

MULTIPOINT MESHLESS FINITE DIFFERENCE METHOD – RECENT DEVELOPMENT

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ABSTRACT

Presented is the actual state of the art in development of multipoint approach to the meshless finite difference method (MFDM) [1], based on the higher order (HO) approximation. The multipoint FD method was introduced a long time ago by Collatz [2]. Its main concept is based on raising the order of FD approximation of a searched function by assuming additional (HO) degrees of freedom in the FDM nodes, including e.g. the right-hand side value of a considered differential equation. In this way, using the same set of nodes, one may generate higher order FD operators. Such approach may improve the quality of solution of boundary value problems analyzed by means of the FDM. Like in the HO correction term method [3], this improvement may be achieved without raising the number of nodes in the mesh, or using so called defect (deferred) correction approach [4], based on increasing the number of nodes included into each FD star.

In some recent papers [3, 5, 6] the Authors returned to the original multipoint Collatz of the FDM (regular meshes, local formulation of b.v. problems), and extended it to arbitrary irregular clouds of nodes, as well as to application of the moving weighted least squares (MWLS) approximation, making possible in this way, the multipoint MFDM solution approach. Further extensions considered here enable analysis of b.v. problems posed in various global (weak) formulations, including the Petrov-Galerkin ones [7].

Two basic versions of the Multipoint MFDM – general and specific are considered. The specific approach is simpler and easier to implement, but its application is more restricted, mainly to linear b.v. problems. In the specific formulation, the additional degrees of freedom are known (like right-hand side of the eqs). The general formulation can be used for all types of b.v. problems (e.g. for non-linear ones). In this version of multipoint approach, the additional degrees of freedom are sought. Each of these multipoint FD cases provides higher order approximation FD operators, using the same FD star, as needed to generate difference operators in the classical FDM approach, based on interpolation.

This paper presents the current status of development of the multipoint HO MFDM approach, as well as results of some 1D and 2D benchmark b.v. problems given in both local and global formulations. Examined and compared are precision of the results, their convergence and efficiency obtained for various formulations.

The approach is under current development. Further research is planned.

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