# A New Partitioned Staggered Scheme for Flexible Multibody Interactions of Low Mass Ratios

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In generic flexible multibody interaction problems, the mass ratio of flexible body to rigid body can be very low. So, a small change in the higher mass structure triggers relatively large inertial effects on the lower mass structure. Several partitioned staggered methods have been proposed to solve such multibody interaction problems wherein the systems are spatially decomposed into partitions/substructures. These can be categorised as either strongly coupled or loosely coupled. Strongly coupled (implicit) methods involve predictor and corrector iterations to ensure the convergence of the interface properties at each coupling time step. However, the associated iterations increase the complexity to implement the analyses as well as the computational cost at each time step. Loosely coupled (explicit) methods integrate the multibody equations independently at every time step i.e. separately advance in each time-step over each partition. The continuity of velocity and force along the interfaces is satisfied through algebraic jump conditions in a staggered fashion. These methods are often chosen due to their relative simplicity and low computational cost. However, these procedures when applied to flexible multibody of low mass ratios, suffer from numerical instability and temporal inaccuracy caused by spurious energy production along the interface and special treatments are generally required to address these issues.

In this work, a new partitioned staggered time-integration scheme is developed and its applicability extended to the problems involving low mass ratios, viz., below $10^{-1}$. The formulation includes a dynamic parameter in terms of mass ratio that adjusts the amount of interfacial traction, which plays a key role in the stability and accuracy of the simulations. To assess the stability and accuracy of the scheme against the strongly coupled strategy, the effect of mass ratio is investigated for a typical multibody system, viz., double pendulum, wherein the versatility of the scheme is demonstrated for various low mass ratios. As an application of this scheme, an offshore engineering problem of coupled floater-mooring system problem is considered.

**Keywords:** flexible multibody interaction, low mass ratio, partitioned staggered scheme

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