

PROCEEDINGS

The Comparisons Between Peridynamic Differential Operators and Nonlocal Differential Operators

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ABSTRACT

Nonlocal differential operators have become an increasingly important tool in the field of numerical modeling and computational science. In recent years, two specific types of nonlocal differential operators have emerged as particularly useful in simulations of material and structural failures, such as fracture and crack propagations in solids. In this paper, the first type of nonlocal operator is based on the nonlocal operator theory in peridynamic theory, which is called PDOs [1,2]. The second type of nonlocal operator is derived from the Taylor series expansion of nonlocal interpolation, which is called NDOs [3-5]. NDOs are usually used to discretize the governing equations in the updated Lagrangian particle hydrodynamics (ULPH) method. While the differences of these two nonlocal operators may seem subtle, and they often cause confusion and misunderstandings. Therefore, this study is devoted to analyze and compare the differences between the two types of differential operators in terms of interpolation accuracy, crack expansion as well as multiphase flow simulation. It is found that, firstly, the NDOs are insensitive to the uniformity of particle distribution, and can converge in both uniform and non-uniform particle distributions, in contrast, PDOs can only yield convergent results in uniform particle distributions. Secondly, in the examples of crack propagation simulation, the results obtained by the PDOs have better agreement with experimental observations, and more suitable to handle the complex crack branching patterns. For simulating the rising bubble problem, NDOs can provide better results for the dynamic behaviors of rising bubble.

KEYWORDS

Crack growth; fracture; peridynmaic differential operators (PDOs); nonlocal differential operators (NDOs)

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