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Calculation of Vortical Structure Evolution Using Combined Discrete Singularity and Boundary Element Method

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Method of discrete vortices is a powerful tool for analysis of vortical structure evolution. However the method has several disadvantages, for example, incorrect calculation of interaction of discrete vortices on small distance and large computational errors in points near the boundary. To overcome of second difficulty the combined discrete vortex and boundary element method with integration along real boundary was proposed. Discrete singularity method generalizes discrete vortex, including also discrete sources, discrete dipoles, etc. It gives an opportunity to consider more complex flows. To avoid the first problem, different regularization schemes were developed. In the present work opposite idea of using of discrete vortical dipoles together with discrete vortices instead regularization in some specific cases is applied. It gives good results for calculation of vortical sheet behind thin airfoil under small attack angle. In general case, regularization schemes and scenarios of interaction are used in the present work. Computational stability of vortical structures is considered in the present work too. It is shown that a dipole can lead to destruction of even most stable vortical structures such as vortical rings. Interactions of vortical structures and dipole-vortical structures between themselves and with solid boundaries are numerically investigated too.

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