitoring data have been developed. The software tools allow for interactive visualization of micro-seismic activity hypocenters and context information, event filtering, fracture zones and faults recognition representing them as flat polygons in 3D environment. The algorithms of faults and other rock formation objects recognition are based on cluster analysis, methods of computational geometry, classical and modified approximation methods.

This work was supported by RFBR grant 14-07-00699.