Interaction Simulations Between Fluids and Complicated Structures Using EMPS-FEM

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Abstract: The interactions between fluids and complicated solid structures are common phenomena in practical engineering applications, e.g., water-tire interaction in the hydroplaning problem. In this work, we advocate the coupled explicit moving particle simulation method and the finite element method (EMPS-FEM) to solve this problem, where the EMPS is used to describe the fluid flow and the FEM is for structural deformation. In the existing EMPS-FEM method, the interface interaction between the fluid and the structure is solved by an explicitly represented polygon (ERP) wall boundary model. For the situations with complicated solid structures, e.g., angled edges, the ERP model attempts to address the particle leakage problem by adding repulsive forces to the particles. However, numerical inaccuracy and instability may arise in this model, because only the repulsive force contributed by the nearest polygon is considered for each particle undergoing leakage. The purpose of this work is to develop a robust and accurate EMPS-FEM coupling approach based on the ERP wall boundary model. Special attention is paid to the interaction situations with complicated solid structures. Numerical examples are performed to validate the effectiveness of the proposed algorithm.

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