Adaptive and Multiscale Meshfree Methods for Large Deformation Analysis in Automotive Applications

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In recent years, a new class of numerical methods, collectively called the meshfree method, has been developed as a generalization of finite element methods for computational mechanics. Meshfree methods employ new approximation theories that allow the construction of shape functions and domain discretization without the need of an explicit mesh. This unique property provides meshfree methods with considerable advantages over the conventional finite element methods in solving problems involving moving discontinuities, multiple-scale phenomena, and large material distortion and structural deformation. The most significant advantage in meshfree methods is the flexibility in customizing approximation functions for desired smoothness, accuracy, or special characteristics of particular engineering and scientific problems. Adaptivity formulation and multiscale solution strategies can also be constructed with relative ease.

In this talk, the recent advances of meshfree methods with adaptive refinement strategies for large deformation, contact-impact, and damage fragment problems will be discussed. The application of the adaptive meshfree methods to rubber materials, elastomeric devices, particle filled elastomeric composites, metal forming processes, and fragment impact problems will be presented. Multiscale computational methods for prediction of microstructure evolution and wrinkling formation during manufacturing processes will be briefly reviewed, and their future applications to multiscale failure prediction of elastomeric devices will be outlined.