DYNAMICAL LOAD BALANCING DURING SIMULATIONS OF INSTABILITY FLOWS

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In this work we describe the algorithm of dynamical computational load balancing that was implemented in three-dimensional eulerian gas dynamic program that is used for numerical simulations of instability flows over dynamically refined mesh [1, 2].

Balancing of computational load between MPI-fragments is executed along lines (set of MPI-fragments that are situated along preferential direction) independently and may be carried out in three regimes: accounting number of cells, accounting real calculation time, and automatic (or composite) regime. We use adaptation with reservation to minimize overheads for adaptation and balancing: we construct a sequence of adaptation, balancing or calculation stages during fixed count of steps ("Adaptation – Balancing – Calculation" cycle). The optimal count of steps in cycle is determined by minimization of task calculation time.

For testing of realized algorithm we considered a spherical implosion of a light material by a dense shell (Youngs' problem). A source of instabilities was the initial harmonic perturbation on the contact boundary. The calculations are made using second-level dynamically adaptive mesh refinement in the region of instability growth. We analyze the calculation time of the problem using different regimes of load balancing algorithm.

The result of the research proves the efficiency of using adaptive mesh refinement with reservation within "Adaptation – Balancing – Calculation" cycle. As we can see on the picture 1, the total calculation time of task decreases. At the same time the overheads for adaptation and balancing algorithms are less than 5%. The automatic regime of load balancing is the most stable for three-dimensional modelling.

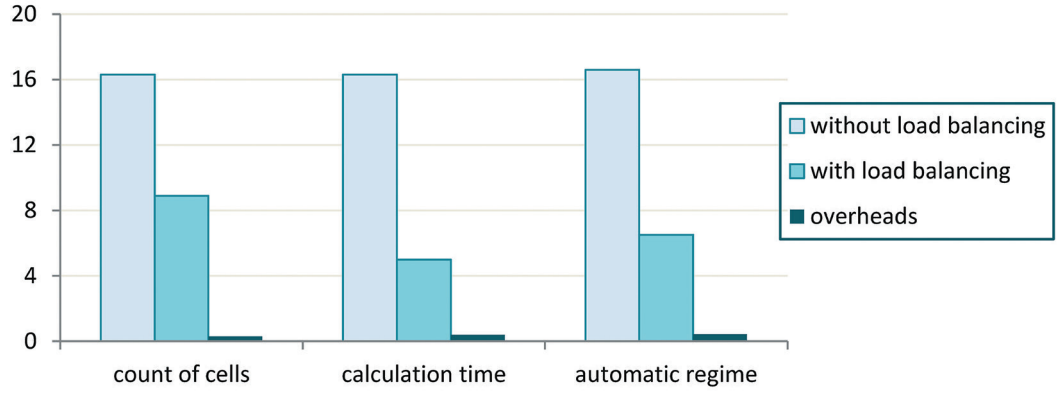

Fig. 1. Time characteristics of calculation Youngs' problem in two-dimensional case using different load balancing regime within "Adaptation – Balancing – Calculation" cycle

References

1. **Glazyrin, I. V.** The finite volume scheme for multicomponent compressible flows on unstructured mesh in three-dimensional program Focus [Text] / I. V. Glazyrin, N. A. Mikhaylov // JCMMP. – 2021. – Vol. 61, No. 6. – P. 1019–1033.

2. **Glazyrin, I. V.** An application of the dynamic mesh refinement to model Rayleigh-Taylor instability [Text] / I. V. Glazyrin, N. V. Glazyrina, N. A. Mikhaylov, M. A. Pisklova // XVI international conference "ZST" : collection of thesis. – Snezhinsk : FSUE "RFNC – VNIITF named after Academ. E. I. Zababakhin", 2023. – 364 p.

3. **Joggerst, C. C.** Cross-code comparison of mixing during the implosion of dense cylindrical and spherical shells [Text] / C. C. Joggerst, A. Nelson, P. Woodeard et al. // Journal of Computational Physics. – 2014. – Vol. 275. – P. 154–173.