DIFFERENCE OPERATORS BASED ON TWO VOLUME-ELEMENTS ON MESHES BY VORONOI DECOMPOSITION AND DISCRETE GREEN-GAUSS LAWS, AND STRUCTURE-PRESERVING NUMERICAL METHODS FOR PDES

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Abstract

In recent years, we found some discrete Green-Gauss laws and other laws for difference operators on two types of volume-elements defined by Voronoi decomposition.
Of course, there already exist some studies which concern discrete Green-Gauss laws and difference operators based on Voronoi decomposition.
However, their essential mathematical tool is the exterior differential form theory, i.e., they need various elements in spacial sub-domains like nodal-, edge-, facet-, and volume-elements.
Meanwhile, we apply tensor analysis as an essential mathematical tool to discretize differential operators and integration one based on spatial stencils made by Voronoi decomposition.
So, we need only two volume-elements as the elements on which discrete operators to define in our context.
In other words, our method is more simple to treat than conventional studies on Voronoi meshes.
Using these discrete laws, we can apply the discrete variational derivative method, which is one of the structure-preserving numerical methods for PDEs, on Voronoi meshes.
It means that we can design some structure-preserving numerical schemes based on arbitrary located spatial points; which become Voronoi generators in this context.
We also show some numerical computation examples for the Cahn-Hilliard equation by this idea.

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