EXTRAPOLATIONS METHODS OF HYDRODYNAMICS PROBLEMS SOLVING IN PRELIMITING CASES

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Prelimiting cases in solutions of different problems are most difficult for investigation. This caused by tending of any geometric or physical parameter to its maximum or minimum value. Analytical or empirical determination of asymptotic dependences form of solution is used in such situations. Unknown parameters of the dependences are found from numerical experiment.

The using of finite difference filters is one of the ways for empirical determination of dependence form [1]. This allows suppressing one or a few components of dependence to be found and to select the main one. But extrapolation error accumulation caused by influence of different components to each other bounds these methods application. An iterative procedure is offered to extrapolation error decrease. The procedure includes rough estimate of parameters of the two or more components of the dependence to be found, filtering out the other components and correction of the main component. Then the main component is filtered out from the dependence and the other ones are corrected. The process is repeated iteratively.

The finite difference filtration leads to sharp increase of round-off error connected with bounded number of digits of computer. Approximation by the least squares method is used to decrease influence of this error.
The results of investigation of characteristics of steep waves on free surface are discussed as an example of these methods application. It is known that the dependences of typical parameters have oscillating aperiodic form when an wave amplitude of characteristics of steep waves on free surface are discussed as an example of these methods application tends to its maximum value [3]. The oscillations damp rapidly and an accuracy about $10^{-12} – 10^{-13}$ needs to detect them. But to obtain such accuracy in a prelimiting case is rather difficult because a problem solution has different behavior near and far of wave crest. An incorrect mathematical problem arises. It is necessary to extrapolate the dependence by values known in narrow range. Nevertheless, the dependence extrapolated on the whole range of solutions up an accuracy order 10^{-13} is obtained. The sequential correction and comparison of different methods of filtration allows confirming this estimate.

References

[1] V. Zhitnikov and N. Sherykhalina, “Application of multistage extrapolation for hydrodynamic problems”, Proceedings of the symp. “High speed hydrodynamics (HSH - 2002)”, June 16-23, 2002. Cheboksary, Russia, pp. 407-418.
[2] M. S. Longuet-Higgins and M.J.H. Fox, “Theory of the almost-highest wave, Part 2, Matching and analytical extension”, *J. Fluid Mech.*, v. 85, pp. 769-786, 1978.