Stochastic boundary method of fundamental solutions and applications to exciton transport in nanowires.

Karl Sabelfeld [1]
Institute of Comp.Math.& Math. Geophysics, Russian Academy of Sciences, Novosibirsk
E-mail: sabelfeld.karl@yahoo.de

A mesh-free Stochastic Boundary Method (SBM)) based on randomized versions of the method of fundamental solutions (MFS) is suggested. The randomization is used in the following steps of MFS: (1) the singular source positions are randomly distributed outside the domain, (2) the large system of linear equations for the weights in the expansion over the fundamental solutions is resolved by a randomized SVD method we introduced in [1], or the randomized projection method we developed in [2], and (3) when solving the inhomogeneous problem, the integral representation through the Green integral formula is evaluated by the Monte Carlo integration and using the symmetry of the Green function. We construct also a new method of stochastic boundary method based on the inversion of the Poisson formula representing the solution in a disc (a sphere, in $\mathbb{R}^3$). We present a series of applications of the suggested SBM: we combine SBM with the Random Walk on Spheres and Random Walk on Boundary algorithms which results in methods giving the solution in any set of arbitrary points, without introducing any mesh in the domain, we construct an efficient algorithm for evaluation of Green functions and their normal derivatives on the boundary and the relevant Poisson-type integral formulae for arbitrary domains. The Laplace, biharmonic, and the system of elasticity equations are involved in our analysis. Numerical experiments carried out for the Laplace and Lamé equations confirm our finding that the best results are obtained with the overdetermined systems generated by MFS where the number of source points is considerably smaller than the number of collocation points. We present some numerical results and give a brief discussion of the performance of the suggested methods. Applications to the transport of excitations in nanowires is given.

References.

[1] Sabelfeld K. and Mozartova N. Sparsified Randomization Algorithms for low rank approximations and applications to integral equations and inhomogeneous random field simulation. Mathematics and Computers in Simulation, in press.

[2] Sabelfeld K. and Loshina N. Stochastic iterative projection methods for large linear systems. Monte Carlo Methods and Applications, vol.16, issue 3-4, 2010, pp. 343-359.

[1]This work has been supported partly by the RFBR (09-01-00152) and DFG (Grant KA 3262/1-1).