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A new technique of high-speed boundary element methods using multipole expansion for target region

*** Hiroshi YAMAGISHI[1] and Kenji AMAYA[2]**

[1] Department of Mechanical and Environmental Informatics, Graduate School of Information Science and Engineering, Tokyo Institute of Technology,2-12-1 O-okayama, Meguro-ku, Tokyo, 152-8550 Japan

[2] Graduate School of Information Science and Engineering, Tokyo Institute of Technology,2-12-1 O-okayama, Meguro-ku, Tokyo, 152-8550 Japan

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ABSTRACT

A new technique for boundary element analysis of potential problems using a multipole expansion to obtain the solution efficiently only in a target region has been developed. The capability of the present technique was verified by numerical simulations. In this technique, region to be analyzed is divided into target boundaries and non-target boundaries as shown in Figure 1, and the multipole expansion is applied to boundary integral equations on non-target boundaries, and the expansion is truncated at the term where the error bound of the higher terms is guaranteed. This technique decreases the calculation amount by introducing multipole moments as the unknown valuables in place of the unkown flux distribution in the non-target boundaries. To demonstrate the effectiveness of the method, example analysis of doughnut shaped Laplace field Ω was performed as shown in Figure 2. The outer circle boundary is

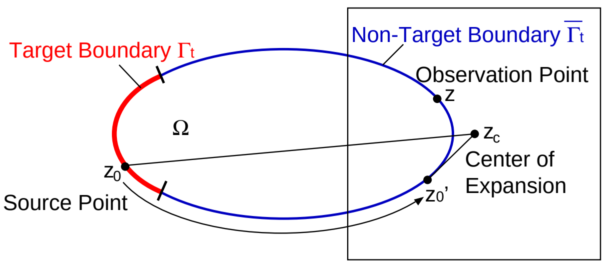

Figure 1: Source point z_0,observation point z and center of expansion z_c.

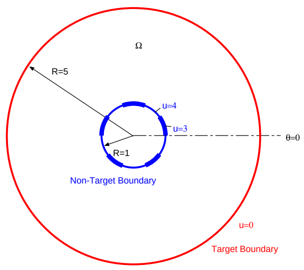

Figure 2: Boundary condition for example

set as the target boundary(R=5),and the inner circle boundary is set as the non-target boundary(R=1). Boundary conditions on both target and non-target boundary are Dirichlet conditions and set potential u=0 on target boundary and set potential u=3,4 alternately on non-target boundary respectively. Our purpose is to solve the flux distribution on target boundary precisely and the flux distribution on non-target boundary roughly. Figure3 shows Flux distribution on target boundary using the standard BEM and the present method,respectively. The number of elements on target boundary is 1000 and the number of non-target boundary is 9000. Next the computational time of the present method is examined in comparison to the computational time of the standard BEM. The number of elements on target boundary is fixed at 1000, and the number of elements on non-target boundary is varied from 50 to 9000. Figure4 shows the relationship between computational time and the total number of elements in logarithmic scale. When the solutions only in the target region are needed, especially in large size boundary value problems, this technique enables us to obtain them quickly and precisely.

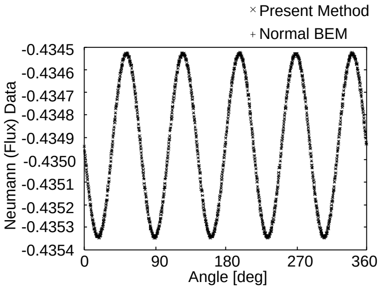

Figure 3: Flux distribution on target boundary

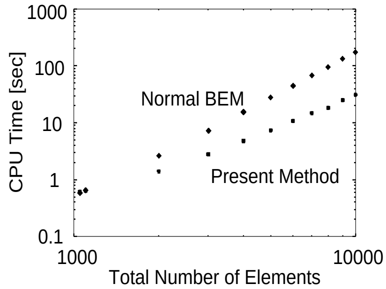

Figure 4: Comparison of computational time (log scale)

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